HOUSING IMPACT ANALYSIS

U.S. Department of Housing and Urban Development
Office of Policy Development and Research

HOUSING IMPACT ANALYSIS

PREPARED FOR

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
OFFICE OF POLICY DEVELOPMENT AND RESEARCH

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JANUARY 2006

NOTICE

Foreword

This report is a guidebook designed to assist all levels of government in developing sound policies regarding the impact of proposed regulations on the affordability of housing.

The need for an analytical tool that would permit policymakers to better assess the impact of prospective rules and regulations upon housing costs, affordability, and housing markets has been recognized for many years. In 1991, the Advisory Commission On Regulatory Barriers to Affordable Housing in its landmark report, *Not In My Back Yard*, recommended the development of a methodology that could be used to conduct a housing impact analysis. Throughout the 1990s, the Congress and many other governmental and nongovernmental institutions often mentioned the need for these analytical tools.

In 2003 then-Secretary of Housing and Urban Development Mel Martinez launched *America's Affordable Communities Initiative: Bringing Homes Within Reach Through Regulatory Reform*. This Initiative reinforces HUD's commitment to work with states and localities to address regulatory barriers to housing affordability. As part of the Initiative, the Office of Policy Development and Research undertook a number of research projects to better understand the nature of the problem and to develop new tools that would help in the development of sound regulatory policies. A number of these projects, including development of a methodology to assess housing impacts, were identified in the 2003 HUD report, *Why Not In Our Community?*, an update to the 1991 Advisory Commission report. This publication, *Housing Impact Analysis*, is one of a series of guidebooks that are being developed to assist federal, state and local governments address regulatory barriers.

Current federal regulatory development procedures, specifically Executive Order 12866, require economically significant new federal rules to undergo a Regulatory Impact Analysis (RIA). The RIA examines costs, benefits, and economic transfers among members of the public affected either directly or indirectly by the regulation. The primary concern of the RIA, however, is with directly regulated entities, not housing. Consequently the RIA may not analyze how the rule affects housing costs from the standpoint of homeowners or occupants. This new study provides the methodology to supply that missing piece. It describes how to prepare a Housing Impact Analysis (HIA) that quantifies the positive or negative effects of specific regulations on housing costs and affordability. The presumption is that the HIA would be performed as a supplement to the RIA.

The objective of this research is to produce a methodology for identifying and analyzing regulations that would have a significant impact on the cost and availability of housing. The primary audience for this report is federal government economists who have experience estimating the economic impact of non-HUD regulations but may not be familiar with the economics of the housing sector. The secondary audience is HUD analysts who are knowledgeable about the housing sector but will use the results of this research to improve their economic and housing impact analyses of HUD's own rules. Although these guidelines are technically rigorous and based on economic theory, statistical techniques, empirical studies of housing markets, and benefit-cost analysis, they are practical and not difficult to implement.

A motivating factor for this project was to provide more concrete examples of the scope of Housing Impact Analyses to help inform debate within the Administration or in Congress over whether to impose such a requirement for all federal rulemaking. Even if no such requirements are mandated in the future, HUD and PD&R will find the principles of Housing Impact Analysis useful when performing RIAs of HUD rules and reviewing other agencies' rules that may affect housing affordability. We believe it can be just as helpful to other agencies in analyzing the effects of their own regulations.

State and local regulatory practices have larger and more immediate impacts on housing affordability than the vast majority of federal regulations. This report could also form the basis of future PD&R research products or outreach efforts regarding state and local regulations. Given its wide potential applications, this report can be a powerful and valuable resource of the Department's regulatory barriers initiative.

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Executive Summary

Housing has widely been recognized as an important asset to society, and experience has shown that many federal, state and local regulations affect the supply and cost of purchasing, owning or renting different types of housing. Current procedures require economically significant new federal rules to undergo a Regulatory Impact Analysis (RIA) that is generally based on a societal point of view. As a result, the RIA may not necessarily analyze how the rule affects housing costs from the standpoint of homeowners or occupants. This report describes how to prepare a Housing Impact Analysis (HIA) that quantifies the positive or negative effects of specific regulations on housing costs and affordability. The presumption is that the HIA would be performed as a supplement to the RIA.

The report is presented in four major sections and several appendices. Section 1 identifies numerous relevant federal and state regulations that affect housing and home building, and could merit detailed analysis. Section 2 covers the framework for quantitative analysis of the housing market including a discussion of underlying economic theory and review of selected articles. Section 3 presents information about when and how a preliminary HIA can and should be performed to screen a regulation and determine if an in-depth analysis is necessary. It goes on to illustrate this process for a series of housing-related rules from several different agencies. Section 4 describes a general process for in-depth analysis of how a rule affects the housing sector. It also illustrates in-depth analysis of two specific regulations: the EPA effluent guidelines for construction and development, and the HUD wind standards for manufactured homes. Additional background material on housing analysis data, dealing with uncertainty in estimated relationships and measurement of housing-related benefits, appears in the appendices. Each of these sections is summarized below.

Section 1. Introduction. Section 1 introduces the basic issue with an overview of how regulations are assessed during the process of adoption, and the way housing impact assessments can be added to the range of other considerations that currently guide regulatory action. Examples of the potential economic impacts of regulation on the housing supply curve, market prices, and transfer payments to owners or renters are briefly described. This is followed by summaries of a wide range of regulations that are of direct interest because they can affect housing development, design, construction, purchase, finance, operation, repair or remodeling. Selected federal examples include:

- EPA regulations on pollutant sources and clean water
- OSHA safety regulations applicable to construction workers
- Department of Energy standards for the efficiency of various types of equipment and appliances used in houses; and
- HUD standards for real estate settlements, FHA mortgages and manufactured (HUD-Code) housing.

In addition to federal regulations, the broad range of state and local regulations that affect housing costs for development and construction are discussed. Some of these regulations represent implementation of federal rules, while others deal with topics based on regulatory authority that is exercised by state or local agencies. Example issues under state and local control include zoning requirements for design or location of housing, assessment of impact fees, and provisions of building codes and standards. Assessing the economic impacts of housing-related regulations adopted by the federal government or by states and localities would provide information of potentially wide interest.

Section 2. Quantitative Analysis of the Housing Market. Section 2 presents detailed information from the economic literature that would be useful in conducting a quantitative analysis of the housing market. This section is designed to assist in preparing economic analysis of a wide variety of regulations. Section 2.1 sets forth a review of the general approach to modeling housing supply, housing demand and the interaction of supply and demand to produce market outcomes. Section 2.2 introduces the range of public and private data sources for housing market analysis. Section 2.3 discusses key parameters and indices used to quantify market elements. Section 2.4 reviews a variety of standard housing affordability metrics that are found in the literature and potentially applicable to regulatory analyses.

Section 2.1. Housing Supply and Demand. Section 2.1 begins with discussion of the definitions of "housing" and "housing market" which underlie most of the analysis in this report. It goes on to cover housing supply, housing demand and the way supply and demand lead to market outcomes. Housing supply reflects new construction and the availability of existing units. Individual units can vary widely in important features, even in small geographic areas, but will typically be analyzed as if they were potential substitutes for one another. The housing production industry is highly competitive, with large numbers of competitors even in local markets and generally low barriers to market entry and exit, and the regulatory process typically involves large numbers of subcontractors and building inspectors.

Housing demand is an issue that has been studied extensively. Hedonic market research has focused on price/demand determinants such as house size, number of bedrooms and bathrooms, lot size, age of structure and various other items. Demand can be viewed as demand for housing services, which covers both owner and renter demand, or as demand for houses as assets, which introduces aspects of investment portfolio analysis.. Costs of relocation can affect housing demand if they are high enough to impede house purchases or discourage moving from one rental unit to another.

The integration of housing supply and demand is key to modeling this sector. Conventional supply and demand curves are used in some cases, but in others a more complex four-quadrant view of the market is used. The four-quadrant model distinguishes clearly between market price (for owner-occupants or owners of rental property) and market rent (for apartment renters). It also divides the overall market into new unit construction and rental of existing units. Under this approach, impacts of a single change such as higher costs of construction can be determined separately and simultaneously for owner-occupied and rental units.

Section 2.2. Data Sources. Section 2.2 lists various types of data that may be relevant to analyzing impacts of a specific regulation on affordable housing, and notes the factors that determine what data are relevant. It also explains how the supporting data are presented in Appendix A, with specific descriptions organized into the following topics: general surveys, housing supply, housing demand, house prices, interest rates, housing finance and regulation measures. Most of these data are generally free and downloadable.

Section 2.3. Key Parameters from the Empirical Literature on Housing Markets. Section 2.3 reviews various published sources of key parameters and indices that can be used to quantify elements of housing markets. This begins in Section 2.3.1 which discusses elasticity of supply in production of new units (the percentage increase in quantity supplied associated with a given percentage increase in price), then covers renovation and the effect on supply elasticity of subdividing the market based on factors such as household income, unit quality and cost. Essentially all sources report that supply elasticity is greater than 1.0 (a 1 percent increase in price is associated with an increase in supply of more than 1 percent), although values vary widely with lower values found in highly regulated markets. Section 2.3.2 moves on to income elasticity of demand (the percentage change in quantity of housing demanded associated with a given percentage change in income, estimated to be around 0.8 to 1.0) and price elasticity of demand (the percentage change in quantity of housing demanded associated with a given percentage change in housing price, estimated to be between -0.5 and -1.0), and presents equations used to estimate changes in price and output based on these elasticities. Other relevant modeling parameters discussed in Section 2.3 include housing tenure (Section 2.3.3) turnover and vacancy (Section 2.3.4), costs or benefits relating to real estate transactions (Section 2.3.5) and effects of code provisions on affordability (Section 2.3.6).

An extensive discussion of several relatively recent articles that estimate and report parameter values for housing submarkets appears in Section 2.3.7. These articles indicate that the lowest supply elasticities (around 0.9 to 2.1) are for small cities and constrained cities, and the highest elasticities (2.6 to 4.3) are for unconstrained cities. Finally, recent articles providing overviews of affordable rental housing are briefly described in Section 2.3.8.

Section 2.4. Potential Housing Affordability Metrics. Section 2.4 expands the discussion of affordability by summarizing and discussing a variety of standard housing affordability metrics found in the literature. These include:

- an index from the National Association of Realtors measuring whether or not a typical family could qualify for a mortgage loan on a typical home,
- a variation affordability index documenting the percentage of families that can afford median-priced homes,
- an index estimating the percentage of homes affordable to a median-income family

- HUD guidelines on housing affordability based on housing cost (including utilities) relative to gross monthly income, and
- a definition of housing affordability from legislation introduced (but not passed) in 1998.

Section 3. Performing a Preliminary Housing Impact Analysis. Section 3 sets out procedures an analyst can use to perform a Preliminary HIA of a proposed regulation and illustrates their application to a variety of regulations. The Preliminary HIA is primarily intended to determine whether or not potential housing impacts are large enough to warrant an in-depth analysis under simplistic assumptions, such as all of the costs of a regulation, including relevant mark-ups, being fully passed on to consumers. Section 3.1 presents an overview of the issues and a summary of the implications of the HIA results. Section 3.2 reviews potential standards for determining whether a regulation has a "significant" impact on housing. Section 3.3 sets forth general guidelines and simplifying assumptions for generating the Preliminary HIA. A series of examples of Preliminary HIA are presented in Section 3.4.

Section 3.1. Preliminary HIA Overview. The Preliminary HIA represents a starting point in analyzing a regulation for housing impacts. It should be incorporated as one part of a larger overall process of regulatory impact analysis. For federal agencies this includes screening to determine whether or not economic effects on housing costs are likely to exceed a specific trigger such as $100 million per year. If so then an in-depth analysis should be prepared, as further described in Section 4. Otherwise in-depth study is not required, and the Preliminary HIA results should simply be reported along with the underlying RIA.

Section 3.2. Potential Standards for Determining "Significant" Impact on Housing. The trigger for determining whether the Preliminary HIA requires in-depth analysis rests on assessing whether or not the impact of the regulation is "significant." Section 3.2 reviews several standards that might be used for this determination. One standard applies a fixed scale to total market impact while others involve more complex data. The alternative standards include (i) application of a sliding scale to total market impact (less total impact is required where per-unit impact is large), (ii) assessment of geographically concentrated impact in relatively small market areas, and (iii) review of disproportionately large impact on lower-income or rental housing. For example, a sufficiently large per-unit impact on a small number of households might warrant in-depth analysis even if it does not reach the total level of $100 million. Or, a shallow and uncertain impact affecting millions of households may deserve more study to improve the precision of the impact estimation. While the alternative standards for assessing significance of impact have certain advantages they also raise many complications. Therefore, this report focuses on using total market impact, partly because it is the traditional criterion and partly because it is straightforward to apply.

Section 3.3. Guidelines for Preliminary Housing Impact Analysis. Section 3.3 presents guidelines or instructions for carrying out a Preliminary HIA. They are written in general terms so they could potentially be applied to a wide range of proposals. The analytical process is simplified with certain key assumptions; for example, that:

- all compliance costs are marked up and passed through by product manufacturers, trade contractors and others to the ultimate consumer of housing;
- price changes do not affect production levels; and
- consumption does not shift from one part of the market to another.

Key outputs of the Preliminary HIA are also summarized and discussed in this section. They include estimated average cost per affected unit, estimated numbers of affected units by structure type (single-family, multifamily and manufactured housing), and a computed gross housing impact based on average cost and number of affected units. The magnitude of this gross impact can then be used to determine if an in-depth analysis is necessary.

Section 3.4. Examples of Preliminary Housing Impact Analysis. Application of the Preliminary HIA to analyze the financial effects on housing of seven selected federal rulemakings is covered in Section 3.4. The specific rules were issued between 1992 and 2002 by four different agencies, and included:

- Energy efficiency standards for residential central air conditioners and heat pumps (DOE, 2002)
- Restrictions of emissions of volatile organic compounds from paints and other architectural coatings (EPA, 1998)
- Phase II stormwater management rules for erosion control at construction sites (EPA, 1999)
- Regulations implementing the Real Estate Settlement Procedures Act (HUD, 1992)
- Fall protection standards for workers on construction jobsites (OSHA, 1994)
- Effluent guidelines and standards regulating discharge of wastewater from construction sites (EPA, 2002), and
- Regulations for improving the resistance of Manufactured Housing to high winds (HUD, 1993).

Impact calculations for each of these rules as presented in Section 3.4 are generally broken out into three housing types (single-family detached, multifamily and manufactured housing) and two housing ages (newly produced and existing).

Analysis of data in the published reports and occasional supplementary information indicates that the estimated total impacts of these individual rules on the housing sector range widely. The smallest impact was just $600,000 per year for the EPA restrictions of VOC emissions from paints and architectural coatings, while the maximum impact was almost $2 billion per year for the DOE efficiency standards for residential central air conditioners and heat pumps. Intermediate results include $22 million per year for the OSHA fall protection standards, $54 million per year for the Manufactured Housing high wind standard, $99 million per year for the

EPA Phase II stormwater management rules, $115 million per year for the HUD RESPA rule, and $128 million per year for option 2 of the EPA effluent guidelines for construction sites. Based on these results and the traditional $100 million cutoff, in-depth analysis would be required for three of these rules: the DOE energy efficiency standard for air conditioners and heat pumps, the EPA effluent guidelines for construction sites, and the HUD RESPA rule.

Section 4. In-Depth Methodology. Section 4 focuses on how to perform an In-Depth HIA, which would be appropriate for studying regulations determined to have a substantial effect on the housing market. It includes Section 4.1 explaining each step in the analysis, Section 4.2 illustrating how this approach can be applied for in-depth analysis of two specific federal regulations (one from EPA and one from HUD), and Section 4.3 summarizing the analytical process.

Section 4.1. Overview of 8-step Process. Section 4.1 lists and discusses the eight steps recommended for an In-Depth HIA of a regulatory proposal:

1. Identify the baseline trend without the regulation along with an appropriate timeframe and geography.
2. Get engineering estimates for direct costs to comply with the proposed regulation plus customary markups.
3. Collect or estimate supply and demand elasticities that apply to the regulated market(s).
4. Use the elasticities to calculate pass-through rates and consider the extreme cases of 0 percent and 100 percent pass-through rates.
5. Determine the range of house price changes based on the elasticities.
6. Consider indirect or secondary market effects given the size of the house price change.
7. Drill down to housing submarkets by type of housing structure and neighborhood.
8. Conduct affordability analysis by income and tenure groups with special consideration for vulnerable subgroups.

Baseline and Incremental Compliance Costs. Steps 1 and 2 begin the In-Depth HIA process with identification of a construction baseline and estimates of the incremental costs of compliance with a regulation. Good parameter values to use for basic items can be summarized as:

- Assume a future timeframe of 5 years, which is typically long enough for the regulation to take full effect and for the markets to respond
- Use recent history (5 years or less) for house price levels, interest rates and spreads, household income, inflation and finance terms
- Use the 30-year, fixed rate mortgage with a 10 percent down payment as the easiest mortgage terms for calculating payment impacts
- Assume the transaction costs for a real estate sale average about 8.7 percent of the sale price, and

- Base estimated long term trends on 10 years for macroeconomic variables (like income and unemployment rates) and 20 years for housing variables (like interest rates and house price appreciation rates). A good source for housing data and trends at the national level is *U.S. Housing Market Conditions,* published quarterly by HUD.

Supply and Demand Elasticity and Market Effects. Steps 3 to 7 of the In-Depth HIA process use the baseline and incremental compliance costs together with supply and demand elasticities to estimate the degree to which costs will be passed through and lead to market price changes. More complex models are also used to determine indirect effects that the regulation causes in other parts of the housing market. It is unfortunate that elasticities are not more stable, but there is general consensus that the elasticity of demand is –0.5 to –1.0 and, with less certainty, the elasticity of supply is 1.0 to 4.0. With that range of elasticities, the pass-through rate ranges from 0.5 to 0.9. Given the uncertainty about elasticities, especially in the short run and in highly regulated markets, it is recommended to do a sensitivity test with pass-through rates of zero and one in addition to more likely values between 0.5 and 0.9.

Assuming straight line demand and supply functions, the change in price and quantity can be calculated:

$$\Delta P = \left(\frac{E_S}{E_S - E_D} \right) * \Delta C$$

$$\Delta Q = \frac{E_S * E_D * Q_1 * (\Delta C / P_1)}{E_S - E_D}$$

where ΔP is the change in price, E_S is supply elasticity, E_D is the demand elasticity, ΔC is the change in production cost, ΔQ is the change in quantity sold, P_1 is the price before the regulation, and Q_1 is the initial equilibrium market quantity sold. The bracketed portion in the change in price equation is the pass-through rate $(E_S /(E_S\text{-}E_D))$.

Although admittedly difficult, one distinction between the preliminary analysis and the in-depth analysis is the inclusion of submarket and neighborhood effects. Housing is an unusual commodity in that its location is permanent and its value is sensitive to the characteristics of the neighborhood. Moreover, the unit itself is a mix of components that can vary widely in size, shape and configuration. For these reasons, average or median house values can be a poor representation of the distribution. Hedonic regression (OLS regression of log value on available unit and neighborhood characteristics) can be highly useful to measure the impacts on house values. Submarkets of similar units, either by structure or price level, are more sensitive to cross-market effects because they are substitutes. Increases in housing costs are most likely to spillover to other units in the same submarket. The total effect of a regulation might be much larger if the HIA incorporates the spillover effects into related submarkets and neighborhoods.

Distributional Impacts and Affordability Effects. Step 8 of the In-Depth HIA process involves specific evaluation of distributional impacts and affordability effects of the regulation as experienced by particular subgroups. Affordability measures housing costs relative to household income. There are many ways to adjust housing prices for local variation in taxes, utilities, insurance, maintenance and expected house price appreciation. Ultimately, fluctuations in interest rates and house prices are likely to dominate changes in the other factors and forecasting those macrovariables is challenging. A practical solution may be to rely on the forecasts of OMB or national trade organizations and then apply the same forecast to scenarios with and without the new regulation.

Flexible underwriting has blurred the boundary between affordable and unaffordable. The primary concern is to apply consistent standards and financing terms for affordability to households with and without the regulation. However, rather than measuring how many households cross an arbitrary line, a broader solution of housing price burden would be appropriate. If affordability is defined as a household paying 30 percent or less of its income on housing, then unaffordability can be measured as the number of additional households paying more than 30 percent of their incomes on housing. That definition can be focused by excluding higher-income households (e.g., households receiving more than the area median income).

A necessary component of HIA is to measure the change in affordability for vulnerable subgroups including low-income, minority, elderly and disabled households. The Census (Public Use Microdata Sample, PUMS) can be an excellent source of representative household information for demographic breakdowns by income, race, age and household composition.

Section 4.2. Examples of In-Depth Analysis. Section 4.2 illustrates the suggested methodology with two specific case studies presenting in-depth analysis of housing impacts. The first case study involves an EPA rule, Effluent Guidelines for Construction and Development, proposed in May 2002, and the second case study is a HUD rule, Wind Standards for Manufactured Housing, proposed in 1993. Descriptions of these studies emphasize the modeling techniques, which can be applied to many other regulations, rather than particulars of the findings.

Effluent Guidelines for Construction and Development. The first case study, reviewed in Section 4.2.1, involves the Effluent Guidelines for Construction and Development regulations. This was proposed by EPA in 2002 and designed to reduce the sediment in storm water runoff from construction sites. While the underlying rule was never ultimately enacted, the analysis in the EPA report rests on sound economic principles and presents extensive information about potential effects the rule would likely have on the housing market. The report used a market-based approach to estimate price change under the rule based on elasticities of supply and demand. Option 1 involved enhanced inspection, Best Management Practices certification and plan review on sites of 1 acre or more. Option 2 was the most expensive; it would establish specific provisions in the Construction General Permit as minimum requirements for all construction sites nationwide, and additional requirements for larger sites. Option 3 entailed no new regulations, and Option 4 would adopt some of the requirements from Option 2 but not others.

Cost analyses for model sites began by estimating the baseline costs for erosion and sediment control (ESC), and determining financed costs, capital contributions, overhead and normal profits from the land developer. The total is used to estimate the increase in sales price per unit, which is more than twice as large as the initial ESC costs to comply. Assuming 100 percent pass-through based on inelastic demand the report estimated that prices would increase between 0.11 and 0.19 percent for different unit types. Impacts on baseline financial ratios were also estimated under an extreme assumption of zero cost pass-through (where return on net worth dropped by as much as 8.4 percent, under option 2) and alternative pass-through rates of 84 - 91 percent based on supply and demand elasticities (where return on net worth dropped by 1.48 percent for single-family and 0.84 percent for multifamily).

The report also analyzed barriers to entry resulting from the EPA regulation, concluding they were small for multifamily and very small for single-family so no barrier to entry would be created. National compliance costs for stormwater controls under Option 2 (including residential and non-residential construction) were estimated at about $556 million. Estimated cost impacts were used to calculate the change in housing affordability based on the number of households that could no longer qualify to afford the house at the higher price. Housing price changes under Option 2 based on elasticities were estimated at $62 for single-family and $72 for multifamily. Welfare effects based on loss of consumer and producer surplus were also estimated, assuming a drop in house sales, and changes in housing affordability measures (the proportion of homes that a household with median income could afford) were computed by census division. The affordability changes ranged from -0.08 percent to -0.23 percent. The report concluded with a summary of annual costs and benefits for Option 2, including welfare effects, with costs at $557 million and benefits at $14.5 million. As previously noted, the rule was never approved.

Wind Standards for Manufactured Homes. The second case study, reviewed in Section 4.2.2, involves the Wind Standards for Manufactured Homes. This was proposed by HUD in 1993 soon after Hurricane Andrew caused extensive damage in South Florida. The rule was implemented in 1994.

The revised standards increased required wind resistance in high-wind Zones II and III, and were designed to substantially reduce the percentage likelihood of significant loss from a future Hurricane Andrew-level storm. The revisions were justified because they were targeted to specific zones with high winds, and because they help prevent negative externalities resulting from weather-related destruction of manufactured homes located near other units. Standards were ultimately set to increase marginal production costs by amounts close to expected private benefits ($1,500 for single-section in Zone II and $2,000 for single-section in Zone III). The requirements included higher design loads and uplift forces, shutters or instructions for installing shutters to protect windows and doors, foundation systems for homes near the coastline designed to satisfy the highest windload exposure, and higher standards for fastening roof, wall and floor framing assemblies to one another.

The projected benefit of the revised wind standards was to eliminate 75 percent of wind damage in Zone II and 83 percent in Zone III, as well as reducing dislocation, injuries, deaths and various social costs. Private benefits for single-family units computed over their service lives and discounted at 7 percent per year were $1,516 in Zone II and $2,022 in Zone III based on the change in the probability of wind damage. Public benefits based on reduced FEMA spending and similarly calculated ranged from $782 to $1,063 in Zone II and $1,043 to $1,418 in Zone III. Benefits from reduced cost of death and injury were also calculated, with lifetime values of $39 in Zone II and $43 in Zone III. Various other benefits were considered likely to increase the benefits of the more stringent wind standard by small amounts, but could not be quantified.

Economic costs of complying with the new HUD standard were also estimated. Increased material costs were multiplied by an industry standard multiplier of 2.22 to incorporate other production and management costs. Production cost increases ranged from $1,492 (single-section, Zone II) to $2,722 (multiple section, Zone III). Pass-through of these cost increases to consumers was estimated at 56 percent, although this rate would be much closer to 1.00 to the degree that the zones represent submarkets and manufacturers were able to shift production across zones. Total annual costs of $51.7 million were calculated as the sum of costs to consumers, costs to producers and deadweight loss, compared to total annual benefits of approximately $83.8 million, for net benefits of $32.1 million.

Affordability and distributional impacts of the new standard were estimated based on the cost impacts, along with the assumption that owners would buy the land to which the unit is attached. The net effect of changing down payment, purchase arrangements and tax rate is to increase monthly payments by less than two percent. More complete measures of affordability would be appropriate in a HIA. These include estimating how many buyers would have to spend more than 28 percent of their income to purchase a new manufactured home under the more stringent wind standards, estimating how many households would have enough income to purchase a new unit meeting the new wind standards, or comparing monthly housing cost increases to median household income. Further analysis would consider the lengthy time periods required before market effects appear, and the impacts on submarkets including low-income, elderly households located outside metropolitan areas. Finally, possible approaches to extending the housing impact analysis for manufactured housing wind standards were described, including effects on existing manufactured homes, site-built homes, rental units, coastal housing and flood insurance.

Section 4.3. Summary of the In-Depth Methodology. The final part of this chapter, Section 4.3, reviews the basic steps included in the In-Depth HIA methodology and summarizes the most logical, appropriate ways to apply these steps and associated parameter values to use in analyzing any potential regulation that affects housing. Methods for including submarkets, neighborhood effects and affordability analysis for the overall group and for low-income, minority, elderly and disabled household subgroups are also described.

Appendices A, B and C. Valuable data sources potentially relevant to HIA are described in Appendix A, "Housing Analysis Data Sources." Although custom estimation of parameters for a particular study is preferred as a general matter, in many situations budget limitations may force agencies to rely on parameters estimated in related studies. Appendix B, "Quantitative Analysis of Uncertainty," briefly suggests ways to handle uncertainty or volatility in estimates of supply and demand elasticity. Finally, the Housing Impact Analysis is primarily concerned with housing costs, but sometimes the regulations confer benefits that are measured as avoided future costs. Appendix C, "Measuring Benefits in the Context of Housing," describes the methods for benefit valuation and discusses their advantages and disadvantages.

Conclusions. The housing cost impacts resulting from a wide variety of different regulations have been a concern for many years. Systematically documenting how new regulatory requirements increase or decrease production costs and the degree to which these changes directly or indirectly affect the prices of new and existing homes will enhance the quality of the underlying debate about new regulatory requirements. This report presents background data and illustrations of how that process can be performed, first by setting forth general frameworks for screening housing cost impacts and estimating their size and incidence, and second by illustrating application of preliminary and in-depth analysis methods to specific regulations. This process can not only be used to document housing impacts, but also potentially to limit cost and price impacts while serving the underlying regulatory goals.

1. Introduction

The preamble to the Housing Act of 1949 recognized the importance of housing to society and established "the goal of a decent home and a suitable living environment for every American family." Yet despite more than half a century of work towards that goal, the rising costs of housing have still left many lower-income families unable to afford monthly rents. Home ownership rates have risen very slowly, with high prices for new and existing houses in some areas preventing low and even middle-income families from buying their first home.

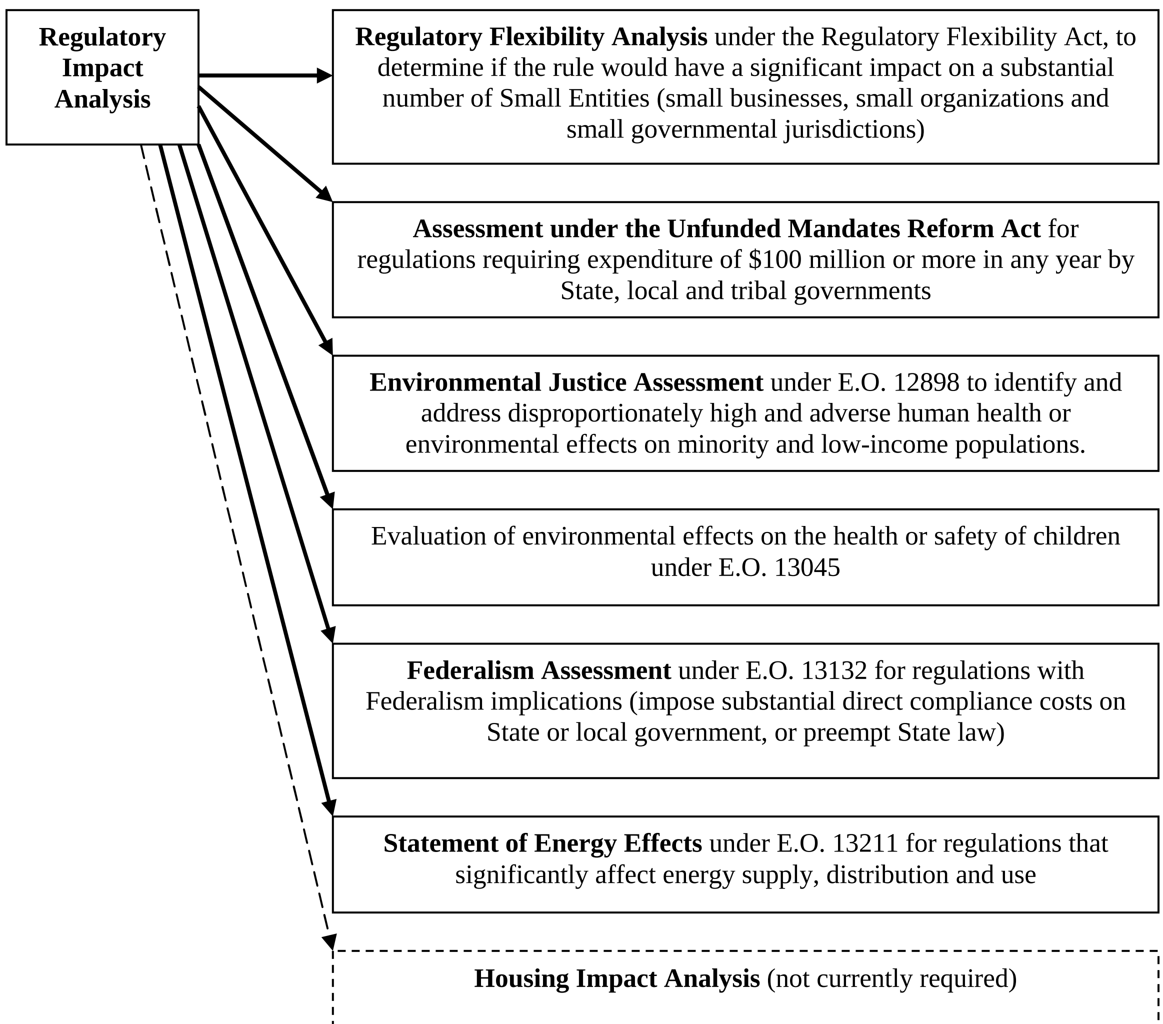
Nonpartisan commissions set up to study housing market issues have found that a variety of federal, state and local regulations and similar actions have contributed to the rising costs of new and existing housing, both for sale and for rent. While the social values served by most of these regulations are acknowledged, there is also concern that potential adverse impacts on housing may be overlooked when regulations are developed and adopted.

Various suggestions for reform have been made. For example, in 1991 the Kemp Commission report, *Not In My Back Yard*, recommended that an analysis of the impacts of new federal regulations on the affordability of housing be made part of the rulemaking process. In 2000 the Millennial Housing Commission made a similar recommendation. Even though both recommendations applied only to federal rules, by showing leadership in performing "housing impact analysis" the federal government would also be encouraging state and local governments to take a similar look at their own rules and regulations.

There has been little explanation of how a Housing Impact Analysis might be performed or what the key outputs would be. This report illustrates an approach to performing such an analysis in connection with a rulemaking action. The report describes the wide range of rules to which such an analysis could be applied, summarizes background economic theory, reviews data sources, parameters and previous relevant regulatory analyses, illustrates methods and expected outputs for a simplified preliminary housing impact analysis, and presents a more detailed approach to be used where substantial housing impacts are anticipated. The core audience for the report is regulatory analysts in federal agencies pursuing rulemaking actions, who may someday implement procedures such as those described in this report. Other audiences include analysts at other levels of government as well as researchers and interest groups involved with regulatory issues and housing policy.

From a practical standpoint, a Housing Impact Analysis will most likely take place as part of a larger process of regulatory assessment. This process is already in place at the federal level. General requirements for assessing costs and benefits in a "Regulatory Impact Analysis" (RIA) were first introduced in Executive Order 12291, "Federal regulation" (February 17, 1981). These were revised and reissued as Executive Order 12866, "Regulatory Planning and Review," (October 4, 1993) where they continue to apply. In addition, various statutes such as the Endangered Species Act contain related requirements for analyzing the economic impacts of particular agency decisions. Furthermore, over the years a whole series of specialized additional requirements have been added under which federal agencies must analyze certain rules for particular effects such as environmental impacts, impacts on small businesses, and impacts on the family. Thus, a Housing Impact Analysis examining how a regulation would affect the cost, supply or affordability of housing represents an extension of current procedures, and would typically be developed and considered in this larger analytical environment. The way a Housing Impact Analysis might fit in with current federal processes for regulatory analysis is illustrated in Figure 1-1.

Figure 1-1
Supplements to Regulatory Impact Analysis of Federal Regulations (Partial List)



It is important to point out that just because a Housing Impact Analysis shows that a rule would increase the cost or reduce the supply of housing does not automatically make the rule a bad idea, or poor social policy. Obviously a rulemaking agency has the legal responsibility to make an overall judgement in light of all the relevant factors, not based on housing impacts alone. In other words, analyzing impacts on housing is properly just one part of a larger analysis in which different values must compete. The value of formal consideration of housing as part of the process is to ensure that regulatory agencies identify the impact of their decisions on housing costs and affordability. In addition to advancing public debate, this will help agencies craft regulations that serve policy goals without unduly compromising housing affordability.

The body of this report is organized into four sections. The balance of Section 1 gives a conceptual overview of the variety of ways that regulations can impact housing cost, production and affordability, with examples of specific regulations from various agencies that affect different parts of the process. Section 2 reviews standard procedures for quantitative analysis of housing supply and demand as well as the theory and practical knowledge of key parameters including demand and supply elasticities. Section 3 discusses how to perform a Preliminary Housing Impact Analysis that would be used to determine whether or not an in-depth analysis is warranted, and illustrates the preliminary impact analysis procedure with respect to rulemakings from several different federal agencies. Section 4 describes the general methodology to be used for an In-Depth Housing Impact Analysis and applies this to two federal regulations: EPA effluent guidelines for construction and development, and HUD wind standards for manufactured housing. Additional information on sources of potentially relevant data is in Appendices.

1.1 Types of Regulations that Affect the Housing Market

This section gives an overall picture of different types of regulations that would be expected to affect housing cost and affordability. It is organized into three categories: regulations affecting development, design and construction; regulations affecting purchase and financing, and regulations affecting ongoing costs of ownership. This is followed by a discussion of the types of impacts that can occur and examples of regulations from various federal agencies that could affect the housing market.

Regulations affecting development, design and construction. Houses and apartments are produced by building companies and contractors from developed and undeveloped land, labor, materials and equipment. Perhaps the largest category of regulations of interest affect this process. Examples include:

- *Regulations that affect the supply of land or the cost of land development*. This includes EPA requirements to control runoff from construction sites and Department of Interior requirements prohibiting construction in areas inhabited by endangered species.
- *Regulations that affect the cost of building materials, supplies or components*. This includes DOE regulations governing energy efficiency of furnaces, air conditioners and major appliances.
- *Regulations that affect standards of building design or performance*. This includes HUD regulations for design and construction of manufactured housing, and FEMA flood insurance standards for buildings located in the 100-year flood plain.

- *Regulations that affect the supply, productivity or wages of construction labor*. Examples include worker safety regulations that require training and special equipment or modified work practices.
- *Regulations that affect production overhead or the cost of operating a building company*. This includes recordkeeping, paperwork, licensing or insurance requirements.
- *Regulations that affect the cost of owning or operating capital equipment used in construction.* This includes EPA standards for fuel efficiency of light trucks or emission standards for vehicles and heavy construction equipment.

Regulations affecting purchase and financing. A second category of regulations that can have a direct effect on housing affordability grow out of the way homes are bought and sold. Housing is either purchased by homebuyers, usually in transactions involving realtors, appraisers, inspectors, lenders, insurers and title companies, or owned by investors and leased to households in the rental sector. Regulations affect these processes in many different ways.

- *Regulations affecting purchase and sale of housing.* This category includes regulations that affect the nature and cost of closing services, whether paid by the buyer or the seller. Examples would be point-of-sale notice and disclosure requirements, regulations governing sales or brokerage practices such as anti-discrimination laws or requirements for good-faith estimates of settlement costs, and rules governing the financial relationships between third parties such as limits on markups for services procured on behalf of parties to the transaction.
- *Regulations affecting mortgage financing*. These are rules that apply throughout the banking industry such as truth-in-lending disclosures and rules affecting secondary lender standards including down payments, tax and insurance escrows, private mortgage insurance, appraisals and surveys. Goals for secondary lender financing of housing purchases by disadvantaged buyers and capital standards for primary or secondary mortgage lenders would also fall into this category, because of their indirect effect on mortgage interest rates or lending fees. While mortgages insured by FHA are probably subject to the most extensive body of formal regulations derived from federal rulemakings, all mortgages are affected directly or indirectly by federal and state regulations. FHA (and secondary lender) rules governing loans on multifamily properties would have a comparable effect on market rents.

Costs associated with these regulations may fall on the buyer or the seller, and may be paid in cash up front or amortized over the duration of the mortgage. The nature and magnitude of their effect on affordability may ultimately depend on how they are paid or financed.

Regulations affecting ongoing costs of ownership. A third broad category of regulations that can affect housing affordability are regulations that change the ongoing costs of operating, maintaining and repairing houses.

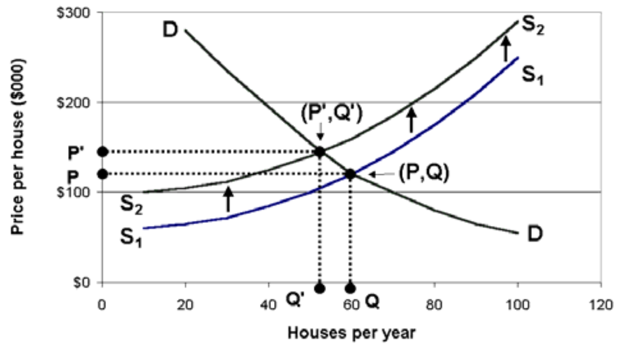
- *Regulations affecting cost of utilities*. The costs of energy, water, sewer and communication services are affected by regulatory policies.

- *Regulations affecting cost of replacement products*. Regulations that increase the cost of building products or materials affect the cost of ownership to the extent those items are incorporated into existing buildings, such as when older systems fail and must be replaced with new products that are required to meet higher standards
- *Regulations affecting hazardous materials found in existing buildings*. Regulations addressing worker protection and waste disposal can affect housing affordability by reducing labor productivity or adding direct costs. These include regulations for removal or handling of asbestos (found in some older floor tiles, pipe insulation, building papers, wall finishes and siding), lead paint (found throughout the pre-1978 building stock) and other potentially hazardous materials.
- *Regulations affecting the scope of renovation work.* Regulations that trigger requirements to retrofit older buildings with newer technologies or bring specific features up to code when other work is performed can increase the cost of renovation work.
- *Regulations affecting taxes and tax treatment of housing expenses*. Tax policies falling into this category including policies affecting the level of state and local property taxes as well as rules governing the deductibility of mortgage interest and property taxes from federal and state taxable income.
- *Regulations affecting public assistance for housing expenses*. Federal and state housing assistance to low-income families are based on complex policies determining who qualifies and how much assistance they can receive. Those regulations have a direct impact on housing affordability.

Types of impacts of regulation. The effects of regulation on the housing sector can take several different forms. While short-run considerations are more problematic, over time the housing industry is characterized by ease of market entry and exit and a high degree of competition. This suggests that, at least in the long run, regulatory costs imposed on builders will be passed through to consumers. This view is common as a first approximation to reality, although it may be tempered by more sophisticated analysis based on estimated elasticities of housing supply and demand. To the extent that builders pass added costs forward, there will be increases in the price of homes or the level of market rents, reflected in larger mortgages, higher "up-front" costs for down payments and closing expenses, or higher rents. In other circumstances the higher costs may be absorbed by landowners, manufacturers, suppliers or labor. If the costs remain with the builder they can reduce the profitability of land developers, building companies, contractors, or investor-owners. Regulations can also affect the monthly costs of operating a home, or the less predictable costs of major repairs and remodeling. All of these changes can in turn affect the level of new housing production and rehabilitation, as well as employment and wages in the construction sector.

Like other markets, housing markets have their own unique features but are still properly studied in a supply and demand framework, where market prices and the amount of housing services purchased are determined by the willingness of producers and owners to supply housing, and the willingness of buyers and renters to pay for it. While characteristics of the housing market are further discussed below in Section 2, from a theoretical perspective the impacts of regulations on price and output are determined by their effect on the underlying supply and/or demand curves and the shapes of those curves. Most of the types of regulations discussed above would lead to shifts in the supply curve.[1]

Figure 1-2
Impact of a Shift in the Supply Curve



As production costs rise the supply curve will shift up by a corresponding amount. This is shown in Figure 1-2, where higher costs shift the supply curve up from S_1 to S_2, causing price to rise from P to P' and output to drop from Q to Q'. Note that cost pass-through is incomplete in this diagram due to the finite elasticity of supply as well as the non-zero elasticity of demand. As a result, P'-P is smaller than the added cost (the vertical shift between S_1 and S_2). Furthermore, the area of the rectangle with height (P'-P) and width Q' represents the ex post transfer payment from buyers to sellers (i.e., the price increase per unit times the number of units produced after the regulation is enacted). This represents the financial burden imposed by the regulation on homebuyers who remain in the market.

A final concept often arising in regulatory impact analysis and also illustrated in Figure 1-2 is "deadweight loss," a measure of the allocative economic inefficiency or loss of social welfare resulting from the regulation. Deadweight loss shown in the figure includes the loss in consumer surplus plus the loss in producer surplus. In this example the loss in consumer surplus is the area of the triangular region defined by the points (P,Q'), (P',Q') and (P,Q). This area equals the value, in dollars, of consumer willingness to pay in excess of the old market price P, for houses that are no longer produced after the regulation is enacted. Similarly, the loss in producer surplus is the triangular area above the old supply curve and below the horizontal line P, to the right of Q'. This represents the lost profitability, in dollars, of homes that could have been produced for less than P and sold for P before the regulation was enacted. It represents lost profit to producers.

Other relevant regulations could potentially lead to shifts in the demand curve. One way to view increased cost of purchasing a home that are imposed directly on consumers (e.g. higher closing

[1] Note that to the degree regulations add time to the process of developing, building or renovating housing they will increase the cost of interest on loans or the opportunity cost of invested capital. Either effect will operate as an upward shift in the supply curve, similar to that illustrated in Figure 1-2.

costs), or increased operating costs of housing, is as creating a lower "effective demand" curve, shifted down by the amount of the cost. The intersection of supply and effective demand determines output and the amount paid to producers, while the amount paid by consumers will be the price on the demand curve corresponding to the *ex post* output level. As before, the actual impact on price and output will depend on the shapes of the supply and demand curves.

Even though most regulations of interest will have a direct effect on newly built homes and apartments, it is important to recognize that the effects can spill over to affect virtually the entire market. For example, as higher costs of producing new homes raise their price and reduce production, the demand curve for existing homes will rise insofar as new and existing homes represent substitute products. The higher demand curve for existing homes will lead to higher market prices for existing homes as well as more transactions, reflecting a shift of buyers from one sector to the other. This relationship is captured by the "cross-price elasticity" of new and existing homes. In this way a regulation that increases the price of new homes can simultaneously (1) impose an affordability burden on purchasers of existing homes, and (2) create a windfall profit for sellers of existing homes. It also provides an unrealized capital gain for owners whose property values rise even though their homes are not for sale, and higher property taxes on all owners as assessments rise. In principle, regulations that affect existing homes could affect prices and production of new homes by the opposite process. Finally, market rents can also be affected by regulations that impact new (or existing) homes if demand for apartments increases, because prospective homebuyers defer purchase in response to high or rising prices of for-sale housing. Some consideration of these spillover effects may prove important to a full accounting of the impacts of regulations on housing affordability.

Relationship to transfer payments. Many regulations that affect the cost of housing do so by imposing true economic costs in the form of additional labor or products that are more expensive to produce. However, much or all of the impact of regulation may take the form of "transfer payments" representing shifts in wealth from one party to another but not associated with consumption of economic resources. Many government programs are of this type. The purest examples of transfer payments are subsidies from the federal government to consumers through social welfare programs, such as Community Development Block Grants or Section 8 housing choice vouchers. A less pure example might be a limit on deductibility of mortgage interest, which would transfer resources from borrowers to the federal government. Under a conventional benefit-cost analysis, transfer payments are identified but tracked separately from costs associated with consumption of economic resources. Under current OMB procedures, transfer payments are looked at as determinants of the "distributional" impacts of regulation rather than their effect on the economic well-being of society. Yet from the standpoint of the home buyer, the home owner or the renter, the effects of transfer payments and "real" economic costs can be precisely the same: a higher expense required to purchase housing services, and a corresponding drop in housing affordability. Thus, the scope and focus of a proper housing impact analysis, which is to determine how a regulation affects the cost and affordability of housing, can logically differ from the scope and focus of a benefit-cost analysis, which is to determine how a regulation affects the well-being of society. This report focuses on housing impact analysis and will consider transfer payments in that context.

1.2 Example Regulations

This section presents some specific examples of rules and regulations that may have had impacts on the housing market, and describes how the effects would arise. Most of these examples are "major" or "economically significant" federal regulations that were subjected to regulatory impact analysis under E.O. 12866 and were described in various editions of the annual reports prepared for Congress by the Office of Management and Budget under the Regulatory Flexibility Act.

Environmental Protection Agency. The U.S. Environmental Protection Agency (EPA) is responsible for several types of regulations that can affect the cost of housing.

- EPA adopted rules for Phase II of the National Pollutant Discharge Elimination System in 1999 under the Clean Water Act, designed to eliminate sediment carried by storm water runoff from construction sites. These rules extend coverage to one- to five-acre construction sites, and require permits, plans and technology to control erosion, all of which increase the cost of developing on smaller parcels. The Final Rule was published at 64 FR 68722 (December 8, 1999).
- EPA adopted standards in 1998 under the Clean Air Act limiting emission of volatile organic compounds from architectural coatings. These regulations required reformulating coatings in ways that affect the cost and potentially the performance of paints that are used widely in the construction industry. The Final Rule was published at 63 FR 48848.
- EPA has set emission standards on several occasions under the Clean Air Act for light trucks and for large diesel-powered construction equipment such as cranes, bulldozers and dump trucks used widely in construction.
- EPA adopted National Primary Drinking Water Regulations in 2001 under the Safe Drinking Water Act that reduced the maximum amount of arsenic in drinking water supplies from 50 ppb to 10 ppb. The requirements imposes costs for capital upgrades, testing, monitoring and reporting on public drinking water systems that would affect the cost of utilities for new and existing homes. The Final Rule was published at 66 FR 6976 (January 22, 2001).

Fish and Wildlife Service. The Fish and Wildlife Service (FWS) of the Department of Interior is responsible for listing plant and animal species as threatened or endangered under the Endangered Species Act, and for designating "critical habitat" for listed species where activities such as land development and construction may be subject to additional regulation. The National Marine Fisheries Service of the U.S. Department of Commerce has similar responsibility for marine species. Many of the listing and habitat designation regulations have had impacts on housing.

Occupational Safety and Health Administration. The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor sets workplace safety rules that are enforced by OSHA or designated state occupational safety programs. In many cases specific rules are adopted for the construction industry. Recent OSHA rules that directly affect construction include the Lead in Construction Rule and the Standards for Fall Protection.

- The OSHA Lead in Construction Rule limits worker exposure to airborne lead, which raises the cost of certain kinds of remodeling work ranging from demolition to repainting. Compliance typically involves exposure monitoring, modified work practices (such as sanding wet), and use of respirators and protective clothing. The Rule was published at 57 FR 26627 (May 4, 1993).
- The OSHA Standards for Fall Protection in the Construction Industry require protection from fall hazards (e.g. personal fall arrest systems, guard rails or various alternatives) in activities such as framing and roofing. The Final Rule was published at 59 FR 40672 (August 9, 1994).

Several years ago OSHA also proposed an Ergonomics rule that was designed to reduce injuries from job activities requiring repetitive motion. The rule would have applied to all industries, including construction, and would have covered activities such as nailing and lifting that are widely performed on construction sites. However, this rule was withdrawn by an act of Congress.

Department of Energy. The U.S. Department of Energy (DOE) sets minimum energy efficiency standards for various types of equipment found in homes, under the National Appliance Energy Conservation Act. These regulations are periodically revised as technology improves and energy markets change. In recent years DOE has proposed increases in the minimum efficiency of central air conditioners and heat pumps (66 FR 7170), refrigerators and freezers (62 FR 23101, April 28, 1997), water heaters (66 FR 4474, January 17, 2001), clothes washers (66 FR 3314, January 12, 2001) and a variety of other appliances. Requiring higher levels of efficiency increases production cost, which is passed through to wholesale and retail purchasers. These products are found in virtually all new homes and used to replace similar products in existing homes, so cost impacts will be felt by new home purchasers as well as home owners. Higher efficiency also reduces operating costs which benefits the purchaser, but no savings on operating costs can be realized until the "first cost" hurdle is overcome. The net effect ultimately depends on the present value of all the associated cash flows, which may vary across households depending on their financial circumstances.

Department of Transportation. The U.S. Department of Transportation (DOT) has set "Light Truck Corporate Average Fuel Economy Standards" for model years dating back at least to the 1990's. Compliance with those regulations increases production and purchase cost for affected vehicles. Light trucks are used in many parts of the economy, but may be disproportionately used in construction. As with the DOE energy efficiency standards, higher purchase costs are offset by reduced operating costs.

Department of Housing and Urban Development. Several rules promulgated in the last decade or so by the U.S. Department of Housing and Urban Development (HUD) have potentially affected the cost of housing. These include:

- Settlement procedures under the Real Estate Settlement Procedures Act, published in a Final Rule on November 2, 1992 (57 FR 49600) and in subsequent rulemakings.
- Energy conservation standards for HUD-code manufactured housing (published October 25, 1993; effective October 25, 1994), including minimum thermal insulation requirements and requirements for whole-house mechanical ventilation systems.
- Wind standards for HUD-code manufactured housing located in high-wind zones (published January 14, 1994; effective July 13, 1994); included new wind zones, new table of design wind pressures, and related changes.
- Federal Housing Administration (FHA) regulations applicable to FHA mortgage insurance, eligible mortgages, down payments and other terms and conditions of FHA financing or aspects of FHA operations.
- Regulations establishing housing finance goals for Government Sponsored Enterprises (Fannie Mae and Freddy Mac)

State and Local Government Agencies. Many well-known examples of regulations that affect housing affordability are adopted at the state and local government level. There is sometimes a complex interplay between federal mandates and local requirements where locally adopted rules result indirectly from federal actions, such as the imposition of special construction requirements for buildings located in the 100-year flood plain. Localities must enact these rules in order to make federally-sponsored flood insurance available, and flood insurance is required before secondary lenders will buy mortgages on affected properties. Whether the underlying construction requirements result from federal regulation or from state and local regulation is in some respects a semantic issue. Building codes that are locally adopted have also incorporated a variety of requirements springing from legally enforceable federal mandates, such as minimum appliance efficiency standards promulgated by DOE or accessibility standards required under the Fair Housing Act. But most local regulations of interest in this section regard initiatives that are largely or entirely local in nature, many of which can have major effects on housing costs and production. Several widespread categories of these regulations are listed below.

- **Zoning including subdivision standards; lot sizes, densities, set-backs and architectural standards.** These types of restrictions on what can be built where are the rule rather than the exception in modern communities. They typically limit the number of building lots that can be located on a parcel of land, and in some cases the types of structures that can be built on those lots. The net effect may be to increase the cost of land used to build new housing, if the government-imposed rules are an effective constraint on the land market.

- **Impact fees, development exactions and proffers.** These systems require builders to pay fees or dedicate land for use by local governments associated with meeting infrastructure needs of new homes such as roads, schools, water supply, wastewater treatment, parks, etc.
- **Building codes and standards.** These regulations, variations of which are in effect in practically every community, set minimum requirements for new construction and rehabilitation designed to protect public health, safety and welfare. They govern structural systems, plumbing and electrical systems, HVAC systems, fire protection, energy conservation and similar topics.
- **Development moratoria.** Outright bans on new construction, often tied to lack of capacity for schools, wastewater treatment, or other essential infrastructure elements.

While local regulations and regulatory systems are not the direct focus of this report, there is clearly room to apply a housing impact analysis methodology to document their effects on housing cost and supply.

HOUSING IMPACT ANALYSIS

2. Quantitative Analysis of the Housing Market

2.1 Housing Supply and Demand

It is customary to speak of supply and demand in the "housing market" in the same terms as in any other economic market, and to view the interaction of supply and demand as determining market prices and the level of production. Standard economic principles do apply, yet this sector also has many complexities and unique features that should be understood before undertaking a housing impact analysis. This section discusses housing supply and housing demand, as well as standard sources for data on the housing stock, new production, prices, values and related parameters that will often be used for analyzing the housing market.

There are two threshold issues for consideration. The first is the definition of "housing," the product under study. The second is the definition of a "housing market" for purposes of analysis, especially the appropriate spatial dimension. The discussion of these issues is followed by a review of the fundamental concepts of housing supply and housing demand.

Definition of "housing." There are actually two relevant definitions of "housing" for purposes of this study. The first definition involves housing as a physical asset, typically a very durable asset. Thus defined, "housing" includes single-family homes, attached homes, condominiums, co-operatives, manufactured housing (whether or not considered real estate), apartment buildings and any other structure suitable for use as a dwelling. The second definition involves housing as a service, or a stream of services. These services include the right to occupy, use and enjoy a dwelling unit and the features it contains for a period of time. Renters purchase housing services through lease arrangements. Owner-occupants purchase housing assets, often with the aid of long-term financing through specialized capital markets, largely in order to enjoy the related housing services (this type of arrangement dominates in the U.S., with over two-thirds of households owning their own homes). In addition, investors may build or purchase housing assets with the intention of leasing housing services to others, and merchant builders construct homes to sell the assets to others, whether owner-occupants or investor/landlords. Regulators most commonly focus on the house as a physical asset. Understanding the relationship between the market for housing assets and the market for housing services is important to a clear understanding of the operation and dynamics of the housing sector. Note that similar distinctions arise with buildings in commercial, retail and other sectors. These concepts can sometimes be downplayed when analysis is at a general level, but they must be specifically addressed whenever explicit modeling is undertaken.

Definition of a "housing market." A second point of introduction involves the definition of a "housing market," especially its spatial dimension. This term can be found in use at all levels of aggregation, from a national market to the market in a single neighborhood. There is no absolute boundary; the best answer may depend on the underlying question, or even on the availability of relevant data. In theory the market should be large enough that the number of homes available and number of purchasers or renters are "large", but small enough that most consumers consider the available homes or apartments to be potentially viable substitutes for one another. The most workable definition, widely employed in studies of urban areas, typically has a housing market corresponding to each metropolitan area. Not only are metropolitan areas reasonably large by design, they also take account of natural patterns of commuting and commercial activity. Metropolitan areas are regarded as suitable ranges for commuting, which is clearly an important factor in an individual household's choice of location. This approach is also valid to the extent that house prices across metropolitan areas are relatively independent, i.e., the price of housing in the New York metropolitan area has little or no effect on the price of housing in the Boston metropolitan area. The spatial dimension of a housing market will arise later when impacts of regulation are considered. At a minimum a reasonable scope of market affected will need to be determined. A regulation that affects only a small portion of a housing market may have a very different impact, in terms of who ultimately absorbs costs, than a regulation in effect throughout a market. Comprehensive impact analysis may also require estimating and aggregating impacts in multiple markets, or analyzing a much more broadly defined market.

2.1.1 Housing Supply

The stock of housing at any point in time is the total number of dwelling units, including detached homes, attached homes, condominiums, co-ops and apartments. The occupied housing stock is, by definition, equal to the number of households. The overall stock of housing obviously represents the totality of all previous construction, including additions, less units withdrawn due to depreciation, destruction or conversion to other uses. Only a small fraction of these dwelling units may be "on the market" (for sale or for lease) at any particular time. Thus, the "housing supply" at a point in time, as that concept arises in economics, is the collection of units available for purchase or lease. Houses become available for purchase when new homes are built or converted, or households dissolve, decide to trade up, relocate to another area, or move to apartments. Rental units become available when new apartments are built or converted, or leases expire and tenants move to new quarters or buy houses. The "vacancy rate" is often used as one measure of available supply, although this does not reflect occupied homes for sale or apartments available for lease at a future date. Housing supply is sensitive to price in the usual way; other things equal, higher market prices would typically induce more construction and more new and existing units to be offered for sale or rent.

The Role of New Construction. New construction and the rate of housing production represent gross additions to the housing stock. This process of addition is extremely slow, totaling only about 1% to 2% of the overall housing stock each year. Since most newly built units are sold or leased, they are an important component of the number of homes on the market at any time, even though the majority of housing transactions involve resales of existing homes or leases of existing apartments. In urbanized areas that are already built out, construction of new homes is very low, leaving major renovation and resales of existing homes as the bulk of the market. Given the rate of new construction and information about the housing stock and the durability or depreciation of housing, an overall housing stock can be determined at which level new construction exactly offsets retirements and loss of existing units.

Special Qualities of Housing. The "housing market" is often described as if all housing units were identical or close substitutes. While these kinds of summary references are unavoidable, they should not obscure the fact that homes and apartments are highly heterogeneous. Even in relatively small geographic areas housing units can and do vary widely in features such as square footage, age, location, architectural features, space layout, internal finishes, and the presence or absence of myriad conveniences. Some of these differences reflect regional styles, some reflect differences in vintage, and some reflect differences in the tastes or preferences of previous occupants. The many distinguishing features of different homes and apartments warrant caution in applying the usual economic assumption of fungibility (i.e., that the underlying goods or services being traded are identical or perfectly substitutable for one another). Homes are also fixed in place, for all practical purposes, so the purchaser must relocate to the house rather than vice-versa and there is no realistic opportunity for arbitrage across housing markets.

Competitive Environment in Residential Construction. The construction industry (including but not limited to the housing industry) is widely seen as a bellwether, highly cyclical industry that can lead the economy into recession or recovery. Home building as an industry is dominated by small firms, with the vast majority building 20 homes or less per year. Even on the local level, this industry structure is generally regarded as very competitive by economic standards. This is, of course, an abstraction insmuch as all homes and apartments are not substitutes for one another; development, construction and sale take time and are not instantaneous; and local markets may be thinly traded. But the competitive assessment persists, based largely on the large number of competitors and the very low barriers to entry and exit of construction firms. Building companies can easily switch from home building to remodeling, or relocate from one area to another depending on market conditions. They also can and do shift from building single-family homes to townhouses or multifamily low-rise housing, or even from residential to light commercial work. Capital requirements for equipment and facilities are minimal compared to most other industries, although access to inexpensive, reliable construction financing and skilled subcontractors are critical to most builders. This industry structure is key to an understanding of how the market adjusts to regulatory actions. It generally keeps returns at a competitive level and ensures costs are passed forward (to consumers) or backward (to suppliers or landowners).

Although the degree of competition in the housing sector is usually taken as given, it is worth noting that regulations can also affect the competitive environment. This can happen whenever they impose disproportionate impacts on one category of producers; for example, small firms (which often experience higher unit costs of regulations). Any such effect would tend to shift the balance of producers away from the higher-impacted group and towards the lower-impacted group.

Role of Land Development. Builders typically move from one area to another as development opportunities are identified and exploited. Yet home building usually follows a process of land acquisition and development, including construction of infrastructure, that can take many years. Land development requires patient capital and is ordinarily done by larger firms, who may build on the finished lots or sell them to other builders. Key factors constraining the level of production include lack of building lots in desirable locations, and lack of access to skilled subcontractor labor. Housing production is also sensitive to interest rates and availability of construction financing. The construction of apartment buildings in particular can be strongly affected by tax policy (e.g., the Low-Income Housing Tax Credit).

Production Factors, Inputs and Constraints. The production of homes requires land or building lots, building materials, construction equipment, design work, and literally dozens of subcontractors with specialties including excavation, foundations, framing, siding, HVAC equipment, electrical, plumbing, painting and roofing. These activities take place in a regulatory environment that may involve development approvals, impact fees or off-site improvements, building permits, construction inspections, and the issuance of a Certificate of Occupancy. Merchant builders focus largely and sometimes entirely on the efficient sequencing and coordination of the thousands of necessary steps. Nevertheless, construction of a fairly simple house on a suitable building lot can take three to six months or longer from breaking ground. Once construction has begun, the improvements have little or no salvage value and the design rapidly becomes fixed, so in the short term there is very little flexibility in the number or characteristics of newly constructed units. Production will automatically tend to lag behind changes in demand.

2.1.2 Housing Demand

Several factors are acknowledged as the fundamental determinants of overall demand for housing services. These factors include:

- the number of households and net rate of household formations,
- household incomes, including current income and "permanent income,"
- trends in household incomes, and the income elasticity of demand for housing,
- family sizes and household composition, especially the number of dependent children,
- job creation (or job loss) in the local market area, and
- location relative to centers of employment and commerce.

Hedonic Price Theory. The heterogeneity of the housing stock has led to an extensive literature modeling housing prices based on attributes that are seen as likely contributors to demand. The exact specification of attributes may reflect data availability, but features that are often included are house size (square footage); number of bedrooms; number of bathrooms; lot size; presence of amenities such as a basement, a garage, a fireplace and/or brick siding; age of the structure; characteristics of the neighborhood or larger community; distance to centers of employment and commerce; and school and school district characteristics. Many other features such as energy efficiency have been investigated in specialized models, but are not as widely recognized. One potential advantage of the hedonic model is its use in supporting rational appraisal determinations, including adjustments of prices for comparable properties.

Demand for Housing Services vs. Demand for House Purchases. As previously noted, although household demand for housing is logically viewed as demand for housing services, outside of the rental market houses are sold as physical assets at prices far in excess of monthly or annual rents. Specialized mortgage capital markets that help to translate consumer willingness-to-pay for housing services into willingness to pay for a house form the basis of the owner-occupied segment of the market. Financial parameters that are key to this translation are:

- mortgage term, interest rate, and whether the rate is fixed or variable
- property tax rates
- tax deductibility rules for mortgage interest and property taxes
- cost of property insurance and any required mortgage insurance
- minimum down payment requirement (maximum loan-to-value ratio)

Further issues affecting the translation from demand for housing services to demand for purchase of a house include:

- the purchaser's current income and lending rules relating maximum loan payments to income,
- the purchaser's debt profile and credit history (which may make credit unavailable or unaffordable),
- the purchaser's ability to accumulate funds required for the down payment and closing costs (perhaps the single largest barrier to homeownership for lower-income households),
- the anticipated operating costs for utilities, maintenance and repairs,
- the anticipated duration of occupancy by the purchaser, and
- the purchaser's expectations regarding future growth in the asset value and the applicable capital gains tax treatment when a gain is realized.

While the individual factors are sometimes subjective and can be very complex, the sum total of their effects is to convert a household's willingness-to-pay, say, $1,000 per month to rent a home to a willingness to purchase the same home for a selling price of $225,000. In principle this conversion process is very similar to the calculations a rational investor makes in deciding whether or not to purchase an asset that yields a given stream of returns.

Search Issues and Transaction Costs for Renters and Buyers. The long, complex and expensive process of purchasing housing services also distinguishes this market from most others. Given a gap between household desires for housing services and features of current housing, the first decision is whether to move or to improve in place. While renters may be precluded from improving their current apartments, home owners can and do make changes, often substantial.

For households that cannot or do not wish to modify existing homes but still wish to improve their housing, the process of search and relocation is the other alternative. Unfortunately, even with a large housing stock, relatively few homes or apartments may be on the market at a given time. Buyers have the choice of finding the best of what is available or waiting for more choices to materialize. This process can take months or even years, depending on what the buyer is looking for. The housing market is also not very "transparent" -- other than what can be determined visually or information provided by a seller's agent (who may not be seen as objective), buyers have relatively little access to information about the construction of a structure or characteristics of the neighborhood that may ultimately prove important. This kind of uncertainty is far from the "perfect information" of economic theory and ultimately serves as a deterrent to action.

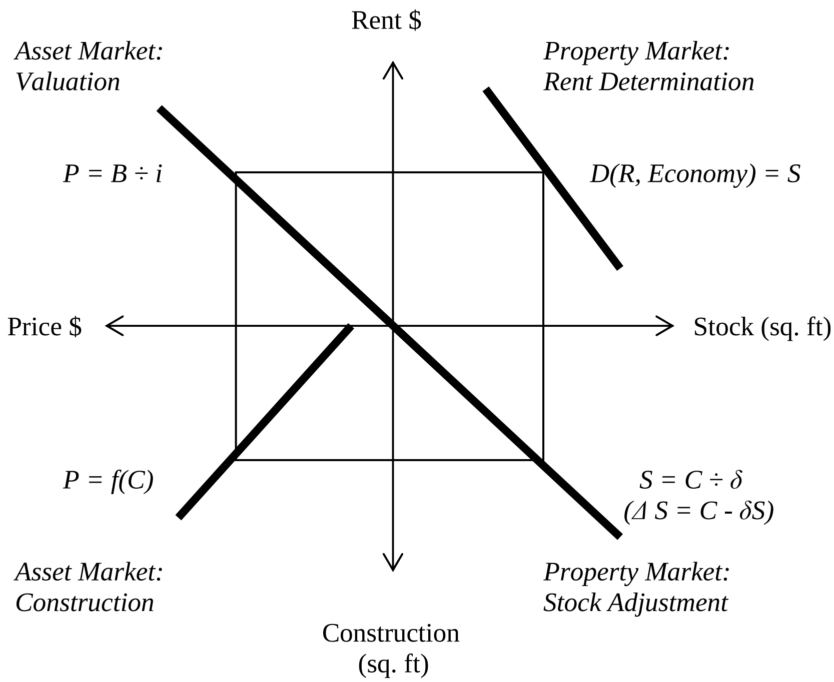
The transaction costs of relocation can also be a major impediment to moving. Relevant out-of-pocket costs of relocation including moving household possessions, storage, temporary living quarters, time invested for self-help and the pure disruption of daily living can be very high for both renters and purchasers. This constitutes a form of "barrier to exit" for housing consumers, since a new unit needs to be much superior to an existing one for the new occupant to be better off after a move. For prospective owner-occupants an elaborate and expensive additional process is involved, including steps such as contract negotiation, mortgage application and approval, inspections, appraisal, title search and settlement. The associated expenses can add thousands of dollars to the cost of a house, and those costs may be very difficult to finance. Buyers with existing homes face additional uncertainty about how and when those homes will sell, as well as significant carrying costs during any period of overlapping ownership, while renters who want to change units must time their departures precisely and still face problems of overlapping rental payments. The overall effect is that real estate markets operate in a form of "slow motion" characterized by substantial lead and lag times, and that owner-occupied structures in particular typically have tenures of many years.

Based on these considerations, it is apparent that the set of variables determining consumer demand for homes and housing services is larger and more complex than the variables relating to virtually any other product or service. Yet, notwithstanding these complexities, vibrant, healthy markets for housing exist all around the United States, and homeowners across the country enjoy the benefits every day. The challenge for the analyst is to capture enough of the complexity to give meaningful results, without becoming mired in details and ambiguities that cannot be resolved.

2.1.3 An Integrated View of Housing Supply and Demand

While economic conditions in the housing sector are often depicted using supply and demand schedules in a conventional single-quadrant coordinate system (see Figure 1-2 above), this glosses over the distinction between housing as a service and housing as an asset. An alternative view that uses four quadrants to visually relate both aspects of the market, as presented in DiPasquale and Wheaton, is depicted in Figure 2-1 below.[2]

Figure 2-1
Four-Quadrant View of the Housing Market



The upper right quadrant contains the demand curve for housing services by renters or owner-occupants. The periodic rent payment is on the y-axis and the quantity of housing demanded is on the x-axis. The upper left quadrant relates the demand for housing services to the demand for purchase of houses; it contains a ray that starts at the origin and translates periodic rent (on the y-axis) to price of the underlying asset (on the x-axis). The slope of that ray represents a capitalization ratio that reflects factors discussed above. The lower left quadrant contains the supply curve for housing assets produced each period by the construction sector. Price of the asset is on the x-axis and amount of construction is on the y-axis. Finally, the lower right quadrant relates the amount of new construction per period to an equilibrium total housing stock, using a ray that starts at the origin. The slope of the ray is related to the depreciation and removal rates for existing stock.

The equilibrium condition for the housing market under this approach is represented by the rectangle overlaid on the four quadrants with corners on the lines (or curves) in each quadrant. This can be found by selecting different values of, say, the rent variable and moving around the

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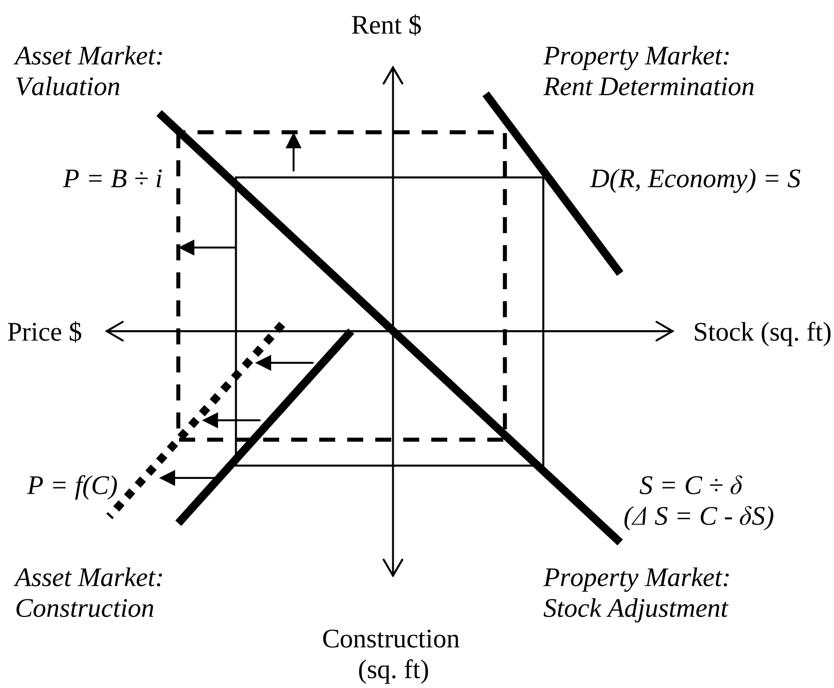
2 DiPasquale, Denise and William C. Wheaton, *Urban Economics and Real Estate Markets,* Prentice-Hall, New Jersey, 1996, p.8.

four quadrants using the line or curve in each quadrant. The value of rent that gives a closed rectangle (such as the box illustrated in the Figure) is an equilibrium point. Any other variable on either axis could be used as well (e.g. housing stock, level of construction, or price).

The impact of a regulation that raises construction cost can be traced through the four-quadrant model. The regulation would shift the line in the southwest quadrant to the left by an amount that reflects the increase in construction cost. The new equilibrium would be represented by a box shifted up and to the left, with higher price, higher rent, lower square footage in the equilibrium housing stock, and a lower level of new construction. This is illustrated in Figure 2-2, also based on DiPasquale and Wheaton, with the shifted supply schedule and the new equilibrium box shown as dotted lines and arrows denoting movement in the lines.

Figure 2-2
Effect of a Regulation Increasing Cost of Production



Advantages of this four-quadrant modeling approach include its visual orientation and the straightforward way it provides for incorporating variables that are clearly important, such as mortgage interest rates and depreciation of the existing housing stock. Yet it should not be concluded that the classical supply and demand approach previously shown in Figure 1-2 is inadequate or should never be used. Rather, the choice of which model to use depends on the regulation under study and availability of data.

2.2 Data Sources

In order to analyze the impact of a regulation on affordable housing, various types of data on building features, production costs, supply, demand, market prices, financing and other topics may be required. The relevant data will depend on whether the regulation affects new homes, existing homes, apartments, multifamily buildings, particular designs, particular locations, or some subset or combination of these and other variables. Fortunately, a great variety of potentially relevant data sources are currently available, including key federal surveys such as the Census and the American Housing Survey as well as data from numerous private organizations.

A general compilation of information about a wide range of potentially relevant, generally available data appears in Appendix A. This includes background discussion as well as detailed descriptions of data sources, lists of publications and web links. It can be used as a starting point for identifying data and parameters to be used in analyzing the housing impacts of a specific regulation. The individual data sources in Appendix A are organized under the following headings:

- General surveys and compilations
- Housing Supply
- Housing Demand
- House Prices
- Interest Rates
- Housing Finance
- Regulation Measures

Other sections of this report make frequent use of data sources cited in Appendix A.

2.3 Key Parameters from the Empirical Literature on Housing Markets

A cost-benefit analysis of a regulation affecting housing will have to rely on a number of parameters from the existing literature to estimate impacts. Given the wide range of possible regulations, it is difficult to narrow the list of valuable parameters. Nevertheless, it is quite likely that the analysis will entail elasticities of supply and demand for housing. Regulations that increase the cost of production (shift the cost curve up) are likely to increase the market price and affect the housing tenure decision as households seek less expensive housing options. If significant numbers of households decide to move, the impact model may need values for turnover and vacancy rates along with average sales times. Given the focus on affordable housing, this review of the empirical literature also includes several recent articles on the 'big picture' view of housing affordability showing trends in rents, house prices, user costs and house price burdens.

It is frequently not possible to summarize a body of research in a single number, like homeownership rate of 67 percent or elasticity of supply of 3.0. Often the estimates cover a range depending on the data and technique used. When the research has converged on useful point estimates, we report them, but other times the interested reader will have to dig into the literature for a specific application. This review of the literature is designed to facilitate that search.

A final word of caution… unlike in chemistry or physics, there are few economic parameters that do not change over time, place or subgroup. Modelers may be forced to use the 'best available' estimates from the literature, but they still have a responsibility to understand the limitations of the estimate. Some limitations are included in this review to explain the range of results. The full citations are listed at the end of the chapter for a better understanding.

2.3.1 Elasticity of Supply

If supply is responsive to price increases (elastic supply), economic theory says the increase in supply will soon match demand and return prices to equilibrium levels. On the other hand, if supply is not responsive to price increases (inelastic supply), the low amount of construction will not soon bring the market into equilibrium, and prices will rise even more. One possible explanation for rapidly increasing house prices in certain metropolitan areas is that supply is inelastic. That begs the question of why supply is inelastic, which we will get to, but first we review what is known about supply elasticity based on national time series.

Some of the earliest studies found evidence for elastic supply, though their methods and data are considered simplistic by today's standards. Muth (1960) found no significant relation between the price of housing and the quantity supplied for data from 1919 to 1934. The real value of new construction was regressed on the relative price of housing, controlling for building input prices. An insignificant coefficient on housing prices suggested that supply was so elastic that the quantity of housing could be high or low without much impact on prices, i.e., the supply curve was nearly flat. One problem with this approach is that it cannot distinguish between perfectly elastic and perfectly inelastic supply. In either case, there is no significant relationship between quantity supplied and price.

Follain (1979) improved on the econometrics,[3] but found similar results of elastic supply for data from 1947 through 1975. Olsen (1987) criticized the specifications used by both Muth and Follain, stating that the input prices they used were not exogenous and, therefore, should not have been considered independent variables. Blackley (1999) used a long time series, 1950-1994, and found elasticity estimates of 1.6 to 3.7. An elasticity of 1.6 means that an increase in house prices of 1 percent generates an increase in housing supply of 1.6 percent. Topel and Rosen (1988) used quarterly data on starts from 1963-1983 and found a long-run elasticity of 3.0. In another analysis using national data for 1963 to 1990, DiPasquale and Wheaton (1994), estimated supply elasticity in the range of 1.0 to 1.4. The traditional dividing point between elastic and inelastic is 1.0, so that findings of DiPasquale and Wheaton continue to suggest that housing supply is moderately elastic.

In reviewing the previous findings, Malpezzi and Maclennan (2001) thought the range of results might be sensitive to the time period examined. The highly elastic findings of Muth and Follain reflected a period of relatively flat or declining prices, whereas Topel and Rosen used years with rising prices. To avoid this sensitivity to time period, Malpezzi and Maclennan used the longest possible time series they could collect, 1889 to 1997, although their post-WWII models provide the most useful information for us. Malpezzi and Maclennan estimated two different kinds of models, a flow model (which assumes all adjustment takes place in a single year) and a stock adjustment model (which assumes an adjustment of 0.3 per year). Supply elasticity estimates for the flow model range from 6 to 13, while the elasticity estimates for the stock adjustment model were from 1 to 6. One reason for estimating a stock adjustment model is the assumption that supply is inelastic in the short run, but increases in the long run as developers more fully respond to the price change. That being the case, the authors could not explain why the stock adjustment model gave lower elasticity estimates and called for more research.

Mayer and Somerville (2000a) provide a different approach linked to Tobin's q theory (Tobin, 1969) and price changes rather than price levels. The idea is that construction starts are positive as long as q, the ratio of the market price of new housing to construction cost (including financing, land, labor and materials), is greater than one. Timing is important because it takes time for developers to obtain land suitable for building. A major source of delay and uncertainty is obtaining approval from local planning and zoning boards. Therefore the land available at time t (ld_t) is a function of expectations at time t-1 of the changes in house prices (Δp_t) and construction costs (Δc_t).

$$ld_t = f(E_{t-1}(\Delta p_t, \Delta c_t)) = g(\Delta p_{t-1}, \Delta c_{t-1})$$

[3] The regression models had better controls for simultaneity and serial correlation.

Starts are constrained to be the minimum of the ideal construction starts (S^*), given current demand, and the land that is available and ready for building (ld_t). S^* is a function of the current growth in house prices and construction costs, while ld_t is a function of lagged growth in house prices and construction costs. By substituting in the functions for S^* and ld_t, we get a new function for S_t in terms of the current and lagged changes of house prices and construction costs.

$$S_t = \min[S_t^*, ld_t] = \min[S_t^*(\Delta p_t, \Delta c_t), ld_t(\Delta p_{t-1}, \Delta c_{t-1})] = g[\Delta p_t, \Delta c_t, \Delta p_{t-1}, \Delta c_{t-1}]$$

This model supports an approach of estimating supply responses in terms of first differences rather than levels. Each housing market may have a different equilibrium level according to its location and industrial structure, but the supply response to price changes from the equilibrium level are expected to be similar. Moreover, in levels, supply and house prices are nonstationary[4] variables (Meese and Wallace, 1994; Rosenthal, 1999), and a regression of nonstationary variables can lead to spurious correlations (Granger and Newbold, 1974). The solution is to estimate the regression with first differences or changes, which are stationary variables. Thus, starts (the change in supply, ignoring conversions) are regressed on changes in house prices and construction costs.

Using quarterly national data from 1975-1994 (76 observations), Mayer and Somerville estimate that a 10 percent increase in real prices leads to a 0.8 percent increase in the housing stock created by a temporary 60 percent spurt in starts spread over 4 quarters. The authors criticize the stock-adjustment model for adjusting too slowly. The DiPasquale and Wheaton (1994) model closes the gap between actual and desired stock by only 2 percent per year, taking 35 years to reach the desired stock. The Mayer and Somerville model estimates an abrupt change in starts that lasts for a very short period of time and makes a surprisingly small change in the stock. The results may be sensitive to the relatively short estimation period, or the instrumental variable estimation for endogenous house prices and construction costs may be weakening the results.[5] Despite the weak empirical results, the model highlights the importance of land constraints in supply responsiveness.

A separate paper by Mayer and Somerville (2000b) emphasizes the impact that land use regulation can have on supply elasticity. They divide regulatory constraints into two classes:

4 A variable, y_t, is stationary if (for all t=1,2,...,n and for all k=...,-2,-1,0,1,2,... given t-k>=1) the following conditions are met:

$$E(y_t) = \mu$$
$$E[(y_t - \mu)^2] = \gamma_0$$
$$E[(y_t - \mu)(y_{t-k} - \mu)] = \gamma_k$$

Loosely, the conditions for stationarity are that the variable has a fixed mean and variance. Variables that are trending upward have an increasing mean and variance. First differencing takes out the upward trend and usually leaves a stationary variable suitable for regression modeling. (Fanses, 1998, p. 68)

5 The construction cost variable is insignificant in the Mayer and Somerville (2000a) models as it is in most of the DiPasquale and Wheaton (1994) supply models.

development/impact fees and delays in the approval process. The model attempts to determine whether it is the fees or the delay that is most responsible for a low supply response. Expecting delays, developers hold an inventory of land that is more-or-less ready for building. Greater uncertainty about the approval process could motivate developers to hold more land in inventory. When prices do increase, developers draw on their inventory, which suggests a fairly quick response in the short run but slows down as their inventory is depleted. In the long run, the supply response is limited by the approval process. That approval process can itself slow down either by political choice or as a result of bureaucratic overload from new requests.

Using AHS quarterly data for 44 metropolitan areas from 1985 to 1996, Mayer and Somerville regress the log of single-family permits on the change in house prices (and 5 lags), change in prime interest rate, log of population, and three measures of regulatory control. The regulation variables come from the Wharton Urban Decentralization Project (Linneman and Summers, 1991). The three regulatory measures are:

1. The number of months for subdivision approval,
2. A count of the number of ways growth management techniques have been introduced in the MSA (referendum, legal action, municipal, county, state authority or administrative action),
3. An indicator of whether development or impact fees are imposed in the MSA.

The model results show that a standard deviation increase in months delay causes a 20 to 25 percent reduction in the number of permits. Each additional method of growth management causes a 7 percent decline in permits. Put together, an MSA with 4.5 months delay and 2 methods of growth control has a 45 percent reduction in permits compared to an MSA with 1.5 months delay and no growth management. The coefficient on fees is insignificant, whereas the coefficient on delay is negative and significant, suggesting that delay is a bigger factor in supply inelasticity than fees. A model with price changes interacted with a regulation dummy lends support to the land inventory idea, because the negative impact of regulation takes several quarters to take effect. The key point, however, is that supply elasticity is lower in highly regulated housing markets. Even though supply elasticity is hard to measure and probably varies over time, we do have evidence that it is lower in a highly regulated environment.

A recent study by Glaeser, Gyourko and Saks (2004) emphasizes the links between the labor market and local housing supply. Looking over several decades, they observe that MSAs can grow rapidly, as much as 50 percent per decade, but decline only slowly, rarely more than 10 percent per decade. The growth asymmetry is a combination of long run elastic supply in construction and a durable stock that does not easily convert to non-residential uses. When housing supply is elastic, increases in labor demand create large increases in population, but relatively small increases in wages. Whereas when housing supply is inelastic (perhaps due to land use regulation), then increases in productivity and labor demand mean small changes in population, but large increases in wages and house prices. The authors also show that as urban density doubles, housing prices rise by 34 percent. In terms of long run supply elasticities, the message is that supply can grow in spurts but the stock declines gradually, so separate elasticities may be appropriate for gains vs. losses.

Primary data sources, like AHS and Census, do track changes in stock, but not usually on an annual basis. However, those data sources show that population in the 1990s increased by 33 million, at a faster rate than in previous decades, but construction only increased supply by 13 million, which is slower rate than in previous decades. Given cyclical patterns, especially in construction, changes across decades may be a crude measure, but it does appear that supply is not responsive to price changes in high-cost metropolitan markets. One explanation is that the housing market is really a set of market segments by quality. In equilibrium markets, new construction adds to high quality market segments and the older units filter down to supply affordable housing. In "hot" markets with excess demand, the downward filtering process is reversed, reducing the supply of lower-cost housing. Renovations and remodeling can exacerbate the problem by upgrading affordable units, which then become higher cost. The problem of high house prices seems to be inelastic supply, but it has been quite difficult to derive a consistent measure. One reason may be that supply elasticity varies by market, and it is difficult to get data for a large panel of metropolitan areas. The evidence we do have from a panel of AHS cities suggests that land availability and regulatory constraints are important factors in the responsiveness of supply to house prices.

Renovation. Based on AHS data for the 1990s, each year homeowners spent over $91 billion on remodeling, with a disproportionate share in the largest 35 metropolitan areas surveyed in the metropolitan AHS (Reade, 2001). Over 70 percent of the work is done by professionals, and the rest are do-it-yourself (DIY) projects. Of the total, 40 percent of the remodeling is spent on replacement projects and 38 percent for discretionary projects. Discretionary projects include kitchen and bath remodels, room additions, and space reconfigurations, while replacement projects are major system upgrades or substitutions of new for old. Discretionary spending is highest in high-cost cities such as San Francisco, Boston, New York City and Los Angeles. Replacement spending is most common in cities with older housing stock, such as Portland (OR), San Francisco, Cincinnati and Philadelphia. In addition, Duda (2001) notes that each year the federal government spends about $6 billion to renovate the housing stock. These funds are generally matched by state and local government funds as well as private spending. However, it is believed that most of that spending is not recorded in the remodeling expenditure statistics.

Malpezzi, Ozanne and Thibodeau (1987) estimate that net depreciation is in the range of 0.5 to 2.0 percent per year. At that rate, they projected that about 4 percent of the nation's $8.6 trillion housing stock would require maintenance (not including remodeling) and that would amount to roughly $300 billion per year. However, the Commerce Department estimates only about $100 billion per year is reported in spending on improvements, maintenance and repairs. This difference of $300 vs. $100 billion suggests that reported estimates of maintenance are grossly underestimated.

Statistics from the 2001 AHS show remodeling expenditures have reached $214 billion with $132 billion in homeowner improvements and $34 billion in homeowner maintenance and repairs and $48 billion on rental properties (Joint Center for Housing Studies, 2003). Since 1995, almost 90 percent of the 7 percent annual growth rate in remodeling expenditures is by owners. Projects costing $20,000 or more have gone from one-third of expenditures in 1994-95 to nearly one-half in 2000-01. Remodeling by minority owners is growing. Between 1995 and 2001, minorities accounted for 40 percent of the increase in homeowners and 39 percent of the improvement expenditures (compared to 5 percent growth among white owners). Regionally, the older homes, higher incomes, and limited new development of the Northeast have combined to make home improvement expenditures larger than new construction, especially in center cities.

The combination of low interest rates and growing house values has created a boom in cash-out refinancing. According to the Federal Reserve Board, between January 2001 and June 2002, 4.9 million households refinanced their homes and cashed out $131 billion of their equity. Of that amount, an estimated $46.3 billion was used for home improvement spending. There appears to be a positive feedback loop in which increasing house prices lead to increased equity, which allows cash-out refinancing used for home improvements and higher house prices.[6] All that is needed to speed up the process is low interest rates.

Gyourko and Tracy (2003) bring in transitory income as another factor driving renovation and home maintenance. Using AHS data for estimation, they found a maintenance elasticity with respect income of 0.16 (OLS) and 0.23 (IV, Instrumental Variable estimation to correct for measurement error in income changes). These elasticities fall in between the estimates of Dynarski and Gruber (1997) who estimated general expenditures from transitory income using Consumer Expenditure Survey data (0.08 for OLS and 0.60 for IV). The main point is that owners use their house for consumption smoothing. When transitory income is high, they use the extra income to remodel or do major repairs and when income falls those projects are deferred.

Market Segmentation, Maintenance and Filtering. High quality housing is usually distinguished from low quality (or affordable) housing, not only by the size and price of the unit, but also by the age and neighborhood of the unit. There are many gradations in quality and no one scheme of market segmentation can fully capture the distinctions. The general pattern is that

6 Case, Quigley, and Shiller (2001) show that housing wealth has a distinctly higher impact on consumption (elasticity about 0.06) than stock market wealth (elasticity about 0.03). During much of the 1990s, both the stock market and house prices rose together, boosting consumption. Since 2000, stock prices have been falling, but consumption has held up on the strength of house price appreciation and been facilitated by cash-out refinancing.

similar qualities are close substitutes and thus compete in price, while large quality differences do not compete, unless there is a major renovation or favorable surrounding neighborhood. Another general pattern is that newly built houses tend to be high quality with the latest styles and functionality, whereas older houses are lower quality with outmoded styles and lacking new features. As the units age, their value tends to fall though the rate of depreciation depends on the degree of maintenance, remodeling and new construction. If new construction is limited, perhaps by zoning regulation, then high-income households will focus their demand on the best of the existing units. Despite the age of those units, their value can be bid up and the normal pattern of downward filtering reversed. We highlight the issues of maintenance and filtering because they are a more important source of affordable housing than new construction.

The concept of filtering has a long tradition, starting with Lowry (1960), Grigsby (1963) and Olsen (1969), O'Flaherty (1996), and Bier (2001). Filtering has taken on several flavors according to its usage. Income filtering refers to units that shift from high-income households to low-income households as the unit ages. Price filtering features the shift from high quality units to low quality units over time as measured by the unit's price. Similarly, quantity filtering focuses on the decline in the quantity of housing services over time. The three kinds of filtering are closely related as new construction tends to offer more housing services at a high quality and price that only high-income households can buy.

Weicher and Thibodeau (1988) test the quantity filtering hypothesis using Census and AHS data. For each MSA, they regress the share of substandard housing on new construction. If downward filtering worked as described, the test should show that an increase in new construction would reduce the amount of substandard housing in an MSA. Controlling for vacancy, cost variables, demand variables and the share of government subsidized housing, the results showed that new construction does reduce the number of substandard units on a one-for-one basis. However, the share of government subsidized units does not affect the number of low-quality units. This finding suggests that the best way to reduce substandard housing is through private construction. That construction should not be modest quality units, but rather of high quality units letting the downward filtering supply the affordable units and replace the substandard units.

Murray (1983) uses national time series data from 1961 to 1977 to test the degree of crowding out or displacement from HUD-subsidized housing construction. The study found that privately financed low-quality housing starts did not increase the overall stock of housing. However, government-financed subsidized housing for low-income and elderly households did increase the total amount of housing. Over the long run, the 370,000 subsidized, government-financed units made a net contribution to the housing stock of 130,000 units or 35 percent. In a follow-up study, Murray (1999) used a longer time series (1935-1987) and reached similar conclusions. He hypothesized that public housing enables single parents to move out of their parent's unit and form their own household. Similarly, elderly move out of their children's unit and form independent households in their own unit. However, middle income households do not reconfigure, but rather switch from an old unit to a newer unit. The net effect is that subsidies for middle-quality units have the effect of replacing existing unsubsidized units with subsidized units or crowding out the private supply. On the other hand, public housing enables crowded households to expand into separate units without diminishing the demand for private units.

Empirical tests of filtering have focused primarily on rental housing, using AHS data. Malpezzi and Green (1996) estimate that an increase in the rental stock of 1.4 percent from new construction will increase the number of lower-priced, low quality units by 2.5 percent. Somerville and Holmes (2000) use multinomial logit estimation to estimate transitions of affordable units to higher rent (26 percent), owner-occupied (4 percent) or demolition (7 percent). Net of those changes, 52 percent of the units remain affordable and another 10 percent remain affordable with government subsidies. Somerville and Holmes also found that affordable units in mixed neighborhoods (many unaffordable units in the same AHS zone[7]) are more likely to filter up.

An analysis of affordable owner-occupied housing is provided by Collins, Crowe and Carliner (2001). Starting with the 1999 AHS, they divide owner-occupied houses into quartiles by market value. The comparison among quartiles shows that the income and education of the occupants, unit size, percentage of units detached, quality of unit and quality of neighborhood are positively correlated with house value, while the household head age, first-time buyer status, percent minority and the percent manufactured housing are negatively related to house value. Of particular note, the bottom quartile contains 32.5 percent manufactured housing and a significant portion of retirees, which account for the effect on both high age and low income. When 1997 and 1999 data are separated by regions of the country, the research shows that the share of low-income homeowners living in manufactured homes is increasing, especially in the South. Also, low-income homeownership rates have decreased slightly in high-cost areas such as the Northeast.

Adjusting for user cost of capital and metropolitan median incomes, taxes and insurance, a unit is designated as affordable if a household with 80 percent of area median income would qualify for a mortgage using conventional underwriting requirements (10 percent down payment and 28 percent housing payment-to-income ratio). By that standard, the affordable owner-occupied stock has shrunk from 47.3 percent in 1997 to 44.2 percent in 1999. Excluding manufactured housing, the West region saw the biggest drop, from 26.0 percent in 1997 to 21.3 percent in 1999. While low-income households generally live in the affordable stock, one-quarter to one-third of high-income households live in homes that meet the standard of affordability. From the high-income householder's point of view, income can be spent on non-housing consumption rather than moving into a more expensive house. From the low-income householder's point of view, the available stock of affordable units is smaller after the high-income households have had their pick. Undoubtedly, many low-income households cannot find a unit at their preferred

[7] An AHS zone is a contiguous territory of about 100,000 people with an effort made to group together socio-economically similar neighborhoods.

balance of quality and cost, so their demand is channeled to the closest substitute, which is usually more expensive.

Focusing on additions to the affordable owner-occupied stock between 1997 and 1999, there were a total of 540,000 units built within that 2 year period. Of those units, 69 percent (375,000) were manufactured houses, two-thirds of which (251,000) did not include ownership of the land. As for filtering of the existing stocks, upward filtering dominated with 1.4 value increases for each decrease. On net, 1.7 million units became unaffordable through changes in value. Another 153,000 became affordable as the net result of conversions and 157,000 were lost from the affordable stock due to vacancies. Overall, the affordable stock shrank between 1997 and 1999 primarily due to upward filtering, i.e., price increases.

Rothenberg, Galster, Butler and Pitkin (1991) subdivided the housing market into many submarkets according to tenure and household income. The empirical results show a very complex pattern of supply elasticities by submarket, which suggests that, far from constant, elasticities are context sensitive depending on the opportunities for conversion and substitution between submarkets. Elasticities are higher for markets with close substitutes.

McCloskey (1985) offers a less sophisticated approach that may be sufficient when the proposed changes are small and other markets can be assumed to remain unchanged. The price elasticity of supply for submarket *i* is ES_i approximated by:

$$ES_i = \left(\frac{Q}{Q_i}\right) * ES - \left[\frac{(Q - Q_i)}{Q_i}\right] * ED$$

where *Q* is the quantity sold in the total market, *Qi* is the quantity sold in the ith market, *ES* is the price elasticity of supply and *ED* is the price elasticity of demand.

Glaeser and Gyourko (2004) do not deny the possibility of filtering, but claim the filtering effect is dominated by the declining or growing cities effect. In their view, the growth in a city depends on labor productivity and then gets channeled according to the regulation and supply elasticity of that city. Positive shocks in productivity increase population more than house prices as long as housing is elastically supplied. House prices have to increase more than construction cost plus the cost of regulation to activate a supply response. The authors estimate that the elasticity of house price change to population gain is 0.23 compared to 1.8 for population loss. Negative shocks decrease housing prices more than they decrease population. The combination of cheap housing and weak labor demand seems to attract individuals with low levels of human capital. The net effect is that declining cities are highly persistent and low house prices prevent new construction. The skilled workers (college graduates) more readily migrate to growing cities and the unskilled go to inexpensive housing. But this is a trap, both for the workers and the cities. The increasing concentrations of unskilled workers generate more negative externalities than growth opportunities so the city is mired in a stagnant economy. A broader point for modeling purposes is to recognize the asymmetry in gains vs. losses. See also Redfearn, 2003.

2.3.2 Elasticity of Demand

Demand elasticities are usually easier to estimate because the large, public data sets, like Census and AHS, are household surveys. Those surveys contain measures for household demographics, income and some wealth along with house prices, which are the main ingredients for calculating price elasticity of demand. In fact, it may be more accurate to estimate demand elasticities for a particular application that are customized for a time and place than to take estimates from the literature. This section presents values and citations for income elasticity of demand and price elasticity of demand. The final portion provides a simple way to combine demand and supply elasticities to estimate the net change in market price and quantity.

Income Elasticity of Demand. DiPasquale and Wheaton (1996) estimate income elasticity of demand to be about 0.8, which corresponds to earlier estimates by Quigley (1979). Housing is certainly a necessity and low-income households spend a higher percentage of their income on housing than higher-income households. The precise estimate depends on how income is measured as well as how the households are selected. Goodman (1995) uses recent movers rather than all households because recent movers are more likely to have chosen the level of housing they wanted. In other words, recent movers represent equilibrium demand. Another adjustment by Goodman is to use permanent income rather than current income, which includes a substantial share of transitory income. In the short run, a household knows the transitory income will not last, so they are less likely to consider it in making a major purchase, such as a house, that requires regular monthly payments. When income elasticity is measured based on permanent income for recent movers, the estimate can exceed 1.0.

Malpezzi and Mayo (1987) also found income elasticity greater than one for the very long run. As communities develop, they spend progressively higher shares on housing. The house becomes something more than mere shelter. It transforms into a luxury good as a place for entertainment as well as an investment good. With restrictions on the supply of housing based on land use, the value of the house can increase beyond the replacement value and, indeed, faster than general inflation. Expectations about house price appreciation can justify spending a large portion of the household's current budget on housing costs. Ultimately, high capital gains when the house is sold can provide a high return on investment that is above and beyond the use value of the house.

Price Elasticity of Demand. The price elasticity of demand is generally considered in the range of –0.5 to –1.0 (Mayo, 1981; Malpezzi and Maclennan, 2001). Again, the precise estimate depends on the selection of households and markets. Households who are more mobile probably have lower transaction costs and, thus, are more likely to change housing based on a relative change in house values. Age of household head is another important factor in mobility. Older people establish roots in their community, are less likely to change jobs and are less likely to have additions to their household. Older households also tend to have more wealth. As a result, a selection of recent movers will have a smaller share of older households and a higher sensitivity to price when selecting a new housing unit.

Ellwood and Polinski (1979) estimated the range for price elasticity of demand from –0.75 to -1.20 with a preferred estimate slightly inelastic or less than 1.0 in absolute value. This estimate is widely cited and accepted. Most housing economists expect demand for housing to diminish slightly with an increase in prices, though the length of adjustment period and the availability of close substitutes could affect which end of the range is most appropriate. By comparison, Meeks (1993) estimates the price elasticity of demand for manufactured homes (MH) as –2.4, which is quite elastic. Presumably, manufactured homebuyers are more sensitive to price because MH is a low-cost alternative to site-built housing or rental housing. Other factors making demand more elastic are the low level of buyer income and the high depreciation rate for MH that makes it a less desirable long-term investment.

Combining Elasticities. For many regulations, it may be possible with engineering studies to determine the increased cost of production. The question then becomes: How much of the increased cost will be passed on to the consumer? In effect, the cost study tells how much the supply curve is shifted up, the question is what will be the equilibrium price given a downward sloping demand curve. HUD’s Regulatory Impact Analysis (1994) on wind standards for manufactured housing used the following approach:

$$Change\_in\_\text{Price} = \frac{ES * C}{ES - ED}$$

$$Change\_in\_Quantity = \frac{ES * ED * \left(C/P_1 \right) * Q_1}{ES - ED}$$

where *ES* is the price elasticity of supply, *ED* is the price elasticity of demand, *C* is the per unit cost increase, P_1 is the initial equilibrium market price and Q_1 is the initial equilibrium market quantity sold. The underlying presumption is that the change would be small enough so that the estimated elasticities would remain relevant and unchanged. Note that the elasticity of demand is assumed negative, so the denominator will be positive. The larger are the elasticities, either supply or demand, the smaller will be the change in price. Large elasticities mean flat supply and demand curves, so the change will affect quantity more than price. Given that the elasticities are unitless, the units in the change in price formula come from *C*. Similarly, the units in the change in quantity formula come from Q_1.

2.3.3 Housing Tenure

Beyond elasticities, there are many other parameters that could be useful in modeling the impact of regulations on housing. Green and Malpezzi (2003) provides an excellent overview of housing markets. Although the homeownership rate has been stable around 67 percent for several years, Green and Malpezzi point out that it has risen substantially from 45 percent in 1940 to 66 percent in 1980. The homeownership rate drifted down during the 1980s and recovered in the 1990s. Another fairly stable parameter is the share of households in government subsidized units, about 6 percent. The average household size has declined from 3.2 in 1970 to 2.6 in 2000.

In round terms, Mayer and Somerville (2000) describe the total housing stock as 100 million units including about 6 million manufactured housing units. About 2 million new single-family units are built per year. Most of the single-family rental units were originally built as owner-occupied, but later converted to rental so that about 25 percent of rental are single-family units. New construction accounts for about half of the new supply of housing; maintenance, renovation and remodeling provide the other half.

2.3.4 Turnover and Vacancy

DiPasquale and Wheaton (1996) are another useful source of information about the housing markets. In particular, they explain the relationship between mobility, vacancy and sales time. Mobility is related to age and tenure. Based on 1989 AHS data, 19 percent of owners and 45 percent of renters aged 25 to 34 years old moved in the last year. In contrast, for seniors (aged 65 and above), the percentage of movers drops to 2 percent for owners and 12 percent for renters. Over all ages, 7.6 percent of owners and 35.7 percent of renters move each year or 17.8 percent of all households moving each year. See also Berkovec and Goodman (1996) and Hort (2000) on turnover.

For single-family housing, about 8 to 10 percent of the stock is sold each year or about 5.5 million units. Vacancy for single family is quite low, about 2 percent or 1.3 million units. The ratio of vacant inventory to sales gives an average sales time of 0.24 years or 2 to 3 months. The vacancy rate for rental units is about 8 percent and the annual mobility rate is about 30 percent, which gives an average lease up time of about 3 months.

$$\text{Vacant inventory (units)} \div \text{Sales (units/year)} = \text{Average Sales Time (years)}$$

A higher vacancy rate for rentals is needed to accommodate the higher turnover or mobility rate for rentals. Beyond the frictional vacancy needed for turnover and maintenance, the variation in vacancy rates indicates how strong the demand is relative to supply. Tight markets with relatively high demand have low vacancy rates and short times to sale (1-2 months), while loose markets with relatively low demand have high vacancy rates and longer lease up or sales times (4-6 months).

Gabriel and Nothaft (2001) describe vacancy as having two components, incidence and duration. The incidence is determined by population mobility and duration is largely determined by search costs and heterogeneity of the housing stock. Rents are more responsive to incidence than duration.

2.3.5 Estimating Costs or Benefits from Real Estate Transactions

One measure of the cost of regulation is the reduction in construction, lending, home buying and maintenance. In effect, the cost of regulation can be partially measured as the loss in benefits from less real estate development. Collins, Belsky and Tripathi (1999) have written a useful paper "Estimating Economic Impacts of Community Lending." This paper provides very practical guidance and parameters for measuring the economic benefits of:

- Helping families buy their first home,
- Financing the construction and rehabilitation of homes, and
- helping financially-troubled households maintain homeownership.

Among the useful parameters, they provide a table of the length of stay for first-time home buyers (32 percent have moved after 5 years based on AHS data). The Consumer Expenditure Survey is tabulated to show that families moving into a new house have additional spending relative to income of 3.4 percent on furniture, 1.4 percent on appliances and 3.7 percent on home maintenance and insurance. See also Emrath (1994) "Consumption Spending of New Home Buyers."

For an estimate of real estate transaction fees, the real estate broker fee is 6 percent of the home price and the title insurance is 0.25 percent of the sale price. Mortgage origination fees average about 1 percent. Deed recording fees and transfer taxes average 1.25 percent of the sale price. Other closing costs include $300 for legal fees, $50 for credit reports, $150 for inspections and $100 in miscellaneous costs do not vary with the house price. Collins et al. (1999) estimate real estate transaction costs at 8.7 percent of the sales price. These values can vary significantly by local jurisdiction, so it is best to substitute local estimates when possible.

The local economic effects of construction spending is reported in Emrath (1997). The total dollars for the construction project can be multiplied by 0.686387 for total local income, by 0.000017 to get the annual full-time equivalent increase in local jobs and by 0.058274 for local government taxes and other revenue. Another section estimates the costs saved by preventing foreclosure.

2.3.6 Estimating Building Code Effects on Affordability

Hammitt, Belsky, Levy and Graham (1999) provide a detailed and thoroughly documented description of increased construction costs on affordability. The emphasis is not on how much the building code would cost, but rather what is the impact of that increased cost on the health and income of families. According to Hammitt et al., the higher construction costs increase the price of homes (both new and existing), which increase the health and safety risks through income and stock effects. The income effect arises because families spend more on housing and have less for health and safety. The stock effect is based on slower replacement of the existing stock of less-safe housing units. Overall, the research shows that a code change that increases construction or maintenance costs by $150 would induce “offsetting risks yielding between 2 and 60 premature fatalities or, including morbidity effects, between 20 and 800 lost quality-adjusted life years” (p. 1037).

2.3.7 Measuring Housing Submarkets

Housing submarkets are particularly important because houses are large, varied and permanent (or practically so). Unlike most commodities, the value of a house is closely tied to the location of the house and the arrangement of other houses nearby. Unfortunately, there is no simple or well-accepted way to define submarkets. The following four examples provide sophisticated techniques for defining and measuring submarket cross-effects. The reader can safely skip over this section, though Table 2-1 of supply elasticities may be useful for distinguishing between highly regulated and less regulated markets. Goodman and Thibodeau (1998 and 2003) use hierarchical linear modeling as a way to find similar submarkets. Rothenberg et al. (1991) takes more of a filtering approach in grouping units by building age. Bajari and Kahn (2005) develop a 3-stage hedonic model on a cross-section of Census data to estimate willingness-to-pay and demand elasticities. Finally, Harter-Dreiman (2003) takes a Vector Error Correction (VEC) approach with times series data at the MSA level to estimate supply elasticities. See Cameron, Muellbauer and Murphy (2005) for a time series model of interactions among the British regional housing markets. Ultimately, the analyst will have to decide which approach fits best and customize estimates for the particular housing impact analysis.

Goodman and Thibodeau (1998) use hierarchical linear modeling to identify housing submarkets and this technique could be translated for regulatory analysis. Every house falls into numerous jurisdictions: towns, counties, school districts, utility districts and development zones. The simplest approach would be to include fixed effect indicators for each type of jurisdiction. This approach captures the net effect of location on house value, but does not explain what causes that net effect. In addition, the fixed effect approach does not identify which housing submarkets are closely related to one another despite differences in jurisdiction. The impact of a regulation will depend, in part, on competition from related submarkets that do not face the new regulation or the added costs associated with the regulation. Demand will shift to other submarkets and the builder or seller of the regulated property will not be able to pass-through the regulatory costs. The availability of close substitutes makes the demand more price sensitive or elastic.

A first step in understanding cross-market analysis is the identification of housing submarkets. The technique presented by Goodman and Thibodeau (1998) builds on hedonic regression by interacting a neighborhood variable (school scores) with the size of a housing unit. The assumption is that neighborhood quality is capitalized in the value of the house and the interior size is a proxy for lot size. If the coefficient on the interaction of school scores with house size does not change when an area is added to the estimation sample, then the authors conclude the new area is really part of the same submarket. House prices respond the same way because the hedonic price of school quality (per square foot of house) is the same in either market.

In more detail, the hierarchical model in this example has two levels. The first level is a standard hedonic model of log house prices regressed on two structural characteristics: the log of dwelling size and a polynomial in building age. Let there be J school zones (j=1,...,J) and houses within the jth zone are indexed with i (i=1,...,n_j). Then the first level hedonic regression model is:

$$\ln(price_{ij}) = \beta_{0j} + \beta_{1j}\ln(size_{ij}) + \beta_{2j}age_{ij} + \beta_{3j}age_{ij}^2 + \beta_{4j}age_{ij}^3 + r_{ij}$$

where r_{ij} is the residual, $r \sim N(0,\Omega j)$. The second level of the hierarchical model estimates the impact of the neighborhood (quality of school) on the unit price per square foot.

$$\beta_{1j} = \gamma_0 + \gamma_1 score_j + u_j$$

where u_j is the residual, $u_j \sim N(0,\tau)$. Substituting for β_{1j} gives the combined model:

$$\ln(price_{ij}) = \beta_{0j} + \gamma_0 \ln(size_{ij}) + \gamma_1 \ln(size_{ij}) * score_j + \beta_{2j}age_{ij} + \beta_{3j}age_{ij}^2 + \beta_{4j}age_{ij}^3$$
$$+ \ln(size_{ij})u_j + r_{ij}$$

The residual is composed of the last two terms (shown on the second line), which means there is heteroskedasticity in the residual (increasing in size). The estimation accommodates that heteroskedasticity in an iterative process of Generalized Least Squares.

Based on the estimated coefficients for γ_1, the 18 school zones could be collapsed to 5 housing submarkets. Relative to the overall average house price, the low-cost submarket had a 47 percent discount and the high-cost submarket had a 44 percent premium. The 47 percent house price discount can be further apportioned to 18 percent, due to a hedonic price difference for the submarket ($\Delta\beta_i$), and 28.7 percent, due to a difference in housing characteristics (a combination of size and school quality).

In other words, house prices in the low-cost submarket were lower both because school quality is valued less and because there was lower school quality in that neighborhood. Similarly, the impact of a regulation will be a combination of the change in available housing characteristics (including neighborhood amenities) and a change in consumers willingness-to-pay for those characteristics. Any substitution in demand away from the target area of the regulation depends on the size of the target submarket and the similarity of neighboring submarkets. If the relevant submarkets are close substitutes and large, it may be relatively easy for homebuyers to avoid paying for the new regulation by buying outside the regulation area. In that case very little of the regulation-induced costs can be passed through to the buyer and most of the cost burden falls on the seller.

Rothenberg et al. (1991) use predicted values from a hedonic regression to subdivide an urban market into housing quality submarkets. Their method (pp. 381-382) entails pooling data across SMSAs, but estimating separate hedonic equations for renters. Then two predicted values were calculated, one for occupied units and the second for vacant units. Those values were summed for owners and renters separately across SMSAs. The distribution of aggregate values was partitioned into 6 submarkets by percentile (15^{th}, 30^{th}, 50^{th}, 75^{th}, and 95^{th}). The most heterogeneous submarket was the open-ended top category because the distribution is highly skewed to the right.

This approach to market segmentation does not consider geographic proximity or neighborhood effects, at least not directly. Rather, the researchers have grouped together units with the same structural characteristics, such as: number of rooms, age of structure, extent of plumbing, etc. Unfortunately, there is no theoretical basis for the selected specification or distribution breakpoints. The choices are largely driven by the kind of data available and how homogeneous the researcher wants the submarkets to be. The cross-MSA analysis was done on 1960 Census and 1975-76 AHS data. A different specification including 5 neighborhood attributes was estimated for a single SMSA, Des Moines in 1963 and 1971. Nevertheless, the approach does generate groups of houses containing about the same number of rooms, from the same decade and with the same quality of plumbing. The fact that 80 percent of the census tracts had units from four or more submarkets suggests that hedonic price is a better identifier for submarket than geographic area.

The empirical results estimating cross-market elasticities are notable for its wide range of results. The authors write (p. 424): "As a whole, these results indicate dramatically different price sensitivities in different sectors of the market, thereby challenging previous works that have attempted to estimate 'the' elasticity for an unstratified market." In the high-quality owner submarkets, the prices of adjacent submarkets had a positive cross-market elasticity, as expected. Relatively high prices for substitutes means owners will prefer their own submarket to expensive alternatives. The cross-market elasticity for quality submarket 4 relative to submarket 5 is about 2. The cross-market elasticity of submarket 5 for the lower submarket (4) is about 1. At the low end of the renter submarkets (1), the cross-market elasticity relative to the next better rental housing submarket is 3. If prices in rental submarket 2 are close to the prices in rental submarket 1, renters will readily substitute into the next higher submarket. Unfortunately, the lack of consistency or significance undercuts the reliability of the estimates. The price measures are the ratio of market price to hedonic price normalized by non-housing prices. The authors note that multicollinearity and the lack of distinguishing variation between submarkets was a problem. Better results may require quarterly or annual data on a smaller set of submarkets and allow for dynamic adjustment rather than assuming equilibrium housing markets.

Bajari and Kahn (2005) use a 3-stage hedonic model to estimate the demand and willingness-to-pay for housing attributes. In the first stage, a hedonic model is estimated with local polynomial modeling, which uses weighted least squares to give more influence to observations with similar outcomes. The second stage applies the first order conditions to calculate individual tastes from the implicit prices estimated in the hedonic regression and the observed choice of attributes. The third stage estimates a joint distribution of tastes and demographics by regressing household preferences on observed demographic characteristics.

There are several advantages to their method, which offset the more complicated estimation procedure. The first is that it can be applied using Census PUMS data. In fact, the empirical work looks at housing demand by recent movers in three metropolitan areas using 1990 Census data. Submarkets are defined by the PUMA areas. A second advantage of the technique is that it accommodates unobserved product characteristics. Ignoring those omitted variables would create a downward bias to elasticity estimates. A third advantage is that household preferences for continuous characteristics can be calculated from the first order conditions for utility maximization. Moreover, preferences for non-continuous characteristics can be estimated in a maximum likelihood framework. The last stage of the estimation relates individual taste coefficients to household demographics. The demand functions can be used to estimate marginal propensities to consume and elasticities. The willingness-to-pay estimates can be used to predict welfare gains or losses from a change in regulations.

Harter-Dreiman (2003) uses a time-series approach to measuring supply elasticity based on annual data for 76 MSAs from 1980-1998 as reported by OFHEO. The vector error correction (VEC) system is based on the cointegrating equation:

$$\ln(P_{it}) = \alpha_i + \beta \ln(I_{it}) + \upsilon_{it}$$

where $\ln(P_{it})$ is the natural log of house prices in MSA i at time t and $\ln(I_{it})$ is the natural log of personal income. The MSA fixed effects are captured by α_i and υ_{it} is the error term. The cointegrating equation is estimating in the first step and the fitted values for υit are included in equations for income and prices:

$$\Delta \ln(I_{it}) = \beta_{i0} + \beta_1 \Delta \ln(I_{it-1}) + \beta_2 \Delta \ln(I_{it-2}) + \beta_3 \Delta \ln(P_{it-1}) + \beta_4 \Delta \ln(P_{it-2}) + \lambda_1 \upsilon_{it} + \beta_5 D_{1986} + \beta_6 D_{1991} + \varepsilon i_{it}$$

$$\Delta \ln(P_{it}) = \alpha_{i0} + \alpha_1 \Delta \ln(I_{it-1}) + \alpha_2 \Delta \ln(I_{it-2}) + \alpha_3 \Delta \ln(P_{it-1}) + \alpha_4 \Delta \ln(P_{it-2}) + \lambda_2 \upsilon_{it} + \alpha_5 D_{1986} + \alpha_6 D_{1991} + \varepsilon p_{it}$$

where D_{1986} is a dummy for the impact of the Tax Reform Act of 1986 and D_{1991} is a dummy for the 1991 recession. One advantage of the VEC system is that it requires so few variables, but the lack of exogenous variation could also be considered a liability.

Assuming log linear demand and supply equations:

$$\Delta \ln(Q_d) = \xi_d \Delta \ln(P) + \xi_I \Delta \ln(I)$$
$$\Delta \ln(Q_s) = \xi_s \Delta \ln(P) + \xi_w \Delta \ln(W)$$

where Q is the quantity of housing, either demanded or supplied, W is the construction wage shock in the supply equation and ξ stands for the respective elasticities. This system can be solved for the elasticity of supply:

$$\xi_s = \xi_d + \xi_I (\Delta \ln(I) / \Delta \ln(P)) + \xi_w (\Delta \ln(W) / \Delta \ln(P))$$

Using estimates of demand and income elasticities from the literature and assuming no construction wage shock, Harter-Dreiman estimates a range for the elasticity of supply:

$$\xi_{SU} = (\Delta \ln(I) / \Delta \ln(P)) - 0.5 \qquad \text{for } \xi_I = 1 \quad \text{and} \quad \xi_P = -0.5$$
$$\xi_{sl} = 0.75 * (\Delta \ln(I) / \Delta \ln(P)) - 1 \qquad \text{for } \xi_I = 0.75 \quad \text{and} \quad \xi_P = -1.0$$

The empirical results from the cointegrating equation give the range of supply elasticities as shown in Table 2-1. The constrained cities are 28 cities with supply elasticity limited by regulation as determined by Malpezzi (1996).

Table 2-1
Supply Elasticities

Location	Range of Supply Elasticity
All Cities	1.8 – 3.2
Large Cities	1.4 – 2.7
Small Cities	0.92 – 2.1
Unconstrained Cities	2.6 – 4.3
Constrained Cities	0.97 – 2.1

From the price equation, we can estimate the speed of adjustment to shocks: about 70 percent of the adjustment occurs in the first 5 years and 90 percent within 10 years. Impulse response functions can also provide supply elasticity estimates for 10-year adjustment periods, which turn out to be very close to the supply elasticities from the cointegrating equation.

2.3.8 Housing Affordability

There are several recent reviews that provide good overviews of housing affordability, particularly of affordable rental housing. Quigley and Raphael (2003) show that house prices have increased in nominal and real terms, especially since the mid-1990s, but the housing cost burden for owners has done down due to falling interest rates and expected capital gains. The story for renters is different in that rent burdens have increased from 20 percent in 1970 to 26 percent in 1990 and 2000. Over the same timeframe of 1970 to 2000, the share of the lowest-income renters (in the bottom income quintile for renters) who are paying more than 30 percent of their income for rent has increased from 67 percent to 79 percent. From Quigley's and Raphael's point of view, the problem is low income rather than high rents, which in real terms have not changed dramatically. See also Malpezzi and Green (1996) and Goodman (2001) for other reviews of the "bottom of the U.S. housing market."

Finally, manufactured housing is an important ingredient in the U.S. housing market. Apgar et al. (2002) provide a good overview of the market with recent facts and many citations.

2.4 Potential Housing Affordability Metrics

An in-depth Housing Impact Analysis is presumed to include some measurement of how a regulation impacts housing affordability, along with information about price and quantity impacts on the housing sector. This section reviews different potential methods for quantifying affordability, or impacts on affordability. Most of the methods focus on affordability from the perspective of potential purchasers, and they generally address households and/or homes near median levels of income and price respectively.

2.4.1 Descriptions

- **NAR Housing Affordability Index: Ability of median-income family to buy median-priced home.** The most widely reported index for measuring housing affordability is the National Association of Realtors' "Housing Affordability Index" (NAR HAI), which "measures whether or not a typical family could qualify for a mortgage loan on a typical home." It actually measures more, showing how far overqualified or underqualified the median family is with respect to buying the median home. The data requirements for this index are extremely modest. It can be computed on a national basis or for any other desired market area so long as the median house price and median family income are known; distributions of house prices and family incomes are not required. An index value of, say, 120 means that a median-income family has 120 percent of the income required to qualify for a mortgage to buy the median-priced house. NAR HAI values are separately published for fixed-rate and adjustable mortgages, as well as a composite index. The index values based on composite mortgage rates have ranged from 130 to 140 over the last few years.

  The NAR HAI calculation assumes a 20 percent down payment, a qualifying ratio of 25 percent (i.e., monthly principal and interest payments on the mortgage cannot exceed 25 percent of gross income) and a 30-year loan at the "effective mortgage rate" for pre-occupied homes as reported monthly by the Federal Housing Finance Board (the "effective" rate reflects the amortization of initial fees and charges as well as interest on the note). The underlying equations used to calculate the NAR HAI are documented at http://www.realtor.org/Research.nsf/files/Formulas_HAI.pdf/$FILE/Formulas_HAI.pdf.
  Note that property taxes and insurance are not specifically considered, nor are ancillary expenses such as utilities. In addition, the index apparently is based specifically on sales of "preexisting homes" and so does not consider prices of new homes in determining the local median price. The NAR HAI is readily computed and often reported at the state or metropolitan-area level using local house prices and Census data. Long-term historical values of the HAI are available on the NAR and HUD websites. Note that the HAI is dimensionless, and theoretically can assume any non-negative value. Unpublished research suggests that from 1971 to 2002 the NAR HAI was been strongly negatively correlated with mortgage interest rates (r=-0.94)

  There are also limited statistics on the NAR website presenting NAR HAI values for first-time home buyers. Although the first-time-buyer methodology is not specifically documented, these index values appear to use prices for "starter homes," median incomes of first-time buyers, a 10 percent down payment, and the same effective interest rate used by the NAR HAI (but increased by 0.25% to reflect the cost of private mortgage insurance). Values of the NAR first-time buyer HAI for 2002 through 2004 ranged from 77 to 81, meaning that the median-income first-time buyer had about 80 percent of the income needed to qualify for a mortgage on the median-priced starter home.

- **Variant Housing Affordability Index: Percentage of families that can afford median-priced home.** This index, also sometimes referred to as the Housing Affordability Index, "measures the percentage of households that can afford to purchase a median-priced home". Like the NAR HAI, these values are based on a down payment of 20 percent and a 30-year mortgage, but unlike the NAR HAI, values of this index can only range from 0 to 100. As an example, values published by the California Association of Realtors show that in March 2003 this index was 28 percent for California and 59 percent for the U.S. as a whole. Logically a value of 50 for this index would correspond to a NAR HAI of 100. Computing this index for an area requires (1) a complete household income distribution and (2) a median house price for the area.

  The affordability impacts of a change in house price are sometimes quantified using a closely related approach. This involves selecting a base house price (which may be the median price or any other value), determining the number of households with sufficient income to theoretically afford the base house based on the usual down payment, mortgage terms and maximum housing expense limit, then adjusting the base house price to reflect, for example, costs of a proposed regulation, and determining the number of households with sufficient income to afford that house at the higher price. The difference in number of households corresponds to the number that are "priced out" by the price increase. Where the median house price is used, this corresponds to the change in this affordability index (multiplied by the number of households in the relevant area). Note that this difference in number of qualifying households is based on all households, whether or not they are currently in the market to buy a house. Thus, especially when expressed as a number of households rather than a percentage, the computed difference is a theoretical illustration of a change in affordability, and not an estimate of actual market impact.

- **NAHB-Wells Fargo Housing Opportunity Index: Percentage of homes affordable to median-income family.** The NAHB-Wells Fargo Housing Opportunity Index (HOI), which has been published since the third quarter of 2003, is a revised version of the NAHB Housing Affordability Index, which was published through the first quarter of 2002. For any given area, the HOI is defined as "the share of homes sold in that area that would have been affordable to a family earning the median income." NAHB bases incomes on annual median family income estimates for metropolitan areas published by HUD, while housing costs are based on prices in sales transactions compiled from public records and reported by a private firm. The HOI calculations assume a down payment of 10 percent, a 30-year fixed rate mortgage at the effective interest rate reported by the Federal Housing Finance Board, and taxes and property insurance based on NAHB estimates using metropolitan data from the Census Bureau, together with a qualifying ratio of 28 percent (monthly housing expenses divided by gross monthly income). The HOI is simply the percentage of sales transactions in a metropolitan (or other) area for which the monthly cost of the actual house purchased is less than or equal to 28 percent of the monthly median income for the area. Computing the HOI requires a distribution of house prices and a median income for the area of interest. Like the variant HAI, values of this index can range from 0 to 100, and a value of 50 would correspond to a NAR HAI of 100. However, the HOI and the variant HAI measure distinctly different things, with the variant HAI having units of percent of households that can afford the median-priced home, while the HOI has units of percent of homes that are affordable to the median-income buyer.

- **HUD Guidelines on Housing Affordability.** According to HUD guidelines, housing is "affordable" if it costs an owner or renter no more than 30 percent of gross monthly income for housing costs, including utilities. Households that pay more than 30 percent of gross monthly income for housing are sometimes referred to as "cost burdened." Various studies have used household-level data to estimate the number of homeowner and renter households that are cost burdened. This differs from the other affordability indices computationally, because it specifically includes utilities and it uses a 30 percent maximum ratio between housing cost and household income. It also differs conceptually, because it applies to occupied homes, and because it is performed house-by-house, basing the affordability determination on the combination of each home and the particular household that identifies. In effect it requires a joint distribution of housing costs and household incomes, rather than separate distributions of the two variables like the other indices.

- **H.R. 3899 Definition of Housing Affordability.** This bill, the proposed "American Homeownership Act of 1998", set forth a procedure for incorporating a Housing Impact Analysis into federal rulemaking actions, and specifically called for evaluating impacts on housing affordability. Section 102(j) defined the term as follows:

> "The term 'housing affordability' means the quantity of housing that is affordable to families having incomes that do not exceed 150 percent of the median income of families in the area in which the housing is located, with adjustments for smaller and larger families. For purposes of this paragraph, area, median family income for an area, and adjustments for family size shall be determined in the same manner as such factors are determined for purposes of section 3(b)(2) of the United States Housing Act of 1937."

This method of quantifying affordability is similar to the NAHB HOI, except that it uses 150 percent of median income rather than 100 percent of median income as the reference point for determining housing cost (and will, therefore, indicate that more housing is affordable than would the HOI). Like the HOI, basic data requirements for calculating this affordability index in any given area include (1) a distribution of house prices in the area, and (2) median family income for the area. There is no explicit guidance about how to translate household income into house payment (down payment amount, interest rate, etc.), although other affordability indices show how this can be done. The implications of the required adjustments for family size in the definition are not clear.

- **Rental Housing Affordability.** No published index tracking the affordability of rental housing has been identified. Various calculations assessing the ability of rental households to spend different amounts on housing appear on the National Low Income Housing Coalition website; for example, at http://www.nlihc.org/oor2000/wherefrom.htm. These are related to assessing affordability at the household level using the HUD 30 percent criterion. However, these appear much more complicated to derive and interpret than the other affordability indices described above.

2.4.2 Summary and Limitations

The following table lists key information about the affordability metrics described above.

Table 2-2
Summary of Housing Affordability Metrics

Name	Source	Definition	Range	Data Required
NAR - Housing Affordability Index (HAI)	National Association of Realtors	Median income ÷ median house price	≥ 0	median income, median house price
Variant HAI	Local Realtors	Percent of households that can afford the median-priced home	0-100	mortgage parameters, income distribution, median house price
Housing Opportunity Index (HOI)	NAHB - Wells Fargo	Percent of homes that are affordable to the median-income household	0-100	mortgage parameters, median household income, house price distribution
HUD Guidelines	custom tabulations	Percent of households with housing costs above 30 percent of gross monthly income	0-100	joint distribution of housing costs and gross monthly income
H.R. 3899 (1998)	not tracked	Percent of homes that are affordable to a household with 150 percent of median income	0-100	mortgage parameters, median income, house price distribution, adjustment factors

These methods for quantifying the affordability of housing all have various limitations. None of them consider inflation or anticipated price appreciation on investments in housing. They do not consider the tax benefits or after-tax cost of homeownership, which vary by state, by household and over time. They do not consider the separate affordability burden presented by down payment requirements, even for buyers who have the income to qualify for the necessary mortgage. And they do not reflect adjustments for changes in housing quality, so the product for which affordability is being tracked can itself be changing over time in square footage, amenities, location and other features.

Data limitations are another consideration, especially for a method that may be applied in a wide range of markets. The NAR HAI requires only a median income and a median sales price. The variant HAI requires a distribution of incomes and a median sales price. The HOI requires a distribution of sales prices and a median income. The variant HAI may be easier to determine so long as recent Census data can be used to compile an income distribution, since median sales prices are widely available. However, until American Community Survey data become widely available, updated income distribution data may be less available than house price distribution data. The best choice may depend on the circumstances.

HOUSING IMPACT ANALYSIS

3. Performing a Preliminary Housing Impact Analysis

3.1 Preliminary HIA Overview

This section describes the procedures an analyst can use to perform a Preliminary Housing Impact Analysis (HIA) of a proposed regulation. The Preliminary HIA represents a starting point that is intended to provide a basic, straightforward estimate of the impacts of the regulation on costs of owner-occupied and rental housing. Results of the Preliminary HIA are specifically used to determine whether or not an in-depth analysis of the regulation is appropriate.

This section begins with an overview of the evaluation process and a discussion of how the Preliminary HIA relates to the In-Depth HIA. Section 3.2 describes potential criteria that can be used to determine whether impacts estimated in the Preliminary HIA warrant development of an In-Depth HIA. Although there are several possible criteria, this report recommends that federal regulations use an overall dollar threshold (such as $100 million in total annual impact on housing costs) as the judgment criterion, similar to the general approach used to determine if a formal Regulatory Impact Analysis is required under E.O 12866. State regulations could use a lower dollar threshold with similar analytical methods. Section 3.3 presents the basic steps involved in generating the Preliminary HIA. Finally, Section 3.4 reviews a series of federal regulations and presents tables showing how the preliminary HIA would be applied to those regulations.

While the procedures discussed in this section are somewhat generic in nature, they have been designed in light of current processes used by federal agencies to review the costs and benefits of regulatory activities. That is, when an executive branch agency proposes a new or amended regulation, the agency is required under E.O. 12866 to screen the proposal and determine whether or not it is a "significant regulatory action." A significant regulatory action is one with an estimated annual impact on the economy of $100 million or more per year. "Annual impact" is broadly defined to include higher costs and lost profits or consumer surplus, as well as transfer payments. If the screening process determines that the regulation is economically significant, the Agency is required to prepare a Regulatory Impact Analysis (RIA) identifying and, where feasible, quantifying the benefits and costs of the rule. The RIA is first published in conjunction with a Proposed Rule, and revised if necessary when a Final Rule is published. If the internal screening determines the regulation is not economically significant, then the finding is documented for the record, no further impact analysis is required under E.O. 12866, and the agency certifies its finding as part of the rulemaking notice. Of course these specific requirements do not apply to state or local regulations, although presumably they undergo some type of screening process and, where needed, more detailed analysis that could potentially be used to address housing impacts as well as other impacts.

This section describes how to incorporate a HIA into a larger overall process of regulatory impact analysis, whether the underlying regulation originates with a federal agency or at some other level of government. Laying out a straightforward procedure for doing this and integrating it with existing requirements will simplify compliance by all agencies, including agencies that do not have a specific mandate or specialized expertise relating to housing. The overall approach can be summarized as follows:

1. If an internal screening analysis determines that a regulation does not require detailed study of economic impacts (e.g., for a federal agency, no RIA is required), then no HIA is required. The purpose is to exempt rules with generally modest overall economic impacts from any requirement to specifically assess housing impacts. At the federal level, the most common basis for such a determination is that total economic effects are not expected to exceed $100 million per year.

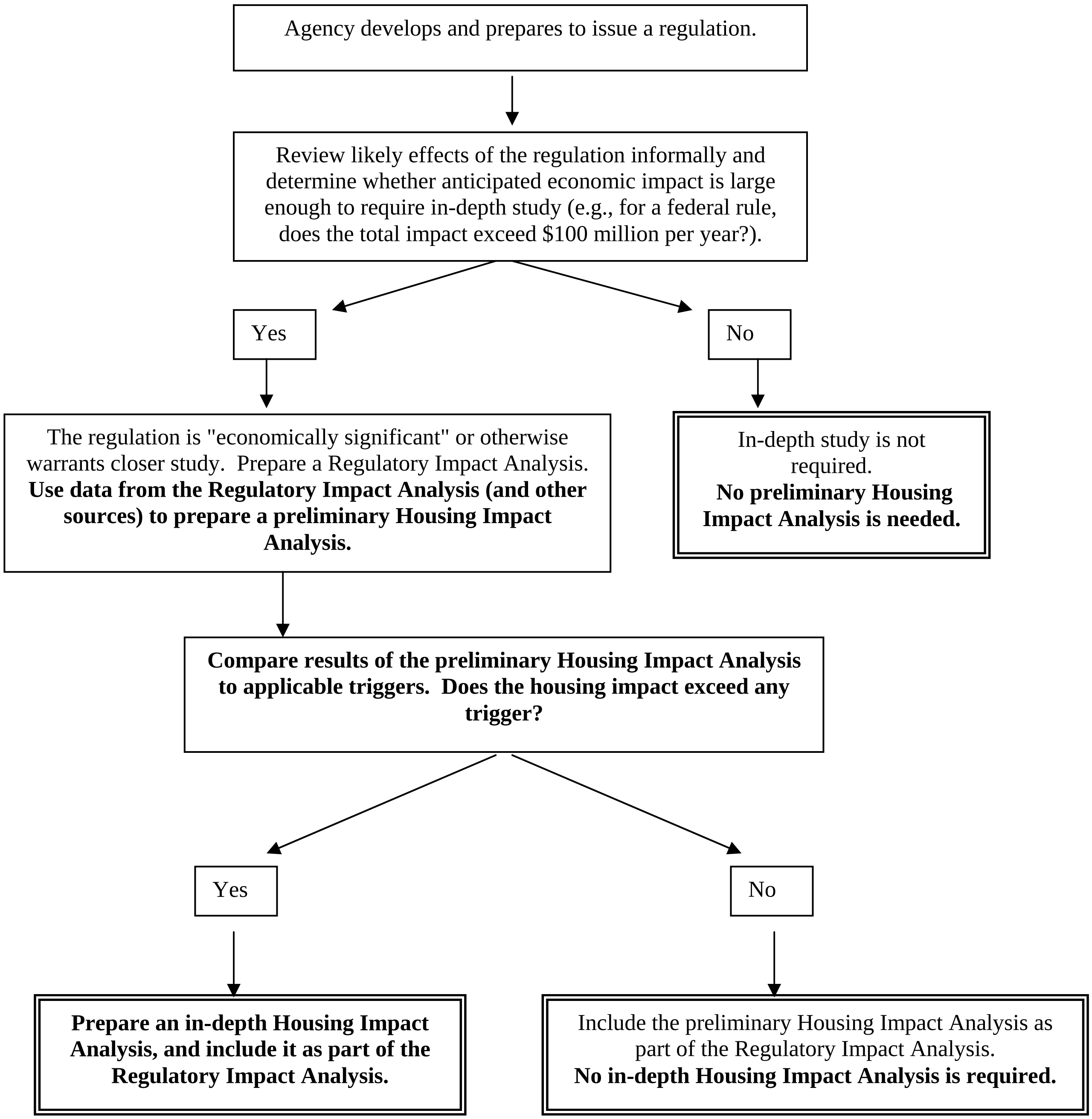
2. If the internal screening analysis determines that the regulation is likely to have a sufficiently large economic impact, then a regulatory impact analysis of the rule should be developed, identifying the costs, benefits and transfer payments resulting from the rule. At that point a preliminary HIA is also prepared. The preliminary HIA is designed to assess potential housing impacts and give a simplified assessment of their magnitude. It should build as necessary on information in the underlying RIA. Deferring the preliminary HIA to this point ensures that basic quantifications of impact are available for use as inputs.

3. Results of the preliminary HIA are compared to a screening criterion or set of criteria ("triggers") to determine if an in-depth HIA is required. For example, if housing cost impacts are estimated to exceed $100 million per year, then an in-depth HIA could be required. If an in-depth HIA is not required, then the preliminary HIA is included as a part of (or supplement to) the RIA, and no further analysis is necessary. Note that the appropriate trigger(s) may depend on the level of government adopting the regulation, with smaller triggers being more appropriate for state or local rules than for federal rules.

4. If results of the preliminary HIA trigger a requirement for an in-depth HIA, then it is prepared and included as a part of (or supplement to) the RIA. In addition, the agency should review the results of the in-depth HIA to determine whether it is feasible to revise the regulation to reduce housing impacts or adverse effects on housing affordability, while still achieving the underlying regulatory goals. The agency should document its analysis and explain the changes to the rule, if any, resulting from the review as part of the HIA.

A flowchart summarizing this approach is in Figure 3-1 below.

Figure 3-1
Flowchart for Implementing Housing Impact Analysis



Implementing this approach requires defining criteria that would trigger an in-depth HIA based on results of the preliminary HIA, specifying a methodology for performing a preliminary HIA, and specifying a methodology for performing an in-depth HIA.

3.2 Potential Standards for Determining "Significant" Impact on Housing

Federal agencies engage in many thousands of rulemaking activities each year. In the interests of efficiency, an in-depth Housing Impact Analysis should not be required for all proposed rules. Rather, it is assumed that a preliminary analysis of housing impacts will be performed, using a simplified methodology, to determine whether or not potential effects of a rule on the housing sector are "significant", or large enough to warrant an in-depth analysis.

The present section identifies a series of potential standards or rules, any one or more of which can be used to determine whether the results of a preliminary analysis indicate the need for an in-depth analysis. Several possibilities are described, not all of which need be applied. While it is important to incorporate a standard of significance into the preliminary analysis procedure in order to avoid in-depth analysis of irrelevant rules, the ultimate choice of which trigger(s) to use is not a matter of economic theory, but a question of policy.

3.2.1 Standard Based on Total Housing Market Impact

The most straightforward potential standard would be based on total housing market impact. That is, assuming a preliminary analysis leads to an estimated total housing market impact (i.e., impact on total consumer cost of housing), the estimated market impact can be compared to an arbitrary cutoff value. If it exceeds the cutoff, an in-depth analysis will be required.

Use of a cutoff based on total housing impact is similar to the existing process by which a rule is reviewed under E.O. 12866 to determine if it is "economically significant", meaning it has a total anticipated impact on the economy of more than $100 million per year. If so, a Regulatory Impact Analysis is required. An analogous rule for application here would say that if the total impact of a rule on the cost of housing exceeds $100 million per year then an in-depth Housing Impact Analysis is required as part of the rulemaking process; otherwise it is not required. Of course a different cutoff such as $50 million per year or $200 million per year could also be used.[8]

Most regulations will not directly affect all households or consumers of housing, but will have effects concentrated in one or more sub-groups within that overall population. These sub-groups could include homeowners, renters, all house purchasers, new home purchasers or existing home purchasers. Given a cutoff of $100 million per year, the threshold effect on any of these groups depends on how large the group is. For example, a regulation that affects all existing homes (and no others), would have to impose costs averaging $1.33 per house per year to reach a total impact of $100 million per year, while a regulation that only affects newly built homes would

8 The $100 million cutoff value dates back at least to E.O. 12291, which was issued in 1981.

have to add an average of $67 per house to reach $100 million per year. Table 3-1 illustrates the minimum impact per unit in each sub-group that would total $100 million if all units in a category are uniformly affected, assuming impacts fall entirely within that subgroup. Of course, few if any regulations will affect all homes, or all housing units in any of the subgroups. Regulations that only affect a fraction of units would require proportionately larger impact per unit to reach the cutoff value and trigger a requirement for a housing impact analysis.

Table 3-1
Housing Impact Analysis Standard Based on $100,000,000 Total Market Impact

Affected Group	Approximate Quantity	Amount per unit
Homeowners	75,000,000	$1.33 per year
Renters	25,000,000	$4.00 per year
All house purchasers	6,000,000 per year	$16.67
- New house purchasers	1,500,000 per year	$66.67
- Existing house purchasers	4,500,000 per year	$22.22

3.2.2 Standard Applying a Sliding Scale to Total Housing Market Impact

The use of a single standard such as $100 million per year as presented above is simple, but there are reasons to at least consider using other approaches. For example, as a matter of policy, regulations that would impose very large costs on small numbers of housing units might be subjected to an in-depth housing impact analysis, even if the total estimated impact does not exceed $100 million per year. Under this approach the larger the per-unit cost impact for affected units, the smaller the total estimated impact would need to be.

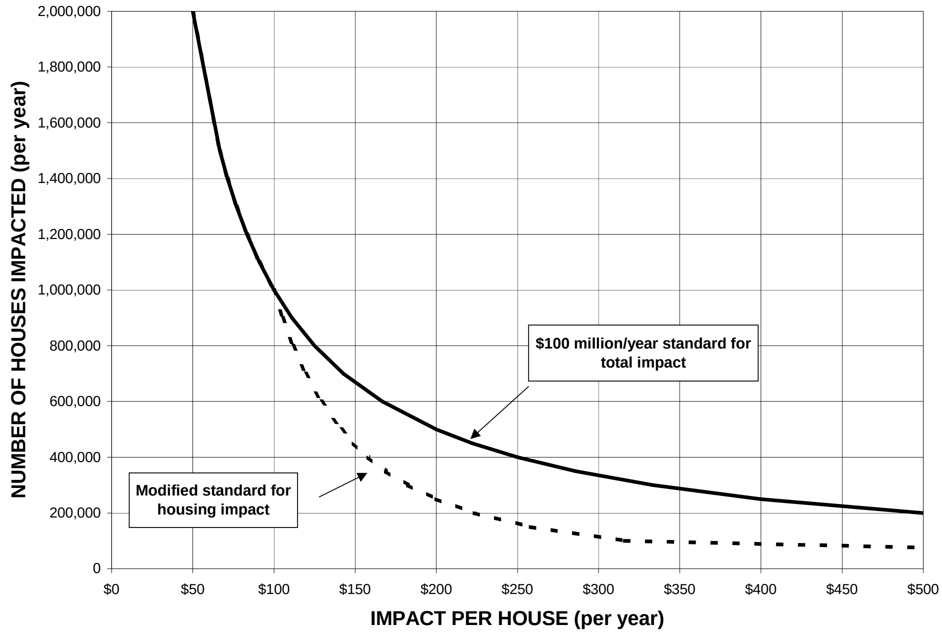
Table 3-2 illustrates a framework that could be used for this purpose. The first row of the table corresponds to the traditional $100,000,000 total impact rule. Successive rows represent higher dollar cost or percent cost increase per unit that could also trigger an in-depth HIA even though the total impact on housing costs is less than $100 million. For example, the second row indicates that a regulation which increased cost by more than $1,000 per unit (or 0.5 percent of the base cost) and affected more than 50,000 units per year would trigger an in-depth analysis, while the bottom row indicates that a cost increase of more than $10,000 per unit affecting more than 1,000 units per year would also trigger an in-depth HIA. While these numbers are arbitrary, the idea is that the minimum total impact drops as the dollar cost burden per unit increases.

Table 3-2
Total Impact Triggers for In-Depth Housing Impact Analysis

Number of housing units affected per year	Size of impact per affected unit (either column)		Total Impact on Housing Costs	In-depth HIA Required?
	Dollar cost increase	Percent cost increase		
any	any	any	$100,000,000	Yes
> 50,000	> $1,000	> 0.5%	$50,000,000	Yes
> 20,000	> $2,000	> 1%	$40,000,000	Yes
> 5,000	> $4,000	> 2%	$20,000,000	Yes
> 1,000	> $10,000	> 5%	$10,000,000	Yes

Under this approach, regulations imposing very high per-unit costs (above $1,000) would be closely evaluated for housing impacts even where they affect relatively few homes. In principle this can be implemented with the same general type of data now used to determine whether total impact exceeds $100 million per year. A variation on this approach that avoids the discontinuities inherent in the table is illustrated in Figure 3-2. The heavy curve represents the current $100 million total impact trigger, while the dashed curve illustrates potential relaxed criteria for rules with high unit impact.

Figure 3-2
Housing Impact Analysis Trigger Values



Using this Figure, if the point corresponding to average cost impact of a rule and number of affected housing units lies above and to the right of the dashed line, an in-depth analysis is required, even if the point lies below the heavy line (i.e., total impact is less than $100 million).

There are some serious issues with this method. Even if the underlying principle is acceptable, it could prove arbitrary or difficult to select an appropriate dashed line for the modified standard. The way the groups are defined could affect the sensitivity of this procedure and change the results. Unfortunately, the approach becomes unwieldy or complex to implement when many different groups are affected by different amounts. Assessing the groups one at a time seems incomplete while aggregating them and using average impacts masks the extremes and is essentially the current approach. Simultaneous evaluation of multiple groups without aggregation could be very difficult.[9]

3.2.3 Standard Based on Large Impact in a Small Market Area.

Triggers that compare overall impact to a fixed dollar threshold do not address the possibility of substantial impacts on homes in a small market area. Rules such as designation of critical habitat for an endangered species might fall in this category, imposing relatively large costs on homes in

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9 In principle, any number of groups could be used to develop a "cumulative impact" curve, showing how many households have impact greater than or equal to any given value. Then the cumulative impact curve would have to be compared to the criteria (e.g., the dashed line in the Figure). If the cumulative impact curve rose above the criteria curve at any point, then the in-depth analysis would be triggered.

a small geographic area. A separate test for concentrated impacts could be devised to address this. So, for example, an in-depth HIA could be triggered if impacts averaging more than a specified amount (say, $1,000 per unit or 0.5 percent of value) are experienced by at least a minimum number of units per year (say, 10,000) in a market area or areas up to a given size (say, containing up to 5,000,000 housing units). If so, then an in-depth HIA would be required to accompany the RIA. The problem is that data needed to make this determination appear to go beyond what will usually be available in a RIA.

3.2.4 Standard Based on Disproportionate Impact on Lower-Income or Rental Housing.

Concern about housing affordability is commonly driven by concerns about the inability of lower-income households to pay the cost of decent housing along with all the other costs of ordinary living. The triggers identified so far do not discriminate between impacts on entry-level homes or apartments and impacts on luxury housing, yet many would consider a regulation that adversely affects inexpensive housing to be more socially detrimental than a regulation that has a comparable impact on luxury homes. For this trigger, the regulation is assessed specifically for its impact on consumer costs of lower-cost housing (for example, housing occupied by consumers below median income). If the total impact on consumer costs of these housing units exceeds a fixed cutoff (such as $50 million per year), then an in-depth HIA would be triggered. However, compliance costs are usually based on the physical characteristics of the unit, so determining cost as a function of occupant income instead could be difficult. Similarly, given that incomes of renter households are generally below incomes of owner-occupants, and in view of the societal interest in facilitating the transition into homeownership, a special trigger based specifically on impacts on rental housing might be warranted. So, for example, even where total housing impacts do not reach $100 million, if they are substantial and are concentrated in the rental sector then an in-depth HIA would be triggered. A separate trigger for rental housing impacts could be used for this purpose.

While the foregoing sections identify several possible approaches other than total dollar impact for triggering an in-depth analysis, there is no clear practical alternative in hand. Therefore, the discussion that follows generally assumes a total dollar impact standard will be used.

3.3 Guidelines for Preliminary Housing Impact Analysis

Some general points about the approach to a preliminary HIA are listed below.

- The primary purpose of the preliminary analysis is not to characterize impacts with precision, but rather to get an overall sense of how large the impacts on housing costs are likely to be, and use that information to determine whether an in-depth analysis of housing impacts is necessary. There is no need to do a detailed HIA of a regulation that appears unlikely to have more than a *de minimis* impact on housing costs.

- The housing cost impacts assessed in a HIA are not necessarily additive to cost impacts documented in the underlying RIA of the regulation. Rather, they may simply be a different way of looking at the cost impacts of the regulation. For example, a standard setting higher efficiency levels for air-conditioning systems clearly will impose higher costs of production on manufacturing companies, and the regulatory impact analysis will naturally focus on determining these costs. However, the higher manufacturing costs would likely translate into higher costs for distributors and/or air conditioning contractors, with those higher costs representing housing cost impacts to the extent they are passed through to new home buyers, homeowners replacing old systems, or landlords who raise rents to recover higher costs. In other words, developing a Housing Impact Analysis will frequently involve translating costs imposed at one point in the process into costs experienced by the consumer of housing (whether homebuyer, homeowner or renter). It would usually be misleading to add the housing cost impacts to the higher costs of manufacture to determine "total costs" of the regulation.

- Although this discussion and examples in this report focus on significant adverse impacts on housing costs rather than positive impacts or benefits, there is no reason a preliminary HIA (or, for that matter, an in-depth HIA) could not be performed, using essentially the same approach, for regulations that reduce housing costs, or regulations that have mixed effects on housing costs for different groups. However, housing cost increases imposed on one group and housing cost decreases imposed on another should be tracked separately and not netted out against each other. This ensures that policymakers can understand all the implications of their decisions and explicitly weigh mixed impacts.

- The relevant housing costs ultimately to be determined are those imposed on homebuyers, homeowners or renters by reason of their role as purchaser, home owner and/or tenant. These costs can take several different forms, such as higher house purchase prices, higher transaction costs for purchases (loan origination or closing services), higher periodic payments for mortgage, taxes, PMI or homeowners insurance, higher costs of house operation, maintenance and repair, higher rents, and possibly other similar costs.

- In some cases it may be unclear whether a cost is properly considered a "housing cost." For example, costs for water, sewer and electricity used in homes are necessary expenses that presumably should be included as costs of house operation, but telephone and cable TV costs might not be. Where the classification is unclear, the analysis should at least identify the issue and explain how the costs are being treated.

- Key simplifying assumptions that can be used in preparing the preliminary HIA are:

    - all costs imposed by the regulation on intermediaries (such as product manufacturers, distributors, developers and trade contractors) are marked up and passed through to the ultimate consumer of housing (home buyer, homeowner or renter),

- for owner-occupied units, regulatory costs financed through a mortgage or other loan are treated as incurring costs in full the year the borrowing takes place, without regard to amortization or tax benefits,
- for rental units, costs are counted when they are incurred by the building owner, even though they might be passed through to the tenant and recovered over a period of time,
- price changes resulting from cost pass-through do not affect housing production or consumption, so *ex ante* market data can be used to estimate impacts and there are no changes in consumer surplus or producer surplus, and
- there are no cross-price effects between different sectors of the housing market so, for example, higher prices for new homes do not affect prices for existing homes or market rents.

The purpose of these simplifying assumptions is to make the preliminary analysis much more straightforward, and to defer more complex questions about impact to an in-depth HIA, if required. Some of the simplifications, such as immediate 100 percent pass-through, appear to represent a "worst case" approach for impact on housing consumers, although there is no claim that this method will always overstate impact. However, if the analyst chooses to set forth and use a more rigorous approach for preliminary analysis, that is also acceptable.

- Reductions in housing cost to purchasers, homeowners or renters should not be netted out from increased costs, even if both cost increases and cost reductions result from the rule, except to the extent that both increases and decreases are experienced by the same households at or near the same point in time.

- If multiple alternatives for the regulation are under consideration (e.g., different levels of stringency), then the housing impact of each alternative should be separately calculated, and the need for an in-depth HIA should be made separately for each alternative. Another possibility would be to do an in-depth HIA for <u>every</u> alternative if the impact of <u>any</u> alternative would warrant it. This is a policy judgment and not a question of methodology.

- If effects of the regulation are expected to vary significantly from one year to the next, then the impact analysis should be conducted over a reasonable period of time, and results for the year with the greatest impact should be used to determine whether an in-depth HIA is necessary. If the regulatory impacts are expected to reach and remain at a "steady state" within a reasonable period, then the time period should extend until the steady state is reached, and results for the steady state should be considered along with results for earlier years in determining whether an in-depth HIA is necessary.

General steps in preparing the preliminary HIA and determining the need for an in-depth HIA are as follows:

1. **Estimate the average cost imposed by the regulation per affected housing unit.**
   Estimate the impact of the regulation on the cost of building and, if appropriate, operating an affected housing unit. This step is necessary because most regulations that affect housing costs do not impose costs directly on consumers of housing. Rather, they impose costs directly on others involved in the production or sale of homes and housing services, such as land developers, product suppliers, trade contractors, home builders or landlords. These types of direct and immediate impacts are typically quantified in a RIA from a federal agency. So, for example, an OSHA regulation requiring worker protection against falls is analyzed based on its direct impact on roofing contractors and similarly affected trades, and a Department of Energy requirement to increase the energy efficiency of central air conditioners is analyzed to determine costs imposed directly on air conditioner manufacturers. Yet each of these regulations presumably affects the cost of housing as well, because the directly affected parties will attempt to pass their higher costs to their customers, and so on, until the consumer of housing is reached.

   Estimating the potential impact of a regulation on the cost of a housing unit typically involves taking the immediate cost impact on the regulated party and converting it to cost impact per housing unit by applying appropriate mark-ups and conversion factors. For example, if a regulation increases the costs of land development by $X per acre, this can be converted to cost impact per housing unit by first multiplying times average lot size in acres, then times a correction factor (between 0 and 1) representing the net lot yield from development-sized parcels, and finally by a factor corresponding to the home builder's mark-up of the lot price. Or, as another example, if a regulation increases the cost of producing central air conditioning systems by $Y, this can be multiplied times a factor representing markup to the retail level, then times the number of air conditioning systems per new home and finally times penetration of central air in new housing to compute the impact on cost of new housing. If the costs vary significantly across housing units by type, design, method of construction, location or other factors, then the conversion to cost per housing unit can be performed for each category of housing, and the average cost can be based on a weighted combination of all the categories.

   Owner-occupied vs. rental units. For owner-occupied units the cost becomes a "housing impact" when it is paid by the owner. For rental units the costs are typically experienced by the owner, who attempts to pass it through to the tenant as part of the rent. It would be possible to estimate the higher stream of rental payments corresponding to the owner's pass-through of a one-time cost, and this would accurately reflect the impact on the renter. But for many regulations affecting multifamily or rental properties this will lead to a scenario where total impacts on renters grow over time, because the number of affected renters grows each year and each affected renter pays a premium each year. It appears that for purposes of the preliminary HIA a simpler procedure would be highly desirable. Therefore, it is suggested that in analyzing rental properties the preliminary analysis should treat the costs of regulation as experienced by the landlord as "housing impacts" without modeling whether and how those costs will be recovered from the tenant. It is equivalent to assuming those costs are immediately passed through from the owner to the tenant, in full. This will simplify the analysis and tend to lead to a higher estimate of impact in the early years. Certainly if an in-depth analysis is ultimately performed, one relevant topic would be to use a more realistic approach to modeling impacts as renters will actually experience them over time.

2. **Estimate the total number of housing units experiencing cost impacts due to the regulation.**
   Estimate the total number of housing units likely to experience the calculated average cost from #1 due to the regulation, or determine the proportion of units so affected and multiply by annual new home production (for impacts on buyers of new homes) or the stock of homes or apartments (for impacts on owners of existing homes or renters). If the cost analysis in #1 is done separately for multiple categories of housing, then use this process to estimate the number of affected units in each category.

3. **Estimate the gross housing impact due to the regulation.**
   The gross housing impact from the regulation equals the average cost increase per housing unit (from step #1) multiplied by the number of housing units affected (from step #2). If multiple categories of housing units are analyzed for cost in step 1 and for incidence in step 2, then multiply cost and incidence together for each category and sum over all categories to determine the gross housing impact.

4. **Determine if an in-depth analysis is required.**
   The principal result that would trigger an in-depth analysis is a gross housing impact that exceeds a predetermined amount, assumed for this discussion to be $100 million per year. Because this is an annual rate, the units must be correct. For a rule imposing one-time costs this would be computed for year N as:

   $$\textit{units impacted in year } N \times \textit{ total dollar impact per unit.}$$

   For a rule that imposed recurring costs this would be computed for year N as:

   $$\textit{total units impacted through year } N \times \textit{ dollar impact per unit in year } N.$$

   The $100 million per year impact standard is simple, straightforward and customary. It would make no distinction between an impact of $100 on each of 1,000,000 households each year, or an impact of $10,000 on each of 10,000 households per year. Of course, the $100 million critical value could be reduced proportionately where state or local regulations are being analyzed, based on the size of the state or local housing market relative to the national market. More complex approaches discussed in Section 3.2 might reduce the $100 million cutoff for regulations that impose high per-household costs, or for regulations that disproportionately impact rental units, or lower-income households. However, alternative criteria based on the characteristics of impacted households may be difficult or impractical to implement, especially where the amount of impact varies widely across affected households. The whole question of just what result should trigger an in-depth analysis is essentially a policy decision, not a question of economic theory or methodology.

For many, indeed most, proposed rules, this preliminary HIA based on these procedures will not trigger an in-depth HIA. The vast majority of rules will have no clear or direct impact on housing costs. Other rules might have a plausible effect that is too small or too broadly diffused. A federal agency's explanation of why an in-depth analysis is not required could then be summarized in the RIA or the Federal Register notice for the rulemaking. But for other rules the relationship to housing costs will be clearer, and an in-depth HIA will be triggered based on results of the preliminary HIA.

3.4 Examples of Preliminary Housing Impact Analysis

This section presents examples showing how the preliminary HIA process described above would be applied in the context of historical rulemakings from several different federal agencies, and reviews whether or not the results indicate an in-depth HIA would be required. Specific RIAs used for the examples evaluate the following regulatory proposals:

- DOE energy efficiency standards for residential central air conditioners and heat pumps
- EPA standards restricting emissions of volatile organic compounds from paints and other architectural coatings
- EPA Phase II stormwater management rules for erosion control at construction sites
- HUD regulations implementing the Real Estate Settlement Procedures Act
- OSHA fall protection standards for workers on construction jobsites
- EPA effluent guidelines and standards regulating discharge of wastewater from construction sites, and
- HUD regulations for improving the resistance of manufactured homes to high winds

The material on each rule begins with a summary based on the Regulatory Impact Analysis. Next, basic housing impact calculations for the rule are presented in a table, generally organized in a standard format by housing type (new and existing single-family detached, new and existing multifamily, new and existing manufactured housing). To the extent possible, the calculations are based on data taken directly from the RIAs and represent data that were current when the underlying RIA was prepared (as if the preliminary HIA had been prepared at the same time). Data from other sources such as the American Housing Survey are occasionally used, and additional values are estimated when necessary. The computed housing impacts for different regulations should only be compared very cautiously, since the dates range from 1992 through 2002 and no attempt has been made to adjust any dollar figures for inflation. Markups are presented as a multiplier in percentage terms where a markup listed as "120%" means a base cost is multiplied by 1.20 (i.e., increased by 20%). Comments on many specific entries appear in the tables or in notes under each table. The discussion assumes that the $100 million gross housing impact threshold is the only trigger for invoking an in-depth housing impact analysis.

3.4.1 DOE: Central Air Conditioner Efficiency Standard (RIA 2002)[10]

This regulation was promulgated by DOE under the National Appliance Energy Conservation Act (NAECA) to revise the minimum efficiency ratings for central air conditioners and heat pumps. Efficiency ratings quantify the number of BTUs of cooling delivered for each watt of electricity consumed by the equipment, and are expressed as "Seasonal Energy Efficiency Rating" (SEER). The baseline requirement for most of these equipment types was SEER 10. The RIA evaluated potential requirements of SEER 11, 12, 13 and 18 using life-cycle costs (LCC) and payback periods. The efficiency standard ultimately selected was SEER 13 (subsequently lowered to SEER 12 but changed back to SEER 13 by judicial action).

Central air conditioning systems are essentially universal in new homes in many areas and quite common in others, with some homes including multiple systems. The equipment is less common but still widespread in the housing stock as a whole. As part of the LCC analysis of revisions to the standard, Table 5.8 of the report estimates weighted-average total installed costs for central air conditioners and heat pumps based on SEER levels of 10, 11, 12, 13 and 18. For split system air conditioners the costs to upgrade from SEER 10 to SEER 12 and SEER 13 are $274 and $479 respectively. For split system heat pumps the cost to upgrade from SEER 10 to SEER 12 and SEER 13 are $265 and $487 respectively. While the higher SEER adds to equipment cost, it also saves energy and reduces operating costs. The RIA estimates cooling energy savings for increases in SEER, heating energy savings for increased heat pump efficiency, and impact on repair costs. Simple payback analysis was also performed, as contemplated by NAECA.

Market penetration of air conditioners and heat pumps is based on data for the nine Census Divisions from the 1997 Residential Energy Consumption Survey. The report cites data indicating that about 34 percent of air conditioner and heat pump shipments went to new homes. Total future shipments are forecast based on separate modeling for new construction, discretionary replacements, replacements due to product failure, and replacements due to remodeling. Chapter 10 presents a "Consumer Sub-Group Analysis" limited to households with incomes at or below the poverty line, concluding that the life-cycle cost benefits of moving to higher efficiency levels are less for low-income households than for households in general, and simple payback periods are longer, primarily due to lower electricity prices to that group.

The report does not specifically estimate the impact of higher air conditioner and heat pump costs or lower operating costs on the prices or production of new or existing homes or apartments, or the affordability of new or existing houses or apartments. Lower life-cycle cost would represent an overall improvement in affordability so long as affected consumers have

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10 *Technical Support Document: Energy Efficiency Standards for Consumer Products: Residential Central Air Conditioners and Heat Pumps*, U.S. Department of Energy, May 2002. The complete document, which includes an RIA and other materials, is available at http://www.eere.energy.gov/buildings/appliance_standards/residential/ac_central_1000_r.html (as of December 1, 2005).

access to capital at the assumed discount rate used to compute life-cycle cost. Table 3-3 presents Preliminary Housing Impact Analysis results based on data in the RIA.

Table 3-3
Preliminary HIA for DOE Central Air Conditioner Efficiency Standard

Annual impact:	**Option 1 10->12 SEER**	**Option 2 10->13 SEER**	
New single family detached (SFD) homes	1,256,000	1,256,000	*2001 New One-Family Houses Completed*
x A/C or HP per home	1.15	1.15	*treats heat pump as if it is CAC; 10-20% have two systems*
x % of homes with central A/C or HP	86%	86%	*census data give 86% for 2001*
x SEER 10->12/13 upcharge	$274	$479	*NOTE: around 12-20% currently SEER 12, 4-5% are SEER 13*
x contractor/builder markup	132%	132%	*upcharge based on 120% x 110% (totals 132%)*
= total impact on new SFD homes	**$449,273,109**	**$785,408,100**	
New SFD homes affected per year	**1,080,160**	**1,080,160**	
Existing SFD homes	67,129,000	67,129,000	*2001 AHS total occupied detached homes*
x A/C or HP per home	1.0	1.0	*more than one system only applies to new*
x % of homes with central A/C or HP	50%	50%	*older buildings, northern states, window units*
x SEER 10->12/13 upcharge	$274	$479	
x hvac contractor markup	120%	120%	
x annual replacement rate	6.67%	6.67%	*based on 15-year life for CAC and heat pump*
= total impact on existing SFD homes	**$735,733,840**	**$1,286,191,640**	
Existing SFD homes affected per year	**2,237,633**	**2,237,633**	
New apartments (including SFA)	315,000	315,000	*2001 MF completions per Census*
x A/C or HP per home	1.0	1.0	
x % of homes with central A/C or HP	75%	75%	*93% in 2004 but some are whole-building*
x SEER 10->12/13 upcharge	$375	$580	*assumes single-package system*
x builder/contractor markup	132%	132%	*probably low; markup by GC and subcontractor*
= total impact on new apartments	**$116,943,750**	**$180,873,000**	
New apartment units affected per year	**236,250**	**236,250**	
Existing apartments (including SFA)	31,913,000	31,913,000	*all units except SF detached per 2001 AHS*
x A/C or HP per home	1.0	1.0	*assume all are single-package systems*
x % of homes with central A/C or HP	50%	50%	*adjusts for buildings with large CAC systems*
x SEER 10->12/13 upcharge	$375	$580	*about $100 per unit higher than split system*
x hvac contractor markup	110%	110%	
x replacement rate	7.5%	7.5%	*assumes about a 15-year system life*
= total impact on existing apartments	**$493,654,219**	**$763,518,525**	
Existing apartment units affected per year	**1,196,738**	**1,196,738**	
New manufactured housing	193,229	193,229	*2001 total shipments per MHI*
x A/C or HP per home	1.0	1.0	
x % of homes with central A/C or HP	77%	77%	*percent of new placements with CAC in 2001 per MHI*
x SEER 10->12/13 upcharge	$274	$479	*assumes split system*
x manufacturer/retailer markup	110%	110%	
= total impact on new manufactured housing	**$44,844,200**	**$78,395,517**	
New mfg. housing units affected per year	**148,786**	**148,786**	
Existing manufactured housing	7,219,000	7,219,000	*occupied MH units per 2001 AHS*
x A/C or HP per home	1.0	1.0	*more than one system very unlikely*
x % with A/C or HP	40%	40%	*some will have window or through-the-wall systems*
x SEER 10->12/13 upcharge	$274	$479	*assumes split system*
x hvac contractor markup	120%	120%	
x annual replacement rate	6.67%	6.67%	*based on 15-year service life*
= total impact on existing mfg. housing	**$63,296,192**	**$110,652,832**	
Existing mfg. hsg. units affected per year	**192,507**	**192,507**	
ANNUAL TOTAL HOUSING COST IMPACT	**$1,903,745,310**	**$3,205,039,614**	
Total homes affected per year	**5,092,074**	**5,092,074**	
Average impact per affected home	**$373.86**	**$629.42**	

NOTES:

Annual energy savings due to higher efficiency are not included in the calculation
Heat pump systems are treated exactly like CAC due to similar requirements, functionality and cost impacts
Around 12% - 20% of split systems already are rated SEER 12 or above and would not be affected (RIA p. 5-112)
Suggests impact under Option 1 might be about 20% lower
Around 4% - 5% of split systems already are rated SEER 13 or above and would not be affected (RIA p. 5-112)
Suggests impact under Option 2 might be about 5% lower
Units with SEER 11 (either option) or SEER 12 (Option 2) would experience smaller incremental cost impacts

The calculations in Table 3-3 assume that central air conditioning units are sold to and installed by HVAC contractors who mark up higher costs by 20 percent. Units sold to builders for new construction are marked up another 10 percent. The calculations reflect the growing trend to install two central air conditioning systems in a single home for improved overall performance, assumed to take place in 15 percent of new homes. Because some new homes in northern states lack central air conditioning systems, the new home impact is multiplied by the fraction of new homes with air conditioning (approximately 90 percent according to Census data).

For existing homes, the calculations require data about penetration of air conditioning in the stock of existing homes and the service life or annual probability of replacement of those units. Table 3-3 above assumes that 50 percent of existing homes have central air conditioning systems or heat pumps. This adjusts for homes without cooling systems as well as homes cooled by window units (which are not covered by this rule). There is a 20% subcontractor mark-up for existing homes, but no builder markup, and a typical service life of 15 years is assumed, implying that between 6 and 7 percent of systems are replaced each year.

For new and existing multifamily buildings, only a fraction use central air or heat pump systems covered by the rule. For those cases it is assumed the owner pays or finances the increased construction cost required to pay for the more expensive equipment, with costs treated as incurred at that time for purposes of the preliminary analysis. Actual pass-through of this cost to tenants over time is not modeled, nor are energy savings. Note that if the tenant pays utilities then any subsequent rent increase would be offset by the energy savings, so the tenant's total housing costs (including utilities) may increase, decrease or remain the same. On the other hand, if the owner pays the utilities then the owner's higher carrying cost would be offset, in whole or in part, by the value of the energy savings, and the rent may not change in the first place. These factors could be further evaluated in an in-depth analysis.

For manufactured housing impacts are based on 2002 placements of 192,000 units, and a 2001 stock of 7.2 million occupied units. According to the Manufactured Housing Institute just under 80 percent of new units in 2002 had central air conditioning. It is assumed that 40 percent of existing units have central air conditioning and the average service life is 15 years.

Preliminary impacts of both variations of the proposed rule on housing costs appear at the bottom of the table. First-year cost impacts for the increases to SEER 12 and SEER 13 are about $1.9 billion and $3.2 billion respectively. Both values exceed the $100 million trigger, so an in-depth Housing Impact Analysis would be required for both efficiency levels. Note that these calculations do not adjust for current penetration of units meeting the proposed efficiency levels, which means the SEER 12 impact may be overstated by as much as 20 percent, and the SEER 13 by around 5 percent. In addition, energy savings resulting from the regulation are not reflected in these numbers, even though they might be sufficient, in present value terms, to offset the higher cost of equipment. This would properly be addressed in an in-depth analysis.

3.4.2 EPA: VOC of Architectural Coatings Rule (RIA July 1998)[11]

The EPA Architectural Coatings VOC Rule, issued under Title I of the Clean Air Act of 1990, is designed to prevent formation of smog in the lower atmosphere by reducing emissions of volatile organic compounds (VOCs) from architectural coatings such as paints, stains, primers, sealers, varnishes and numerous related products used throughout the building industry. The rule limits VOC content, which primarily affects coatings formulated with organic solvents rather than water-based products such as latex paint. Manufacturers have several ways to comply: they can reformulate non-complying products to increase solids and reduce solvent content, they can take advantage of a "tonnage exemption" for small amounts of non-complying production, or they can pay "exceedance fees" on excess VOC content.

The RIA indicates that 60 percent of architectural coatings are used in residential properties, roughly two-thirds of that amount by do-it-yourselfers and the rest by contractors. There is no information about what amount of these products are used in a typical home.

Based on modeling of how the compliance alternatives would be used for different types of coatings, the report indicates that prices for the products would rise by less than $0.01 per liter, leading to a drop in output of less than 0.1 percent (p. 3-5). Annual net social welfare loss (deadweight loss) of $22 million is projected, including producer, consumer and government sectors (p. 3-8). Appendix D of the RIA describes the methodology for tracing price and quantity impacts through two related markets (i.e., the regulated product and a substitute product), and for computing the producer and consumer components of deadweight loss. The RIA does not specifically analyze the impact of the projected $0.01 per liter price increase for architectural coatings on the cost, price or production of new homes, on the cost of maintaining existing homes, or on housing affordability.

Table 3-4 presents results of a Preliminary HIA based on data in the RIA. The Table adjusts for the fact that the rule impacts new residential properties only to the extent they are built using solvent-based paints and stains. It also impacts existing residential properties where solvent-based paints and stains are used for maintenance and repair. There has been a trend in recent years away from oil-based and towards water-based paints and stains for household applications. Judgmental estimates of the overall use of architectural coatings used per home and the penetration of solvent-based products in that mix are used. In light of these factors it appears the rule will have very little impact on housing costs, with an estimated total less than $600,000 per year for all housing units combined. No in-depth HIA would be required based on this Preliminary HIA.

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11 *Economic Impact and Regulatory Flexibility Analyses of the Final Architectural Coatings VOC Rule.* U.S. EPA, Office of Air Quality Planning and Standards, Final Report, EPA-452/R-98-002, July 1998. Available at http://www.epa.gov/ttn/atw/183e/aim/aimpg.html (as of December 1, 2005).

Table 3-4
Preliminary HIA for EPA Architectural Coatings VOC Rule

Annual impact:	**LOW VOC**	
New single family detached (SFD) homes	1,271,000	*1998 site-built SF housing starts (per census)*
x liters of paint/stain per home	50.0	*interior walls, ceilings, exterior trim, some siding: 12.5 gallons*
x % solvent-based	10%	*alkyd paint mostly on exterior trim, also oil-based stains*
x added cost per liter	$0.01	*per RIA*
x builder/painting contractor markup	120%	*assumes added costs are at wholesale level*
= total impact on new SFD homes	**$76,260**	
New SFD homes affected per year	**1,271,000**	
Existing SFD homes	62,111,000	*Occupied SFD homes per 1997 AHS Table 2-1*
x liters of paint/stain per home	50.0	*about 12.5 gallons per home*
x % solvent-based	10%	*exterior trim, windows, siding; stains*
x added cost per liter	$0.01	
x painting contractor markup	120%	
x replacement rate	10%	*ten-year replacement cycle*
= total impact on existing SFD homes	**$372,666**	
Existing SFD homes affected per year	**6,211,100**	
New apartments (including SFA)	344,900	*MF units started in 1998 (C20 January 1999)*
x liters of paint/stain per home	25.0	
x % solvent-based	5%	
x added cost per liter	$0.01	
x painting contractor markup	120%	
= total impact on new apartments	**$5,174**	
New apartment units affected per year	**344,900**	
Existing apartments (including SFA)	29,832,000	*Occupied units with >1 unit in structure per 1997 AHS*
x liters of paint/stain per home	25.0	*much less than for a house (6.25 gallons?)*
x % solvent-based	5%	*less outside area for apartments than houses*
x added cost per liter	$0.01	
x painting contractor markup	120%	
x replacement rate	20%	*five-year replacement cycle for rental properties*
= total impact on existing apartments	**$89,496**	
Existing apartment units affected per year	**5,966,400**	
New manufactured housing	372,843	*1998 mfg. housing shipments per MHI website*
x liters of paint/stain per home	25.0	
x % solvent-based	10%	
x added cost per liter	$0.01	
x painting contractor markup	110%	
= total impact on new mfg. housing	**$10,253**	
New mfg. housing units affected per year	**372,843**	
Existing manufactured housing	6,544,000	*Occupied mfg.housing per 1997 AHS*
x liters of paint/stain per home	25.0	
x % solvent-based	10%	
x added cost per liter	$0.01	
x painting contractor markup	110%	
x annual replacement rate	10%	
= total impact on Existing mfg. housing	**$17,996**	
Existing mfg. hsg. units affected per year	**6,544,000**	
ANNUAL TOTAL HOUSING COST IMPACT	**$571,845**	
Total homes affected per year	**20,710,243**	
Average impact per affected home	**$0.028**	

NOTES:

Does not specifically include anything for paint or stain on pre-manufactured components
-- these would include wood flooring, architectural woodwork, paneling
More detailed approach could consider siding types, e.g. wood and stucco require painting

3.4.3 EPA: Final Phase II Storm Water Rule (RIA October 1999)[12]

The EPA Phase II Storm Water Rule requires implementation of best management practices to control storm water discharges from one- to five-acre construction sites (larger sites were covered by a previous rule). The rule was adopted under the Clean Water Act and is designed to prevent construction site runoff containing sediments and/or toxic pollutants from affecting rivers, lakes and wetlands. Chapter 4 of the RIA presents estimated costs of compliance through technical means (silt fences, mulch, seeding, stabilization, earth dikes and sediment traps) as well as costs of securing a waiver for eligible sites. Costs are applied to 27 prototype sites (3 site sizes x 3 levels of soil erodibility x 3 slopes) with average cost estimated at $1,206 (all costs are in 1998 dollars) for a one-acre site, up to $8,709 for a five-acre site. Administrative compliance costs of $937 per site were added to this amount. For each of the estimated 15 percent of sites eligible for a waiver, a cost of $34.19 was assigned. These per-site costs were applied to a total of 110,223 affected sites per year, divided into three size categories (note that the rule would not affect subdivisions or projects larger than 5 acres, which were already subject to regulation, nor would it affect smaller sites where similar programs were already in effect). Overall costs for erosion and sediment control were estimated at just over $500 million per year. In addition, the costs of post-construction runoff controls were also estimated for multifamily projects.

These figures were supplemented by an analysis of potential small business impacts that converted them to average compliance cost per home of $404 (5.3 homes on a one-acre site), $651 (8.5 homes on a 3-acre site) and $480 (20.1 homes on a 5-acre site). Average compliance costs ranged from about 0.3 percent to 0.4 percent of median home sale price, and slightly lower proportions of mean sales price. The report acknowledges that "it is unlikely that the compliance costs ... would have a significant effect on [small building contractors] because costs will be passed on to the eventual purchaser of the property" (p. 8-9). Multi-family residential compliance costs were estimated at 0.2 percent to 0.4 percent of the median condominium price, or 0.4 percent to 0.9 percent of the median apartment price, using a similar methodology.

The RIA includes comments on other relevant issues, noting that contractors building single family detached residences are able to pass regulatory costs on to buyers in light of highly elastic long-run supply and relatively inelastic demand. They point out that "this cost increase will affect a very small share of the overall housing market" since during that time only 21.6 percent of homes sold were newly built, and only 12 percent of newly built homes are estimated to be in developments affected by the rule, meaning that only 2.6 percent of all homes sold are likely to incur the cost increase.

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[12] *Economic Analysis of the Final Phase II Storm Water Rule, Final Report,* U.S. EPA, Office of Wastewater Management, October 1999. Links to chapters in the RIA can be found on the page http://cfpub.epa.gov/npdes/docs.cfm?program_id=0&view=allnpdes&sort=name&amount=all (as of December 1, 2005)

The report does not specifically estimate the effect of the rule on housing production, or on prices of new or existing homes. It does estimate per-unit compliance costs as a percent of mean and median home sales prices, and suggest that these costs will be passed through to the purchaser. There is a brief discussion of affordability (pp. 8-14 to 8-15), but other than indicating the affordability effects would be small (in responding to a public comment that a 1 percent increase in the price of a median home would make 460,905 families ineligible to buy that home), no quantitative analysis of affordability is presented. Results of a Preliminary HIA based on information in the RIA are in Table 3-5.

Table 3-5
Preliminary HIA for EPA Phase II Storm Water Rule

Annual impact:	PHASE II	
New single family detached (SFD) homes	1,270,800	*1998 privately-owned SF housing starts per C20/99.1*
x added cost per home	$500.00	*$404 (1-acre site), $651 (3-acre site), $480 (5-acre site)*
x builder markup	120%	*assumes added costs are at wholesale level*
x percent homes affected	12%	*only homes on sites < 5 acres affected by this regulation*
= total impact on new SFD homes	**$91,497,600**	
New SFD homes affected per year	**152,496**	
Existing SFD homes	64,536,000	*1999 occupied SFD homes per AHS*
x added cost per home	$0.00	*Does not affect existing homes*
x builder markup	120%	
= total impact on existing SFD homes	**$0**	
Existing SFD homes affected per year	**0**	
New apartments (including SFA)	344,900	*1998 privately owned starts with > 1 unit in structure*
x added cost per unit	$150.00	*scaled down arbitrarily from SFD impact per unit*
x builder markup	120%	*assumes added costs are at wholesale level*
x percent affected	12%	*only affects sites < 5 acres*
= total impact on new apartments	**$7,449,840**	
New apartments affected per year	**41,388**	
Existing apartments (including SFA)	31,482,000	*1999 occupied homes with > 1 unit in structure per AHS*
x added cost per home	$0.00	*Does not affect existing apartments*
x builder markup	120%	
= total impact on existing apartments	**$0**	
Existing apartments affected per year	**0**	
Manufactured housing (new or existing)	**$0**	*unlikely to be any meaningful effect*
ANNUAL TOTAL HOUSING COST IMPACT	**$98,947,440**	
Total homes affected per year	**193,884**	
Average impact per affected home	**$510**	

NOTES:
Does not adjust for sites eligible for waiver

The Preliminary HIA indicates that the total annual impact on housing costs is about $99 million, just below the $100 million trigger, so technically an in-depth HIA would not be required. Obviously this conclusion is highly sensitive to specific values used in the calculation, including the composite costs of $500 per SFD home and $150 per new multifamily unit. Even though the impacts may not quite reach $100 million per year, the high per-unit impact suggests this is a case where a lower trigger standard for in-depth review might be appropriate.

3.4.4 HUD: Real Estate Settlement Procedures Act Rule (RIA 1992)[13]

This HUD Rule involves amendments to regulations previously adopted under the Real Estate Settlement Procedures Act (RESPA). The amendments would (1) require mortgage brokers to provide Good Faith Estimates of settlement costs, (2) require disclosure of mortgage brokerage fees paid by lenders, (3) require storage of all RESPA disclosures for five years, and (4) require disclosure of fees for computerized loan origination systems which charge the borrower an access fee. The amendments would also (1) clarify that certain controlled business arrangements are permissible, (2) clarify that RESPA may pre-empt certain state laws regulating title insurance and other settlement services, and (3) clarify that settlement services include loan origination (thereby prohibiting the payment of fees to real estate agents, mortgage brokers and others for mortgage referrals).

A large majority of all residential real estate purchases, both for new and existing homes, are covered by RESPA, and closing costs are recognized as an important element of the overall cost of housing. Key estimates in the RIA include:

- a cost impact of $56.8 million per year for the good-faith estimates required of mortgage brokers, based on broker involvement in 35 percent of all loan originations, a total of 3,600,000 loan originations per year for house purchases using mortgages, an average of 1.5 applications for each loan, and an average cost of $30 per disclosure
- negligible costs for the required disclosure of mortgage brokerage fees paid by lenders
- costs for required disclosures of controlled business arrangements of about $20 per disclosure or $48 million per year, based on activity in 1990.
- costs for required disclosures relating to computerized loan originations of $20 per disclosure or $3.2 million per year
- additional costs for storing disclosure forms of $24,000 per year.

The RIA contains relatively little discussion of the incidence of these costs or the likelihood they will be passed from lenders and others to consumers who are purchasing or refinancing a home. The analysis focuses on unit costs per real estate transaction and number of affected transactions. While this provides information that could be used in a housing impact analysis, the RIA does not attempt to evaluate impacts on new or existing house prices or on housing affordability.

Results of a Preliminary HIA for this rule based largely on the RIA are presented in Table 3-6. For both new homes and new apartments, impacts are broken into three specific categories, corresponding to specific disclosure requirements in the rule. The amount of costs and number of transactions affected by each disclosure requirement varies by category as described in the RIA. As shown in the Table, the annual total housing cost impact is estimated at about $115 million (1990 dollars), which would trigger an in-depth HIA.

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13 *Real Estate Settlement Procedures - Regulatory Impact Analysis.* Department of Housing and Urban Development, Office of the Assistant Secretary for Housing - Federal Housing Commissioner. FR-1942 (1992). Available at http://www.aei-brookings.org/admin/authorpdfs/page.php?id=835 (as of December 1, 2005).

Table 3-6
Preliminary HIA for HUD Real Estate Settlement Procedures Act Rule

Annual impact:	New RESPA regulations	
New single family detached (SFD) homes	963,600	*1992 SFD completions*
x percent of completions that are sold	85%	*excludes homes built by a general contractor for an owner*
x percent of sales financed with mortgage	87%	*from American Housing Survey*
x added cost per home (good faith estimate)	$45.00	*= 1.5 applications/loan * $30/application (1990$) (per RIA)*
x builder markup	100%	
x percent homes affected	35%	*= 35% (proportion that use real estate brokers)*
= total SFD impact for Good Faith Estimate	**$11,223,170**	
New SFD homes affected per year by GFE	**249,404**	
x added cost per home (CBA disclosure)	$30.00	*= 1.5 applications/loan * $20/disclosure (1990$)*
x builder markup	1.00	
x percent homes affected	55%	*assume 45% + 10% of applications trigger new CBA disclosure*
= total SFD impact for CBA disclosure	**$11,757,606**	
New SFD homes affected per year by CBA	**391,920**	
x added cost per home (CLA)	$30.00	*= 1.5 applications/loan * $20/disclosure (1990$)*
x builder markup	1.00	
x percent homes affected	3%	
= total SFD impact for CLA disclosure	**$641,324**	
New SFD homes affected per year by CLA	**21,377**	
Existing SFD homes sold per year	3,181,000	*1990 data: total sales minus 1990 completions*
x percent with mortgage	87%	
x added cost per home (GFE)	$45.00	*= 1.5 applications per loan x $30 per application (1990$)*
x builder markup	100%	
x percent broker involvement	35%	*Brokers in resales but not so much in refinancings?*
= total EH impact for Good Faith Estimate	**$43,587,653**	*does NOT include REFINANCING or HOME EQUITY*
Existing homes affected per year by GFE	**968,615**	
x added cost per home (CBA disclosure)	$30.00	*= 1.5 applications/loan x $20/disclosure (1990$)*
x builder markup	1.00	
x percent broker involvement	55%	*Assumes 45 + 10 percent of loans trigger disclosure (see RIA)*
= total EH impact for CBA disclosure	**$45,663,255**	
Existing homes affected per year by CBA	**1,522,109**	
x added cost per home (CLA)	$30.00	*= 1.5 applications per loan x $20/disclosure (1990$)*
x builder markup	1.00	
x percent homes affected	3%	
= total EH impact for CLA	**$2,490,723**	
Existing homes affected per year by CLA	**83,024**	
New apartments (including SFA)	340,000	*est. for 1990 (all privately owned > 1 unit in building)*
x added cost per unit	$0.00	*does not affect multifamily transactions (except coop/condo)*
x builder markup	100%	
x percent affected	0%	
= total impact on new apartments	**$0**	
Existing apartments (including SFA)	30,003,000	*total with >1 unit per 1989 AHS*
x added cost per home	$0.00	*does not affect existing apartments*
x builder markup	100%	
= total impact on existing apartments	**$0**	
Manufactured housing (new or existing)	**$0**	***NOTE: only affected if financed through conventional mort***
ANNUAL TOTAL HOUSING COST IMPACT	**$115,363,730**	*expressed in 1990 dollars (GDP defl. multiplier to 2004 = 1.32)*
Total homes affected per year	**1,914,029**	*uses highest incidence for new + highest for existing*
Average impact per affected home	**$60.27**	

NOTES:

Dollar estimates are based on 1992 data from the HUD RIA (costs are in 1990 dollars)
Number of homes based on 1990 new and existing sales transactions from Bureau of the Census
Impact includes costs for good-faith estimate by broker (GFE), disclosure of controlled business arrangements (CBA) and disclosure of computerized loan originations (CLA)
Based on sales transactions; does not include refinancing or home equity loans
Assumes charges overlap so homes affected based on highest incidence for new homes + highest for existing homes

3.4.5 OSHA: Fall Protection Standard for Construction (RIA July 20, 1994)[14]

This regulation revised OSHA fall protection requirements for workers throughout the construction industry, including but not limited to residential construction. Fall protection requirements are generally triggered whenever workers are directly exposed to a potential fall of six feet or more. Compliance is typically accomplished through personal fall arrest systems, perimeter guardrail systems or safety nets. An estimated 22.2 percent of all reported injuries and illnesses in construction in 1987 were due to falls (although 40 percent involved falls from ladders, stairs, scaffolds and other scenarios not covered by the rule). Analysis in the RIA is complicated by relatively low compliance with the pre-existing fall protection requirements in the OSHA rules. This makes it difficult to develop a baseline from which to measure incremental costs and benefits.

Incremental costs of compliance are addressed in Section V of the RIA. Annual compliance costs for the entire construction industry were estimated at $40 million. More than $25 million of this is required to provide fall protection for work on roofs. Total costs of compliance were found to represent less than 0.01 percent of industry revenues and 0.02 percent of the net value of construction. The report states that "compliance costs can be incorporated in cost estimates and in bids for projects" and that "costs are expected to be passed through as an increase in the cost of construction, and the effect on profits and prices should be negligible."

The RIA does not discuss the possibility that compliance with the rule will reduce worker productivity (e.g., roofing workers tethered to lifelines may work more slowly than before), although time required for training, equipment set-up and equipment inspection is included in the cost impacts. No specific estimates of cost incurred for residential construction or cost per new housing unit built are presented, even though costs are reported as a percentage of the net value of construction. There is no estimate of the impact of the rule on the level of production of detached houses or apartments, and no quantification of the impact on affordability.

The results of a Preliminary HIA based on data in the RIA are in Table 3-7. Most of the effect of this rule would be felt in the low-rise residential sector through its impact on roofing work. This applies for construction of new homes as well as re-roofing of existing homes, which is assumed to take place at approximately 18-year intervals. The estimated annual impact on costs of housing is $22.2 million, with about 4.4 million units affected. This is not large enough to trigger an in-depth HIA under the $100 million threshold. Note that impact on multifamily buildings is not included, even though it would exist. Furthermore, the table is limited to costs for roofing work. However, since roofing represents half of the overall impact of the Rule according to the RIA, including proportionate charges for other work in the Preliminary HIA seems quite unlikely to change the conclusion.

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14 *Regulatory Impact and Regulatory Flexibility Analysis of Subpart M - Fall Protection (29 CFR Part 1926).* U.S. Department of Labor, Occupational Safety and Health Administration, Office of Regulatory Analysis. July 20, 1994.

Table 3-7
Preliminary HIA for OSHA Fall Protection Standard for Construction

Annual impact:	New Part 1926 Subpart M	
New single family detached (SFD) homes	1,160,300	*focus here is on roofing (but also trusses, brick, siding)*
x added cost per home	$4.00	*corresponds to $5 million out of $40 million total*
x contractor markup	120%	*assumes added costs are at subcontractor level*
x builder markup	120%	
x percent homes affected	100%	*all homes have roofs*
= total impact on new SFD homes	**$6,683,328**	
New SFD homes affected	**1,160,300**	
Existing SFD homes	58,918,000	*total occupied SFD homes per 1993 AHS*
x roof replacement annual %	5.5%	*assumes roof lasts 15-20 years before replacement*
x added cost per home	$4.00	*corresponds to $16.5 million out of $40 million total*
x contractor markup	120%	
= total impact on existing SFD homes	**$15,554,352**	
Existing SFD homes affected	**3,240,490**	
New apartments (including SFA)	258,600	*1994 starts per C20, but number of buildings matters*
x added cost per unit	$0.00	*per building bigger than for SFD, per unit smaller*
x contractor markup	120%	
x general contractor markup	120%	
x percent affected	100%	
= total impact on new apartments	**$0**	
New apartments affected	**0**	*clearly would affect some new apartments*
Existing apartments (including SFA)	30,151,000	*1993 occupied homes with >1 unit in structure*
x added cost per unit	$0.00	
x contractor markup	120%	
x percent affected	100%	
= total impact on existing apartments	**$0**	
Existing apartments affected	**0**	
Manufactured housing (new or existing)	**$0**	*these would be largely or entirely unaffected*
ANNUAL TOTAL HOUSING COST IMPACT	**$22,237,680**	
Total homes affected per year	**4,400,790**	
Average impact per affected home	**$5.05**	

NOTES:
Unclear how to allocate the cost between residential and nonresidential, or roofing and other functions
Doesn't include any cost for multifamily; not enough information to estimate
With total cost of $40 million per RIA, this is unlikely to exceed $100 million even with markups
No productivity impact modeled (consistent with RIA)

3.4.6 EPA: C&D Effluent Guidelines (RIA (Proposed Rule) May 2002)[15]

This regulation is focused on addressing storm water discharges from construction sites, and was issued as a follow-up to the EPA Phase II Storm Water Regulations (discussed in Section 3.4.3 above). The RIA evaluates two regulatory options. Option 1 requires inspection and certification of on-site erosion and sediment controls and incorporation of best management practices specified by a qualified professional. Option 2 goes further, incorporating a series of requirements for application of "best practicable technology currently available." The RIA uses estimates of compliance costs to assess the economic impacts on regulated entities within the construction and development (C&D) industry. It also addresses cost pass-through and impacts on housing affordability. The affected industries include those in land subdivision and development and residential building construction (single-family and multifamily), and some nonresidential builders, but not remodeling contractors.

The economic impact analysis of the proposed rule is based on model projects of different sizes, with modeling at the establishment level and the national market level. Variations include 100 percent and zero percent cost pass-through. Under a partial equilibrium supply and demand framework, the weighted average change in new house sales price to the single-family buyer under 100 percent cost pass-through was estimated at 0.01 percent for option 1, and 0.07 percent for option 2. For the multi-family buyer these figures were 0.01 percent for option 1, and 0.04 percent for option 2. EPA indicated that based on empirical estimates of supply and demand elasticity, the cost pass-through rate would be on the order of 85 percent, and used this value to analyze impact on housing markets at a national level. Other analyses looked at impacts on building firms if costs were not passed through.

The RIA estimated higher production costs for new single-family homes at $16.91 per house (option 1) and $90.79 per house (option 2), and costs for multifamily buildings of $0.003 per square foot of floor area (option 1) and $0.019 per square foot of floor area (option 2). A pass-through including the contractor's indirect costs and profit increases price by $36 per single-family home under option 1 and $201 per single-family home under option 2. Based on a literature review the RIA models housing with a highly elastic long-run supply (4.0) and relatively inelastic demand (-0.7), leading to decreases in number of homes sold of 0 to 0.02 percent for single-family housing, and 0 to 0.01 percent for multifamily housing. The 0.02 percent drop in single-family sales was estimated to represent about 248 units per year.

Two measures of housing affordability are presented in this RIA. One measure determined that if regulatory costs were completely passed through, 29,100 households (0.15 percent) would no longer qualify for a mortgage to buy the median priced new home. The second measure analyzed the "Housing Opportunity Index" (HOI), which represents the proportion of households

15 *Economic Analysis of Proposed Effluent Guidelines and Standards for the Construction and Development Category*. U.S. EPA, Office of Water, EPA-821-R-02-008, May 2002. Available at http://www.epa.gov/waterscience/guide/construction/econ/final.htm (as of December 1, 2005).

in a housing market that can afford the median priced home, and was performed for 215 metropolitan areas. HOI dropped by a maximum of 0.02 percent and 0.11 percent for options 1 and 2 respectively. Finally, the deadweight loss of the regulation over all types of construction was estimated at $200,000 for option 2. According to the RIA, total social costs exceeded total benefits by over $100 million per year for option 1, and about $450 million per year for option 2.

The report estimates impact of the regulation on housing production and housing prices at the national level and in 215 metropolitan-area markets using a standard partial-equilibrium supply and demand framework. It also quantifies how affordability is impacted by these effects using two standardized measures relating house prices to incomes. However, there is no discussion of potential impacts on the price and affordability of existing homes.

Results of a Preliminary HIA are in Table 3-8 below. Impacts are limited to newly built units, since it is very unlikely that existing units would be affected. The estimated housing cost impact totals about $24 million per year under Option 1 and $128 million per year under Option 2. The latter option exceeds $100 million and would require an in-depth HIA.

Table 3-8
Preliminary HIA for EPA C&D Effluent Guidelines

Annual impact:	Option 1	Option 2	
New single family detached (SFD) homes	1,043,045	1,043,045	*= 1995-97 ave. SF units authorized; RIA table 4-11*
x added cost per house	$16.91	$90.79	*costs in 1997 dollars per RIA table 5-3b*
x builder/developer markup	120%	120%	*assumes added costs are at wholesale level*
= total impact on new SFD homes	**$21,165,469**	**$113,637,667**	
New SFD homes affected	**1,043,045**	**1,043,045**	
Existing SFD homes	67,129,000	67,129,000	*Occupied SFD homes per 2001 AHS*
x added cost per home	$0.00	$0.00	*would not apply unless substantial site work is done*
x builder/developer markup	120%	120%	
x replacement rate	0%	0%	
= total impact on existing SFD homes	**$0**	**$0**	
Existing SFD homes affected	**0**	**0**	
New apartments (including SFA)	356,722	356,722	*1995-97 ave. authorized per RIA p.4-48*
x added cost per unit	$7.00	$40.00	*these costs includes markup; see Table 5-15 col. 4*
x builder/developer markup	100%	100%	
= total impact on new apartments	**$2,497,054**	**$14,268,880**	
New apartments affected	**356,722**	**356,722**	
Existing apartments (including SFA)	31,919,000	31,919,000	*2001 occupied homes with >1 unit in structure*
x added cost per unit	$0.00	$0.00	*would not apply unless substantial site work is done*
x builder/developer markup	120%	120%	
x replacement rate	0%	0%	
= total impact on existing apartments	**$0**	**$0**	
Existing apartments affected	**0**	**0**	
Manufactured housing (new or existing)	$0	$0	*possible effect on development of land-lease parks these are very high density so per-unit costs low.*
ANNUAL TOTAL HOUSING COST IMPACT	**$24,019,245**	**$128,263,269**	
Total homes affected per year	**1,399,767**	**1,399,767**	
Average impact per affected home	**$17.16**	**$91.63**	

NOTES:
RIA indicates total 2.24 million acres developed per year, 2.18 million acres subject to the rule
this is reduced based on site size exclusions in option 1 (< 1 acre) and option 2 (< 5 acres)

3.4.7 HUD: Wind Standard for Manufactured Housing (RIA 1993)[16]

This rule was proposed in connection with HUD's regulating design and construction of manufactured housing through the Manufactured Housing Construction and Safety Standards. It requires strengthening newly produced manufactured homes shipped to certain states to increase resistance to high winds, and sets up guidelines for state and local government regulations of anchorage tie-downs for manufactured homes (most of which use tie-down anchors rather than conventional foundations used in site-built housing). The rule was proposed after Hurricane Andrew damaged large numbers of manufactured homes in south Florida, reportedly including the destruction of 97 percent of all such homes in Dade County. Under the rule, design wind speeds in wind zones II and III were increased and the design engineering methodology was updated in order to improve resistance of manufactured homes to high wind events in both zones.

The RIA estimated that the HUD standard would increase production cost per unit in wind zone II by $1,492 for single-section homes and $1,813 for multi-section homes; in wind zone III the cost increases were $2,119 per single-section home and $2,722 per multi-section home. Estimates of demand elasticity (-2.4) and supply elasticity (3.0) were then used to solve for changes in quantity and price in those two zones. Shipments to zones II and III were estimated to drop by 2,801 units per year (about 10 percent), while average price per home increased by amounts ranging from $829 to $1,512 (about 3 to 5 percent) depending on zone and number of sections. Note that under the demand and supply elasticities used for this analysis, around 40 percent of the added production cost would be absorbed by manufacturers rather than being passed through to purchasers. Finally, estimates of deadweight loss in consumer and producer surplus are derived and presented.

The RIA specifically estimates impacts on production and market price of manufactured homes using standard partial-equilibrium supply and demand analysis. It does not discuss any possible effect on prices of existing homes or new site-built homes, or any impact on rents. It also does not analyze implications of these price changes for housing affordability.

A Preliminary HIA for this regulation is in Table 3-9 which separately computes impacts for single-section and multi-section homes in zone II, and for single-section and multi-section homes in zone III. Baseline production levels and compliance costs are taken from the RIA. It is unclear whether these cost impacts would be marked up at the retail level to reflect impact on housing purchasers (they are not marked up in this analysis). The estimated annual cost impact is $54 million. Even though this falls well below the $100 million trigger, it does represent an average impact of $1,741 on each of 31,102 units, i.e., a relatively large per-unit impact on a small number of units. Furthermore, in this case all of the affected units are manufactured

[16] *Regulatory Impact Analysis of Improved Wind Standards For Manufactured Housing*. U.S. Department of Housing and Urban Development. January 14, 1994. Available at http://www.aei-brookings.org/admin/authorpdfs/page.php?id=861 (as of December 1, 2005).

homes, where both owner-occupants and renters tend to have lower incomes than for other types of housing. Both factors suggest that an in-depth analysis of housing impacts might be appropriate.

Table 3-9
Preliminary HIA for HUD Wind Standards for Manufactured Housing

Annual impact:	Single Zone II	Multi Zone II	Single Zone III	Multi Zone III	
New single family detached (SFD) homes	1,029,900	*Privately owned SFD starts in 1992 per C20*			
x added cost per home	$0.00				
= total impact on new SFD homes	**$0**				
Existing SFD homes	57,486,000	*Occupied SFD homes per 1991 AHS*			
x added cost per home	$0.00				
= total impact on existing homes	**$0**				
New apartments (including SFA)	169,800	*Privately owned 1992 starts in structures with >1 unit*			
x added cost per unit	$0.00				
= total impact on new apartments	**$0**				
Existing apartments (including SFA)	30,032,000	*1991 occupied homes in buildings with >1 unit per 1991 AHS*			
x added cost per unit	$0.00				
= total impact on existing apartments	**$0**				
New manufactured housing:					
Annual production by zone (homes)	14,631	12,271	2,268	1,932	*RIA table 8*
x added cost per home	$1,492	$1,813	$2,119	$2,722	*RIA table 9 (1993$)*
x mark-up	1.00	1.00	1.00	1.00	*retail markup?*
= total impact on manufactured housing	**$21,829,452**	**$22,247,323**	**$4,805,892**	**$5,258,904**	
Number of manufactured homes affected	**14,631**	**12,271**	**2,268**	**1,932**	*all units in zones 2-3*
ANNUAL TOTAL HOUSING COST IMPACT	**$54,141,571**	*expressed in 1992$*			
Total homes affected per year	**31,102**				
Average impact per affected home	**$1,740.77**				

NOTES:

4. In-Depth Methodology

4.1 Overview of 8-step Process

The in-depth methodology of the Housing Impact Analysis is focused on housing costs and affordability. Housing costs are sensitive to land values, interest rates, labor markets, neighborhood conditions and much more. The distinction between the preliminary analysis and the in-depth analysis is the attempt to be more comprehensive in the consideration of factors that could move house prices and thus the affordability of housing. There is no clear-cut rule for capturing all the major effects and ignoring the minor effects. Ideally, when the size of the effect falls below the "noise" level, the analyst would stop. Until better data and techniques become available, the analyst will have to use his or her judgment as to how aggressively to search for indirect or secondary effects. Ultimately, there is a balance between completeness and simplicity within the available analysis budget.

The following 8 steps outline the process.

1) Identify the baseline trend without the regulation along with an appropriate timeframe and geography.
2) Get engineering estimates for direct costs to comply with the proposed regulation plus customary markups.
3) Collect or estimate supply and demand elasticities that apply to the regulated market(s).
4) Use the elasticities to calculate pass-through rates and consider the extreme cases of 0 percent and 100 percent pass-through rates.
5) Determine the range of house price changes based on the elasticities.
6) Consider indirect or secondary market effects given the size of the house price change.
7) Drill down to housing submarkets by type of housing structure and neighborhood.
8) Conduct affordability analysis by income and tenure groups with special consideration for vulnerable subgroups.

Step 1 establishes the markets, timeframe and geography within which the proposed regulation is likely to have some effect. The baseline trends show what the researcher expects to happen without the implementation of the regulation. Changes relative to the baseline trends can then be attributed to direct and indirect impacts of the regulation. Subsections on Policy Definition and Baseline Identification provide more description for Step 1.

Step 2 measures the compliance costs. In production regulations, those costs will be engineering costs determined by experts in the production process. The compliance costs include the added cost of constructing the house or some item used in the house as well as one-time transition costs and on-going tracking to verify compliance. Most of steps 1 and 2 should have already been accomplished in the Regulatory Impact Analysis. The extension is to incorporate the full housing market effects that may have been downplayed during the RIA. The subsection Incidence of Costs considers how compliance costs on the producer are passed through to the consumer. "Direct Effect on Housing" demonstrates diagrammatically how regulation shrinks the market. The full burden of the regulation is the opportunity cost as described in Analyzing Social Costs. The cost impact on producers can also affect the degree of competitiveness in a market through financial stress and ultimately affect the costs passed on to the homebuyer. Another way to view costs are benefits that will not happen and benefits are often measured as avoided costs. Appendix B discusses measuring benefits in the context of housing and the Wind Standards case study considers benefits in a full cost/benefit analysis. However, the main focus in the Housing Impact Analysis is on financial costs to the consumer.

Steps 3, 4 and 5 use elasticities to determine pass-through rates of costs to house prices paid by consumers. Step 3 is collecting or estimating the elasticities and in this case we are focused on the housing market elasticities that relate the quantity supplied and demanded to the price of housing. Recognizing the sensitivity of elasticities to a wide range of factors, the analyst would ideally estimate a customized set of elasticites for the particular regulation and economic situation. However, data and budget limitations may not permit such refinement and the analyst may have to adapt elasticities from the literature, as described in Section 2.3. The earlier description of elasticities is augmented in this chapter in three subsections: Elasticities of Demand and Supply, Determinants of Demand Elasticity and Determinants of Supply Elasticity.

In a simple linear model, the pass-through rate is the ratio of the elasticity of supply divided by the difference in the elasticity of supply less the elasticity of demand. However, uncertainty about the elasticities and the degree of market competitiveness mean that practically the pass-through rates of zero and 100 percent should also be considered. See Appendix C for more on uncertainty. Good examples of calculating house price change from elasticities are provided in the Effluent Guidelines and Wind Standards case studies.

Step 6 broadens the measure of regulatory impact to consider indirect or secondary impacts. A regulation may not only change the cost of producing housing, but also change the demand for labor and the income of workers. Those workers, in turn, may have less income to spend on housing or the production sites have shifted so that housing is needed in different areas. A number of modeling techniques, such as input-output models and general equilibrium models, have been developed to trace the shifts of supply and demand through the economy.

The housing market is really a set of submarkets that can either be defined by type of structure and cost or by local neighborhood. Changes in the supply of housing in the same neighborhood are likely to have a greater impact on house prices than construction in a more distant town. **Step 7** considers the housing submarket and its influences on house prices. A particularly useful technique to measure the impact of neighborhoods on house prices is hedonic regression. Ideally, the size of the regulatory impact could be measured from areas in which it has already been implemented. If that is not possible, a proxy of similar magnitude may be available or at least the local changes in the type of construction can be used to measure the house price impacts.

Once the house price changes have been determined, **Step 8** entails showing how the price changes get distributed across households of varying incomes and tenures. The government is particularly concerned about house price increases affecting low income and minority subgroups. In many places, the lowest income households are renters in older sections of the city. Low income subgroups are most vulnerable to house price increases because they have few housing alternatives and the government does not want to exacerbate homelessness. The sections on Distributional Analyses apply measures of affordability described earlier in section 2.3. The Effluent Guidelines case study demonstrates how the Housing Opportunity Index was estimated by MSA. Affordability is also considered in the Wind Standards case study by estimating how many households would be forced to pay more than 28 percent of their income for compliant units. The case studies conclude with extensions of the analyses to show even more clearly how the regulation would affect affordability.

4.1.1 Step 1: Identify the Baseline

Policy Definition.

Housing Impact Analysis focuses on the impact of a proposed regulation on the housing markets, especially on the affordability and availability of modest quality units. In some cases, such as the in-depth case studies presented below, the connection between the regulation and housing markets will be direct and obvious. The Wind Standards for manufactured housing required producers to make sturdier structures capable of withstanding the forces of a hurricane. The regulation directly affects the production of low-cost housing. In other cases, the connection may be indirect but still substantial. A revised definition of wetlands may change the future residential development of an area that could include affordable housing. In either case, the housing impact analysis should begin by describing the linkage, both direct and indirect, between the proposed regulation and the housing market. The description should identify which linkages will be quantified in the analysis and which linkages, though potentially substantial, are not quantified, given limitations of data, economic techniques and budget.

The impact will probably depend on the strategy for implementation and there may be distinct options. For example, in the EPA rule on effluent and sediment control, there were 4 options originally proposed. The analysis describes each option along with the assumptions made in the process of estimating the costs and benefits for each option. Frequently, one option is not to implement any changes or perhaps no changes that would affect the housing markets. It is still useful to analyze the expected trends in the relevant markets under the “no new regulation” option, because those outcomes serve as the baseline for comparison to the other options. Also, if another regulatory change is being considered that would have a substantial bearing on the regulation under analysis, at least one option should estimate the outcome from both regulations going into effect.

Baseline Identification.

The impact on housing of the regulation is the difference between a future with and without the regulation. The simplest approach is to assume the current markets represent a baseline in equilibrium and the impacts are the changes relative to that baseline. Although this assumption may be sufficient as a first approximation, housing markets are dynamic and not all of the expected changes will be caused by the new regulation. Markets undergoing rapid change, such as the double-digit house price increases in 2004, are usually out of equilibrium and expected to return to equilibrium over the next 5 to 10 years. If the future changes in the market without the new regulation can be reliably predicted, it would be better to use those predictions as the baseline. However, if those baseline predictions are unreliable, it might be better to use a stable base for comparison. The analyst is responsible for identifying the baseline chosen and explaining why the differences relative to that baseline provide the best estimates given available data.

One important aspect of identifying the baseline is specifying the starting point in which the new regulation will take effect. The starting point need not be the date when the regulation has been finalized or designated effective date. The implementation may take some time to set up or the changes may be so widely expected that impacts precede the scheduled implementation date. To preserve a baseline condition untainted by the new regulation, it may be necessary to draw the baseline data well before the scheduled implementation. As a practical matter, the HIA will normally occur before the regulation has been decided, so the baseline data will come months or years before the actual implementation.

4.1.2 Step 2: Measure the Costs

Incidence of costs.

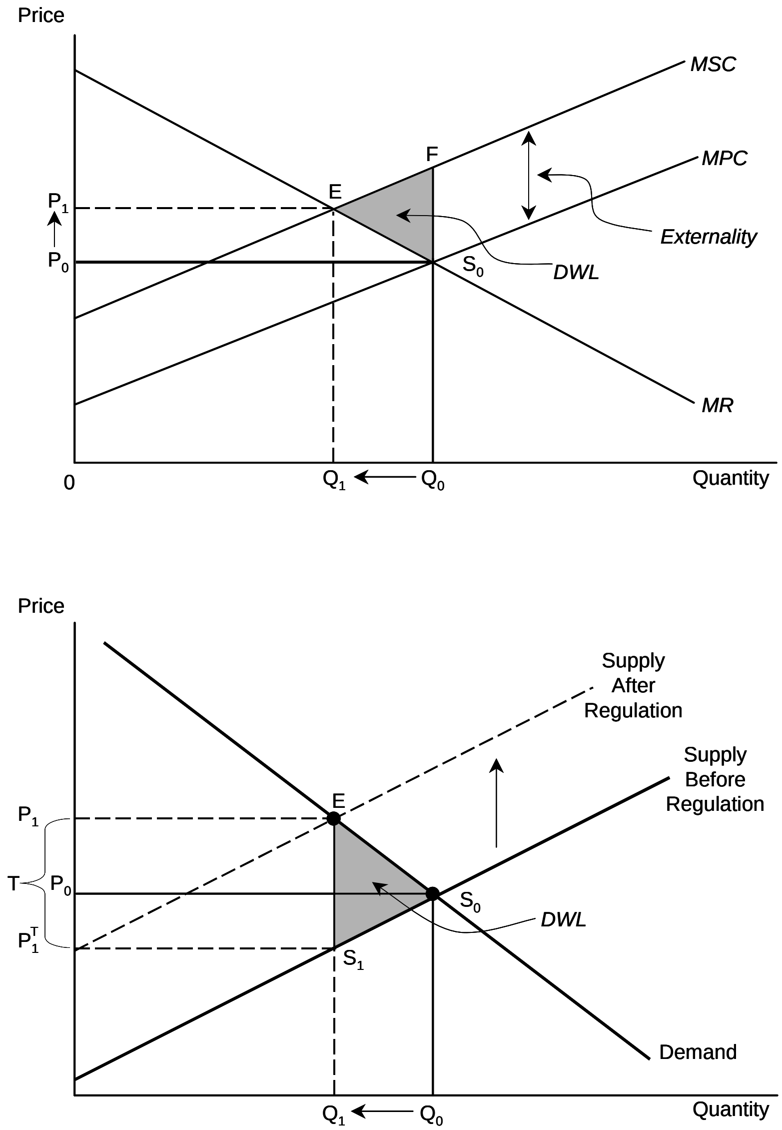
One of the most challenging aspects of the HIA is determining how much of the additional costs caused by the new regulation fall on the end consumer as opposed to the producer or intermediary businesses. The preliminary analysis avoided this thorny issue by assuming all of the regulatory costs are borne by the consumer. Even if this is an unrealistic first approximation, such a conservative assumption is appropriate for the preliminary analysis. However for the in-depth HIA, it is necessary to address the issue more seriously. At a minimum, the analysis should take a 2-prong approach: assume ***none*** of the costs get passed through to the consumer vs. assume ***all*** of the costs are passed through. The typical analysis should add a third prong in which the pass-through rate is based on recent market experience or corresponds to the elasticities of supply and demand. It is difficult to find well-suited pass-through rates or elasticities in the economic literature and can be costly to estimate from existing data. Nevertheless, the assumptions made for the third prong of in-between pass-through rates should be stated clearly and justified, when possible.

Direct effect on housing.

The direct effect of regulation on housing is the change in house prices and quantity of housing after the regulation takes effect. The general expectation is that regulations increasing the cost to produce housing will raise the price and reduce the supply of housing. In a partial equilibrium framework, the changes could be expressed as an upward shift in the supply curve driving up the price of housing, from P_0 to P_1 in Figure 4-1, and reducing the quantity supplied, from Q_0 to Q_1.

The diagram may capture the main effect, but it probably misrepresents the quantitative impact, at least for large effects. To estimate the pass-through rate, analysts typically use supply and demand elasticities, but straight-line demand curves have a wide range of elasticities along the line. The incidence of regulatory costs falls more heavily on the consumer when the supply is relatively elastic (more horizontal in the diagram) compared to demand. The pass-through rate shows how much of the increased regulatory cost is paid by the consumer. In terms of elasticities, the formula for the pass-through rate is $E_s/(E_s-E_d)$, where E_s is the elasticity of supply and E_d is the elasticity of demand. The supply-and-demand diagram is a convenient way to express the market, but it suggests we know more about the shape and placement of supply and demand than is realistic.

Figure 4-1
Direct Effect on Housing



Notes: $P_0 P_1$ = Consumer share of price increase
$P_1^T P_1$ = Cost to producer of regulation
$(P_0 - P_1) / (P_1^T - P_1)$= Pass-Through Rate
DWL = Deadweight Loss

Despite the limitations, it is useful to try to determine in a partial equilibrium framework whether the primary regulatory impact is on the demand side or the supply side. For example, a regulation that increases the energy efficiency of new homes may increase the cost of producing a new home (shifts up the supply curve), but reduce the operating cost. The reduction in operating cost could be seen as an offset to the purchase price and thus reverse some of the upward shift from the production cost. In effect, housing can be seen as a flow of services as much as a purchased product, so that a lower operating cost reduces the annual user cost. However, some buyers are willing to pay more for what they perceive is a better house because in the long run the higher efficiency of the heating system will more than offset the higher purchase price. The increased demand for a higher quality product could be represented by an upward shift in the demand curve. In one sense there is increased demand for the higher quality housing, but in another sense the new housing is a submarket, i.e., a more efficient form of housing. How the market is defined is integral to how it gets represented in terms of supply and demand. A narrow definition makes it easier to be specific about the costs, but the elasticities from the literature are designed for broad markets and may be less appropriate for submarkets.

The **direct compliance cost method** uses engineering or a process cost model to estimate the production and distribution costs. Usually this method requires specialists in construction or engineering to provide these estimates to the economic analysis. The primary assumption is that changes made on the production side are not enough to change price elasticities or substitution on the demand side. In effect, the supply curve shifts by the amount of the added production costs from the engineering study without any change in the demand curve. Even if this assumption is not strictly realistic, it may be the closest approximation if the analyst lacks data for estimating a demand response. Consumers may avoid the price increases by buying substitutes or willingly accept the price increases because the product will be better or no less expensive substitutes are available. If the product is new, there may not be any data to project demand or substitution rates, in which case assuming the current market will continue may be the closest approximation. An assumption of no substitution will probably overestimate the consumer welfare losses and the analyst should note this likely source of bias.

For tax purposes, compliance costs are generally deductible as expenses by for-profit businesses and operating costs are fully deductible. Capital investments must be depreciated according to the tax life for the building or equipment. The impact of the regulation on the profits of producers and suppliers should be based on the after-tax compliance costs. More information on state tax rates can be found at the website: http://www.taxadmin.org/fta/rate/tax_stru.html.

A partial equilibrium analysis is simpler than a general equilibrium analysis because the partial equilibrium assumes the regulation only affects a single industry. Holding other industries "constant" is generally appropriate if the proposed changes are small and the regulations do not directly affect the other industries. A regulation can have macroeconomic effects if the change in quantity sold is large enough to reduce employment. The loss of jobs and income in the first industry may be enough to hurt sales in other markets, especially if the changes are national in scale. If the change in sales and employment is less than the annual fluctuation in recent years, it is reasonable to assume the macroeconomic impact will be insignificant. In that case, a partial equilibrium is most appropriate. A corresponding assumption is that the industry is competitive and the baseline market is in equilibrium. However, if the market is not in equilibrium at baseline (as indicated by accelerated market entry or exit) or the projected impacts are large enough to create macroeconomic shocks beyond the regulated industry, then a multi-market or even a general equilibrium analysis is necessary. Regulations on building supplies, transportation, finance or environment, are most likely to have ramifications on land use and the housing market. For these regulations, a multi-market model may be most appropriate to capture the full effect on the affordability and availability of housing.

Although production costs are the most obvious changes caused by new regulations, direct effects also include benefits and transfers. One form of benefit already mentioned is cost savings, and it can either apply to producers or consumers. Safety harnesses on construction workers can increase production time, but also reduce costly accidents and ultimately impact health insurance rates. Regulations are often designed to avoid future losses or at least prepare for the event and reduce the shock when it occurs. The benefit is measured in terms of deaths, injuries, lost work time and lost income that did not occur due to the regulation.

Transfers are often excluded from cost-benefit analyses because there is no change in resources available to society – just a change in who controls the money.[17] Under the compensation principle[18] a policy is considered good if the economic surplus is more than enough for the "winners" to compensate the "losers." However, in the analysis of affordability of housing, we are very concerned about the distributional impacts of a policy change and transfers can play a critical role. For example, a regulation that blocks new development within 100 feet of lakes would raise the price of existing lakeside dwellings. The seller's gain and buyer's loss is considered a transfer, not a real cost. Other examples of transfer payments include scarcity rents, monopoly profits, insurance payments, indirect taxes and government subsidies.

From the government's point of view, subsidies count as a cost that reduces the funds the government office can spend. Also, the amount of money received by subsidized households is less than the amount spent by the government, which is another form of deadweight loss. Taxpayers must pay for the subsidy and the tax creates a burden on the economy as well as a disincentive to work. The tax pays for both the government agency and the subsidy, but only the subsidy reaches the recipient. Thus, a subsidy is a transfer from taxpayer to subsidy recipient with a deadweight loss to the economy. From the household recipient's point of view, the subsidy enables the household either to buy more housing or spend less of their own money on housing so they can buy non-housing goods. Society may not have more housing, but the low-income household can afford decent housing, which meets an important public policy.

Analyzing Social Costs[19]

The burden of regulation or opportunity cost is the value of goods and services used to comply with the regulation rather than meeting the demands of consumers. The total social cost of a regulation is the sum of the following costs:

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17 See OMB Circular A-4 for more on the treatment of transfers.
18 Also known as the Potential Pareto criterion.
19 This section follows Chapter 8 of the EPA Guidelines for Preparing Economic Analyses (2000).

- Real resource compliance costs
- Transitional costs
- Government regulatory costs
- Indirect costs
- Social welfare losses (deadweight loss)

Real resource compliance costs include the new equipment and labor expended to satisfy the requirements of the regulation. Beyond the direct cost of producing the regulated unit, the compliance costs include planning, training, recordkeeping, reporting and maintenance. Some of these costs may be small once the tracking system is established, but changing the accounting and computer systems can entail significant costs. ***Transitional costs*** go beyond the compliance cost to include the disruption in production as new equipment and different labor are brought on line. The cost of reallocating resources includes the lost production, unemployment and firm closings as resources shift to other markets as the new regulation forces the economy to reorganize. The ***government regulatory costs*** are the administration, monitoring and enforcement costs associated with the regulation. Often there is a parallel with production costs in that the ongoing costs are modest compared to costs of adjusting the accounting and computer networks to accommodate the new reports. However, staff added to conduct training, monitor production processes or bring enforcement actions for non-compliance can be substantial ongoing costs. ***Indirect costs*** include the adverse effects that a regulation can have on product quality, productivity, innovation or changes in the market.

Social welfare costs are the reduction in consumer and producer surplus when a regulation causes the price to rise and/or the quantity to fall. In effect, the social welfare cost is the shrinkage in the market that does not benefit either producers or consumers, thus the name deadweight loss. However, it need not be considered in purely pejorative terms. Consider the example of an externality such as pollution, as shown in the upper graph of Figure 4-1. The supply curve is represented by the marginal private cost (MPC) and the demand curve represented by the marginal revenue (MR). The private market-clearing price is at the intersection of MPC and MR. However, the marginal private cost does not include the pollution externality. The marginal social cost is higher than the marginal private cost by the costs to society associated with the pollution. Society has to pay for the damage from the pollution in terms of added health costs and deferred cleanup costs. If the private market could be induced to internalize those pollution costs, the market-clearing price would be at E with a smaller quantity sold and a higher price. In effect, the producer passed some of the added cost of controlling the pollution on to the consumer. The amount by which the market shrinks is from Q_0 to Q_1 and the dollar value of the area (S_0FE) is the deadweight loss. It is the net societal change from the shift in equilibrium. In this case, the loss was the cost to society that was not paid by either consumers or producers, though of course it would ultimately have to be paid by taxpayers in the society.

Regulation or taxes are the two most common ways for shifting supply to a socially more acceptable equilibrium. The size of the upward shift in the supply curve is either the amount of the tax or the cost of the regulation, marked T in the lower graph of Figure 4-1. The demand curve shows the consumers' willingness to pay for different quantities. Implicitly the consumers are sorted from those few people willing to pay a high price down to the many people willing to pay a low price. The difference between the consumers' willingness-to-pay (demand curve) and the market-clearing price is the consumer surplus. Similarly, the supply curve represents the quantities that producers are willing to supply, sorted from a few low-cost producers willing to supply small amounts up to the high-cost producers willing to produce at higher prices. The difference between the sale price and the supply curve is the producer surplus.

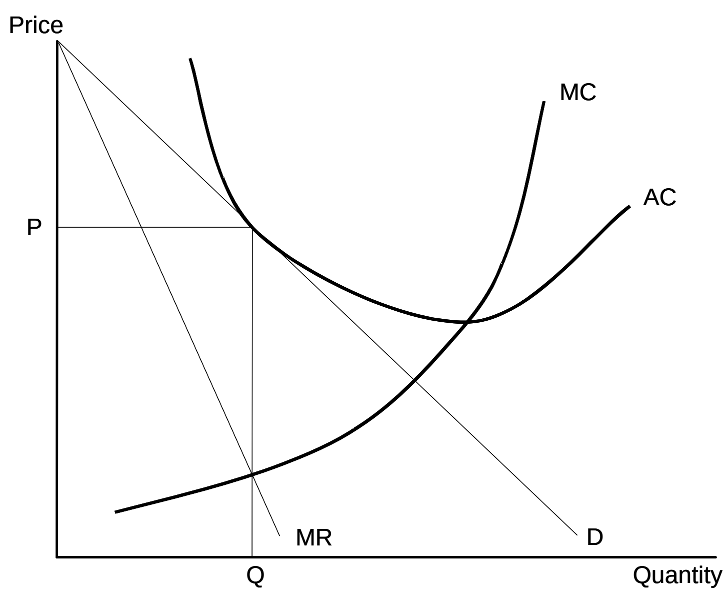
When the tax shifts up the supply curve (perhaps to a more socially acceptable equilibrium), the consumer pays P_1, the producer receives P_1^T and the government collects the tax difference, T. The consumer surplus is smaller, now between the demand curve and P_1, and most of the shrinkage has gone into the tax rectangle, A. Similarly, the producer surplus is smaller, now between the supply curve and P_1^T, with most of the difference going to the tax region, B. However, the shaded triangle, ES_0S_1, is the reduction in consumer and producer surplus not included in the tax rectangles. In that sense, ES_0S_1 is a deadweight loss. It is the reduction in consumer and producer surplus that does not become part of tax revenue. The tax or regulation caused the market to shrink by the value of the deadweight loss. Society may be better off because there is less pollution as well as new tax revenue to repair the damage. The private consumers willing to pay between P_0 and P_1 can no longer buy the product and producers willing to supply between P_1^T and P_0 can no longer sell that product. Put in the housing context, the DWL area represents homebuyers who can no longer afford to buy a home or producers who can no longer supply one profitably. The regulation or tax has pushed up the price beyond what the buyers are willing or able to afford.

Figure 4-1 also portrays the pass-through rate. From the producers' perspective, the increase in cost is T, but the consumer only sees an increase from P_0 to P_1. The change in the consumer price relative to the change in the producer cost is $(P_1-P_0)/T$ or the pass-through rate. If the demand curve is flatter (more elastic), the increase in consumer price is smaller and thus the pass-through rate is lower. At the limit, perfectly elastic demand means a zero pass-through rate, which forces the producer to pay entirely for the cost of the regulation.

On the other hand, if supply is steeper (inelastic), the consumer price rises nearly as much as the increase in production cost so the pass-through rate is close to one. This result is more likely to happen if all the producers face the same cost function. If there is little flexibility in how the producer satisfies the regulation and all producers have the same technology and cost structure, then all the producers can pass along the cost increase to the consumer without losing market share. Any one producer could gain market share by reducing the price, as before the regulation, but only if that producer is willing to reduce its profits. Assuming a competitive market with no excess profits, because there is free entry by new firms, producers will pass along the added costs rather than accept below-normal profits. Rather than accept lower returns, investors would shift their capital out of that industry and the supply would fall.

However, if the industry has barriers to entry, excess profits and monopolistic competition, then producers may pass along less than the full amount of the regulation-induced cost. Monopolistic competition may be the most appropriate description for homebuilders because they have limited pricing power from their product differentiation, but the competition and ease of entry ensures their profits are normal in the long run. Regulation can create barriers to entry and reduce competitiveness, though added profits are limited by added regulatory costs. Monopolies and monopolistic competitors have pricing power because they can set the quantity supplied below the competitive supply (the quantity where marginal cost matches demand). In perfect competition, the demand curve (and thus the marginal revenue curve) are horizontal. However, with monopolistic competition the local differentiation in product, e.g. houses of different size, shape and location, means the demand is downward sloping as is the marginal revenue curve. The profit maximizing point is where marginal revenue equals marginal cost and marginal revenue falls faster than demand, as shown in Figure 4-2 (Viscusi et al. 2000, p. 79). If the regulation does not affect the marginal cost, perhaps because most of the added cost is the initial fixed cost, then the monopolist may still be profit maximizing (though with lower profits) by not passing through all the costs to the consumer. In Figure 4-2, there are zero profits because price equals average cost, reminding us that pricing power does not guarantee positive profits.

Figure 4-2
Pricing and Zero Profits under Monopolistic Competition



Cost Impacts on Producers and Competitiveness

This section discusses the impact of compliance costs on the producers and industries, which bear the costs. In the housing industry, the producers are the land developers, homebuilders and their contractors. Repairs and remodeling are done by home improvement contractors, who can easily shift between new construction and existing houses. Regulations of construction finance and home mortgages affect lenders, brokers and servicers. The efficiency and competitiveness in each of these industries ultimately determines the supply of affordable housing.

Production costs are a combination of upfront costs and ongoing costs as well as fixed costs vs. variable costs. Typically a regulation that forces an industry to change production methods will require a capital investment initially for new equipment and training of workers. The initial adjustments will also include changes to information and accounting systems. Fixed costs can occur after the transition period as buildings and equipment are replaced and better business systems are developed. Private costs are discounted at a rate that reflects the producer's cost of capital, which is higher than the social discount rate because the risk to the producer is higher than risk to society in general. If fixed costs are large relative to recurring variable costs, this creates economies of scale. More units produced will decrease the average cost per unit. Under scale economies, large firms have a competitive advantage from lower costs and more pricing flexibility. The large, fixed costs can be sunk costs in that they are costs that cannot be recovered on exit or liquidation. Moreover, large fixed costs create an entry barrier to small firms, who must borrow more to enter the industry. Without the threat of new firms under-pricing the existing firms, prices tend to rise as regulatory costs are passed through to consumers.

Regulations that affect all the firms in an industry equally are more likely to be passed through to the consumer and less likely to change industry competitiveness. Given that all the firms face the same regulation and compliance costs, there is little opportunity to build market share with low pricing. A firm could only absorb the compliance costs by reducing its profits and lowering its return on capital. If all the firms uniformly pass on the compliance costs through higher prices, the buyer cannot switch firms to avoid the price increment. Without lower cost substitutes, the buyer has little choice but to pay the price increases. The market continues as before with no change to market shares or competitiveness, at least in the short run.

New regulations can alter the competitiveness of an industry when the compliance costs are much higher for some firms than others. As already described, large firms may finance fixed costs at lower cost than small firms, either because their cost of capital is lower or they have greater expertise via specialists in redesigning systems. Large firms may also have an advantage through research and development to devise less expensive processes that comply with the regulation. If the disparity in costs among firms is substantial, the new regulation could exacerbate an existing trend toward consolidation and reduced industry competitiveness. For example in the FHA Wind Standards for manufactured housing (presented as an in-depth case study below), the new standards only apply to a relatively small share of the manufactured housing market in hurricane prone areas. The more stringent building requirements may consolidate the market because small producers cannot afford to run parallel production lines at two different building standards. Or, the new rules could fragment the market as some firms specialize in sturdy construction at a higher price, while other firms withdraw from that market. Either response could reduce the level of price competition from the buyer's point of view.

In a competitive market, no one firm has enough market power to set the price or quantity supplied. Each competitive firm is a price taker as set in the overall market. To develop market power, a single firm or small set of firms must control a substantial share of the market. Typical indicators of market power are measures of industry concentration in the largest 4 or 8 firms. A more comprehensive measure is the Herfindahl-Hirschman Index (HHI) which is the sum of squared market shares for every firm in the industry. The Department of Justice uses the HHI in evaluating the impact of mergers on the competitiveness of an industry.

Attempts to empirically test the relationship between profit and concentration have struggled with the fact that concentration is not an exogenous measure (Carlton & Perloff, 2000, p. 259). Firms may become large and profitable because they are the most efficient or innovative. Firm growth is not necessarily from profits that are the result of excess markups above cost and restrictive quantities supplied. One way to sort out the causation is through time series data that track changes in prices and profits. Assuming there is enough information to identify an industry demand curve and the marginal costs are approximately constant under constant returns to scale, then fluctuations in demand over time allow us to identify the price markup over cost. Another strategy avoids assumptions about the demand curve, but rather concentrates on fluctuations in price and revenues relative to costs. If prices and revenues go up by the same amount as costs, the market is competitive. On the other hand, if prices go up by more than the costs, then the market is not perfectly competitive. The increase in price markup above marginal cost goes to increased profits. Roeger (1995) estimates markups for U.S. manufacturing in the range of 5 to 23 percent, but we do not have comparable estimates for construction.

The change in production quantity (sales) and price affects the profitability and employment of the producing firms. If the compliance costs are largely passed through to the consumer, the decrease in sales depends primarily on the elasticity of demand by the consumers. An inelastic demand curve relative to an elastic supply curve would mean most of the impact from the regulation goes to price increases rather than reduced sales. The increase in revenue may be close to the increased compliance costs so that industry profits are little changed. In this scenario with maintained sales and no change in market shares, there would be little loss of employment or income for workers.

An alternative scenario with more elastic demand could translate into substantial reduction in production and sales. The historical ratio of production to employment in the industry could be used to estimate the impact of lower sales on lost jobs in the industry. Average wage rates or income per worker in the industry could be used to estimate the expected losses of income and spending power. If the reductions in sales are large enough to cause negative after-tax cash flows, those firms are in jeopardy of closure. Smaller firms are often financially weaker, and thus account for a disproportionate share of reduction in sales for the industry.[20] Another form of adjustment is through reduction in entry.

Measures of Financial Stress. Analysis of financial ratios can provide one indicator of an industry in stress, even if it is not sufficient to determine which firms are likely to go out of business. A loss in profitability is reflected in the ratio of net operating income to total assets or the return on equity. Problems in liquidity are revealed in a low interest coverage ratio (cash operating income divided by interest expense) or the times-interest-earned (earnings before interest and taxes divided by interest expense). Another common liquidity measure is the current ratio (current assets divided by current liabilities).

For manufacturing industries, Altman (1993) devised a Z-score, which is a weighted average of five variables that predict the potential for bankruptcy. Those variables are all in the form of ratios:

- working capital / total assets,
- retained earnings / total assets,
- earnings before interest and taxes / total assets,
- market value of equity / par value of debt, and
- sales / total assets.

Although the component variables may still be important in the construction industry, the particular values were benchmarked for manufacturing and service industries.

Two sources on financial ratios that are relevant to construction have been published by the National Association of Home Builders:

Benshoof, M. (2001) An Inside Look at Builders' Books, and
Kone, D. Linda (2000) Land Development, 9th Edition

These sources suggest that it is not the level of the ratios, but rather large changes from baseline to compliance period that provide the strongest indication of financial stress. The key ratios are:

- gross profit ratio = (net sales – operating costs) / net sales,
- current ratio = (current assets – τ*pretax compliance costs) / current liabilities
- debt-to-equity = (total debt + (1-τ)*pretax compliance costs) / net worth
- return on net worth = (net profit after tax – post-tax compliance costs) / net worth

[20] The Small Business Administration provides a useful website for research on small businesses (www.sba.gov/advo/research). In particular, a recent study by Crain (2005) examines "The Impact of Regulatory Costs on Small Firms."

where τ is the tax rate and assumed to be 20 percent.

Of those four ratios, the one most likely to change from compliance costs is the return on net worth because compliance costs are tax deductible. The research shows that it is the post-tax effect that is the most revealing of financial stress, which could lead to worker layoffs and firm closures.

4.1.3 Steps 3, 4, and 5: Use Elasticities for Pass-Through Rates and House Price Changes

Elasticities of Demand and Supply

Elasticities provide a valuable indicator of changes in revenue. When the price elasticity of demand is one (in absolute value), then an increase in price is just offset by a reduction in sales such that the revenue to the supplying firm stays the same. When demand is elastic (more negative than negative one), the reduction in sales is greater than the increase in price so the product of sales and price results is less revenue to the firm. On the other hand, an inelastic demand (less negative than negative one) means the percentage drop in sales is less than the percentage gain in price so the revenue increases. Thus, if a firm has pricing power and faces elastic demand, the firm might choose to maintain the same price and absorb the cost increase in order to keep the same revenue. An alternative motivation would be to maintain the price in the expectation that monopolistic competitors, with a higher cost structure, would increase their price. By maintaining a lower price, the first firm can gain market share, which might enable the firm to increase price and profits in the future.

A useful concept described by Carlton and Perloff (2000) is the residual demand curve or market demand minus the supply of other firms. Residual demand can be expressed as:

$$D_r(p) = D(p) - S_o(p)$$

where $D(p)$ is the market demand at price p and $S_o(p)$ is the supply of other firms. In a perfectly competitive market with n identical firms, the share going to any one firm is simply the market demand divided by n or 1/nth of the market. But in a competitive market the demand is horizontal and each individual firm acts as a price taker. Suppose the demand curve is downward sloping, the elasticity of demand facing an individual firm *i* is:

$$E_d^i = E_d n - E_s^o (n-1)$$

where E_d is the market elasticity of demand (a negative number) and E_s^o is the elasticity of supply of the other firms (a positive number). Even without any change in the market elasticity of demand, an increase in the number of firms raises the elasticity of demand facing an individual firm. For example, suppose the other firms have perfectly inelastic supply (E_s^o=0) and there are 10 firms in the market. Then, a market elasticity of demand of –1 means the elasticity facing an individual firm is –10. An increase in the elasticity of supply by other firms also has the effect of raising the elasticity of demand facing an individual firm.

Determinants of Demand Elasticity. The most important factor determining demand elasticity is the availability of close substitutes. For example, if regulation increases the cost of new housing, a homebuyer has the option of substituting existing housing, rental housing or manufactured housing. Search costs may limit substitution as homebuyers may not realize that close substitutes are available in the local area or will become available in the coming months. Given more time to collect information, buyers can find out what substitutes are available and arrange for alternatives. For large purchases, such as a house, the purchase is a large share of current and future income, which should increase the buyers sensitivity to price. On the other hand, housing is a necessity, which tends to make demand inelastic. Moreover, most homebuyers, particularly first-time homebuyers, may be so inexperienced at buying and financing real estate that they are insensitive to the price. A one percent change in price seems small, almost too small to worry about until the buyer realizes that the small percentage translates into a $1000 or several weeks pay. Familiarity with the buying process may affect a homebuyer's sensitivity to price.

Determinants of Supply Elasticity. Substitutes are also important to the supplier, though suppliers are seeking substitutes for costly inputs. More time and information improve the effectiveness of the search and allow producers to renegotiate contracts with suppliers. Also, the pace of technical advance may allow suppliers to develop cost-saving processes that lower production costs or enable the producers to shift to more profitable products and services. A high degree of market concentration among producers usually allows them more coordinated price movements without fear of losing market share. Expectations about future price of the product can also influence the supplier elasticity. Fluctuations or expected future increases may make it easier for the supplier to absorb current regulatory costs and then recover those costs as part of future increases. Overall, a more elastic supply means a higher cost pass-through rate to consumers.

Another dimension to the supply elasticity is the barriers to entry from new firms. Industries with low barriers can expand by increasing output per firm and increasing the number of firms. Similarly, production processes that are constant returns to scale can expand without increasing costs per unit. Remodeling is a good example of an industry with low barriers to entry. New housing production would have constant returns to scale except local zoning and land use regulations often make it harder for a builder to do large subdivisions than small developments. For housing, land is the critical input factor that can create a barrier to entry for new firms and limits supply elasticity. Local land regulations often have the effect of restricting the supply of land and thus making housing less elastic.

One possible response is the housing industry becomes more concentrated and less competitive. Larger firms are better able to develop the expertise necessary to meet government requirements for building projects. Delay in land development approval forces firms to increase borrowing and contingency funds. In effect, the lobbying, legal and financial components become relatively more important and the actual construction a smaller component of development firms. Thus, regulations not only shift the supply curve by the compliance cost, but also make the supply curve steeper (less elastic). The housing industry is less responsive to price signals and more preoccupied by regulations that must be satisfied before the building begins.

4.1.4 Step 6: Model Indirect Effects

Indirect Effects

An indirect effect of regulation is that more compliance effort reduces the output per worker and return to capital. Investors shift money toward higher margin, higher return projects, which may mean high-end housing in the same market, housing in a different location or non-housing in either market. Another indirect effect could be less investment in research and development. Compliance could crowd out technical innovation and lead to lower quality or higher prices for housing. Employment could shift between skill categories and begin to affect industries competing for the labor.

General Equilibrium (GE) models are designed to measure the cross-industry effects, though these models are generally more costly to calibrate and require more data or strong assumptions. A traditional form of GE model are input-output (I/O) models that are based on an input-output table. Output from one industry becomes input for other industries and the table records the linkages. Increases in an industry are assumed to follow a constant return to scale requiring more inputs from other industries and producing more output to be sold to consumers or other industries. Prices remain fixed and there is no cost-saving substitution by either the producers or consumers. Nevertheless, as a first approximation, I/O models can detail how expansion or shrinkage in one industry seeps into related industries. The Bureau of Economic Analysis has estimated benchmark input-output multipliers in its Regional Input-Output Modeling System (RIMS II) that can be used for GE analysis at the national or regional level (www.bea.gov/bea/regional/rims/). See also Miller (1998), Rogers and Blatt (2003) and Sonis and Hewings (1998).

Linear Programming (LP) models incorporate into an I/O framework an explicit objective function and a set of inequality constraints (Pines and Werczberger, 1982). A problem with LP models is they are prone to corner solutions with excessive specialization and unrealistic behavior. Lack of market information, uncertainty and transaction costs limit the rationality of producers and consumers.

Computable General Equilibrium (CGE) models build on an I/O framework and add incentives for economic actors (Anas and Arnott, 1993 and 1994; Quigley and Swoboda, 2004). CGE models come closer to an optimization view of behavior subject to resource constraints. Producers seek to maximize profits and consumers maximize utility within the limits of their income. Government collects taxes and purchases goods and services. CGE models are often "limited" to housing with different submarkets. In addition, CGE models can be designed for open economies with foreign trade. Prices equilibrate the supply and demand in each market and dynamics can trace out how the system responds to shocks. CGE models are the most comprehensive and complex models, but also the most costly to construct and the most data intensive to parameterize. Well-suited for sweeping changes at a high level of aggregation, CGE models could miss the small impacts of most incremental regulations.

4.1.5 Step 7: Drill down to Housing Submarkets and Neighborhoods

Effects Between Housing Submarkets

Another form of indirect effect on housing is the crossover impacts from a housing submarket. For instance, a regulation that increases construction of new houses can also increase the cost of existing houses. Consumers who wanted to buy a new house may find they can no longer afford a new house, so they shift their demand to the existing house market. Sellers of high quality existing homes benchmark their asking price according to the going market price for new homes. If new homes go up in price, this allows sellers to increase their asking price. The two types of homes are close substitutes.

Ideally, there would be cross-market elasticities that could guide the analysis of crossover effects between variants of housing: new site built, existing site built, rental units, manufactured housing, single-family detached, multifamily, etc. Unfortunately, there are many ways to define submarkets and the measured elasticities vary considerably depending on the size, location and definition of the submarket. The main principle is that elasticity of demand depends on the availability of close substitutes. A corollary is that submarkets tend to have higher demand elasticities. Consumers can avoid price increases within the submarket by substituting units outside the submarket with lower prices.

Neighborhood Impacts.

Subgroup analysis generally refers to demographic subgroups. A different kind of subgroup that is particularly important in housing is the neighborhood. As mentioned in regards to hedonic models, neighborhood property values have an impact on house prices and income groups tend to cluster together. Therefore demographic subgroups and housing submarkets often overlap with geographical definitions of neighborhood. This section describes several studies that have measured neighborhood effects that could be applied to measuring regulatory impacts at the local level.

Until recently, the main data source for neighborhood analysis was the decennial Census. As a result, the Census tract became a standard measure for neighborhood. A drawback of the decennial Census data was that it got out of date halfway through the decade. The American Community Survey (ACS) will fill in the gap with more timely information, though the tradeoff is smaller sample sizes. A new data source, DataPlace (www.DataPlace.org), has been provided by the Fannie Mae Foundation. DataPlace is a collaborative effort of state, local and community-based organizations to combine multiple statistical data sets with mapping technology. The main federal sources of data are from Census, HUD, IRS and the Federal Financial Institutions Examination Council (the same source for HMDA data). The possibility exists that DataPlace will add the functionality of an Automated Value Model (AVM), which would make a hedonic model estimates available for a specific address (Garritano, 2005). Even without the AVM option, DataPlace could prove to be a valuable collection of information for neighborhood analysis.

The first methodology for measuring neighborhood effects is an extension of the familiar hedonic regression model to incorporate environmental amenities and hazards. There is an extensive literature regarding environmental impacts on house prices and land uses. For example, Parsons (1992) looks at the costs of coastal land use restrictions and Kiel (1995) studies the impact on house prices of remediation in toxic contamination sites. Bockstael (1996) and Geoghegan et al. (1997) estimates the ecological and economic impacts of land uses near one's home. So many studies have been done on the effect of air quality that Smith and Huang (1995) conduct a meta-analysis,[21] which estimates a positive relationship between air quality and house prices. Over time, spatial data analysis has become more prominent as econometric software makes the models easier to estimate and GIS data provide the spatial information at a high resolution (Fotheringham, Brunsdon and Charlton, 2002; Haining, 2003).

More recently, Harris (2003) and the EPA find that Superfund sites decrease the value of surrounding properties by 2 to 8 percent. However, Kiel and Williams (2005) examine 74 Superfund sites in 13 U.S. counties and find a range of results, negative, positive and none, depending on the site. Given sufficient data on property values and location, it is relatively simple to measure the impact of a Superfund clean-up effort. However, the impact changes over time as the clean-up proceeds and the stigma of the pollution site wears off. In Kiel and Williams, time is divided into six periods:

- prior to discovery,
- from discovery to the date when the site is proposed for the National Priorities List (NPL),
- from proposal date to official listing date,
- from listing to the commencement of clean-up,
- from clean-up to de-listing, and
- after the date when the site is removed from the NPL.

The hedonic equation regresses the natural log of house prices on structural characteristics, neighborhood measures and time indicators:

[21] Meta-analysis is the synthesis of available literature on a particular topic. The author attempts to reconcile different estimates in order to narrow the range and explain the differences.

LnPrice = a + b1(Bedrooms) + b2(FullBath) + b3(Building Age) + b4(Building Age^2)
+b5(Building Area) + b6(Fireplace) + b7(Pool) + b8(Central Air) + b9(Garage)
+b10(Ln of Tract median family income) + b11(Percent Owner Occupied)
+ b12(Percent Nonwhite) + b13(Tract Unemployment Rate) + b14(Percent College Educ)
+ b15(Ln of Distance from NPL site) + Year of sale Dummy Variables + residual.

Of the 57 regressions with data available, there were 18 that had positive and significant correlations between sale price and the log of distance to the NPL site after the site was listed. The mean impact was 16.26 percent.

Kiel and Williams go beyond the hedonic findings by using meta-analysis to determine what were the factors associated with positive impacts from cleanups. The dependent variable is simply one if the coefficient on distance from NPL site was positive and significant, zero otherwise. The authors found three factors negatively related to house prices:

1) large NPL sites,
2) high population densities near the NPL site, and
3) a high percentage of blue collar residents in the county.

In fact, some of the sites with depressed house prices before the cleanup continued to suffer stigma or lower property values after the cleanup was completed. The main point for our purpose is the technique for measuring neighborhood impacts with the helpful twist of meta-analysis for a better understanding of the relationship.

A second approach to measuring neighborhood impacts on house value is called Adjusted Interrupted Time Series, AITS (Ellen et al., 2001; Schwartz et al., 2003; Galster et al. 2004; Accordino, Galster and Tatian, 2005). AITS estimates the impact of some intervention on house price appreciation. It has been used to determine whether nearby subsidized housing has a negative or positive impact on private house values. GIS or geocoding of each property allows the spatial measure of the neighborhood to be smaller than a census tract, e.g. a 500-foot ring around the target property.

The distinct feature of this approach is the use of a pre/post design that compares both levels and trends of house prices in the surrounding neighborhood both before and after key milestones of some intervention. In our case, the intervention would be the introduction of some government regulation. Also, the Housing Impact Analysis will be done before the intervention, so the estimation will have to be based on a similar intervention that has already occurred. Using a period in time prior to the start of the initiative as the baseline for establishing what prices would have been in the absence of the redevelopment, the pre/post design measures changes in both price levels and trends in a neighborhood during and after the regulation. In effect, the regression estimates whether the neighborhood effects accelerated or decelerated the trend in house prices that was established before the regulation went into effect. The regression specification includes shift and trend variables to see if the houses in treatment neighborhoods either jump up or accelerate in value. It is the examination of these changes relative to changes in other neighborhoods without the regulation that provides evidence for inferring the intervention had a positive or negative effect.

In Accordino et al. (2005), researchers find that house prices in the target neighborhoods increased at 9.9 percent per year faster than in the rest of Richmond after the beginning of the Neighborhoods in Bloom project began. When city investments per block exceeded $20,100, average home sales price in that block increased by 50 percent. Housing investments included: CDBG, HOME, capital improvement funds, code enforcement, tax-delinquent sales and property disposition priority, accelerated historic preservation review, and housing counseling. Similarly, when LISC (Local Initiatives Support Corporation) added to the investments, the home values increased even more. The combined effect had a measurable, positive impact on house prices within 5,000 feet of the target blocks. The authors conclude (p. iv): "...public and nonprofit sectors should target their resources so as to achieve a threshold level beyond which the private market can operate without subsidies..." The size of the intervention in Accordino et al. (2005) was extremely large, which helps explain why the positive effects extended so far from the target blocks. They also found a threshold effect, which suggests that spillover neighborhood effects may be quite modest until they reach a threshold.

Apgar, Duda, and Gorey (2005) estimate the impact of foreclosures, particularly on the municipal government (Chicago). See also Goetz et al. (1997) for results in St. Paul. The costs to the city are a measure of the negative externalities from a foreclosure that are beyond the cost of lower house prices for occupied houses in the neighborhood. Properties that sit abandoned for long periods become a crime scene and a fire hazard. Ultimately the city has to demolish damaged structures and sell the land for redevelopment.

Costs by scenario:

Foreclosure, Sold at Auction, Vacant/Secured	$430
Foreclosure, Sold at Auction, Vacant/Unsecured	$5,358
Foreclosure, Sold at Auction, Significant Crime	$6,753
Foreclosure, Sold at Auction, Demolition Court	$13,324
No Foreclosure, Vacant/Unsecured, Structure Demolished	$19,227
Severe case with Fire	$34,199

Shlay and Whitman (2004) estimated the spillover effects of foreclosed properties in Philadelphia. Properties within 150 feet of an abandoned unit sold for $7,627 less than those not located near an abandoned unit. The effect tapers off to $3,543 at distances 300 to 450 feet and negligible beyond 450 feet. Two abandoned properties in the same block lowers the sales prices for the other houses in that block by $10,000.

Another extension of hedonic modeling is to incorporate a risk measure based on fluctuations in neighboring house values measured by Zip code. Seslen, Wheaton and Pollakowski (2005) extend the idea of user cost by incorporating both expected house price appreciation and risk. The hedonic model has a standard set of structural characteristics. Spatial characteristics are added through measures of neighborhood amenities. Financial characteristics, such as interest rates and tax deductibility of interest rates, can be added through including the user cost of capital. Beyond the purchase price and annual housing payments, user cost is affected by resale value and, thus, expected house price appreciation. A house that is expected to sell for a high price in the future should be worth more to a buyer today. The logical extension is to include risk as well as house price appreciation. Between two houses with equal expected appreciation, the one with more uncertainty or variation should command a lower price. An empirical test by the authors gives mixed results. Risk and appreciation are positively correlated across Zip codes and the location variables seem to capture the expected long-term appreciation. However, house prices are not discounted for risk based on historical variance. This finding suggests either the housing markets are not as efficient as other competitive markets, or it is difficult with existing data to measure separately expectations and risk.

4.1.6 Step 8: Distributional Analysis, Affordability and Subgroups

Distributional Analysis

The distributional analyses drill down from the societal perspective of the cost-benefit analysis to the subgroup perspective. Who are the gainers and losers from the regulatory change? The gains and loses are primarily in terms of income and wealth, such as increased house value and equity. But the changes could also be in terms of opportunities for education, employment, health coverage, recreation, etc. An equity assessment focuses on vulnerable low-income and minority subgroups. Who would be disadvantaged under the new regulation? A proposed regulation deserves special scrutiny if it would further deprive those subgroups, which formerly have had a small share of the community's income and wealth. Another subgroup dimension, that is particularly important to housing, is the geographical distribution. Does the new regulation differentially affect the center city vs. suburbs or rural areas? What region of the country bears the greatest share of the cost burden under the new regulation?

The standard approach in distributional analyses, particularly analyses of household income, is to assume the median is sufficient to represent the entire distribution. The presumption in this approach is that the shape of the distribution does not vary much and the central tendency of the distribution is adequate for comparing distributions. A common practice in government surveys is to top-code, and sometimes bottom-code, responses to protect the confidentiality of the survey participants. Such truncation of the data makes it difficult to determine the mean or the full shape of the distribution, which explains why the median is reported. Another issue with subgroups is that the sample may be too small, especially in the tails, to reliably measure the shape of the distribution. Nevertheless, when the data are available, information by decile provides a more comprehensive picture of the distributional impact for a new regulation.

A similar strategy is to cumulate the number of affected persons or households below a cutoff, such as 60 percent of median household income. The number of people moving across the 60 percent boundary may not be large enough to reliably measure, but the share of population below that cutoff may be a more reliable measure. The poverty rate is another standard cutoff calculated by Census.

Another benchmark measure for housing studies is the homeownership rate. Homeownership is the foundation for a stable community. The federal government has a policy of increasing homeownership rates, especially for low-income and minority households whose homeownership rates fall far below the rate for whites. Homeownership rates have generally been improving over the last decade with falling interest rates, aging of the population, smaller minimum downpayments and easier mortgage credit (Duda and Belsky, 2001). While these favorable factors have lifted the homeownership rates, they have also increased demand for housing that have outpaced supply so that house prices have increased. If house prices increase faster than household income, would-be homeowners are forced to remain renters or find less expensive forms of homeownership.

One component of the homeownership rate and an indicator of housing market pressure is the condominium market, especially in large MSAs. Condominiums matter to regulatory analysis because condominiums are usually a more affordable alternative to owned housing than single-family detached houses. When single-family house prices increase rapidly, homebuyers will substitute condominiums for single-family detached units. That way the homebuyers hope to take advantage of growing house prices and possibly upgrade to a detached unit later. Condominiums can take a variety of structural forms, but many condominiums are units in a multifamily building that look just like rental units. The living space is smaller than detached single-family houses and condos usually have less yard space, but they are closer to employment and entertainment centers. Homebuyers who cannot afford a single-family house in the suburbs would consider a condominium as a more affordable alternative (Jones, 2005). The supply of condominiums depends on new construction and conversion. Existing rental units can be converted to condominiums with minimal construction activity. New condominiums may provide many amenities and skew the condominium price distribution. However, if there is enough information to control for quality differences, the comparison among detached house prices, condominium prices and rents provides a good indicator about the affordable housing market. When house price appreciation is high relative to rents, demand for owned housing will spread to the condo market (Joint Center for Housing Studies, 2005, p. 18). Speculators will also turn to the condominium market as a relatively low-cost way to participate in the rising real estate market. The combination of homebuyer and speculator demand will push condo prices to rival detached SF houses. Once condominium supply catches up with demand, condominium prices will return to a historical position with a price that capitalizes a flow of rents for a comparable rental property.[22]

[22] A useful formula for converting asset values into an annualized flow over n periods is:
$AC = PVC * [(r * (1 + r)^n) / ((1+ r)^(n + 1) - 1)]$.

Another component of homeownership and a low-cost alternative to condominiums or site-built housing is manufactured housing (HUD, 2001; Apgar, 2002). A major reason manufactured housing (MH) is less expensive is that the structure is usually sold separately from the land. Most MH units have been sited on rented land, often in a park with other MH units with community services included in the monthly rent. Also, the chattel financing is for a shorter term and a higher interest rate. Nevertheless, MH provides an affordable alternative to site built housing. Like condominiums, the percent of homeowners in MH can act as an indicator of housing affordability and availability, especially in non-metropolitan areas of the South and West. Potential homebuyers unable to find an affordable site-built house can still get the advantages of homeownership through manufactured housing. Rising household incomes may enable MH owners to upgrade to site-built houses. The turnover in MH ownership will shorten, but the share of MH owners will not necessarily attenuate as other renters become MH owners. Rising incomes may lift MH prices, but the supply elasticity for factory-built houses is quite high. Without the barriers associated with land development, MH producers can increase the supply in response to demand. MH prices are likely to increase with size and quality. Also, the buyer may still have the challenge of getting municipal approval for siting the MH unit on a particular plot. But excess demand for the units is likely to be short-lived as competing producers increase the supply.

Direct measures of affordability compare the cost of housing to household income. The simplest approach is to compare the median house prices to median household income. If house prices are rising faster than incomes, the ratio of medians will increase and fewer households will be able to purchase a home without compensating adjustments in the mortgage financing. In fact, more sophisticated measures of affordability convert house prices into a monthly housing costs based on assumptions about the size of the downpayment and terms of the loan (length of payment period and interest rate).

The NAR affordability index, called the Housing Affordability Index (HAI), measures how much of the median house price could be afforded by a household earning the median household income. HAI assumes the monthly housing payment (principal and interest) is for a 30-year loan with a 20 percent downpayment and a qualifying ratio of housing payment-to-income of 25 percent. The mortgage payment is calculated with the effective interest rate reported monthly by the Federal Housing Finance Board:

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where: AC = annualized cost accrued at the end of each of n periods,
PVC = present value of costs or asset value,
r = discount rate or interest rate per period
n = duration of stream

This formula assumes an initial value at t=0. If the first rental payment does not occur until the end of the first period, then the exponent in the denominator should be changed from n+1 to simply n.

$$Monthly\_Payment = Median\_Price * LTV * \left(\frac{IR}{12}\right) * \left(\frac{(1+(IR/12))^n}{((1+(IR/12))^n)-1}\right)$$

where IR is the effective annual interest rate, LTV is the loan-to-value ratio (such as 80 percent) and n is the term or number of months in the mortgage (typically 360 for a 30-year mortgage). The effective mortgage rate means the interest rate is adjusted by the amortization of initial fees and charges. A significant advantage of the HAI is that it can be calculated from readily available information: median house prices, median household income and current mortgage interest rates. The housing finance market has generated a wide array of adjustable-rate mortgage vehicles, but the 30-year fixed rate mortgage still represents about 65 percent of the market. The index can be customized to first-time homebuyers (or other subgroup) by adjusting the median household income and loan terms common to those buyers.

There are several disadvantages of the HAI as a measure of affordability. For example, the HAI does not determine how many households could afford the median house, but rather what percentage of the median house a householder with the median income could afford. To count the number of households who cannot afford their housing, it would be better to use a housing payment burden approach. In this approach, a choice has to be made about what share of income a household could spend on housing and still afford the other necessities. HUD has set the standard at 30 percent of income, though many low-income households spend much more than that. Assuming the 30 percent limit, affordability could be calculated as the number of households who spend less than or equal to 30 percent for their current housing arrangement. If the focus is on median house price, the calculation could be what share of households has sufficient income to buy the median house.

A second challenge for HAI and housing payment burden measures is the calculation of the user cost of housing. For renters, the housing payment is usually just the rent and utilities. For owners the calculation can be much more complicated, in part, because interest payments and local property taxes are tax-deductible for tax itemizers. Another complicating factor is that owned property provides a current flow of housing service (valued at an imputed rent) and a future resale value. In other words, an owner is both a consumer of housing and an investor in housing real estate. The value of that investment depends on the holding period, the level of maintenance and the amount of home improvement during the holding period. Insurance (both mortgage and property) and utilities are additional complicating factors. Available data are rarely sufficient to calculate a comprehensive measure of owner user cost.

Poterba (1992) defines the user cost of capital for tax itemizers from the equilibrium condition:

$$R = [(1-\tau)(i+\tau_P) + m + \delta - \pi]P_H$$

where R is the imputed rental value, τ is the marginal tax rate for income taxes and τ_p is the property tax rate, m is the maintenance rate, δ is the depreciation rate, π is the overall inflation rate and P_H is the house price. The user cost of capital is in the square brackets. It is assumed the house price appreciates at the same rate as the overall inflation rate. In his calculation from 1980-1990 data, Poterba assumes each taxpayer itemizes, $\tau_p = .025$, $\delta = m = 0.02$, π is the five-year average of the CPI inflation rate, and i is the average commitment rate on new fixed interest mortgages. Given those parameters, Poterba calculates the user cost is 13.3 percent for an income of $30,000 and 11.6 percent for incomes at $50,000 and $250,000. John Krainer (2003) points out that the two aspects most likely to fluctuate over time are the interest rate and the expected house price appreciation. Assumptions about the other parameters in the user cost formula are much less important. Although interest rates and house price appreciation are difficult to forecast, they are at the heart of almost any model that forecasts housing.

Another issue with using the median sales price in an affordability measure, whether HAI or some other, is that sales prices do not control for quality. Separating new construction from existing properties is a step in the right direction. A better solution is using a repeat sales house price index, like the OFHEO's House Price Index (www.ofheo.gov/HPI.asp). The HPI is based on the difference in sales prices for the same unit sold at different times. The sales data come from Fannie Mae and Freddie Mac, so there is excellent coverage for homes with conventional mortgages. The HPI is available at the MSA level back to about 1975 for major metropolitan areas, as well as state, regional and national indexes. OFHEO HPI has become a standard source for house price appreciation. To compare house price levels among MSAs, the Census is used to establish house prices in a base year (e.g., 2000) and then inflated according to the HPI.

OFHEO's HPI is based on repeat sales of houses. The index does not include new construction or houses that rarely sell. Moreover, increases in sales prices are often associated with home improvements. If it is important to value the stock of housing, not just recent sales, and control for changes in quality over time, a hedonic regression model is necessary. A hedonic model regresses the house price (or more commonly the natural log of house price) on measures of the structure and neighborhood that could affect the price (Rosen, 1974). American Housing Survey (AHS) data are well-suited for hedonic estimation because the data have good information on structure, house quality, neighborhood conditions and home improvements. The AHS has both national and metro samples for the largest 45 MSAs (Thibodeau, 1995). Census provides a Constant Quality C-27 Series (now part of C-25) with house prices adjusted for 10 characteristics of structure and location. Census construction data focus on new house sales. The Public Use Microdata Sample (PUMS) from the decennial Census can also be used for hedonic regression (Malpezzi, Chun and Green, 1998). Hedonic regression allows the researcher to impute a house value for a unit of constant characteristics. Thus the affordability measure can focus on how much housing a family can afford without the confusion of changes in the quality of housing.

Collins, Crowe and Carliner (2001) provide a useful method for calculating target affordable house values at the MSA level using AHS and HUD data. The issue is to determine how many houses in the local stock have prices that are affordable to a family earning 80 percent or less of the area median income. The variation by MSA in incomes, house prices, property taxes and insurance rates make it important to measure the affordable housing stock using MSA level parameters, if possible.

The AHS provides self-reported area median property taxes (AMTX) and hazard insurance (AMTI), which can be divided by house values to get the corresponding property tax and insurance rates. The mortgage payment (principal and interest) can be calculated by multiplying the mortgage constant by the loan amount. The formula for the mortgage constant on a 30-year fixed rate mortgage is:

$$Monthly\_Mortgage\_Cons\tan t = \frac{IR}{\left[1 - \frac{1}{(1+IR)^{360}}\right]}$$

where IR is the monthly interest rate in decimals (6 percent is 0.06/12 = .005). The monthly mortgage constant can be multiplied by 12 to get the annual mortgage constant and the annual mortgage payment is the annual mortgage payment times the loan amount. The authors assume a loan-to-value ratio of 90 percent, i.e. a down payment of 10 percent. In addition, they assume a conventional, conforming underwriting limit of 28 percent for the maximum allowable share of income for principal, interest, property taxes and hazard insurance (PITI). Based on available information on the average effective property tax rate and property insurance costs across the country a reasonable assumption is that property taxes are 1.7 percent and property insurance costs 0.4 percent of the home's value.[23] The area median income is published by HUD (www.huduser.org/datasets/il.html) for MSAs and local areas across the whole country.

The final ingredient in the affordability cutoff is to calculate the payment-to-income ratio that a family could afford given 80 percent of area median income. Collins et al. (2001) provides the following formula:

$$X = \frac{LKR}{(P + H + LK)}$$

where

X = payment-to-income ratio (adjusted for local income, taxes and insurance)
L = loan-to-value ratio
K = mortgage constant (use annual mortgage constant if annual income)
R = maximum housing payment-to-income ratio allowed by underwriting (28%)
P = area median property tax as percent of median property value

[23] These assumptions are based on information from the Tax Foundation (www.taxfoundation.org) the Insurance Information Institute (www.iii.org).

H = area median hazard insurance as percent of median property value
I = 80% of area median income

By calculating the payment-to-income ratio X and multiplying it by I (80 percent of the area median income), that gives the maximum payment that a family can afford. That monthly or annual mortgage payment (less property taxes and hazard insurance) can be translated into a loan amount and then into a house value. The formula for the original mortgage balance, MB_0, is:

$$MB_0 = MP\left[\frac{1-(1+IR)^{-n}}{IR}\right]$$

where MP is the mortgage payment (principal plus interest), IR is the interest rate and n is the number of periods. If the mortgage payment is monthly, then the annual interest rate is divided by 12 and the number of periods is in months (360 for a 30 year fixed rate mortgage). This same equation can be used to calculate the remaining balance on a mortgage with n periods remaining. To calculate the house value from the original loan amount:

$$House\_Value = \frac{MB_0}{1-DownPaymentRate}$$

That house value is the highest amount that a household earning 80 percent of the area median income can afford. The selection of income limit, terms of the mortgage or underwriting criteria are somewhat arbitrary. We have suggested traditional values. The proliferation of automated underwriting, subprime lending and adjustable rate mortgages have loosened the underwriting criteria over time. A smaller down payment (3 percent) and a higher payment-to-income ratio (30 or 32 percent) are plausible alternatives.

Mortgage insurance is typically required for loan-to-value rates above 80 percent (down payments less than 20 percent). The mortgage insurance rate varies from 0.5 percent for LTV of 90 percent to 1.0 percent for LTV of 100 percent. The interest rate can be increased to accommodate the mortgage insurance premium.

The researcher can then determine from household level data in AHS or Census the size of the affordable stock, i.e., how many units in an MSA have a value less than the maximum affordable to a moderate-income household. Alternatively, household data on incomes could be used to determine how many households have sufficient income to afford the moderate cost house. A house cost burden analysis determines how many households are paying more than 30 percent of their income for housing. HUD uses 30 percent as the affordable limit primarily for rentals, which often include utilities and thus justify a slightly higher rate than the 28 percent cutoff for underwriting of mortgages.

Synthetic Underwriting

Listokin, Wyly, Schmitt and Voicu (2001 and 2002) provide a detailed study of synthetic underwriting. Their focus was on the affordability of homeownership, so they examined the mortgage borrowing capacity of renters for a wide range of mortgage products available in 2001. It is called synthetic underwriting because the authors use the contemporary underwriting standards to see how many renters could qualify for each mortgage program. Their work deserves attention as an example of affordability analysis that solves many challenging data problems and yet still has important limitations.

The synthetic underwriting approach is an extension of the work started by Savage and Fronczek (1993) during a time when 30-year fixed rate mortgages dominated the conventional and FHA markets. In addition to principal and interest, property taxes and insurance, Listokin et al. have included mortgage insurance, closing costs, debt and imputed credit score. With this information at the household level, a computer program can be designed to calculate how much house a homebuyer could afford. At the time of the research, private low downpayment loans (less than 3 percent) were providing competition for FHA loans. Since that time, new products have evolved like hybrid ARMs, interest-only ARMs, and payment-option loans. As more flexible mortgage products become available, borrowers can qualify to buy more expensive homes with the same level of income. It is this flexibility in mortgage products and underwriting which blurs the boundary of affordability. Housing payments above 30 percent of income no longer disqualify a borrower, but they do increase the payment burden.

The first step in synthetic underwriting is to estimate a target house price that homeowners have demanded. The median house price could be used, as in the HAI, but low-income families may be able to afford a less expensive house. The target house model uses historical data to regress log house prices on income, age, household size, marital status, education, occupation, self-employment, public assistance and residential location. The Survey of Income and Program Participation provides all that data for a panel of new homeowners between 1993 and 1995. Coefficients from that model are used to predict the purchase price that renters are likely to pay for a house that meets their needs. Those target house prices are compared to the maximum purchase price that the potential homebuyers could afford under alternative mortgage products. Housing appears unaffordable if the "demanded" house price is greater than the maximum for which the borrower could qualify.

The results of the synthetic underwriting exercise are instructive. Only 5 percent of renters could afford their target house value. About 2/3's lacked both the income and downpayment, with another 25 percent lacking the wealth or downpayment alone and about 5 percent lacking the income for monthly payments. Gains from flexible underwriting are generally small (less than 1 percent) with bigger gains going to high-income and white demographic subgroups. The biggest impact on homeownership would come from cash grants. A cash grant of $5,000 would increase homeownership by about 1 percentage point and a cash grant of $1,000 would increase homeownership by 0.1 percentage point. Wealth (savings for a downpayment) is more important than income as a barrier to homeownership. Unfortunately, few public surveys collect accurate information about wealth, which makes it very difficult to make absolute determinations about affordability.

The test of synthetic underwriting is whether the homes bought by renters are more or less than the value imputed in the target house prices. Although it is based on a small sample of 456 renters who became owners, the results are remarkable. Of the renters in 1993 who bought a home by 1995, 93 percent bought a more expensive home than the target home price that the model calculated as affordable. Moreover, 88 percent bought a house that was more than 50 percent greater than the "affordable" target price. Part of the problem may be under-reported wealth or gifts from parents. Another issue may be expected capital gains. New homeowners are willing to accept a larger mortgage if they expect the house price to appreciate rapidly. A third problem may be that house values reported by new homebuyers tend to be biased upwards relative to seasoned owners (Kiel and Zabel, 1999).

Three conclusions come from the Listokin et al. research. One conclusion is that it is difficult to unambiguously define affordability. Underwriting criteria change over time and the amount of housing people demanded in the past may not match what they are willing to pay in the future. A second conclusion is that wealth for down payments and closing costs is a greater barrier to homeownership than income. A third conclusion is that regulations would have to have a large impact on the upfront costs of home buying in order to have a measurable effect on homeownership. Nevertheless, Listokin et al. have set a high standard for careful measurement of affordability. Housing payment burden (house payments relative to monthly income) may be a more reliable and comprehensive measure of affordability than counting the number that switch from "affordable" to "not affordable." Almost no matter where the affordable line is drawn, there will be a large number of households making unaffordable house payments. Rather than counting the number that cross the line given assumed loan terms, it may be more useful to measure the change in house payment burdens. To focus on low-income, high-burden households, the affordability measure could limit the "at risk" cases to households with below-median income paying more than 30 percent of their income on housing.

A mismatch analysis compares the stock or supply of affordable units to the demand or number of low and moderate-income households (Nelson, 1994). The affordable supply can be further adjusted by subtracting the number of units housing high-income families. By any measure, there is likely to be a shortage of affordable housing. What is important is the degree of change. The recommended approach is to consistently measure the size of the affordable stock before and after the implementation of the regulation. This analysis projects how much change there would be in the availability of affordable housing due to the regulation.

Subgroup Analysis. The choice of subgroups for analysis depends on the regulation and available data, but the primary targets are disadvantaged and vulnerable populations. Low-income households are described in the Census Current Population Reports (Series P-60 on

Income and Poverty). Income deciles or consumption deciles are another way to distinguish groups. The categories can be set up at one point in time and then adjusted for inflation for comparisons over time. Minority populations of non-white persons have historically been disadvantaged by employment and housing discrimination. A common subgrouping is: African-American, Hispanic, Asian/Pacific Islander and other. The 2000 Census has created new categories for households with mixed ethnic backgrounds. While more precise in its description, the size of the mixed minority subgroups is relatively small and complicates comparisons with earlier reports. Other income-disadvantaged subgroups could include elderly, disabled, and single-parent families.

Housing-based subgroups. Low income correlates imperfectly with housing choice and location. Low-income households are more likely to be renters, with or without government housing subsidies. Households living in public housing or receiving housing vouchers are generally protected against rent increases that would exceed 30 percent of their income. Unsubsidized renter households are vulnerable to rent increases. Moreover, enforcement of building codes may truncate the distribution of housing quality such that a renter does not have the choice to move to a lower quality apartment. If a regulation increases rents, a low-income renter may be forced out of their current unit without a lower cost alternative and eventually become homeless. Data on homelessness are very limited because most government surveys are based on place of residence. Some studies have been done for select MSAs (Burt et al., 2001, 2004; Culhane et al., 2003; Hillier et al. 2003). Moreover, HUD is developing the Homeless Management Information Strategy (HMIS) data that is collecting data on the number of homeless by MSA and the services available.

At a moderately higher income level, first-time homebuyers are another subgroup of concern. If house prices increase, there will be a segment of renters who will not be able to afford homeownership, at least in the short run. Many households reach ownership as they age and acquire sufficient savings for a downpayment. The pattern of homeownership rates by age and race show a large, but narrowing, gap between whites and non-white minorities as they age. The challenge to boost homeownership rates, then, is to reduce the age at which householders become first-time homebuyers.

Elderly homeowners face a different issue, and that is how to afford remaining in their house. Many elderly homeowners are no longer making monthly mortgage payments, rather they are spending an increasing share of their limited income on utilities and health care (Butrica, Goldwyn and Johnson, 2005). A regulation that increased the cost of heating oil or drugs could force some share of the elderly to lose their independent living. The Health and Retirement Survey is a national, longitudinal survey of pre-retirement and elderly households, which may be helpful in estimating norms for wealth, housing, health and expenditures.

Alternative Regulation or Implementation

A thorough Housing Impact Analysis, following a complete Regulatory Impact Analysis, considers alternatives to the proposed regulation, particularly when the proposed regulation has a deleterious effect on affordable housing. The goal is to achieve the same, favorable impacts intended by the proposed regulation while alleviating some or all of the negative, unintended effects on affordable housing. For example, an environmental regulation that prohibits development in wetland areas might reduce the supply of affordable units that would have been built in those low-lying areas. An alternative would be to allow developers density bonuses in less environmentally fragile areas. In that way the supply of affordable housing is maintained and the goal of protecting the environment is achieved.

The situation for each regulation will be different, which makes it difficult to prescribe appropriate alternatives in general. There are several useful concepts from the cost-benefit literature (incentive-based controls, voluntary action), which favor more flexible regulations. As long as preserving or expanding affordable housing is a shared goal, then the regulated parties may be able to determine the most cost-effective means of achieving that goal. Government agencies still have the responsibility of monitoring progress and requiring more stringent regulation if the housing goals are not met.

Command-and-control regulations specify what and how industry must do to comply with a regulation. These regulations are easier for a government agency to monitor because any deviation of the specified action is a violation. Even firms with relatively high production costs might prefer regulations of this type. They know that every other firm in the industry will have to do it the same way and every firm can pass along those costs to the consumer. However, there could be a substantial opportunity cost from this approach because some innovative firms might be able to find less costly ways to meet the objectives of the regulation. In a competitive marketplace, the innovative firms will enjoy greater profits for only a short while before the other firms imitate the cost-saving technique. Regulations that specify the ends, but allow flexibility in the means, can promote cost-saving innovation and competition.

Direct or standards-based controls bring all of the industry up to the standard of the Best Available Technology (BAT). These regulations have the advantage of being feasible and practical. The technology to implement the regulation is already known. As long as the technology is well chosen, then the regulation can bring all the firms into compliance with best practices. Incentive-based controls may be more cost effective by giving producers more flexibility in achieving the targets. Many strategies have been developed, particularly in the environment field, such as: marketable permits, emission taxes, bubbles and offsets, user charges, product charges, subsidies for pollution reduction, government cost-sharing, refundable deposits, pollution indemnity, information and labeling rules. By creative application, these strategies can work with the incentives of private producers and consumers to achieve socially beneficial ends with less market distortion and lower overall costs.

4.2 Examples of In-Depth Analysis

We have chosen two cases of Regulatory Impact Analysis that pertain directly to housing and provide in-depth examples of what could be done for Housing Impact Analysis. The first case study is an EPA rule, Effluent Guidelines for Construction and Development (2002, 2004). The second case study is a HUD rule, Wind Standards for Manufactured Housing (1993). These case studies were chosen, in part, because the underlying rules have an impact on housing affordability and the analyses address affordability issues. In descriptions we emphasize the modeling techniques rather than the particulars of the findings. The findings are important to that specific rule-making, but the modeling techniques can be applied to many other regulations. There are also suggestions on how to extend the analysis so that it would be more comprehensive as a Housing Impact Analysis.

4.2.1 Case Study 1: Effluent Guidelines for Construction and Development

The Environmental Protection Agency (EPA) has been working for years to develop regulations that would reduce the sediment in storm water runoff from construction sites. The sediment deposits have contributed to the loss of capacity in small streams, lakes and reservoirs as well as to costly mitigation efforts in the form of soil erosion control and dredging. Four options were proposed for different levels of sediment control and the Economic Analysis estimates the compliance costs and economic impacts for each option. The analyses were reported in two reports:

- *Economic Analysis of Proposed Effluent Guidelines and Standards for the Construction and Development Category* (May 2002)
- *Economic Analysis for Final Action for Effluent Guidelines and Standards for the Construction and Development Category* (March 2004)

As a shorthand, we will refer to the Proposed Guidelines vs. the Final Guidelines or by year. The modeling approach did not change significantly between reports and is presented in more detail in the 2002 report.

The Final Guidelines describe four options and recommend Option 3, no new regulations. EPA reaches that recommendation after careful analysis of the costs and benefits of all four options. For the most costly option (2), the analysis estimates the total social costs would be $556.9 million per year compared to total social benefits of $14.5 million with deadweight loss of $1 million. On that basis, EPA decided to promulgate no new regulations on effluent control for the construction and development industries.

Option 1 entails enhanced inspection and Best Management Practices (BMP) certification on sites of 1 acre or more via amendment to the National Pollutant Discharge Elimination System (NPDES) stormwater permitting regulations. Option 1 also requires developers to maintain a site log book in which qualified professionals conduct assessments and certify that all plans meet erosion and sediment control (ESC) requirements via Best Management Practices. However, Option 1 does not include codifying provisions of the EPA Construction General Permit.

Option 2 would establish specific provisions in the Construction General Permit as minimum requirements for all construction sites nationwide. There would also be enhanced inspections and Best Management Practice certification for all sites with 5 or more acres of disturbed land. Effluent Limitation Guidelines would apply to sites of 5 acres or more and add a new section for the Construction and Development Category on point source sediment control. The Stormwater Pollution Prevention Plan (SWPPP) would include:

- General erosion and sediment controls and schedule

  Establish vegetation, mulching, geotextiles, sod stabilization, vegetation buffer strips, protect trees, etc.
- Sediment controls

  Structural practices to divert flows of exposed soil, limit discharge of pollution.
- Pollution Prevention Measures

  For construction chemical and waste materials and

  Description of storage & prevention from becoming pollutants in stormwater discharge.
- Plan applies prior to groundbreaking including:

  Narrative of planned construction activity and sequence,

  Maps of site with drainage patterns, surface water, total disturbance area and controls,

  Description of available data on soils,

  Description of BMP to control pollutants in stormwater discharges,

  Estimate of pre-development and post-construction run-off coefficients, and

  Delineation of SWPPP implementation responsibilities.
- Update SWPPP when changes in design or inspections show existing plan ineffective.
- Maintain site log book and certify within 48 hours that appropriate activities carried out.
- Conduct regular site inspections.
- Stabilization of soil after disturbance.
- Maintenance of controls

  Remove sediment from traps and ponds when capacity reduced by 50 percent.

Option 3 entails no new regulations.

Option 4 has provisions for codifying Construction General Permit on 5+ acres (same as Option 2, but without enhanced inspections and BMP certification provision as dictated under Option 1).

Although the reader does not need to understand the details for each option, clearly Option 2 is the most rigorous and expensive due to enhanced inspections and certification provisions.

The baseline for this regulation is Option 3, which means continuing with the existing state and federal regulations and assuming 100 percent compliance. Engineering costs were done by professional site engineers in three categories:

- installation costs,
- design costs (16 percent of installation costs), and
- operating and maintenance costs (100 percent of installation costs).

The installation costs are based on unit costs, such as silt fencing per mile, and it includes inspection, certification and permitting. The engineering costs are adjusted along four dimensions:

- type of land use (SF, MF, commercial, industrial, highway construction)
- land area of project in acres (0.5, 3, 7.5, 25, 70 and 200)
- state (some state regulations are already as stringent as proposed federal regulations)
- regional costs (primarily labor according to R.S. Means).

The cost estimates are used in the project level analysis to estimate the consumer impact from higher house prices. The firm model uses financial ratio analysis to estimate the production costs by firm. Industry level analysis determines the cost to the industry and feeds into a partial equilibrium model of the national housing market, regional impact and net economic impact. Finally, a government impact model is added to industry costs to get the total social costs.

An example of the ***Project Model*** is given in Table 4-1. All dollar values are in constant 2000 dollars. This table is like a pro forma statement for a small SF development project (7.5 acres) assuming 100 percent pass-through of compliance costs to the consumer. The compliance costs start with the Erosion and Sediment Control (ESC) costs, based on an engineering study. In this case, ESC costs would add $4,928 to the land development. Up to that point in the table comparison the baseline and option columns are the same, but below the ESC cost line the column figures diverge. To finance the cost of the land development with ESC costs, the 4-year loan is larger and the interest payments increase by $718. A portion (25 percent) of the added compliance costs comes from the developer's capital, which adds $239 to the opportunity cost (at the same interest rate as the development loan). Overhead is estimated at 10 percent of the preceding development costs (excluding opportunity cost of capital). So the regulation adds $325 to overhead. The normal profit on development is 10 percent, so the regulation adds $690 to profit.[24] Although the regulation requires $4,928 in ESC costs, the total land acquisition and development costs increase by $6,900, almost $2,000 more due to interest, overhead, opportunity cost and profit. Assuming 20 houses are built on the 7.5 acres of developed land, the increase in sales price per unit lot is $528 or 0.17 percent of the baseline sales price. Compared to the ESC costs of $4,928, the combined change in sales price on 20 lots of $10,560 (or 20*$528) is a multiplier of 2.144. In other words, the final change in house price is more than double the initial ESC costs to comply with the regulation.

Although the table in Table 4-1 is only an example, it demonstrates the fundamental issue with compliance costs. The ultimate increase in house prices is a multiple greater than the direct compliance costs because so many indirect costs (interest, overhead, opportunity cost and profit) are estimated as a percentage of accumulated direct costs. Also, the earlier in the development process the compliance costs begin, in this case at the groundbreaking stage, the more stages at which the indirect costs get added on to the original cost and the greater the ultimate change in house price.

24 Although the profit rate has not changed (still 10 percent), the amount of the profit actually increases in this example, which ignores competitive pressures. However, the example might be realistic if there is monopolistic competition and every firm continues to use the 10 percent rate to markup the regulatory costs.

Table 4-1
Cost Comparison for Small, Single Family Development

Project Cost Elements	**Comments**	**Baseline, Old Regs**	**Costs under New Regs**
Land Acquisition (7.5 acre parcel)			
Raw Land		$300,000	$300,000
Interest on land acquisition	65% LTV, 7.5% int. rate, 3 yr loan	$29,955	$29,955
Opportunity cost of capital	35% LTV, 7.5% int. rate	$16,129	$16,129
Total Land Acquisition Costs		$346,084	$346,084
Land Development (7.5 acre parcel)			
Engineering	6% of Land Development	$30,000	$30,000
Due Diligence	$2,500 per acre	$18,750	$18,750
Land development	$25,000 per lot, 2.67 lots per acre	$500,000	$500,000
Erosion and Sediment Control Costs		0	**$4,928**
Contingency	10% of Land Development	$50,000	$50,000
Impact Fees	$15,000 per lot	$300,000	$300,000
Interest on Development Loan	75% LTV, 4 yr loan	$130,950	$131,668
Opportunity cost of capital	25% LTV	$43,650	$43,889
Overhead	10% of Dev Cost (exclud OCC)	$59,320	$59,645
Total Land Development Costs		$1,132,670	$1,138,880
Land Acquisition + Development Costs		$1,478,754	$1,484,964
Profit on Land Acq and Development	10% of total	$164,306	$164,996
Total Land acq and development		$1,643,060	$1,649,960
Construction Costs (per lot)			
Finished lot cost	20 lots on 7.5 acres	$82,153	$82,498
Construction costs	2310 sq. ft. * 53.80 per sq. ft.	$124,276	$124,276
Interest on construction loan	80% LTV, 4 yr. Loan	$32,082	$32,136
Opportunity cost of capital	20% LTV, 4 yr. Loan	$8,021	$8,034
Builder overhead	10% of Const Cost (exclud OCC)	$15,831	$15,857
Total costs to builder		$262,362	$262,801
Marketing fees	7% of house sales price	$22,125	$22,162
Profit	10% of house sales price	$31,611	$31,664
House sales price (calculated)		$316,099	$316,627
Incremental Regulatory Impacts			
Change in Sales price per lot		0	$528
Costs per lot as % of baseline sales price		0	0.17%
Multiplier = (Incremental costs * 20 lots) / ESC engineering costs		0	2.144

An important assumption in this example is the 100 percent pass-through to the homebuyer. Not only the ESC costs, but all the subsequent indirect costs added to the ESC costs are assumed to be paid by the ultimate consumer. The justification provided by the EPA is the work by Luger and Temkin (2000) and Landis (1986), which show the demand to be inelastic so that regulatory costs are fully passed along in the house price paid by the buyer. In the final analysis for different property types and development project sizes, and 100 percent pass-through, sales prices rise an average 0.19 percent for single-family residential, 0.13 for multifamily residential, 0.11 percent for commercial and 0.19 for industrial under Option 2. Assuming zero percent pass-through, builders' profits would decrease by less than 2 percent under option 2 (SF: -1.67 percent, MF: -1.17 percent, Commercial: -0.95 percent, Industrial: -1.67 percent).

The firm model uses Census data (Rappaport and Cole, 2000) to relate the number of starts to the size of the firm and corresponding financial data. The costs per firm are equal to the costs per acre times the number of acres in projects started times the number of projects started per firm per year. Census Characteristics of New Housing (Current Construction Report C-25) is used for data on acres per start for SF development firms. For MF development, EPA assumed an average of 10.8 units per building and RS Means data for the typical MF building footprint. The Center for Watershed Protection (2001) provides the ratio of building footprint to land site size. There are significant differences in acres "disturbed" under each option, especially after controlling for the state provisions, many of which are similar to the Construction General Permit (CGP) component of Options 2 and 4. Also, small builders (50,661 SF builders start 1 to 4 units per year) are assumed to disturb less than 1 acre per year so they are excluded from all options. Medium-sized SF builders (12,708) start 5 to 9 units per year (Rappaport and Cole, 2000) and are assumed to disturb less than 5 acres per year and thus are excluded from Options 2 and 4. As a result of these adjustments, there are substantial differences in the number of acres affected by each option (Option 1: 2.2 million acres, CGP for Option 2 or Option 4: 1.2 million acres, Inspection and certification for Option 2: 1.8 million acres). Options 2 and 4 are smaller than Option 1 because 2 and 4 apply to projects of 5 acres or more whereas Option 1 applies to projects of 1 acre or more. The MF firms were also reduced from 2,699 to 2,080 on the assumption that small MF projects do not disturb more than 5 acres.

The ***financial ratio analysis*** is based on the income statement and balance sheet values for representative firms, as shown in Table 4-2. The summary by industry types is shown in Table 4-3. For example, net profits after tax are decreased by the amount of compliance costs and then divided by the net worth from the balance sheet to estimate the return on net worth. The zero cost pass-through assumes all the cost is paid by the firm to get a worst-case scenario and the partial cost pass-through (86 percent) gives a more likely scenario. The calculation of the 86 percent pass-through rate is based on a long run supply elasticity of 4.0 and an elasticity of demand of –0.7 (DiPasquale, 1999). The calculation is explained in more detail below. The 1997 Census of Construction data on dollar levels by firm size are combined with Dun and Bradstreet's 1999-2000 Industry Norms and Key Business Ratios by four-digit SIC group to construct a model balance sheet and income statement for the typical construction firm. For example, the net sales for a construction firm with 10 to 24 starts per year is $1.987 million. The D&B ratio of total assets to net sales is 0.691, so the estimated total assets for the typical firm is $1.373 million ($1.373 = $1.987 * 0.691). From there, D&B ratios can be used to fill in the asset and liability line items.

Table 4-2
Model Single-Family Residential Construction Firm Financial Data

Line Item		Dollars	Percent
Assets			
1	Cash	$163,390	11.9%
2	Accounts Receivable	$122,199	8.9%
3	Notes Receivable	$9,611	0.7%
4	Inventory	$417,399	30.4%
5	Other Current	$303,438	22.1%
6	**Total Current Assets**	**$1,016,037**	**74.0%**
7	Fixed Assets	$216,938	15.8%
8	Other Non-current	$140,049	10.2%
9	**Total Assets**	**$1,373,023**	**100.0%**
Liabilities			
10	Accounts Payable	$112,588	8.2%
11	Bank Loans	$23,341	1.7%
12	Notes Payable	$201,834	14.7%
13	Other Current	$391,312	28.5%
14	**Total Current Liabilities**	**$729,075**	**53.1%**
15	Other Long Term	$162,017	11.8%
16	Deferred Credits	$10,984	0.8%
17	Net Worth	$470,947	34.3%
18	**Total Liabilities & Net Worth**	**$1,373,023**	**100.0%**
Operating Income			
19	**Net Sales**	**$1,987,009**	**100.0%**
20	Gross Profit	$453,038	22.8%
21	Net Profit After Tax	$23,844	1.2%
22	Working Capital	$286,962	--

Source: Table 4-4 from EPA Final Guidelines, March 2004.

Table 4-3
Baseline Financial Ratio Values

Industry Type	Baseline Gross Profit	Baseline Return on Net Worth	Baseline Current Ratio	Baseline Debt to Equity
Single Family	0.2280	0.0506	1.3936	1.9155
Multifamily	0.1900	0.4639	1.1265	3.0161
Commercial	0.1590	0.2442	1.5620	1.3364
Industrial	0.1840	0.2530	1.5979	1.2472
Heavy	0.2230	0.1983	0.1630	1.0619

Source: Table 5-6 from EPA Final Guidelines, March 2004.

To estimate the post-compliance change in financial ratios, EPA assumes compliance costs are typically financed by a short-term construction loan, which is 80 percent of the value of the project. The builder pays the other 20% out of current assets and the total debt is increased by the amount of the loan. Results show substantial changes only in the return on net worth because compliance costs reduce net profits (after taxes), which are 1.2% of gross revenues for typical firm in the construction industry (SID 1531). The reduction in net profits is under the assumption of zero percent pass-through. An example of the largest reduction in return on net worth is for a firm with 10 to 24 starts and a 7.5 acre projects. The percent changes from baseline by regulatory option are: Option 1: -1.55 percent, Option 2: -8.43 percent, Option 3: 0 percent, Option 4: -6.91 percent. EPA found that these results are also sensitive to the assumption about the share of compliance cost that is tax deductible.

The impact on financial ratios is much smaller when supply and demand elasticities are used to estimate pass-through rates: SF: 86 percent, MF residential: 86 percent, Commercial: 91 percent, and Industrial: 84 percent. The maximum change from baseline under Option 2 using estimated pass-through factors are:

	SF	**MF**
Gross Profit:	-0.13%	-0.28%
Return on Net Worth:	-1.48%	-0.84%
Current Ratio:	-0.01%	-0.05%
Debt to Equity:	0.05%	0.17%
Firms in Fin Stress	5 or 0.0%	1 or 0.0%
Lost Employment[25]	144 or 0.0%	69 or 0.2%

To project firm financial distress, EPA chose as a critical value the financial ratio for the lowest quartile (poorest performing 25 percent of firms). If the regulation depressed the ratio below this critical value, then the firm was considered financially stressed for that ratio. The probability of a firm being stressed is calculated as the average probability of incremental financial stress under each of three financial ratios: current ratio, debt-to-equity ratio and return on net worth. The number of employees at risk is calculated as the number of stressed firms times the average number of employees for that type of firm. This process is done separately for each combination of firm type and project size, then the impacts are aggregated.

Barriers to entry analysis.
A regulation could inhibit a firm from entering the construction industry, especially if the regulation required the firm to make a capital investment of substantial cost. In this case, the regulations require silt fencing and sediment ponds that would increase the borrowing of a new construction firm. Given its new status, lenders may require a higher interest rate or vendors charge more per unit for small quantities of input materials. However, the regulation does not affect most small firms assuming they start with small construction projects. As a check, the estimated compliance costs are divided by each firm's current assets and total assets. If the ratio is small, it is presumed that the regulation would not create a barrier to entry for new firms. The maximum ratio is 1.7 percent for MF assuming Option 2 (as shown in Table 4-4) and zero

[25] Employment measured in full-time employees per year.

percent pass-through, which the authors considered small enough not to create a barrier to entry. Impacts for the estimated pass-through rates or other options are even smaller.

Table 4-4
Maximum Compliance Costs Divided by Current or Total Assets
(under Option 2 using zero pass-through factors)

	SF	MF
Current Assets:	0.4%	1.7%
Total Assets:	0.3%	1.3%

National compliance costs are based on the costs per acre times the number of acres disturbed by each type of project. The engineering costs need to be adjusted for the opportunity costs and interest associated with the use of own capital (20 percent) and borrowed capital (80 percent). The compliance costs for each option are then aggregated across land use type and site size to get a national total. To estimate the number of acres developed, EPA uses the National Resources Inventory (NRI) surveyed by the Natural Resources Conservation Service of the U.S. Department of Agriculture (USDA, 2000).

To distribute the total land developed by land use type, EPA used Census data on building permits for SF and MF projects from 1995 through 1997. Lot sizes (0.31 acres per unit) were adjusted for common areas, such as streets, sidewalks, and open spaces, to reach an average of 0.47 acres per unit. The number of permits was multiplied by the average site size for each land use type and the totals were adjusted to match NRI estimates. Further adjustments for the breakdown of projects greater than 5 acres was done using the results of a 14-community study (U.S. EPA, 1999b).

Table 4-5
Estimated Annual National Compliance Cost of Stormwater Controls
(Option 2, constant 2000$)

SF residential	$143,197,000
MF residential	$103,234,000
Commercial	$296,446,000
Industrial	$ 12,797,000
Total	$555,675,000

Consumer Impact Model for Single Family Housing.
The post-compliance house price is calculated by multiplying the ESC compliance costs by the cost multiplier (2.144 in the example above) and adding the median new home price.

$$P_N = P_0 + mC$$

where P_N is the post-compliance house price, P_0 is the median new home price from the baseline, *m* is the cost multiplier and *C* is the ESC compliance cost.

The impact on the consumer is measured by the change in income that would be necessary to pay for the increase in house price due to the compliance costs and multiplier. An increase in house price reduces the number of households who can afford it. A key assumption is that the mortgage follows conventional underwriting guidelines such that the house payment-to-income ratio is less than or equal to 28 percent. Also, the portion of the house price financed is assumed to follow the average loan-to-value ratio of 77.4 percent with the interest rate on a 30-year fixed rate mortgage of 7.52 percent (FHFB, 2001). None of the parameters used in the calculation are that rigid, especially considering mortgage underwriting practices in 2005 in which zero downpayment loans are common. However, the main object of the exercise is to measure how much more income would be necessary for a household to afford the same house after the regulation took affect. Holding the parameters constant and only changing the compliance costs is more important than the particular parameters selected for the mortgage.

The monthly house payment is the sum of principal, interest, taxes and insurance (PITI):

$$PITI = PI + T + I$$

where *PI* is principal and interest, *T* is property taxes and *I* is hazard insurance. The taxes and insurance rates are from Savage, 1999. The monthly principal and interest on a 30-year (360-month) fixed interest rate mortgage is:

$$PI = \frac{FP_N\left(\frac{r}{12}\right)}{1-\left(1+\frac{r}{12}\right)^{-360}}$$

where *F* is the loan-to-value ratio (77.4 percent), P_N is the new house value, and r is the annual interest rate from 2000 (7.52 percent). The monthly taxes, *T*, are calculated by:

$$T = t\frac{P_N}{1{,}000}$$

where *t* is \$1 per \$1000 of house value. The monthly hazard insurance is calculated by:

$$I = s\frac{P_N}{1{,}000}$$

where *s* is the insurance rate ($0.25 per $1000 of house value). Under traditional underwriting for a conventional loan, the annual income, *Y*, necessary to afford that monthly house payment is:

$$Y = \frac{12 * PITI}{0.28}$$

Table 4-6 is from the May 2002 Proposed Rule (Table 4-19 on page 4-61) and gives an example of the calculation. The number of households who could no longer afford the house at the higher price is 29,000.

Table 4-6
Change in Housing Affordability – Sample Calculation

Data Element	Baseline	Option 2
Average per lot cost difference from baseline	$0	$111
Difference in cost per lot times multiplier	$0	$201
Home price	$288,397	$288,598
Principal and Interest (PI assuming F=.774)	$1,564	$1,565
Real estate taxes (T assuming t=$1/$1000)	$288	$289
Homeowner's insurance (I with s=$0.25/$1000)	$72	$72
Total principal, interest, taxes and insurance (PITI)	$1,924	$1,926
Income necessary to qualify for mortgage (Y)	$82,472	$82,529
Change in income necessary	$0	$58
Number of households shifted	0	29,000
Percent change in number of qualified households	0%	-0.15%

Source: Table 4-19 in EPA estimates from p. 4-61 (EPA, 2002)

This approach to measuring affordability, as shown in Table 4-7 (portion of Table 5-13 in Final Guidelines, 2004, p. 5-30), implies 15,000 households could no longer afford homeownership if Option 2 went into effect.[26] The underlying assumption is that the 28 percent limit on affordability is precise. In fact, that underwriting limit has been widely superceded in the era of automated underwriting, not to mention subprime lending and interest-only mortgages. The method is still valid, in that it highlights the number of households affected, but the line could be drawn at 30 or 32 percent and get similar results.

[26] The difference between 29,000 households shifted in Table 4-6 and –14,900 in Table 4-7 is simply because Table 4-7 is an illustrative example and Table 4-8 shows the actual results using the same method.

Table 4-7
Impact of Option 2 Compliance Cost on Housing Affordability
(Values in constant 2000 dollars)

Effluent and Sediment Control costs (per unit)	$70
Total change in costs (per unit)	$150
Income needed to qualify (assume PITI<28%)	$90,436
Change in income needed	$43
Number of households shifted (no longer afford)	-14,900
Percent of households shifted that could afford baseline	-0.09%

Calculating Price Change from Elasticities.
This section describes the market-based approach of estimating price change based on supply and demand elasticities. The first step is to select from the literature (or estimate from the data) supply and demand elasticities. In this case, EPA selected highly price elastic supply (long run) of 4.0 and somewhat inelastic demand of –0.7 (DiPasquale, 1999). It is worth noting, again, that there is considerable uncertainty around elasticity estimates, which vary by time and place. Critics of an economic analysis can easily find studies to support different elasticity estimates. For this reason, sensitivity testing on elasticities and pass-through rates is critical for building confidence in the reliability of the final results.

EPA takes the simplest approach of a linear partial equilibrium market model, which is appropriate for small changes from the baseline equilibrium. The study also assumes housing is a single, national market. Then the supply curve can be approximated by:

Supply Curve: $Q^s = \alpha + \beta P$

where Q is number of residential building permits issued, P is the price of a new home, α is the intercept calibrated from the baseline equilibrium ($\alpha = Q_0 - \beta P_0$) and β is the coefficient on price. Note that $-\alpha/\beta$ is the minimal price at which production will take place, which will increase by ESC when the regulation is implemented. Then the price elasticity of supply can be expressed as:

$$E_s = \frac{\partial Q^s}{\partial P}\left(\frac{P_0}{Q_0}\right) > 0 \qquad \text{such that} \qquad \beta = E_s * \frac{Q_0}{P_0}.$$

Similarly, a demand curve can be approximated by:

Demand Curve: $Q^d = \sigma + \gamma P$

where σ is the intercept calibrated from the baseline equilibrium ($\sigma = Q_0 - \gamma P_0$) and γ is the coefficient on price. The price elasticity of demand for new homes is:

$$E_d = \frac{\partial Q^d}{\partial P}\left(\frac{P_0}{Q_0}\right) < 0 \qquad \text{such that} \qquad \gamma = E_d * \frac{Q_0}{P_0}.$$

In the simplest model, an increase in the unit cost of compliance (ESC) would create a shift upwards in the supply curve with a new (shocked) intercept α_S:

$$\alpha_s = Q_0 - \beta(P_0 + ESC)$$

In the new equilibrium, supply will equal demand:

$$Q_1^d = \sigma + \gamma P_1 \qquad \text{and} \qquad Q_1^s = \alpha_s + \beta P_1 \qquad \text{so } Q_1^d = Q_1^s \text{ implies} \quad P_1 = \frac{\alpha_s - \sigma}{\gamma - \beta}.$$

Given values for Q_0, P_0, ESC, E_s and E_d, we can calculate P_1 and a cost pass-through rate. In the example, EPA calculates the pass-through rate to be 85 percent, meaning builders absorb 15 percent of the compliance cost and the consumer pays 85 percent.

If the elasticities are used throughout the housing analysis, the impacts are summarized in Table 4-8, drawn from Table 5-14 on page 5-31 and Table 5-17 on page 5-34 in the Final Guidelines (2004).

Table 4-8
Impact on Housing Market Based on Elasticities and Option 2
(Values in constant 2000 dollars)

	SF	MF
Change in cost ($/unit)	$70	$77
New house price (per unit)	$316,162	$132,600
Price change ($/unit)	$62	$72
Quantity change (units)	-157	-115
Quantity change (%)	-0.01%	-0.04%
Loss of output (in millions)	-$49.6	-$15.0
Loss of employment	403	321

Alternative Partial Equilibrium Calculation.
As an aside, here is an alternative and more sophisticated methodology for calculating elasticities using Census data. According to a recent study by Goodman (2005), the suburban supply elasticity (1.26 to 1.42) is greater than center city supply elasticity, which depends on whether the city housing stock is declining (0.03 to 0.13) or increasing (1.05 to 1.08). Also the northeast

region has lower elasticity (0.89) than the rest of US (1.86) with a weighted average of 1.42. The data come from the decennial Census, so long term essentially means 10 years.

Goodman uses the following model for the supply and demand for housing:

Demand for housing units: $\ln Q_t^D = \alpha \ln Y_t + \beta \ln R_t + \delta \ln N_t + \varepsilon_t^D$

Supply of housing units: $\ln Q_t^S = \gamma \ln V_t + \sum_k \eta_k G_t^k + \varepsilon_t^S$

Capital market equilibrium: $\ln R_t = \ln V_t + \ln \rho_t$

Product market equilibrium: $\ln Q_t^S = \ln Q_t^D$

where Y_t is income per capita, R_t is rent, N_t is population, V_t is value of housing stock, G^k is supply shifters (including regional indicators), and ρ_t is the user cost of owned housing.

Solving for *V*, house value:

$$\ln V_t = \frac{\alpha}{\gamma - \beta} \ln Y_t + \frac{\beta}{\gamma - \beta} \ln \rho_t + \frac{\delta}{\gamma - \beta} \ln N_t - \sum_k \frac{\eta_k}{\gamma - \beta} G_t^k$$

Solving for Q, house units: $\ln Q_t = \gamma \ln V_t + \sum_k \eta_t G_t^k$

Differencing eliminates the fixed effects and stacking allows the author to use all three decades of data. Econometrically, the system of equations is either estimated recursively using indirect least squares (ILS) or three-stage least squares (3SLS). User cost is a difficult variable to measure because it depends on expected capital gain and expectations are very difficult to quantify. A simple formulation uses the rent-to-value ratio ($\rho_t = R_t / V_t$) as a proxy for user cost. Goodman also uses the difference in the percentage change in rent-to-value ratios between the suburbs (s) and central city (c):

$$D = Pct.\Delta\rho_S - Pct.\Delta\rho_C = \phi_0 + \phi_S \rho_S + \phi_C \rho_C + \sum_k \upsilon_k G_k$$

The predicted value for D is used as the instrumental value for relative user cost between suburbs and central city.

Table 4-9 reproduces Table 7 from Goodman (2005, p. 560-562) and shows the variation in national average elasticity estimates by decade. The supply elasticity ranges from 1.03 in the 1980s to 1.38 in the 1990s. The range is wider when divided by region, from 0.37 for the Midwest in the 1990s to 2.0 for the South in the 1990s. The main point is that supply elasticity can vary widely by time and place.

Table 4-9
Elasticities by Decade from 3SLS Estimation using Instrumental User Costs

Elasticity	1970-1980	1980-1990	1990-2000	Three Decades
Supply	1.37	1.03	1.38	1.26
Demand price	-0.15	0.05	-0.05	-0.05
Demand income	0.03	0.13	0.24	0.13
Demand population	1.02	0.85	1.09	0.99

Estimating Welfare Effects in the Effluent Guidelines.
The welfare effect from regulation is based on the loss of consumer and producer surplus. EPA assumes consumers would spend less on non-housing goods and services in response to the higher price of housing. The lower volume of house sales at the new equilibrium reduces producer surplus, lowers employment in construction and lowers total output in the economy. The indirect effects on other industries and whole economy are measured using Regional Input-Output Modeling System (RIMS) multipliers published by the U.S. Dept. of Commerce (www.bea.gov/bea/regional/rims/).

The Deadweight Loss (DWL) is the sum of losses in consumer surplus and producer surplus not captured by either consumers or producers. Combining the impacts from the regulation on all types of development activity, EPA estimates $752 million lost in consumer surplus and $87.8 million lost in producer surplus, as shown in Table 4-10 (Table 5-21, EPA, 2004, p. 5-40).

Table 4-10
Annual Change in Social Welfare – SF, MF, Commercial, Industrial Sectors Combined
(in constant 2000 dollars, millions)

Loss of Consumer Surplus	$752.4
Loss of Producer Surplus	$87.8
Total Deadweight Loss	$0.965

For regional estimates, EPA uses building permit data and median new home price data to establish an equilibrium point for each MSA (EPA, 2002, p. 4-67). The demand elasticities are mapped to new construction on the assumption that high growth areas have inelastic demand and low growth areas have elastic demand. EPA uses new housing units authorized during 1990 to 1996 relative to 1990 housing stock as a measure of growth. The range of demand elasticities are taken from the literature, though only DiPasquale (1999) is cited. The estimated increase in compliance costs for the median new home is the shift in supply curve and the local elasticities are used to estimate the change in price, quantity and DWL for each MSA, then averaged by census division.

Affordability Measure by MSA

EPA measures affordability in this study using a calculation similar to the Housing Opportunity Index (HOI) that the National Association of Homebuilders (now NAHB-Wells Fargo) publishes for large MSAs.[27] EPA calls their version RHOI for Rough Homeownership Opportunity Index. The calculation makes some standard assumptions about the distribution of new house prices and the terms of mortgage approval, such as 30-year fixed rate mortgage, 10 percent downpayment and a 28 percent qualifying ratio of housing expense-to-income. With these assumptions, the RHOI calculates what share of new houses a median-income household could qualify to buy. Rather than getting a full distribution of house values by MSA, EPA assumes normally distributed house prices around the median. House prices are normalized by the median and the normalization is assumed to have a standard deviation of 1. In MSAs where NAHB calculates HOI, EPA calibrates the RHOI to match the HOI by adjusting the variance of the house price distribution. The impact of compliance costs on affordability is the change in percentage of homes affordable by the median income household assuming house prices increased by X% of compliance costs (where X% depends on the demand and supply elasticities for that MSA housing market).

The Rough Housing Opportunity Index (RHOI) is calculated as the cumulative probability of homes with prices less than the maximum principal and interest that a household with the median income could afford (i.e., 28 percent of median income).

$$RHOI = Z_{(1,1)}\left(\frac{\int_0^{30}(Median\_Income * 0.28)e^{-rt}dt}{Median\_Sales\_Price}\right)$$

where $Z_{(1,1)}$ is the cumulative normal density function with mean 1 and variance 1. The numerator is the present value of the maximum house payment that the median income can afford at the prevailing mortgage rate, r, over a typical 30-year fixed rate loan. When the present value of the house payments is equal to the median sales price (ratio is 1), then the cumulative normal density is 0.50, i.e. half the households can afford the median new house on the market. The RHOI is rescaled to match the NAHB version of HOI in the MSAs where both RHOI and HOI are calculated using the scaling factor V:

$$V = \left|\frac{Z_{(0,1)}^{-1}(RHOI)}{Z_{(0,1)}^{-1}(NAHB\_HOI)}\right|$$

27 A description of the NAHB-Wells Fargo Housing Opportunity Index can be found at: http://www.nahb.org/generic.aspx?sectionID=135&genericContentID=533

where $Z_{(0,1)}^{-1}$ is the inverse of the standard normal cumulative distribution. Changing the variance of $Z_{(1,1)}$ from 1 to V causes RHOI to equal NAHB_HOI at the observed median family income.

The affordability index RHOI is used to measure the change in affordability due to the increase in compliance cost associated with the effluent regulation. The affordability analysis assumes the median sales price will increase by the amount calculated in the partial equilibrium market model (about 85 percent of the compliance costs) and household income is unchanged. A substantial reduction in affordability would be measured by a substantial percentage reduction in the affordability index, meaning fewer households would be able to afford the median new house after compliance costs are included. As an example, the baseline RHOI is calculated as 0.416 or 41.6 percent of new homes are affordable to households with at least the median income. Suppose the regulation increased new house prices so the index fell to 0.415, then [(0.416-0.415)/0.416] = 0.0024 or 0.24 percent fewer homes are affordable to the median income household after the regulation takes effect.

A summary of affordability results by Census Division is shown in Table 4-11, taken from EPA (2004, p. 5-33).

Table 4-11
SF Average RHOI (level and change for Option 2) by Census Division

Census Division	**Level**	**Change**
1. New England	54.15	-0.17%
2. Middle Atlantic	62.27	-0.17%
3. East North Central	72.50	-0.23%
4. West North Central	78.72	-0.13%
5. South Atlantic	70.24	-0.10%
6. East South Central	69.65	-0.08%
7. West South Central	64.68	-0.08%
8. Mountain	44.51	-0.16%
9. Pacific	32.58	-0.16%

Note: RHOI is the percentage of new houses that can be afforded by a median-income household.

The HOI or RHOI emphasizes changes in affordability for the median income household. It is certainly possible that a regulation could affect the low-quality or high-density units more than the units in the middle of the distribution. The affordability measure could be targeted to low-income, first-time homebuyers by choosing a lower percentile, say the 25^{th} instead of the 50^{th} percentile, for household income and unit sales price. The index level is less important than the change associated with the regulation. If the regulation causes builders to shift upscale and produce more luxury units, the scarcity of affordable units could harm their affordability.

Another way to look at it is the impact of new construction on filtering. If the regulations increase the fixed cost per unit, builders may shift production to fewer, high-quality units that are much less likely to filter down to affordable units as they age. It is plausible that such a shift has less impact on the median house values than the lower quality units. With declining production of low-quality units, the strong demand relative to supply of affordable units could lead to upward price filtering. The net effect could be a greater loss of affordability among low-end existing units than the median of new units. The challenge in customizing the affordability measure is getting sufficient data, especially at the MSA level. Median prices and incomes are much more available and probably more reliable than the 25th percentile.

A second challenge is estimating the cross-market elasticity between new construction and existing housing. The cross-market impact is similar to the issue of cost pass-through. If demand for housing is inelastic, perhaps during robust economic growth, then any increase in regulatory costs that either raise the cost or reduce the supply of new housing will lead to an increase in prices for existing housing.

As a final summary across industry types, Table 4-12 (EPA, 2004, p.8-5) shows the total social costs and benefits of Option 2. Not all of the benefits from sediment control could be monetized. The estimated benefits are based on the reduction in sediment that improves the water quality for boating, fishing, and swimming. Miles and Bondelid (2004) provide willingness-to-pay estimates based on two approaches, water quality ladder and water quality index. Nevertheless, the main point is clearly that the social costs are much larger than the social benefits. On this basis, the regulation would not benefit society.

Table 4-12. Social Costs and Benefits for Option 2
(in constant 2000 dollars, millions per year)

Installation, Design and Permitting	$508.4
Operation and Maintenance	$47.3
Government Costs	$0.3
Deadweight Loss	$1.0
Total Social Costs	$556.9
Total Social Benefits	$14.5

Summary for the Effluent Guidelines Case Study

The Effluent Guidelines provides a good example of how an environmental regulation designed to protect fresh streams can have a substantial impact on the cost of housing. In this particular case, the total social costs outweighed the total social benefits and the regulation was not implemented. More importantly for our purposes, the housing costs and affordability impacts were carefully considered in the Regulatory Impact Analysis. This summary section is designed to highlight the aspects of the example that have broad application in other Housing Impact Analyses.

First, the regulatory analysis for the Effluent Guidelines had four options including an option that entailed no new regulation. A Housing Impact Analysis should be done for each option showing the change in house prices and affordability to the residents relative to what could reasonably be expected without the new regulation. The new guidelines would apply to all states, but some states already had comparable regulations. Therefore, the geography of the impact was in states for which the new regulation was a substantial change.

Second, measuring the costs included the direct Erosion and Sediment Control Costs from engineering studies as well as indirect costs such as interest, overhead, opportunity cost and profit. The earlier the regulation affects the construction process, the greater the impact from customary markups of indirect costs linked to either the direct costs or total costs. Normally, the HIA should assume 100 percent compliance and include transition costs, training costs and accounting/reporting costs that are required under the new regulation. When the costs vary by type of construction project or company, it is necessary to stratify the universe of expected projects so the cost per project can be multiplied by the anticipated number of projects in each stratum.

Third, EPA assumed straight-line supply and demand curves:

Supply Curve: $Q^s = \alpha + \beta P$ and $\beta = E_s * \frac{Q_0}{P_0}$

Demand Curve: $Q^d = \sigma + \gamma P$ and $\gamma = E_d * \frac{Q_0}{P_0}$

where Q_0 and P_0 are the equilibrium quantity and price of housing before the regulation and E_s and E_d are the price elasticity of supply and demand, respectively. After the Erosion and Sediment Control (ESC) costs are added to the original equilibrium price, P_0, the post-regulation supply curve becomes:

$$\alpha_s = Q_0 - \beta(P_0 + ESC)$$

In the new equilibrium, supply will equal demand:

$Q_1^d = \sigma + \gamma P_1$ and $Q_1^s = \alpha_s + \beta P_1$ so $Q_1^d = Q_1^s$ implies $P_1 = \frac{\alpha_s - \sigma}{\gamma - \beta}$.

The pass-through rate (in parentheses below) can be calculated from the price elasticities of supply, E_s, and demand, E_d:

$$\Delta P = \left(\frac{E_s}{E_s - E_d} \right) * \Delta C$$

where ΔP is the change in price and ΔC is the change in cost (or ESC in this case).

Given values for Q_0, P_0, *ESC*, E_s and E_d, we can calculate P_1 and a cost pass-through rate. In the example, EPA assumes a long-run supply elasticity of 4.0 and a demand elasticity of –0.7. The corresponding pass-through rate is 85 percent meaning builders absorb 15 percent of the compliance cost and the consumer pays 85 percent. These are reasonable parameter values for an area with moderately low regulation. More regulation reduces the supply elasticity and pass-through rate toward zero. Goodman (2005) estimates an average supply elasticity of 1.26, which seems more realistic for regulated urban areas. Given the uncertainties about elasticities and pass-through rates, it is recommended to consider the extreme pass-through rates of zero (the supplier bears all the regulatory cost increase) and one (the consumer bears all the cost of the regulation).

The Effluent Guidelines did not measure the indirect market effects of the increased new construction cost on existing housing. Given the small change in new house price (~$150), it is reasonable to expect no discernible change in the cost of existing units. However, if new housing costs appreciably more, then some households would shift their demand to existing houses and drive up the price on those existing houses.

Affordability is measured by MSA using a version of the NAHB-Wells Fargo Housing Opportunity Index (HOI). The HOI measures the percentage of new houses that can be afforded by a median-income household. A lower income standard could easily be chosen to emphasize homeownership affordability for lower-income households. The same type of measure could be applied to demographic subgroups, such as minorities and elderly, to determine how the regulation would affect more vulnerable households.

4.2.2 Case Study 2: Wind Standards for Manufactured Homes

The Wind Standards are regulations determined by HUD to improve the safety of manufactured houses, both to the occupants and neighbors, during hurricanes. This section provides some of the results of the Economic Analysis conducted by HUD, but the more important emphasis is on the methodology including the estimation of benefits as avoided costs. The new standards increase production costs, which are assumed to be passed through to the consumer. The homebuyer should be willing to pay the higher price because a stronger house will suffer less damage in storms on average. However, the justification for government intervention is to prevent the damage to neighboring properties of flying debris from manufactured houses. Hurricane damage can be very expensive both to private owners and society. The higher prices for sturdier units hurt the affordability of those units, but may improve the affordability for existing, non-compliant units if demand shifts to the new units. Submarkets are important in this case because the high wind areas along the coast are small and thus the new regulations apply to a geographic submarket of MH. The Wind Standards are featured as a good example for Housing Impact Analysis with clear analysis, quantifiable costs and benefits, and careful attention to affordability and distributional issues.

In response to the disproportionate damage to manufactured homes (MH) by Hurricane Andrew, HUD adopted more stringent Wind Standards for new MH in 1994. The Department recognized the need to balance safety with affordability. The new regulations were designed to protect owners and neighbors from high winds while preserving MH as a key source of low-cost housing. The primary way to maintain affordability is to target the more stringent standards to Wind Zones II and III, which have historically suffered the greatest wind damage, and not require any change in Wind Zone I. Beyond reducing injuries and deaths, the Wind Standards are designed to reduce insurance costs and property damage both to and by manufactured homes. The Regulatory Impact Analysis conducted by HUD determined the annual benefit from the new wind safety standards to be $83.8 million compared to an annual cost of $51.7 million or an annual net benefit of $32.1 million.

The damage caused by Hurricane Andrew was so extensive and disproportionately MH compared to site-built that HUD felt compelled to look for cost-saving solutions. In Dade County, 97 percent of MH units were totally destroyed, whereas only 11 percent of single-family, site-built houses were destroyed. In Homestead, Florida, 1,167 out of 1,176 licensed and registered MH were completely demolished. Throughout Florida and Louisiana, the hurricane destroyed 11,213 manufactured homes and seriously damaged another 3,016 manufactured homes. Overall, nearly 36 percent of the units destroyed were MH, far out of proportion to their 5 percent share of the housing stock in the affected counties.

The justification for government intervention was based on the market failure in form of negative externality. Manufacturers and owners are unwilling voluntarily to reduce damage to neighboring properties of flying debris from their house during a hurricane. More stringent regulation forces manufacturers and owners to internalize some of those costs. Another dimension of the market failure is asymmetric information about unit durability. The producer is in a much better position than the consumer to determine whether the MH unit is built to high wind safety standards. Given that the more durable construction is hidden in the structure of the unit, consumers assume the unit is built to low standards and are unwilling to pay a higher price based on the manufacturer's labeling and marketing.

The government can solve both types of market failure by requiring all manufacturers to design and build according to more stringent Wind Standards and certify to consumers that the unit satisfies the higher standards. Some consumers are willing to pay the higher price based on the government certification and the expectation that they will recover some of the higher purchase price in the form of lower damage costs (or higher resale value) in the future.

The randomness of hurricane damage creates a tension for homebuyers. If the likelihood of future damage is high and stronger houses would be enough to mitigate the damage, then owners would be willing to pay more for a stronger house. However, in most years and in most places, there is no hurricane damage or the damage is so severe that sturdier houses would not make much difference. In addition, many buyers of MH units have low income and may be more willing to take their chances because they have less to lose. Given these concerns, HUD sought regulations that would reduce the damage in the most likely hurricane areas without raising MH prices in most other areas.

The level of Wind Standards could be set such that the marginal production costs exceeded expected private benefits based on the added social benefits from reduced negative externalities. There is clearly a balancing act for the government. If the standards are set low or do not change current standards, the wind damage will continue to generate extensive private and social costs. If the standards are set high, the private and social costs of wind damage will be low, but the purchase price of compliant MH units will be so high that there will be little demand by potential homeowners and a reduction in affordable housing. In that scenario, the MH market will shrink and the deadweight loss will be large. Therefore, the government endeavors to raise the Wind Standards enough to reduce both private and public costs from storm damage without substantially reducing the MH market or hurting the affordability of MH units. HUD determined the right balance was to set Wind Standards so the increased marginal production costs were close to the expected private benefits ($1,500 for single section in Zone II and $2,000 for single section in Zone III). In other words, HUD determined the right amount to shift the supply curve via compliance costs was about the same as the expected benefits. Yet the justification for the regulation is the elimination of market failures (externalities and asymmetric information).

Description of Changes to the Wind Standards

The following description is not a comprehensive list of the changes to the Wind Standards, but it gives the reader a sense of the types of changes required. In general, there was an attempt to revise performance standards and let the manufacturers determine what would be the most cost effective way to meet the new standards. The Wind Zone map was revised with a more concentrated area for the 100 mph zone (II). MH in Wind Zones II (100 mph) and III (110 mph) must be designed to resist wind pressures for a 50-year recurrence level by ASCE 7-88 (American Society of Civil Engineers standard). The minimum design loads based on the ASCE 7-88 standards are for negative pressure (suction) and higher uplift forces as well as positive pressure. The requirements for structural assemblies and fasteners are set so that MH would be more in line with site-built construction. The new standards expand data plate information and provide shutters or instructions for installing shutters to protect windows and doors. The standards require MH within 1500’ of coastline in Wind Zones II or III to have home and foundation systems sufficient to satisfy Exposure D in ASCE 7-88. Also, the regulation revises the standards for fastening roof framing to wall framing or wall to floor framing to use heavier 26 gauge (instead of 30 gauge) minimum steel strapping.

Economic Benefits

The projected effect of more stringent Wind Standards was to eliminate 75 percent of the wind damage suffered by MH in Wind Zone II and 83 percent for Wind Zone III. With fewer MH units destroyed, there will be less dislocation by storms either during or after, and fewer injuries or deaths for those who remain in their MH unit during storms. Moreover, society will avoid some of the clean-up and relief costs historically caused by wind damage to MH units and communities. To estimate the costs to be avoided, HUD used Hurricane Andrew as the recent standard for insurance claims (Allstate Insurance Co. for insured claims and U.S. Small Business Administration (SBA) for uninsured losses). Also, 1990 Census was used for MH placement data.

DeAlessi (1996) argues that HUD exaggerates the true cost of hurricane damage by using insurance claims without adjusting for depreciation. The insurance claims paid in Dade County were 2/3's for replacement value and 1/3 for cash value. Given that the average MH is 13 years old for owner-occupied and 17 years for renter-occupied, their replacement value with a new unit ($20,000 to $40,000) is considerably higher than their cash value for a seasoned unit ($6,000 to $12,000). The full private cost from storm damage is usually much greater than the replacement of the MH unit itself, because it would include losses for furniture, electronics, clothes and home improvements, such as patios, carports, etc. While it is certainly true that there is a large difference between the cost of a new MH unit and the resale value of an existing unit, most households are worse off after the storm and insurance claim than they were before the storm.

The total expected loss from a Hurricane Andrew level storm is the sum of insured and uninsured losses for MH as distributed between Wind Zones II (29.7 percent) and III (11.8 percent) divided by the corresponding MH units in each zone.[28] Under the old standard, the lifetime expected hurricane loss per MH single section unit was $2,009 in Zone II and $2,430 in Zone III, as shown in Table 4-13. Those expected losses are multiplied by the Damage Reduction Factors to estimate the benefits, i.e., reduced losses, due to more durable MH construction. The lifetime expected private benefits per MH single section is $1,516 in Zone II and $2,022 in Zone III. A lifetime for an MH unit is 33 years and the savings are discounted at 7 percent per OMB Circular A94.

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[28] The data sources on storm losses are: Allstate Insurance Company, Federal Emergency Management Agency (FEMA), National Oceanographic and Atmospheric Administration (NOAA), Florida Manufactured Housing Association, American Red Cross, and U.S. Bureau of the Census.

Table 4-13
Lifetime Expected Private Losses and Benefits per Unit

Private Losses per unit based on Hurricane Andrew experience

	Single Section	Multiple Section
Wind Zone II	$2,008.55	$2,731.66
Wind Zone III	$2,430.34	$3,305.31

Private Benefits per unit based on Damage Reduction Factors

	Single Section	Multiple Section	Damage Reduction Factors
Wind Zone II	$1,516.25	$2,062.13	0.7549
Wind Zone III	$2,021.80	$2,749.69	0.8319

To calculate the Damage Reduction Factors, we start with the probability of structural failure, which depends on the wind load and building resistance. The maximum estimated speed in Hurricane Andrew was 140 mph. Assuming an average wind speed of 110 in Zone III and a standard deviation for a normal distribution of 16 mph (from ASCE), this means there was a 3 percent probability that wind speed exceeded 140 mph. Wind force grows with the square of velocity and the force is adjusted upward by a factor of $(1.3)^{0.5}$ for suction and uplift forces and a factor of 1.05 for hurricane zone exposure. Therefore, a random variable for the effective load wind speed (in miles per hour) has a mean of 119.72 in Zone II and 131.69 in Zone III with a standard deviation of 19.15.

Building resistance is also assumed to follow a normal distribution with Old HUD representing the former MH Wind Standards and New HUD representing the new Wind Standards. The Old HUD standard was designed for a hurricane wind speed of 80 mph multiplied by a resistance factor for lumber construction of $(1.9)^{0.5}$. The New HUD standard is designed for wind speeds of 100 mph in Zone II and 110 mph in Zone III with the same adjustment factor.

The probability that the wind load exceeds the building resistance and causes a structural failure depends on the distribution of the random variable for the difference, Resistance minus Load. As an example for Zone II, mean load is 119.72 and mean resistance for New HUD is 144.73 so the mean of the difference is 25.01 (or 144.73 - 119.72) and the standard deviation is 24.96 or $(19.15^2 + 16.0^2)^{0.5}$. The probability of failure is simply the probability that the Resistance-Load random variable has a value less than 0 (i.e., load>resistance), which is determined for a standard normal variable z=(0-mean)/standard deviation. After calculating the probability of structural failure under the old and new HUD standards, the damage reduction factor is simply the percentage change in failure. For example in Zone II, the probability of failure reduces from 0.6474 to 0.1587 or a percentage change of 75.49 percent. The results for Zones II and III are shown in Table 4-14.

Table 4-14
Distributions for Load, Resistance and the Difference (Resistance – Load), the Probability of Failure During a Hurricane and the Hurricane Damage Reduction Factor

	Wind Zone II	Std Deviation	Wind Zone III	Std Deviation
Load	119.72	19.15	131.69	19.15
Resistance				
Old HUD	110.27		110.27	
New HUD	144.73	16.0	159.21	16.0
Resistance – Load				
Old HUD	-9.44		-21.42	
New HUD	25.01	24.96	27.52	24.96
Prob. of Failure During Hurricane				
Old HUD	0.6474		0.8042	
New HUD	0.1587		0.1352	
Damage Reduction Factor under New HUD (Pct Chg in Prob. of Failure)	0.7549		0.8319	

Public Benefits of New HUD Wind Standards

The amount spent by FEMA resulting from Hurricane Andrew was $773 million, which included emergency housing, disaster relief grants to families, and assistance to local governments for debris removal and preservation of public order.[29] Given that MH accounted for 36 percent of the total housing destroyed, the disaster relief attributable to MH is 36 percent of $773 million, or $278 million. Multiplying that amount by the annual probability of a "Andrew-type" hurricane damage to manufactured housing[30] (29.7 percent in Zone II and 11.8 percent in Zone III) and dividing by the number of MH units (872,720 in Zone II and 286,853 in Zone III) generates an annual per unit disaster relief attributable to MH of $94.67 in Zone II and $114.56 in Zone III.

Following the same approach for private losses, we add up the public losses per year for an expected MH lifespan of 33 years and discount by 7 percent to the starting year. The lifetime expected public losses per unit is prorated by MH unit size as shown in Table 4-15. Those public losses would be avoided according to the damage reduction factors to give the lifetime expected public benefits attributable to the new HUD Wind Standards.

29 The federal costs of Hurricane Andrew exceeded $10 billion. Although much of that cost goes to rebuilding infrastructure and loans for businesses, HUD's measure of public costs based on only FEMA costs is probably conservative. Moreover, the state and local governments spent more on the hurricane recovery effort than was covered by the federal government.

30 The calculation for the annual probability of "Andrew-type" damage to MH starts with a probability for a Category 3 storm in Wind Zone II of 39.1 percent and in Wind Zone III of 8.2 percent from the National Oceanographic and Atmospheric Administration (NOAA). Those probabilities are adjusted to include the probabilities for Category IV and V storms and the proportion of housing stock in MH for those areas.

Table 4-15
Lifetime Expected Public Losses and Benefits per Unit

Public losses per unit based on Hurricane Andrew experience

	Single Section	Multiple Section
Wind Zone II	$1,035.91	$1,408.85
Wind Zone III	$1,253.45	$1,704.71

Public benefits per unit based on Damage Reduction Factors

	Single Section	Multiple Section	Damage Reduction Factors
Wind Zone II	$782.01	$1,063.54	0.7549
Wind Zone III	$1,042.74	$1,418.15	0.8319

Benefits from Reduced Cost of Death or Injury

The probability of death or injury due to structural failure of a manufactured house in a hurricane is quite low. Most residents have wisely evacuated before the hurricane arrives. Nevertheless, it is instructive to see how expected costs of death or injury are calculated.

We start with some key facts from the 1990 Census. In 1990, there were 2,172,478 people living in 1,159,573 manufactured housing units (1.873 persons per unit) in the hurricane Wind Zones II and III. The average resident annual income was $25,000, which is assumed to increase at 3 percent per year for an earning lifespan of 33 years. The non-income social contribution of a person's life, such as the value of parenting or volunteer work, is estimated as 70 percent of annual income. The number of deaths due to wind-induced structural failure of MH units in hurricanes is estimated to be 5, so the probability of death is 5 out of 2,172,478 MH residents. The ratio of injuries to deaths is 25 to 1 and the value of the average injury is 0.24 percent of the year 1 value of life, Walters (1980). The present discounted value is calculated at 7 percent per year.

Each year, the annual income and non-income social contribution (70 percent of income) is added to get total contribution. In future years, the annual income grows by 3 percent per year and the dollar value is discounted by 7 percent. The present value of lifetime income and social contribution is the summation of total contributions for the remaining years. It is calculated to be $813,522 in year 1 and declines in each successive year. Multiplying the remaining lifetime contribution by the probability of death gives the present value of expected cost of death for each of the 33 years (the assumed earning lifespan of MH residents). The sum of those annual expected costs of death was calculated as $47.81 per unit.

For injuries, the calculation starts with the cost of an individual injury, estimated to be 0.24 percent times the value of remaining life in year 1 or $813,522. The cost of the injury is increased by 3 percent per year and discounted by 7 percent to get the present discounted value. The annual cost of injury is multiplied by the probability of injury to get the present value expected cost of injury in each year. The sum of those annual amounts over 33 years is $4.03.

The final step is to add the lifetime expected cost of death, $47.81, and injury, $4.03, to get $51.84. HUD assumed that the Damage Reduction Factors could be applied to death and injury costs in the same way they adjusted private property costs and public spending. Therefore, the lifetime expected value of reduced death and injury is $39.13 in Zone II ($51.84 times 0.7549) and $43.13 in Zone III ($51.84 times 0.8319).

Non-Quantifiable Benefits

The quantifiable benefits were kept conservative by underestimating the full spending from Hurricane Andrew that could be attributed to MH and could be avoided by more durable construction. It is quite possible that more stringent building standards will increase the demand by buyers to live in manufactured housing, particularly in high wind areas. The stronger structures should reduce damage during tornadoes and violent thunderstorms as well as hurricanes. More robust construction should also reduce damage in transportation and installation. By avoiding damage, the compliant MH units may depreciate at a lower rate and retain a higher resale value. Residents will also save the cost of displacement following a bad storm. One offsetting possibility is that residents may be less inclined to evacuate before a storm and thus increase the probability of injury. Overall, these effects should increase the benefits of more stringent Wind Standards, but they are difficult to quantify and probably too small to have a major impact on the cost-benefit analysis.

Even though these effects are hard to predict, in retrospect it may be worthwhile to evaluate what did happen to the market. Using historical data from before and after the regulatory change, event analysis can determine the changes in price and quantity as well as the pass-through rates, demand elasticity and supply elasticity. This information can be quite valuable in understanding the market and predicting the response to future regulatory fine-tuning.

Economic Costs of Meeting New HUD Standards

HUD engineering staff estimated the increase in materials cost required to meet the new Wind Standards. The materials costs are then multiplied by an industry standard multiplier of 2.22 to incorporate other production and management costs (e.g., labor, design, overhead, etc.). The full increase in production cost per unit is presented in Table 4-16.

Table 4-16
Production Cost per Unit under More Stringent Wind Standards

	Single Section	**Multiple Section**
Wind Zone II	$1,492	$1,813
Wind Zone III	$2,119	$2,722

To determine how much of the production costs would be passed through to the consumer, HUD turned to the literature for demand and supply elasticities. Fortunately, there were three studies specifically on manufactured housing which estimated the demand elasticity at –2.37 (Morgan and Belknap, 1982), -2.5 (Gates, 1984) and –2.4 (Meeks, 1993). No estimate for MH supply elasticity was available, so HUD used a long-run supply elasticity for housing, 3.0, from Topel and Rosen (1988). Assuming straight line demand and supply functions, the change in price and quantity can be calculated:

$$\Delta P = \left(\frac{E_S}{E_S - E_D} \right) * \Delta C$$

$$\Delta Q = \frac{E_S * E_D * Q_1 * (\Delta C / P_1)}{E_S - E_D}$$

where ΔP is the change in price, E_S is supply elasticity (3.0), E_D is the demand elasticity (-2.4), ΔC is the change in production cost, ΔQ is the change in quantity of new MH sold, P_1 is the price before the Wind Standards regulation, and Q_1 is the initial equilibrium market quantity sold. The bracketed portion in the change in price equation is the pass-through rate. Given the selected elasticities, the pass-through rate is 56 percent (or 3.0/(3.0+2.4)).

DeAlessi (1996) argues that the pass-through rate is much closer to 1.0, that is, the producers would shift nearly all the increased cost on to the consumers. The claim is that the elasticity of supply should be adjusted for the modest size of the submarkets in either Zone II or III. The formula for a submarket comes from McCloskey (1985, p. 145):

$$E_{Si} = \left(\frac{Q}{Q_i} \right) * E_S - \left(\frac{Q - Q_i}{Q_i} \right) * E_D$$

where Q is the quantity of new MH sold in the total market and Q_i is the quantity sold in the *i*th submarket. Using 1992 MH shipments data from the Manufactured Housing Institute, the submarket for Zone II was 26,902 units out of a total MH market of 210,787. The Zone III submarket is much smaller, 4,200 units in 1992. The submarket supply elasticities are 39.9 for Zone II and 270 for Zone III. Using those submarket supply elasticities in the pass-through equation ($E_{Si}/(E_{Si}+E_D)$) gives a pass-through rate of 94 percent for Zone II and 99 percent for Zone III.

Intuitively, the reason supply is so much more elastic in a small submarket is that suppliers can substitute or shift output from one area to another and readily meet demand with almost no increase in price. This logic does not apply perfectly in the case where MH units from Zone I do not comply with the building code in Zone II or III. The supplier cannot substitute units between submarkets without modification. However, a different logic may explain why so much of the cost increase is passed on to the consumer. The construction of MH units certified for Wind Zones II and especially III may be considered a niche market. A few of the local manufacturers may specialize in producing these units, but the national producers may stay focused on the broader market. With smaller production runs and less competition, the consumer may have little choice but to buy from the available manufacturers. The manufacturers are willing to produce the more durable unit, but only if their return on investment is comparable to producers of Zone I units. In the long run, the Zone III MH manufacturers will only stay in the market if the consumer pays the increased cost required by the regulation.

Without better information on local market responses, perhaps from historical data now that the regulation has been in place for a decade, it is very difficult to predict an accurate pass-through rate. Pass-through rates based on elasticities make the bold assumption that elasticities remain fairly constant over time and, in particular, would not change substantially under new regulations. The literature suggests elasticities do vary over time and place even without a change in regulation. Given the uncertainties associated with elasticities, it seems prudent to estimate a range of possibilities under the alternative assumptions that the pass-through rate is zero, one or some value in (0,1) interval based on market elasticities.

The impacts of the different pass-through rates are shown in Table 4-17. The first panel shows the quantity and price for manufactured houses under the standards in 1992. The second panel shows the changes from those equilibrium market values due to the more stringent Wind Standards proposed by HUD in 1993 assuming a 56 percent pass-through of costs to the consumer. The third panel shows larger declines in quantity placed and increases in sales prices assuming a pass-through of 94 percent for Zone II and 99 percent for Zone III. The higher pass-through rates are calculated using the submarket supply elasticities. If consumers take most of the increased cost burden from the more stringent regulation, the quantity demanded will shrink along with the market for MH in those wind zones. However, if manufacturers find less costly ways to satisfy the Wind Standards, the changes in quantity and price may attenuate over time.

Table 4-17
Manufactured Housing Submarkets, 1992 and 1994

Submarkets under 1992 Wind Standards

	Estimated Shipments per year		**Average Price per Unit, 1992**	
Wind Zone	**Single Section**	**Multiple Section**	**Single Section**	**Multiple Section**
II	14,631	12,271	$19,700	$36,700
III	2,268	1,932	$19,700	$36,700

Changes to Submarkets Under More Stringent 1994 Wind Standards

	Using National Market Elasticities and Pass-Through Rate of 56%			
	Change in Quantity		**Change in Price**	
Wind Zone	**Single Section**	**Multiple Section**	**Single Section**	**Multiple Section**
II	-1,477	-808	$829	$1,007
III	-325	-191	$1,177	$1,512
	Using Submarket Supply Elasticities and Pass-Through Rate almost 100%			
	Change in Quantity		**Change in Price**	
Wind Zone	**Single Section**	**Multiple Section**	**Single Section**	**Multiple Section**
II	-2,509	-1,372	1,402	1,704
III	-580	-341	2,098	2,695

The total cost of the regulation is the sum of costs to consumers, costs to producers and deadweight loss or the social cost of a smaller market for manufactured homes. The cost to consumers is calculated as the change in price (P_2 – P_1) paid by consumers times the new quantity sold (Q_2):

$$Cost\_to\_Consumers = (P_2 - P_1) * Q_2$$

The cost to producers is the added cost of production (ΔC) not covered by the higher price (P_2), that is, added production costs not paid by the consumers:

$$Cost\_to\_producers = [\Delta C - (P_2 - P_1)] * Q_2$$

The third cost is the loss to society from a smaller market in MH. Consumers are buying fewer MH units, so there is less consumer surplus or the amount consumers are willing to pay less the market price. Similarly, producers are making fewer MH units, so there is less producer surplus or the market price less the amount per unit at which producers are willing to build MH. The combined loss in consumer and producer surplus is the deadweight loss or the loss to society from a smaller MH market due to the Wind Standards. Graphically, this is the triangle ES_0S_1 in Figure 4-1. Algebraically, deadweight loss is calculated as:

$$Deadweight\_Loss = \frac{1}{2} * \Delta C^2 * \frac{Q_1}{P_1} * \left[\frac{(E_S * E_D)}{(E_S - E_D)} \right]$$

The total costs are shown in Table 4-18 followed by the total benefits in Table 4-19 calculated for quantity and price associated with the pass-through rate of 56 percent. The net benefit is the total benefits of $83.8 million less the total costs of $51.7 million for a net benefit of $32.1 million.

Table 4-18
Total Cost of More Stringent Wind Standards

	Cost to Consumers			
Wind Zone	**Single Section**	**Multiple Section**		
II	$10,900,229	$11,542,686		
III	$ 2,286,915	$ 2,633,051		
Subtotal			$27,362,882	
	Cost to Producers			
II	$8,720,184	$9,234,149		
III	$1,829,532	$2,106,441		
Subtotal			$21,890,305	
	Deadweight Loss or Social Cost of Fewer MH			
II	$1,101,593	$ 732,299		
III	$ 344,587	$ 260,112		
Subtotal			$ 2,438,590	
Total Costs				**$51,691,778**

Table 4-19
Total Benefits of More Stringent Wind Standards
(Using Pass-Through Rate of 56 percent)

	Private Benefits			
Wind Zone	**Single Section**	**Multiple Section**		
II	$19,944,702	$23,638,107		
III	$ 3,927,851	$ 4,786,960		
Subtotal			$52,297,621	
	Public Benefits			
II	$11,816,566	$13,329,752		
III	$ 2,433,475	$ 2,794,622		
Subtotal			$30,374,414	
	Reduced Death and Injury Benefits			
II	$ 514,766	$ 448,591		
III	$ 83,782	$ 75,078		
Subtotal			$ 1,122,218	
Total Benefits				**$83,794,253**
Net Benefits				**$32,102,476**

Sensitivity Analysis

The HUD analysis presents the benefits and costs for a few select changes in parameters, such as the engineering cost of production, damage reduction factors, and peripheral damage from MH debris. None of the examples show a negative net benefit, which shows how far some assumptions can be stretched and still get a positive net benefit from the regulation.

A more rigorous approach to testing would be to determine distributions for each of the key parameters and then calculate the net benefits for the range of key parameter values. A first round of sensitivity testing would vary a single parameter at a time. It is useful to change one parameter at a time so that it is clear how the net benefits change for that single change. The underlying assumption in those results is the parameter values are independent of one another. Key parameters may be correlated and it is useful to see the net effect if those parameters are varied in a coordinated fashion. The challenge is to determine the appropriate distribution statistics for these key parameters. Often the high degree of uncertainty leads to wide variance estimates, which generates a disconcerting range of net benefits/costs. If a probability distribution can be assigned to the key parameters, then parameter values can be randomly drawn from the distributions. By repeating the calculation of net benefits many times under randomly drawn parameters, the resulting distribution of benefits indicates the degree of reliability around the mean point estimate. More elaborate models are not necessarily more valuable if they rely on questionable assumptions, but it is important that readers and decision-makers recognize the range of plausible results.

Affordability and Distributional Impact

The analysis of affordability is done by comparing the monthly payments for a Zone III multiple section home under the old wind standard vs. the new wind standard. The cost of the MH unit under the new wind standard is 4.1 percent higher, but that increased cost is offset by the assumption that the owner will buy the land to which the unit is more firmly attached. As a real estate loan, the down payment rate is smaller (10 percent vs. 20 percent), the mortgage term is longer (25 years vs. 15 years), and the property tax is higher ($582 vs. $367) but there is no land rent. The net effect is the monthly payment under the more stringent wind standard is only slightly higher ($470 vs. $461 or less than 2 percent) than under the old wind standard. Similarly, the qualifying income, based on a housing payment being no more than 28 percent of income, is just 2 percent higher ($20,159 vs. $19,773).

The main point is that a household making $20,000 per year could still afford the unit under the more stringent Wind Standards, if they purchase the land. No estimates are provided about how many owners would purchase the land beyond the logical argument that sturdier houses with better anchoring make good candidates for land purchase. It is unclear how many MH owners could convert their land rental arrangements into land purchases or whether the land costs would rise with increased demand. Even without the new Wind Standards, owners could potentially save money by owning the land. Although this view was taken in the original RIA, it is necessary in an HIA to hold the ownership and financing arrangements constant unless they are specifically changed by the new regulation. Otherwise, changes in financing get confused with changes caused by the regulation.

A more complete measure of affordability would be to estimate how many MH buyers would have to spend more than 28 percent of their income to purchase a new MH under the more stringent Wind Standards. Census (PUMS) or American Housing Survey (AHS) microdata identify the income of MH owners and renters. More stringent Wind Standards increase the purchase price for a single section by $829 in Zone II and by $1,177 in Zone III. Given assumptions about loan terms, the increased purchase prices would translate into higher monthly payments. One approach is to determine how many new MH buyers would have to pay more than 28 percent of their income for the sturdier units. The share of buyers with insufficient income to afford the new units would measure the loss in affordability due to the regulation. This approach assumes that recent MH buyers or existing MH owners have similar incomes to potential MH buyers in Zones II and III. The number of households would be much smaller because the market area of Zones II and III is relatively small (only 31,102 out of 210,787 or 15 percent).

A broader measure would consider how many households, whether owners or renters, would have enough income to purchase a new MH unit meeting the more stringent Wind Standards. The only difference from the measure above is the inclusion of all households among potential buyers rather than existing MH owners and renters. Certainly some renters in multifamily housing or single family housing would like to become owners and MH ownership is usually the least expensive way to become an owner. Census data for tracts within Zones II and III could be used to target the affordability impact of the regulation.

The 28 percent qualifying rate applies to conventional financing for purchases. The qualifying standard has increased over time as lenders shifted to automated underwriting and were willing to qualify buyers at higher rates of housing payments to income. A more common rate for housing affordability is 30 percent of income and this could be applied to renters (or owners). The ratio of median rent to value could be used to estimate a capitalization rate, possibly customized by state or local area. For example, suppose annual MH rents are 9 percent of MH values. Then an increase in purchase price of $1,000 would translate into an increase in rents of $90. Assuming MH rents increased by $90 on average, how many more renters would pay more than 30 percent of their income for MH housing? The main difference in this affordability measure is the assumption that existing renters remain renters and the increase in MH price translates to the rental market at the capitalization rate. An increase in purchase price may cause some potential buyers to remain as renters and actually increase the demand for MH rentals. Unfortunately, we do not have reliable estimates on the cross-market elasticity of substitution between buyers and renters. A reasonable first approximation is to assume the income distribution of the existing MH renters represents the income distribution of renters after the imposition of the more stringent regulations.

Another approach is to look at how large are the monthly housing increases relative to incomes at the median or 60 percent of the area median income. An increase in monthly housing cost below 5 percent may be small enough for households to accommodate. For example in 1992, the median MH owner had an income of $21,052 and the median MH renter had an income of $14,780. An increase of $1,000 per year in housing expenses is just under 5 percent for the median MH owner household, but almost 7 percent for MH renters and probably twice that percentage for low-income MH renters. Low-income households have very few less expensive housing substitutes. Therefore, an increase of 5 percent in housing costs will force some households into overcrowded arrangements or into homelessness. By considering the impact of housing cost increases on low-income households, we focus on the subgroup most likely to be forced to make changes due to the new regulation.

Subgroups

Subgroup analysis helps identify demographic subgroups that may be particularly affected by the regulation, usually because they have low income or limited ability to adjust to the higher cost burdens. The main subgroups within manufactured housing are owners vs. renters and low-income vs. high-income. In the case of Wind Standards, the regulations are by geographical area (wind zones II and III), so it is valuable to extend the analysis by location to the extent data allow. Racial and ethnic subgroups also deserve attention to make sure a disproportionate share of the cost burden does not fall on them.

One advantage of implementing the Wind Standards on new MH units is that existing units will be relatively unaffected in the short run. If consumers recognize the enhanced durability of new MH built to more stringent Wind Standards, they will be willing to pay more for those new units. And over time as those more durable MH units are resold, they should depreciate at a lower rate than other existing MH units. It is even possible that used, non-compliant units will sell at a discount giving some short run price break to buyers of non-compliant units. The impact of the regulation on the overall MH market may be gradual as the newer, compliant models replace the older non-compliant models. Eventually, the compliant units will dominate the used market, but the increase in prices will probably be small. The gradual replacement gives lower income households more time to adjust, but it also leaves them less protected from storm damage. A retrospective study of depreciation rates could determine whether compliant units hold their value significantly better than non-compliant units.

Manufactured housing is disproportionately occupied by retirees. The low housing cost, small size and predominantly non-metropolitan location of MH units are well-suited to elderly households with low income and little need for commuting to jobs. A significant increase in the price of new MH in Zones II and III could lead buyers to substitute the purchase of existing MH in those zones or to buy a new MH unit outside of those zones. Some elderly are more flexible in location because they do not have to live close to their job. Elderly may also be good candidates for MF rentals in which the management handles all the maintenance responsibilities. Again, we are not aware of a study that has estimated the submarket elasticities, so we do not know how sensitive elderly homebuyers would be to an increase in the price of new MH units relative to other housing options. As shown in the McCloskey (1985) formula for submarket elasticity, the smaller the submarket the more elastic the response (both supply and demand). A retrospective study of submarket responses could be quite valuable in predicting the impact of future regulatory changes.

Possible Extensions of Housing Impact Analysis for MH Wind Standards

There are a number of informative extensions that could have been done as part of the Wind Standards regulatory analysis and would be appropriate as part of a HIA. This section considers neighborhood and secondary effects on existing MH, site-built housing, MF rentals, demand for coastal housing and flood insurance.

The new Wind Standards apply to newly constructed MH units. How will the introduction of sturdier, new MH units affect the value of the non-compliant, existing MH units in the same park or neighborhood? On one hand, the new units are designed to reduce the externalities of flying debris during a hurricane, so neighbors should be glad to have a new unit move in. On the other hand, if added value to buyers exceeds added cost, then the shift in demand for new units could lead to discounts in value of the existing units built to a lower standard. Presumably the discount will be slight at first because the new units will comprise such a small part of the market. Over time the stock of sturdy units will accumulate and buyers of used MH units will have a choice between compliant and non-compliant units. An analysis of other MH innovations may provide sufficient data to predict whether the new standards have a favorable spillover on neighboring units or cause a discount. And at this point, a careful retrospective analysis could determine whether the cross submarket effects mean the more stringent standards should have gone further or went too far.

A more basic question for the neighboring properties is whether the new, compliant units generate the savings and reduce collateral damage as expected. The justification for the regulations was a combination of cost savings, reduction in externalities and better information. Did the new regulations create MH units that produced the promised savings? If the answer is yes and more, that suggests the benefits (or maybe externalities) were underestimated and justify tighter standards. If the answer is no, that could mean not enough time has passed to estimate the full cost savings or simply that the benefits were overestimated.

Another extension is to examine the indirect impact on site-built housing and homeownership. Prospective homebuyers have to decide between MH and site-built housing. The housing choice could be estimated as a random utility model with multinomial logit regression. Alternatively, the choice could be estimated in the context of a system of supply and demand equations for MH, which includes the cross-market price of site-built housing along with own price for MH and rent. In either approach, the challenge is obtaining property level sales prices for areas within Wind Zones II and III. Average price data at the local level may be adequate if there were enough counties, though the limited degrees of freedom will make it more difficult to substitute instrumental variables for endogenous variables. The sample would not have to be limited to the Wind Zones and it could be useful for understanding the interaction between the submarkets more generally. When MH becomes relatively more expensive, does homeownership suffer (from pent-up demand by renters) or do renters rely less on MH as an ownership option and shift to site-built starter homes?

Hurricanes Katrina and Rita remind us that coastal development is a large and growing issue. What are the long run trends in demand factors such as population, household income, migration, immigration, credit availability and homeownership? The Census estimates for 2010 project an increase in coastal population density of 130 percent relative to 1988. As the Baby Boom retires, a substantial share will move to MH in the South. Already 40 percent of MH buyers are at least 50 years old. If coastal areas are already overdeveloped relative to hurricane and flood hazards, the increased price of MH housing along the coast may ameliorate the damage and shift development to safer, less expensive areas. There may even be a significant interaction between flood insurance and HUD Wind Standards. These are very different approaches to mitigating storm damage. In both programs, affordability is worsened, though perhaps still less than the social cost of storm damage along the coast.

Summary of the Wind Standards Case Study

The Wind Standards are regulations that increase the strength of manufactured houses located in areas prone to hurricanes and high winds. Although sturdier MH units cost more to build, they reduce the likelihood of damage to the owners and neighbors as well as reduce the cost to the government following violent storms. The baseline of no regulation applies to areas in Wind Zone I, whereas the new regulations are customized to Wind Zones II and III. Historical damage from Hurricane Andrew is used both to measured expected losses without the regulation and expected benefits with the Wind Standards regulation.

The production costs are estimated by engineers according to additional materials costs and then multiplied by an industry standard multiplier of 2.22 to cover labor, design, overhead and management costs. The elasticities of demand come from the literature for MH (about –2.4). No long run elasticity of supply for manufactured housing could be found in the literature, so they used Topel and Rosen's (1988) estimate for general housing of 3.0. Note that it is quite possible that the elasticity of housing has declined over time as regulations have reduced the availability of land. Although manufactured units are produced in a factory, which can incorporate labor-saving innovations, the MH unit must be installed on a lot and many communities have resisted MH parks. Combining the elasticities of supply and demand, $E_S/(E_S-E_D)$, gives a pass-through rate of costs to consumer of 56 percent.

If we treat the Wind Zones as submarkets of the larger MH market, then this implies higher supply elasticities. We argue that the regulation requires higher standards in the Wind Zones, so a standard submarket elasticity exaggerates the ease by which MH units could be moved into the submarket. Nevertheless, there is still considerable uncertainty about which elasticity and pass-through rate is correct, so a range of possibilities is most appropriate. Sensitivity analysis can also highlight the range of compliance costs and house prices that could occur in different local housing markets or economic conditions. Not considered in this RIA, but expected in an HIA is the consideration of cross-market effects between new and existing MH as well as site-built housing. The primary consideration of more expensive new MH is the quantity demanded for new MH. Another consideration is the spillover effects on the existing MH units and site-built housing. The existing MH units may increase in value as buyers shift demand away from the regulated new units. On the other hand, buyers may recognize the long-run benefits of a sturdier house such that demand drops for the old MH units. The shift in demand toward site-built housing is less ambiguous.

The analysis of affordability argues that the 4 percent increase in cost can be financed in such a way as to minimize the increase in monthly payments. While financing may be important to mitigate the shock of the regulation, it confuses the point as to the costs paid by the homebuyer.

The Effluent Guidelines provide a better example of measuring affordability with consistent terms of financing to determine the reduction in households that could afford the house after the regulation went into effect. The HOI approach draws a sharp line that divided the group who can vs. cannot afford a unit. An alternative view is the housing burden approach in which the assumption could be that the same households buy the more expensive house but their housing costs are a larger share of their monthly income. If there are reliable elasticities of demand, they can be used to determine the quantity demanded.

The Wind Standards RIA did not do a subgroup analysis of affordability, but that should be standard for an HIA. It would be particularly valuable in the Wind Standards case because low-income and elderly households form large shares of the residents in MH. These are the same subgroups who may have the most difficulty leaving their home in a storm or recovering from the damage after the storm.

4.3 Summary of the In-Depth Methodology

To recap, the In-Depth Methodology has eight steps:

1) Identify the baseline trend without the regulation along with an appropriate timeframe and geography.
2) Get engineering estimates for direct costs to comply with the proposed regulation plus customary markups.
3) Collect or estimate supply and demand elasticities that apply to the regulated market(s).
4) Use the elasticities to calculate pass-through rates and consider the extreme cases of 0 percent and 100 percent pass-through rates.
5) Determine the range of house price changes based on the elasticities.
6) Consider indirect or secondary market effects given the size of the house price change.
7) Drill down to housing submarkets by type of housing structure and neighborhood.
8) Conduct affordability analysis by income and tenure groups with special consideration for vulnerable subgroups.

Although it is difficult to specify a particular procedure for a generic regulation, we have provided examples and references so the researcher does not have to re-invent the wheel. Here are some good parameter values to start. Assume a future timeframe of 5 years, which is long enough for the regulation to take full effect and for the markets to respond. Use recent history (5 years or less) for house price levels, interest rates and spreads, household income, inflation and finance terms. The easiest mortgage terms to use for calculating payments is the 30-year, fixed rate mortgage assuming 10 percent down payment. The transaction costs for a real estate sale are about 8.7 percent of the sale price. To estimate long term trends use 10 years for macroeconomic variables (like income and unemployment rates) and 20 years for housing variables (like interest rates and house price appreciation rates). *U.S. Housing Market Conditions* published quarterly by HUD is a good source for housing data and trends at the national level.

To estimate costs, there is no good substitute for engineering costs, especially of a manufacturing process. There are standardized books to estimate construction costs (see Construction Cost Index in Appendix A.2 for Housing Supply). It is unfortunate that elasticities are not more stable, but there is general consensus that the elasticity of demand is –0.5 to –1.0 and, with less certainty, the elasticity of supply is 1.0 to 4.0. With that range of elasticities, the pass-through rate ranges from 0.5 to 0.9. Given the uncertainty about elasticities, especially in the short run and in highly regulated markets, it is recommended to do a sensitivity test with pass-through rates of zero and one in addition to more likely values between 0.5 and 0.9.

Assuming straight line demand and supply functions, the change in price and quantity can be calculated:

$$\Delta P = \left(\frac{E_S}{E_S - E_D} \right) * \Delta C$$

$$\Delta Q = \frac{E_S * E_D * Q_1 * (\Delta C / P_1)}{E_S - E_D}$$

where ΔP is the change in price, E_S is supply elasticity, E_D is the demand elasticity, ΔC is the change in production cost, ΔQ is the change in quantity sold, P_1 is the price before the regulation, and Q_1 is the initial equilibrium market quantity sold. The bracketed portion in the change in price equation is the pass-through rate $(E_S/(E_S\text{-}E_D))$.

Although admittedly difficult, one distinction between the preliminary analysis and the in-depth analysis is the inclusion of submarket and neighborhood effects. Housing is an unusual commodity in that its location is permanent and its value is sensitive to the neighborhood. Moreover, the unit itself is a mix of components that can vary widely in size, shape and configuration. For these reasons, average or median house values can be a poor representation of the distribution. Hedonic regression (OLS regression of log value on available unit and neighborhood characteristics) can be highly useful to measure the impacts on house values. Submarkets of similar units, either by structure or price level, are more sensitive to cross-market effects because they are substitutes. Increases in housing costs are most likely to spillover to other units in the same submarket. The total effect of a regulation might be much larger if the HIA incorporates the spillover effects into related submarkets and neighborhoods.

Affordability analysis starts simple with the comparison of housing costs to income, but it can become much more sophisticated when the researcher controls for differences in houses, user costs and household incomes. User costs control for the deductibility of mortgage interest, local property taxes, maintenance costs, utilities, inflation and, sometimes, expected appreciation. Household incomes can be adjusted for transfers and temporary income fluctuations.

A necessary step is to assume consistent parameters for financing before and after the regulation (unless the regulation actually makes better financing terms available). An old standard is to assume an underwriting limit of 28 percent for the maximum ratio of housing payment to income. These days lenders use automated underwriting and allow much higher payment-to-income ratios. A limit of 30 percent for homeowners is convenient because it matches the HUD standard for rental affordability of 30 percent. But, again, consistency is more important than the particular percentage selected. Affordable units have monthly payments relative to household income of 30 percent or less. A regulation that increases housing costs, reduces the number of people with affordable units. The change in affordability can either be measured in the number of units no longer affordable to their occupants or the reduction in units below a value affordable to a median or low-income family.

Subgroup analysis is an important extension of the affordability analysis. The affordability of housing for the median family income may be a useful benchmark, government housing policy is focused on the housing affordability for low-income subgroups. A necessary component of HIA is to measure the change in affordability for low-income, minority, elderly and disabled households. The Census (Public Use Microdata Sample, PUMS) can be an excellent source of representative household information for demographic breakdowns by income, race, age and household composition.

References

Abraham, Jesse M.; Hendershott, Patric H. (1993) “Patterns and Determinants of Metropolitan House Prices, 1977-91.” In *Real Estate and the Credit Crunch*, ed. Lynne E. Browne and Eric S. Rosengren, 18-42. Boston: Federal Reserve Bank of Boston.

Accordino, John, George Galster, and Peter Tatian (2005) “The Impacts of Targeted Public and Nonprofit Investment on Neighborhood Development,” Federal Reserve Bank of Richmond and Richmond Local Initiatives Support Corporation, July.

Alonso, Fernando (2002) “The Benefits of Building Barrier-Free: A Contingent Valuation of Accessibility as an Attribute of Housing,” *European Journal of Housing Policy*, 2(1): 25-44.

Altman, Edward I. (1993) Corporate Financial Distress and Bankruptcy, 2nd Ed., New York: John Wiley and Sons.

Anas, Alex and Chaushie Chu, (1984) “Discrete Choice Models and the Housing Price and Travel to Work Elasticities of Location Demand,” *Journal of Urban Economics*, 15: 107-123.

Anas, Alex and Richard J. Arnott, (1993) “Development and Testing of the Chicago Prototype Housing Market Model,” *Journal of Housing Research*, 4(1): 73-130.

Anas, Alex and Richard J. Arnott, (1994) “The Chicago Prototype Housing Market Model with Tenure Choice and its Policy Applications,” *Journal of Housing Research*, 5(1): 23-90.

Apgar, William, Allegra Calder, Michael Collins and Mark Duda (2002) “An Examination of Manufactured Housing as a Community- and Asset-Building Strategy,” Report to the Ford Foundation by Neighborhood Reinvestment Corporation in collaboration with the Joint Center for Housing Studies of Harvard University.

Apgar, William C., Mark Duda, Rochelle Nawrocki Gorey (2005) “The Municipal Cost of Foreclosures: A Chicago Case Study,” Homeownership Preservation Foundation, Housing Finance Policy Research Paper Number 2005-1, February 27.

Bajari, Patrick and Matthew E. Kahn (2003) “Estimating Housing Demand With an Application to Explaining Racial Segregation in Cities,” NBER Working Paper 9891, July.

Bajari, Patrick and Matthew E. Kahn (2005) “Estimating Housing Demand with an Application to Explaining Racial Segregation in Cities,” *Journal of Economics and Business Statistics*, 23(1): 20-33.

Bartik, Timothy J. (1987) “The Estimation of Demand Parameters in Hedonic Price Models,” *Journal of Political Economy*, 95:172-183.

Bartik, Timothy J. (1988) “Measuring the Benefits of Amenity Improvements in Hedonic Price Models,” *Land Economics*, 64: 172-183.

Benshoof, M. (2001) An Inside Look at Builders’ Books, Washington, D.C.: National Association of Home Builders, May.

Berkovec, James A. and John L. Goodman, Jr. (1996) “Turnover as a Measure of Demand for Existing Homes,” *Real Estate Economics*, 24(4): 421-440.

Bernanke, Ben and Mark Gertler (1989) “Agency Costs, Net Worth, and Business Fluctuations,” *American Economic Review*, 79(1): 14-31.

Berry, Steven, James Levinsohn and Ariel Pakes (1995) “Automobile Prices in Market Equilibrium,” Econometrica, 63(4): 841-890.

Berube, Alan (2002) “Gaining, But Losing Ground: Population in Large Cities and Their Suburbs in the 1990s,” Brookings Institution Center on Urban and Metropolitan Policy, Washington, D.C.

Bier, Thomas (2001) “Moving Up, Filtering Down: Metropolitan Housing Dynamics and Public Policy,” The Brookings Institution Discussion Paper, September.

Blackley, D.M. (1999) “The Long-Run Elasticity of New Housing Supply in the United States: Empirical Evidence for 1950 to 1994,” *Journal of Real Estate Finance and Economics*, 18: 25-42.

Bockstael, N.E. (1996) “Modeling Economics and Ecology: The Importance of a Spatial Perspective,” *American Journal of Agricultural Economics*, 78: 1168-1180, December.

Bourassa, Steven C., Martin Hoesli and Vincent S. Peng (2003) “Do Housing Submarkets Really Matter?” *Journal of Housing Economics*, 12:12-28.

Bratt, Rachel G. (2002) “Housing and Family Well-Being,” *Housing Studies*, 17:13-26.

Breffle, William S., Edward R. Morey, and Tymon S. Lodder (1998) “Using Contingent Valuation to Estimate a Neighborhood’s Willingness to Pay to Preserve Undeveloped Urban Land,” *Urban Studies*, 35(4): 715-727.

Brown, James and Harvey Rosen (1982) “On the Estimation of Structural Hedonic Price Models,” *Econometrica,* 50(3): 765-768.

Bureau of Economic Analysis (1997) *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II),* 3rd Ed., U.S. Dept. of Commerce.

Burt, Martha R., Laudan Y. Aron, and Edgar Lee (2001) *Helping America’s Homeless: Emergency Shelter or Affordable Housing?* Urban Institute Press.

Burt, Martha R., John Hedderson, Janine M. Zweig, Mary Jo Ortiz, Laudan Y. Aron, Sabrina M. Johnson (2004) "Strategies for Reducing Chronic Street Homelessness," report prepared for HUD, Office of Policy Development and Research, January 15.

Butrica, Barbara A., Joshua H. Goldwyn and Richard W. Johnson (2005) "Understanding Expenditure Patterns in Retirement," Boston College, Center for Retirement Research Working Paper 2004-81.

Cameron, Gavin, John Muellbauer and Anthony Murphy (2005) "Booms, Busts and Ripples in British Regional Housing Markets," University of Oxford Working Paper, November.

Can, Ayse (1992) "Specification and Estimation of Hedonic Housing Pricing Models," *Regional Science and Urban Economics*, 22:453-474.

Can, Ayse and Isaac Megbolugbe (1997) "Spatial Dependence and House Price Index Construction," *Journal of Real Estate Finance and Economics*, 14:203-222.

Carlton, Dennis W. and Jeffrey M. Perloff (2000) *Modern Industrial Organization*, 3rd Ed., New York: Addison-Wesley.

Center for Watershed Protection (2001) "Impervious Cover and Land Use in the Chesapeake Bay Watershed," Ellicott City, MD, January.

Cho, Cheol-Joo (1997) "Joint Choice of Tenure and Dwelling Type: A Multinomial Logit Analysis for the City of Chongju," *Urban Studies*, 34(9): 1459-1474.

Clapp, John M. and Carmelo Giaccotto (1992) "Estimating Price Indexes for Residential Property: A Comparison of Repeat Sales and Assessed Value Methods," *Journal of the American Statistical Association*, 87: 300-306.

Clapp, John M. and Carmelo Giaccotto (1994) "The Influence of Economic Variables on Local House Price Dynamics." *Journal of Urban Economics*, 36(2): 161-83.

Collins, J. Michael, Eric S. Belsky, and Micky Tripathi (1999) "Estimating Economic Impacts of Community Lending," Joint Center for Housing Studies of Harvard University, Working Paper W99-7, July.

Collins, Michael, David Crowe and Michael Carliner (2001) "Examining Supply-Side Constraints to Low-Income Homeownership," Low-Income Homeownership Working Paper Series (LIHO-01.5), Joint Center for Housing Studies of Harvard University, August.

Crain, W. Mark (2005) "The Impact of Regulatory Costs on Small Firms," Small Business Administration, Office of Advocacy, Contract SBHQ-03-M-0522.

Crone, Theodore M., Leonard I. Nakamura, and Richard P. Voith (2004) “Hedonic Estimates of the Cost of Housing Services: Rental and Owner-Occupied Units,” Federal Reserve Bank of Philadelphia, Working Paper No. 04-22, October.

Cropper, Maureen, Leland Deck and Kenneth McConnell (1988) “On the Choice of Functional Form for Hedonic Price Functions,” *Review of Economics and Statistics*, 70(4): 668-675.

Culhane, Dennis , Stephen R. Poulin, Lorlene M. Hoyt, and Stephen Metraux (2003) “The Impact of Welfare Reform on Public Shelter Utilization in Philadelphia: A Time Series Analysis,” *Cityscape*, 6(2).

Cutler, David M., James M. Poterba and Lawrence H. Summers (1991) “Speculative Dynamics,” *Review of Economic Studies*, 58: 529-546.

De Alessi, Louis (1996) “Error and Bias in Benefit-Cost Analysis: HUD’s Case for the Wind Rule,” *Cato Journal*, 16(1): 129-147.

DiPasquale, Denise, (1999) “Why Don't We Know More About Housing Supply?” *Journal of Real Estate Finance and Economics*, 18(1): 9-23.

DiPasquale, Denise, and William C. Wheaton (1994) “Housing Market Dynamics and the Future of Housing Prices,” *Journal of Urban Economics*, 35:1-27.

DiPasquale, Denise and William C. Wheaton (1996) *Urban Economics and Real Estate Markets*, Englewood Cliffs, NJ: Prentice Hall.

Downs, Anthony (2001a) “Attacking the Housing Affordability Problem.” Report to the Millennial Housing Commission, November.

Downs, Anthony (2001b) “What Does 'Smart Growth' Really Mean?” *Planning*, April.

Duda, Mark and Eric S. Belsky (2001) “The Anatomy of Low-Income Homeownership Boom in the 1990s,” Low-Income Homeownership Working Paper Series, Joint Center for Housing of Harvard University, July.

Duda, Mark (2001) “Federally-Sponsored Rehabilitation Activity,” Joint Center for Housing Studies of Harvard University, W01-8, July.

Dynarski, Susan and Jonathan Gruber (1997) “Can Families Smooth Variable Earnings?” *Brookings Papers on Economic Activity*.

Ekeland, Ivar, James Heckman, and Lars Nesheim (2004) “Identification and Estimation of Hedonic Models,” *Journal of Political Economy*, 112: S60-S109.

Ellen, Ingrid Gould, Michael H. Schill, Scott Susin and Amy Ellen Schwartz (2001) "Building Homes, Reviving Neighborhoods: Spillovers from Subsidized Construction of Owner-Occupied Housing in New York City," *Journal of Housing Research*, 12(2): 185-216.

Ellwood, David and Mitchell Polinski, (1979) "An Empirical Reconciliation of Micro and Grouped Estimates of the Demand for Housing," *Review of Economics and Statistics*, 61: 199-205.

Emrath, Paul (1994) "Consumption Spending of New Home Buyers," *Housing Economics*, 25(7): 10-15.

Emrath, Paul, (1997) "Local Economic Impact of Home Building," *Housing Economics*, 45(3): March.

Epple, Dennis (1987) "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products," *Journal of Political Economy*, 95: 59-80.

Fannie Mae Foundation (2002) "Results of the Fannie Mae Foundation Affordable Housing Survey." Conducted by Hard/Teeter. May/June.

Federal Housing Finance Board, (2001) Monthly Interest Rate Survey (MIRS) Periodic Summary Tables (www.fhfb.gov/MIRS/mirs.htm).

Fergus, James T.; Goodman, John L. (1992) "House Prices: Trends, Causes, and Consequences." Unpublished. April.

Fischel, William A. (1999) "Does the American Way of Zoning Cause the Suburbs of Metropolitan Areas to Be Too Spread Out?" *Governance and Opportunity in Metropolitan America*, The National Academy Press, p. 151-191.

Follain, James R. (1979) "The Price Elasticity of the Long Run Supply of New Housing Construction," *Land Economics*, 55: 190-199.

Follain, James R. and O.T. Velz (1995) "Incorporating the Number of Existing Home Sales into a Structural Model of the Market for Owner-Occupied Housing," *Journal of Housing Economics*, 4:93-117.

Fotheringham, A. Stewart, Chris Brunsdon and Martin Charlton (2002) *Geographically Weighted Regression, The Analysis of Spatially Varying Relationships*, John Wiley & Sons.

Galster, George, Chris Walker, Chris Hayes and Patrick Boxall (2004) "Measuring the Impacts of Community Development Initiatives," *Evaluation Review*, 28(6): 1-38.

Garritano, Anthony (2005) "Fannie Quietly Accepting More AVMs," *National Mortgage News*, 29(52):1,34, September 26.

Gates, Howard (1984) "Price Elasticity of Demand for Manufactured Homes," Mimeo, March 7.

Geoghegan, J., L.A. Wainger, and N.E. Bockstael (1997) "Spatial Landscape Indices in a Hedonic Framework: An Ecological Economics Analysis using GIS." *Ecological Economics*, 23(3): 251-264.

Glaeser, Edward L. and Joseph Gyourko, (2002) "The Impact of Zoning on Housing Affordability." Harvard Institute of Economic Research Discussion Paper: 1948. March.

Glaeser, Edward L. and Joseph Gyourko (2004) "Urban Decline and Durable Housing," Working Paper, August 3.

Glaeser, Edward L., Joseph Gyourko and Raven Saks (2004) "Urban Growth and Housing Supply," mimeo, July 29.

Glascock, John L. and V. Carlos Slawson, Jr., (1996) "Using the Housing Affordability Index to Assess Housing Opportunities." Presented at the AREUEA Midyear 1996 Conference, April.

Goetz, Edward G., Kristin Cooper, Bret Thiele, and Hin Kin Lam, (1997) "The Fiscal Impacts of the St. Paul Houses to Homes Program," Neighborhood Planning for Community Revitalization, Center for Urban and Regional Affairs, University of Minnesota, February.

Goodman, Allen C. (2005) "The Other Side of Eight Mile: Suburban Population and Housing Supply," *Real Estate Economics*, 33(3): 539-569.

Goodman, Allen C. and Thomas G. Thibodeau (1998) "Housing Market Segmentation," *Journal of Housing Economics*, 7: 121-143.

Goodman, Allen C. and Thomas G. Thibodeau (2003) "Housing Market Segmentation and Hedonic Prediction Accuracy," *Journal of Housing Economics*, 12: 181-201.

Goodman, Jack (2001) "Housing Affordability in the United States: Trends, Interpretations, and Outlook." Report to the Millennial Housing Commission. November 21, 2001.

Goodman, John L. and John B. Ittner (1992) "The Accuracy of Home Owners' Estimates of House Value." *Journal of Housing Economics,* 2: 339-357.

Green, Richard K. (1999) "Land Use Regulation and the Price of Housing in a Suburban Wisconsin County," *Journal of Housing Economics*, 8(2): 144-159.

Green, Richard, and Patric H. Hendershott, "Age, Housing Demand, and Real House Prices." *Regional Science and Urban Economics*, 26 (1996): 465-480.

Green, Richard and Stephen Malpezzi, (2003) *A Primer on U.S. Housing Markets and Housing Policy*, Washington, DC: The Urban Institute Press.

Greene, W. H. (2003) *Econometric Analysis*, 5th ed., Upper Saddle River, NJ: Prentice-Hall.

Grigsby, William (1963) *Housing Markets and Public Policy*, Philadelphia: Univ. of Pennsylvania Press.

Gyourko, Joseph and Peter Linneman (1993) "The Affordability of the American Dream: An Examination of the Last 30 Years." *Journal of Housing Research,* 4(1): 39-72.

Gyourko, Joseph and Joseph Tracy (1991) "The Structure of Local Public Finance and the Quality of Life," *Journal of Political Economy*, 91(4): 774-806.

Gyourko, Joseph and Joseph Tracy (1999) "A Look at Real Housing Prices and Incomes: Some Implications for Housing Affordability and Quality." *Federal Reserve Bank of New York. Economic Policy Review*, September 1999: 63-77.

Gyourko, Joseph and Joseph Tracy (2003) "Using Home Maintenance and Repairs to Smooth Variable Earnings," *Federal Reserve Bank of New York Staff Reports*, no. 168, May.

Gyourko, Joseph and Richard Voith (1992) "Local Market and National Components in House Price Appreciation," *Journal of Urban Economics*, 32: 52-69.

Gyourko, Joseph and Richard Voith (2001) "Capitalization of Federal Taxes, the Relative Price of Housing and Urban Form: Density and Sorting Effects," The Wharton School, University of Pennsylvania Working Paper 00-12.

Haining, Robert (2003) *Spatial Data Analysis: Theory and Practice*, University Press, Cambridge, UK.

Hammitt, James K., Eric S. Belsky, Jonathan I. Levy and John D. Graham (1999) "Residential Building Codes, Affordability, and Health Protection: A Risk Trade-off Approach," *Risk Analysis*, 19(6): 1037-1058.

Harris, John D. (2003) "Property Values, Stigma and Superfund," U.S. Environmental Protection Agency.

Harter-Dreiman, Michelle (2003) "Drawing Inferences about Housing Supply Elasticity from House Price Responses to Income Shocks," OFHEO Working Paper 03-2, December.

Hendershott, Patric H. and Thomas Thibodeau (1993) "The Relationship Between Median and Constant Quality House Prices: Implications for Setting FHA Loan Limits." *Journal of the American Real Estate and Urban Economics Association*, 18: 323-334.

Hillier, Amy E., Dennis P. Culhane, Tony E. Smith, and C. Dana Tomlin (2003) "Predicting Housing Abandonment with the Philadelphia Neighborhood Information System," *Journal of Urban Affairs*, 25(1): 91-106.

Hoesli, Martin, Elion Jani and Andre Bender (2005) "Monte Carlo Simulations for Real Estate Valuation," International Center for Financial Asset Management and Engineering (FAME), Research Paper No. 148, June.

Hort, Katinka (2000) "Prices and Turnover in the Market for Owner-Occupied Homes." *Regional Science and Urban Economics*, 30: 99-119.

Ioannides, Yannis M. and Jeffrey E. Zabel (2004) "Interactions, Neighborhood Selection and Housing Demand," Working Paper, Tufts University, March 19.

Joint Center for Housing Studies of Harvard University (2003) *Measuring the Benefits of Home Remodeling*, Cambridge, MA: Harvard University.

Joint Center for Housing Studies of Harvard University (2005) "The State of the Nation's Housing: 2005," Harvard University.

Johnes, Geraint; Hyclak, Thomas (1999) "House Prices and Regional Labor Markets." *Annals of Regional Science*, 33(1): 33-49.

Jones, Charisse (2005) "Apartment Renters Feel Squeeze as Units Convert to Condos," *USA Today*, July 6.

Katz, Lawrence and Kenneth T. Rosen (1987) "The Interjurisdictional Effects of Growth Controls on Housing Prices," *Journal of Law and Economics*, 30: 149-160.

Kearl, James R. (1979) "Inflation, Mortgages and Housing," *J. of Political Economy*, 87: 1115-1138.

Kiel, Katherine A. (1995) "Measuring the Impact of the Discovery and Cleaning of Identified Hazardous Waste Sites on House Values," *Land Economics*, 74(4): 428-435.

Kiel, Katherine and Michael Williams (2005) "The Impact of Superfund Sites on Local Property Values: Are All Sites the Same?" Holy Cross Working Paper Series 05-05, March.

Kiel, Katherine A. and Jeffrey E. Zabel (1999) "The Accuracy of Owner-Provided House Values: The 1978-1991 American Housing Survey," *Real Estate Economics*, 27(2): 263-298.

Kone, D. Linda (2000) Land Development, 9th Ed., Washington, D.C.: Home Builder Press of The National Association of Home Builders.

Krainer, John (2003) "House Price Bubbles," Federal Reserve Board of San Francisco *Economic Letter*, March 7.

Krupnick, Alan (2002) "The Value of Reducing Risk of Death: A Policy Perspective," *Journal of Policy Analysis and Management*, 21(2): 275-282.

Landis, J.D. (1986) “Land Regulation and the Price of New Housing: Lessons from Three California Cities,” *APA Journal*, 52: 9-21.

Lerman, Donald L. and William J. Reeder (1987) “The Affordability of Adequate Housing,” *The Journal of the American Real Estate and Urban Economics Association*, 15(4): 389-404.

Levine, Ned (1999) “The Effects of Local Growth Controls on Regional Housing Production and Population Redistribution in California,” *Urban Studies*, 36:2047.

Linneman, P., A. Summers, N. Brooks and H. Buist (1990) “The State of Local Growth Management,” Working Paper No. 81, Wharton: Philadelphia, PA.

Lipman, Barbara J. (2002) “America's Working Families and the Housing Landscape: 1997-2001,” *New Century Housing*, 3(2).

Listokin, David, Elvin K. Wyly, Brian Schmitt and Ioan Voicu (2001) “The Potential and Limitations of Mortgage Innovation in Fostering Homeownership in the United States,” *Housing Policy Debate*, 12(3): 465-513.

Listokin, David, Elvin K. Wyly, Brian Schmitt and Ioan Voicu (2002) *The Potential and Limitations of Mortgage Innovation in Fostering Homeownership in the United States*, Washington, DC: Fannie Mae Foundation, June.

Lowry, I.S. (1960) “Filtering and Housing Standards,” *Land Economics*, 35: 362-370.

Luger, Michael I. and Kenneth Temkin (2000) *Red Tape and Housing Costs: How Regulation Affects New Residential Development,* New Brunswick, NJ: CUPR Press.

Malpezzi, Stephen (1996) “Housing Prices, Externalities, and Regulation in U.S. Metropolitan Areas.” *Journal of Housing Research*, 7(2): 143-83.

Malpezzi, Stephen (1996) “House Price Externalities, and Regulation in U.S. Metropolitan Areas,” *Journal of Housing Research,* 7: 209-241.

Malpezzi, Stephen (1999) “A Simple Error Correction Model of Housing Prices.” *Journal of Housing Economics*, 8: 27-62.

Malpezzi, Stephen, Gregory H. Chun and Richard K. Green (1998) “New Place-to-Place Housing Price Indexes for U.S. Metropolitan Areas, and Their Determinants,” *Real Estate Economics*, 26(2): 235-74.

Malpezzi, Stephen; Green, Richard K. (1996) “What’s Happened to the Bottom of the Housing Market?” *Urban Studies*, 33(10): 1807-1820.

Malpezzi, Stephen and Duncan Maclennan (2001) "The Long-Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdom," *Journal of Housing Economics*, 10: 278-306.

Malpezzi, Stephen and Stephen K. Mayo (1997) "Housing and Urban Development Indicators: A Good Idea Whose Time Has Returned." *Real Estate Economics*, 25(1): 1-12.

Malpezzi, Stephen, Larry Ozanne and Thomas Thibodeau (1987)" Microeconomic Estimates of Housing Depreciation," *Land Economics*, 63(4): 373-385.

Mankiw, N.G. and D.N. Weil (1989) "The Baby Boom, The Baby Bust, and the Housing Market," *Regional Science and Urban Economics*, 19: 235-258.

Masnick, George S. "A Demographer's Perspective on Housing Affordability in the United States at the End of the 20th Century." Report to the Millennial Housing Commission. December 2001.

Mayer, Christopher J. and Tsuriel C. Somerville (2000a) "Residential Construction: Using the Urban Growth Model to Estimate Housing Supply," *Journal of Urban Economics*, 48: 85-109.

Mayer, Christopher J. and Tsuriel C. Somerville (2000b) "Land Use Regulation and New Construction" *Regional Science and Urban Economics*, 30: 639-662.

Mayer, Christopher J.; Somerville, Tsuriel C. "Unifying Empirical and Theoretical Models of Housing Supply." Federal Reserve Bank of Boston Working Paper: 96/12.

Mayo, Stephen K. (1981) "Theory and Estimation in the Economics of Housing Demand," *J. of Urban Economics*, 10(January): 95-116.

McCloskey, Donald N. (1985) *The Applied Theory of Price*, New York: Macmillan.

McFadden, Daniel (1984) "Econometric Analysis of Qualitative Response Models," Ch. 24, 1395-1457 in Zvi Griliches and Michael D. Intrilligator, eds., *Handbook of Econometrics*, Vol. II, Amsterdam: North-Holland.

Meeks, C. (1993) "Price Elasticity of Demand for Manufactured Homes: 1961 to 1989," Mimeo, April 25.

Miles, Amy and Tim Bondelid (2004) *Estimation of National Economic Benefits Using the National Water Pollution Control Assessment Model to Evaluate Regulatory Options for the Construction and Land Development Industry*, Research Triangle Park, NC: RTI International.

Millennial Housing Commission. "Meeting Our Nation's Housing Challenges." A Report of the Bipartisan Millennial Housing Commission Appointed by the Congress of the United States. May 30, 2002.

Miller, Ron (1998) "Regional and Interregional Input-Output Analysis," Ch. 3 in Isard, Miller et al., *Methods of Interregional and Regional Analysis*, Ashgate, pp. 41-133.

Mills, E.S. and B.W. Hamilton (1994) *Urban Economics*, 5th Edition, New York: Harper Collins.

Morgan, W. Douglas and Andrew Belknap (1982) "The Determinants of Mobile Home Shipments: Time Series Evidence," *Business Economics*, May.

Murray, Michael P. (1983) "Subsidized and Unsubsidized Housing Starts: 1961-77." Review of Economics and Statistics, 65(3): 590-597.

Murray, Michael P. (1999) "Subsidized and Unsubsidized Housing Stocks 1935-1987: Crowding Out and Cointegration," *J. of Real Estate Finance and Economics*, 18(1): 107-124.

Muth, R.F. (1960) "The Demand for Non-Farm Housing," in *The Demand for Durable Goods* (Arnold Harberger, Ed.), Chicago: University of Chicago Press.

National Association of Home Builders (2001) "Housing's Impact on the Economy." Report to the Millennial Housing Commission, November.

National Association of Home Builders (1999) The Truth About Regulatory Barriers to Housing Affordability, NAHB.

Navrud, Stale and Richard C. Ready, eds. (2002) Valuing Cultural Heritage: Applying Environmental Valuation Techniques to Historic Buildings, Monuments and Artifacts, Cheltenham, UK: Edward Elgar.

Nelson, Kathryn P. (1994) "Whose Shortage of Affordable Housing?" *Housing Policy Debate*, 5(4): 401-442.

O'Flaherty, Brendan. (1996) *Making Room: The Economics of Homelessness*. (Cambridge, MA: Harvard University Press).

Olsen, E.O. (1969) "A Competitive Theory of the Housing Market," *American Economic Review*, 59(4): 612-622.

Olsen, E.O. (1987) "The Demand and Supply of Housing Services: A Critical Review of the Empirical Literature," in *Handbook of Regional and Urban Economics*, (E.S.Mills, Ed.), Vol. 2, Amsterdam: Elsevier.

Parsons, G.R. (1992) "The Effect of Coastal Land Use Restrictions on Housing Prices: A Repeat Sale Analysis," *Journal of Environmental Economics and Management*, 22: 25-37.

Poterba, James M. "House Price Dynamics: The Role of Tax Policy and Demography." *Brookings Papers on Economic Activity* v0, n2 (1991): 143-83.

Poterba, James M. (1992) "Taxation and Housing: Old Questions, New Answers," *American Economic Review*, 82: 237-242.

Pines, D. and Elia Werczberger (1982) "A Linear Programming Model of the Urban Housing and Land Markets: Static and Dynamic Aspects," *Regional Science and Urban Economics*, 12: 211-233.

Quigley, John M. (1979) "What Have We Learned About Urban Housing Markets?" in *Current Issues in Urban Economics*, ed. Peter Mieszkowski and Mahlon Strazheim, pp. 391-429. Baltimore: Johns Hopkins University Press.

Quigley, John M. and Steven Raphael (2003) "Is Housing Unaffordable? Why Isn't It More Affordable," Institute of Business and Economic Research, Working Paper No. W03-002, September.

Quigley, John M. and Aaron Swoboda (2004) "The Economic Impacts of Critical Habitat Designation: A General Equilibrium Analysis," UC Berkeley Working Paper, September.

Rappaport, B.A. and T.A. Cole (2000) *1997 Economic Census-Construction Sector Special Study: Housing Starts Statistics – A Profile of the Homebuilding Industry*. U.S. Census Bureau, July.

Reade, Julia (2001) "Remodeling Spending in Major Metropolitan Areas," Joint Center for Housing Studies of Harvard University, N01-4, September.

Redfearn, Christopher. (2003) "Think Globally, Aggregate Locally: Index Consistency in the Presence of Assymetric Appreciation." Paper given at the AREUEA Conference, January.

Rodda, David T., Ken Lam and Andrew Youn (2004) "Stochastic Modeling of Federal Housing Administration Home Equity Conversion Mortgages with Low-Cost Refinancing," *Real Estate Economics*, 32(4): 589-617.

Roeger, Werner (1995) "Can Imperfect Competition Explain the Difference Between Primal and Dual Productivity Measures? Estimates for U.S. Manufacturing," *Journal of Political Economy*, 103: 316-330.

Rogers, Molly and Roger Blatt (2003) "Economic Impact of Affordable Housing Development," The Association of Oregon Community Development Organizations, April.

Rosen, Sherwin (1974) "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy*, 82: 35-55.

Rosenthal, Stuart S. (1999) "Residential Buildings and the Cost of Construction: New Evidence on the Efficiency of the Housing Market," *Review of Economics and Statistics*, 81: 288-302.

Rothenberg, Jerome, George Galster, Richard V. Butler, and John K. Pitkin (1991) *The Maze of Urban Housing Markets: Theory, Evidence and Policy*. Chicago: University of Chicago Press.

Rothenberg, Jerome, George C. Galster, Richard V. Butler and John R. Pitkin (1991) *The Maze of Urban Housing Markets: Theory, Evidence, and Policy*, Chicago: The University of Chicago Press.

Savage, Howard A. (1999) *Who Can Afford to Buy a House in 1995?* Washington, D.C.: U.S. Census Bureau. Supplemental material is available online at: (www.census.gov/hhes/www/housing/hsgaffrd/afford95/aff95src.html)

Savage, Howard A. and Peter J. Fronczek (1993) *Who Can Afford to Buy a House in 1991?* Current Housing Reports H121/99-1. Washington, DC: U.S. Department of Commerce, Bureau of the Census.

Scheutz, Mary Kay and Sammis White (1992) "Identifying and Mitigating Local Regulatory Barriers to Affordable Housing in Waukesha County, Wisconsin," Urban Research Center, University of Wisconsin-Milwaukee.

Schill, Michael H. (2001) "Regulatory Barriers to Housing Development in the United States." Report to the Millennial Housing Commission. November 11, 2001.

Schwartz, Amy Ellen, Ingrid Gould Ellen, Ioan Voicu, Michael H. Schill (2003) "Estimating the External Effects of Subsidized Housing Investment on Property Values," prepared for the Federal Reserve System's Conference on Sustainable Community Development, March 27-28.

Segal, David and Philip Srinivasan (1985) "The Impact of Suburban Growth Restrictions on U.S. Housing Price Inflation, 1975-1978," *Urban Geography*, 6(1): 14-26.

Seslen, Tracey, William C. Wheaton, and Henry O. Pollakowski (2005) "The Investment Performance of Housing and 'Hedonic' Spatial Equilibrium," mimeo, August.

Shlay, Anne B. and Gordon Whitman (2004) Research for Democracy: Linking Community Organizing and Research to Leverage Blight Policy, University of Toledo COMM-ORG working paper. (comm-org.wisc.edu/papers2004/shlay/shlay.htm)

Sinai, Todd and Nicholas S. Souleles (2003) "Owner-Occupied Housing as a Hedge Against Rent Risk," NBER Working Paper 9462, January.

Smith, V.K. and J. Huang (1995) "Can Markets Value Air Quality? A Meta-Analysis of Hedonic Property Value Models," *Journal of Political Economy* 103(11): 209-227.

Somerville, Tsuriel.; Holmes, Cynthia (2001) "Dynamics of the Affordable Housing Stock: Microdata Analysis of Filtering." *Journal of Housing Research*, 12: 115-40.

Sonis, Michael and Geoffrey J.D. Hewings (1998) "Economic Complexity as Network Complication: Multiregional Input-Output Structural Path Analysis," *Annals of Regional Science*, 3: 407-436.

Stevens, T.H., R. Belkner, D. Dennis, D. Kittredge and C. Willis (2000) "Comparison of Contingent Valuation and Conjoint Analysis in Ecosystem Management," *Ecological Economics*, 32: 63-74.

Stone, M.E. (1993) *Shelter Poverty: New Ideas on Housing Affordability*, Temple University Press: Philadelphia, PA.

Thaler, Richard (2003) *Advances in Behavioral Finance II*, (New York: Russell Sage).

Thibodeau, Thomas G. (1995) "House Price Indices from the 1984-1992 MSA American Housing Surveys," *Journal of Housing Research*, 6(3): 439-481.

Tiwari, Piyush (2000) "Housing Demand in Tokyo," International Real Estate Review, 3(1): 65-92.

Tobin, J. (1969) "A General Equilibrium Approach to Monetary Theory," *Journal of Money, Credit, and Banking*, 1:15-29.

Topel, R. and S. Rosen (1988) "Housing Investment in the United States," *Journal of Political Economy*, 96: 718-740.

U.S. Department of Agriculture (2000) 1997 Natural Resources Inventory Summary Report, Table 8: Changes in Land Cover/Use Between 1992 and 1997 (www.nhq.nrcs.usda.gov/NRI/1997/summary_report/original/table8.html)

U.S. Department of Housing and Urban Development (1993) "Manufactured Home Construction and Safety Standards on Wind Standards: Regulatory Impact Analysis," appeared in 58 *Federal Register* 19536 (April 14) RIN: 2502-AF91.

U.S. Department of Housing and Urban Development (2001) "A Community Guide to Factory-Built Housing," prepared by Steven Winter Associates, Inc. for the Office of Policy Development and Research, September.

U.S. Department of Housing and Urban Development (2004) "Strategies for Reducing Chronic Street Homelessness," Office of Policy Development and Research, January.

U.S. Environmental Protection Agency (1997) The Benefits and Costs of the Clean Air Act: 1970-1990, prepared by the Office of Air and Radiation and the Office of Policy, Planning and Evaluation. EPA/410/R-97/002.

U.S. Environmental Protection Agency (1999a) "Handbook for Non-Cancer Valuation," Draft prepared by Industrial Economics, Inc. for the Social Policy Council, Social Science Discussion Group.

U.S. Environmental Protection Agency (1999b) *Economic Analysis of the Final Phase II Stormwater Rule*, Washington, D.C.:U.S. Environmental Protection Agency, Office of Wastewater Management.

U.S. Environmental Protection Agency (2000a) "Guidelines for Preparing Economic Analyses," Washington, D.C., September. EPA/240/R-00/003.

U.S. Environmental Protection Agency (2000b) "Cost of Illness Handbook," Office of Toxic Substances, Washington, D.C.

U.S. Environmental Protection Agency (2002) "Economic Analysis of Proposed Effluent Guidelines and Standards for the Construction and Development Category," Office of Water, Washington, D.C., May. EPA/821/R-02/008.

U.S. Environmental Protection Agency (2004) "Economic Analysis for Final Action for Effluent Guidelines and Standards for the Construction and Development Category," Office of Water, Washington, D.C., March. EPA/821/B-04/002.

Viscusi, W. Kip (1992) *Fatal Tradeoffs: Public and Private Responsibilities for Risk*, New York: Oxford University Press.

Viscusi, W. Kip (1993) "The Value of Risks to Life and Health," *Journal of Economic Literature*, 31(4): 1912-1946.

Viscusi, W. Kip, John M. Vernon and Joseph E. Harrington, Jr. (2000) *Economics of Regulation and Antitrust, 3rd Edition*, Cambridge, MA: The MIT Press.

Walters, Jeffrey L. (1980) "Economic Benefit-Cost and Risk Analysis of the Results of Mobile Home Research Wind Safety Analysis," U.S. Dept. of HUD, April (HUD-0001602).

U. S. Department of Housing and Urban Development (1994) *Regulatory Impact Analysis of Improved Wind Standards for Manufactured Housing*, Washington, DC: U.S. Government Printing Office.

Weicher, John C. and Thomas Thibodeau (1988) "Filtering and Housing Markets: An Empirical Analysis," *J. of Urban Economics*, 23: 21-40.

Zorn, Peter (1989) "Mobility-Tenure Decisions and Financial Credit: Do Mortgage Qualification Requirements Constrain Homeownership?" *AREUEA Journal*. 17(1): 1-16.

Appendix A: Housing Analysis Data Sources

In conducting an impact analysis of regulation on affordable housing, it is often necessary to access the best housing data available. The federal government has collected much of this information in the form of survey data, such as the Census and the American Housing Survey (AHS). Every survey has limitations, either in sample size, scope of questions, frequency of collection, geographical coverage, etc. Empirical analysis must choose from the most appropriate sources, which depend on the particular regulation being studied. For those less familiar with analysis of housing markets, the data sources described here provide a good starting point.

The following criteria were used in selecting data sources for inclusion:

- Major source of household micro data,
- Summary information of average household or unit characteristics by location,
- Useful parameters or time series for modeling supply and demand, and
- Preference for publicly available data (ideally free and downloadable).

This listing starts with the major household surveys that provide representative samples for the entire country on a regular basis. When used with a behavioral model, these surveys can provide the data for benchmark relationships as well as responsiveness to past changes. Individual unit or household data can also be summarized in many ways depending on the size and place. The surveys or summaries can measure average relationships over time, which are good for projecting trends in housing supply and demand. Finally, the list features publicly available data, which can be downloaded from the web for free or nominal cost. In most cases, links are included to help the reader reach the data quickly, though a search engine may still be necessary when links become obsolete.

The data are organized under the following seven broad topics:

- General surveys and compilations
- Housing Supply
- Housing Demand
- House Prices
- Interest Rates
- Housing Finance
- Regulation Measures

Although housing statistics are organized in many forms, in fact most of the data originally come from either the American Housing Survey or the Census. Therefore, the list starts with these sources and compilations of that data, such as the Statistical Abstracts. Census also conducts a number of surveys on housing supply, including permits, new construction, manufactured housing and remodeling. Cost of construction data become highly specialized by material and location, which is supplied by private vendors at moderate cost. Housing demand is driven by population and income. Beyond the decennial Census, there are more frequent, but much smaller, surveys such as the Current Population Survey and Consumer Expenditure Survey for tracking information on demographics, employment, income and prices. This section also includes references to county and metro data along with references to assisted housing data. House prices bring together the impact of supply and demand. The section on house prices gives information on repeat sales, house price indices, new and existing home sales price data, hedonic price indexes and fair market rents. Interest rates are another critical ingredient in the house market and three valuable sources are cited: St. Louis Federal Reserve, the Monthly Interest Rate Survey and Freddie Mac. Beyond interest rates, housing finance data are available from Home Mortgage Disclosure Act (HMDA) data, Residential Finance Data and other surveys. The final section is on regulation measures. New regulations do not occur in a vacuum, but rather in the context of an existing, often complex, set of regulations. Although the measurement of regulations through indexes is an undeveloped area, the list includes a number of sources that give the fledgling state of the art.

Two good starting points for the reader and, indeed, the source for much of the information in this section are the summary publications:

U.S. Department of Housing and Urban Development (2002) *Guide to PD&R Data Sets*, Office of Policy Development and Research, 30 pages. Download free from: http://www.huduser.org/datasets/pdrdatas.html.

Patrick A. Simmons, (2001) *Housing Statistics of the United States*, Washington, D.C.: Bernan Press; 558 pages including two excellent appendices describing the data and sources.

A.1 General Housing Surveys

American Housing Survey (AHS), 1973-2003

Census website: http://www.census.gov/hhes/www/ahs.html
HUD website: http://www.huduser.org/datasets/ahs.html
Descriptive booklet: http://www.census.gov/prod/2004pubs/ahsr04-1.pdf

The AHS is divided into two major components, the national sample and the metropolitan sample. The national sample is a representative sample of 60,700 housing units from 878 counties covering all 50 states and the District of Columbia. The national survey is done every other year by the Census for HUD and the current sample was begun in 1985. The metropolitan survey covers 47 metropolitan areas on a rotating panel basis such that most MSAs are sampled every 4-6 years with about 4,800 units per metro area.

An important aspect of the AHS is that the survey follows units rather than households and those units can be linked over time. New units are added each survey to track new construction and existing units fall out of the sample through demolition or conversion to non-residential uses. Recent movers and new homebuyers can be identified as well as all types of residential units, apartments, single-family homes, manufactured houses and vacant units. House prices are based on the respondent's estimate.

The AHS provides much more depth than the Census by collecting information on unit quality, neighborhood quality, equipment, fuels, size of housing unit as well as demographics, family composition and income. A major use of the data is to measure worst case needs in terms of structural adequacy, overcrowding and affordability. The current version of the codebook is extremely large (1200 pages), but it is well-organized. Both the codebook and data (since the 1995 survey) can be downloaded. Printed summaries of the data are also available on the web. The current set of variables has been stable since 1997. All records are weighted and most missing data are allocated with flags to indicate allocations.

One significant drawback for small area research is that MSAs must be larger than 100,000 for identification. Therefore, there is no information on county or census tract, but groups of tracts are identified as zones of at least 100,000 persons. Center city, suburbs and non-metro areas are designated.

Census of Housing, every 10 years, tabulations (SF3) and microdata (PUMS)
Main website: http://www.census.gov/
Download data through American FactFinder:
(factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_lang=en&_ts=)

The Census does not have the rich set of variables available in the AHS, but it is a much larger sample of the long forms filled out by 1 in 7 households. Tabulations of the data (frequency counts by characteristic) are available for an amazing array of geographies down to the census tract and even block group level. For detailed, local analysis, the census is the primary source of data on occupied units, type of tenure, vacancy status, age, race and income of householder, unit size, units in structure, year built, number of vehicles, type of heating fuel, type of kitchen facilities, rent, mortgage payments and house value.

The Public Use Microdata Sample provides records at both the household level and the person level. Confidentiality protections reduce the geographical information available in PUMS (area larger than 100,000), but the data can be organized in many other configurations not included in official tabulations. The Minnesota Population Center (www.ipums.org) has created data extracting software that facilitate longitudinal comparisons going back to 1850. Changes in survey variables and the massive amount of data can make longitudinal analysis a massive undertaking, but ipums has made it much easier and still free.

Steven Ruggles, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King, and Chad Ronnander. *Integrated Public Use*

Microdata Series: Version 3.0 [Machine-readable database]. Minneapolis, MN: Minnesota Population Center [producer and distributor], 2004.

American Community Survey (ACS)

Main website: http://www.census.gov/acs/www/index.html

American Fact Finder site listing of available data sets by survey year: http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_lang=en&_ts=122566718473

The ACS is really an annual version of the decennial census. The major drawback of the census was that the data were quite outdated for many purposes by the end of a decade. The ACS is a "rolling" survey in that it will be conducted every year and replace the long form in 2010. The questions in the ACS are very similar to the long form questions except the frame of reference is the previous 12 months. Another change is that "current residence" (place where householder spent the last 2 months) replaces "usual residence" (place where householder spend most of the time). This change in wording is expected to increase the representation of seasonal properties and reduce the recorded vacancy rate (as much as 1.2 percentage points). Census questions on same residence five years ago have been adjusted to 1 year ago.

Given that the data will be collected steadily over time (250,000 forms sent each month), it will take longer to acquire enough sample for reliable estimates. For areas with populations over 65,000, the annual estimates are projected to begin in 2004. For medium-sized areas, populations between 20,000 and 65,000, the annual data will begin in 2006 and small-sized areas will have to wait until 2008. Testing of the ACS started as part of the preparation for the 2000 Census and a Census 2000 Supplementary Survey (C2SS) was done in parallel with the decennial Census. Data for 2000 to 2003 are already available on the web from American FactFinder. By 2008, the Census Bureau expects to release a "research file" of annual ACS data for areas down to Census tract. This "research file" will provide the most complete and current information to planners, but the models using this data will have to adjust for thin samples taken over an extended period of time. For smaller areas, the reduction in sample size is between 0.75 and 0.50, whereas for larger population areas the reduction in sample size is to down to 0.14. In general, the smaller samples mean less precise estimates. ACS standard errors will be about 2.5 times larger than long form standard errors for single year estimates. The most precise version with 5-year moving average is expected to have ACS standard errors 1.33 times the long form standard errors.

Statistical Abstract of the United States (www.census.gov/statab/www/)

Although it is possible to download, most people will prefer to reference only select tables from the massive Statistical Abstract or buy the printed version. Either way, the Statistical Abstract is an excellent summary of Census data as well as other Federal agencies and non-government data.

Several other handbooks on statistics from FedStats (www.fedstats.gov/fast.html):

- State and Metropolitan Area Data Book
- Health, United States
- Department of Education Statistics, 2002
- Report on American Workforce, 2001
- National Transportation Statistics, 2003

U.S. Housing Market Conditions (www.huduser.org/periodicals/ushmc.html)
This quarterly publication is produced by HUD with commentary, a standard set of tables at the national level and overviews of economic and housing market trends for ten geographical regions. Historical data at the national level are provided on permits, starts, completions, manufactured housing placements, single-family home sales (new and existing), house prices, affordability index, interest rates, mortgage insurance activity, delinquencies and foreclosures, vacancy rates and homeownership rates.

A.2 Housing Supply

Building Permits Survey – Census Survey of Construction (C40)
(censtats.census.gov/bldg/bldgprmt.shtml)
The Building Permits Survey is a good source of data on new housing supply, yet the census website is mostly designed for printing out a table for a single county or place. An alternative source better designed for research is from the Real Estate Center at Texas A&M University (recenter.tamu.edu/data/databp.html). The data are provided at the national, state and metro level for both residential and nonresidential activity. The residential data are further subdivided by new single-family, new multifamily and improvements. This site also includes data on employment, population and mortgage rates.

Survey of Construction – starts, completions, sales (C20, C25)
(www.census.gov/const/www/)

Value of New Construction Put in Place – Census (C30)
(www.census.gov/const/www/c30index.html)

Census of Construction Industries (CCI), 1997, 2002
CCI occurs every 5 years with surveys at employer establishments primarily engaged in construction according to the North American Industry Classification System. The companies are divided into subgroups according to with or without payroll and then further divided by 4-digit or 6-digit industry code.

Manufactured Housing (MH) (www.census.gov/const/www/mhsindex.html)
This portion of the Census website on construction data provides information on shipments, placements, dealers' inventory and average sales price.

Construction Cost Index

Construction costs can vary widely according to type of structure design, materials, local labor costs as well as local land use restrictions, permits, fees and inspections. On the engineering side, the following books contain estimated construction cost data (for purchase):

Boeckh Construction Costs Index (Marshall & Swift/Boeckh) (www.msbinfo.com/newsroom/2_newsroom.asp?story=61&news_year=2004)

RS Means Building Construction Cost books by type of construction and metro area (www.rsmeans.com/)

Saylor Publications Residential Construction Costs (books or CD) (www.saylor.com/rcc2005.htm)

The Business of Building (NAHB) contains business statistics such as financial ratios, profit margins, and salary ranges for officers, managers and superintendents for builders of various sizes including the mid-sized custom homebuilder. (www.builderbooks.com)

Remodeling Online (NAHB) with estimates for 35 US metro areas (www.remodeling.hw.net/)

Residential Energy Consumption Survey (RECS) by the Energy Information Administration (EIA) of the U.S. Department of Energy; most recently done in 2001; see http://www.eia.doe.gov/emeu/recs/contents.html.
This survey measures the energy consumption for many types of households, structures, type of fuel and places. The survey covers a nationally representative sample of 4,822 households with separate estimates for four Census regions, nine Census divisions and the four most populous states (California, Florida, New York and Texas). Information in this survey would be particularly useful for costing regulations affecting energy efficiency and usage.

A.3 Housing Demand

Housing demand is usually benchmarked according to either the AHS or decennial Census, which have reliable measures of population, income and tenure status. However, if it were important to measure more frequent changes or more specific spending patterns, there are useful surveys by the Department of Labor's Bureau of Labor Statistics (BLS) and the Department of Commerce's Bureau of Economic Analysis (BEA) that can fill in some gaps.

Current Population Survey (www.bls.census.gov/cps/cpsmain.htm)

The Current Population Survey (CPS) is a monthly survey of about 50,000 households that provides information on labor force characteristics, such as employment, unemployment, earnings, hours of work, previous work experience, occupation, industry, unionization and income. The survey also collects demographic information on age, sex, race, marital status and educational attainment. The sample is selected from the civilian non-institutional population and the household respondent answers for each member of the household 15 years and older. Studies of labor force participation, unemployment insurance and poverty typically use CPS data, particularly the outgoing rotations of the March Income Supplement.

Consumer Expenditure Survey (www.bls.gov/cex/home.htm)
The Consumer Expenditure Survey (CES) is a combination of quarterly interview survey and diary survey that collects information about the buying habits of American consumers (families and individuals). The data include expenditures and income before taxes. Annual tables are available on the web for 1984 to 2003 or the micro level data can be downloaded. The current survey has a sample of approximately 7,500 households. The interview survey collects information on out-of-pocket expenditures for housing, apparel, transportation, health care, insurance and entertainment. One common use of the CES is for residential improvements and repairs.

Consumer Price Index (www.bls.gov/data/home.htm)
The Consumer Price Index (CPI) is based on a survey of 23,000 retail and service establishments across 87 MSAs and rent data from 50,000 landlords or tenants. The survey produces monthly data on changes in prices paid by urban consumers for a representative basket of goods and services. The weights for each item in the basket are based on the CES. Indexes are available for two population subgroups. The CPI-U for all urban consumers covers 87 percent of the population and CPI-W is for urban wage earners and clerical workers covering 32 percent of the population. Indexes are also subdivided by major groups of consumer expenditures: food and beverages, housing, apparel, transportation, medical care, recreation, education and communications, and other goods and services.

Besides adjusting income and transfer payments, the CPI is most commonly used as a measure of inflation. The index of general price changes can be used to deflate nominal time series so that the resulting series is in dollars of constant buying power. Given that housing is a large portion of a consumer's basket of monthly purchases, housing economists worry that deflating house prices with CPI-U will take out of the deflated series the house prices they are trying to measure. A common solution is to use the CPI less shelter price index to deflate housing prices. Sub-indices for rents, homeowner's costs, maintenance and repairs, construction materials and energy costs can also be useful for tracking changes in housing costs at least for large metro areas or broader regions. Selected series can be downloaded in spreadsheet form via LabStat on the BLS website.

Personal Consumption Expenditures Price Index (www.bea.doc.gov/beahome.html)
The Personal Consumption Expenditures (PCE) price index by the Bureau of Economic Analysis (BEA) is an alternative to the CPI price index. The BLS constructs the CPI as a fixed-weight average of prices for a basket of goods and services based on the Laspeyres formula. The basket had been changed about once every 10 years up until 2002 when BLS began revising the basket every 2 years. The BEA constructs the PCE price index with a

chain-weight Fisher Ideal formula. The index is an average of two fixed-weight measures with one measure using the past year's composition of purchases and the other using the current year's composition of purchases. By averaging the two measures, the PCE price index allows for shifts in consumption baskets. Usually the CPI and PCE price indices track very closely, but deviations can occur. For much more detail, see Todd E. Clark, "A Comparison of the CPI and the PCE Price Index," at www.kc.frb.org.

Survey of Income and Program Participation (www.sipp.census.gov/sipp/)
SIPP provides comprehensive information about the income and program participation of individuals and households in the United States. The survey collects data on income, employment, debts, assets, liabilities and government transfers. However, there is little information on the unit structure or quality as in the AHS. The SIPP information on income and wealth is useful for determining the demand for and capacity to pay for housing. Thus, it can be very helpful in creating affordability measures (see Savage and Fronczek, 1993; Savage, 1999; Listokin et al., 2002).

The survey design is a continuous series of national panels, with sample size ranging from approximately 14,000 to 36,700 interviewed households. The duration of each panel ranges from 2 1/2 years to 4 years. For the 1984-1993 panels, a panel of households was introduced each year in February. A 4-year panel was introduced in April 1996. A 2000 panel was introduced in February 2000 for 2 waves. A 3-year 2001 panel was introduced in February 2001. The panel nature of the data makes it possible to track transitions of households between renter and owner status.

Regional Economic Information System (www.bea.doc.gov/bea/regional/data.htm)
The BEA also collects valuable information on wages, employment by industry and transfer payments as part of the Regional Economic Information System (REIS). The data are collected from 3,110 counties or county equivalents in 335 metropolitan areas. This is particularly handy for annual estimates at the county level, which can be aggregated for a more consistent measure of MSA economic activity from 1969. The BEA also defines economic areas, which are logical economic groupings, but often do not mesh well with data from other sources.

County Business Patterns (www.census.gov/epcd/cbp/view/cbpview.html)
Census also provides employment and economic information by industry at the county level. The data series have been published annually since 1964 with industries categorized by the Standard Industrial Classification (SIC) up to 1997 and the North American Industry Classification System (NAICS) thereafter.

State of the Cities Data (socds.huduser.org/index.html)
HUD has collected and posted on HUD User a great deal of data by city or urban area. The data are particularly good for comparative analysis of suburbs vs. center city. Conveniently,

data are collected from the decennial census, unemployment rates, employment and pay (County Business Patterns), FBI crime data (socds.huduser.org/FBI/FBI_Home.htm), building permits, city and suburban government finances and Comprehensive Housing Affordability Strategy (CHAS) data.

Low-Income Housing Tax Credits Database (www.huduser.org/datasets/lihtc.html)
This database contains project level information on nearly 20,700 tax credit projects, which is the main method for creating subsidized affordable housing. It may be useful in a study of the regulatory impact on affordable housing to locate the number of units in a particular market. An average of 1,300 projects or 90,000 units were placed in service from 1995 to 2001. The database contains variables with project address, number of units and low-income units, number of bedrooms, year the credit was allocated, year the project was placed in service, whether the project was new construction or rehab, type of credit and other sources of project financing. Moreover, the data have been geocoded to facilitate examination of spatial relationships.

Publicly Assisted Housing (www.huduser.org/datasets/assthsg.html)
Although relatively few public housing units are being built now, there is a large stock of public housing that is affordable to low-income households. An analysis of impacts on affordable housing would be incomplete without consideration of the public housing units. The HUD database, A Picture of Subsidized Households in 1998 (also known as PICTURES data) provides somewhat dated, but still useful information on the 5 million subsidized households in the United States.

A.4 House Prices

Office of Federal Housing Enterprises Oversight (OFHEO) Repeat Sales Housing Price Index; http://www.ofheo.gov/HPI.asp
Each year millions of mortgages are sold to either Fannie Mae or Freddie Mac, and the mortgage packet includes information on the value of the property. OFHEO, the regulator for Fannie Mae and Freddie Mac, has pooled this data together and developed a house price index based on repeat sales. The index measures the gain in value from one year to the next based on sales prices. Except for cases of remodeling, the change in value between sales should be a pure price effect. Indices are created down to the metro level. Unfortunately, remodeling is quite common, so it is inevitable that some of the price gains are due to quality improvements, but it is still better than transactions data, which simply averages all the sales values in a given market. The OFHEO house price index is widely considered the most reliable house price index and is commonly used in conjunction with the decennial census, which provides a cross-section of house values. The metropolitan index is used to inflate or deflate the average house values in-between the census years.

NAR Existing Home Sales Survey
(www.realtor.org/research.nsf/pages/EHSPage?OpenDocument)

Despite the better control for unit quality, the National Association of Realtors (NAR) data on house prices are frequently quoted in the press. It can be useful in research as well, when the urban area is too small to have an OFHEO index or when the timeliness of data is particularly important. The other advantage of the NAR Existing Home Sales Survey data is that it is probably a more comprehensive measure of the market (all units in the multiple listing service). The NAR also has a new homes survey and an affordability index. The affordability index is based on the ratio of median family income to the income needed to purchase the median-priced home using current interest rates and mortgage terms. Unfortunately, the NAR data for historical series or local markets are not available for free.

Hedonic housing price indexes by MSA
Malpezzi, Chun and Green (1998) have published an alternative house price index using hedonic regression to control for quality differences. The index values are at the MSA level using census (PUMS) data from 1980 and 1990. Their tables also include a rent index for the same set of MSAs. Conveniently, these index values and a lot of other useful MSA-level data have been posted by Malpezzi on the Wisconsin website. See Malpezzi, Stephen, G. Chun and R. Green (1998) "New Place-to-Place Housing Price Indexes for U.S. Metropolitan Areas and Their Determinants," *Real Estate Economics* 26(2): 235-274.
(www.bus.wisc.edu/realestate/resources/resdownl.asp)

HUD Fair Market Rents (www.huduser.org/datasets/fmr.html)
Each year HUD posts the Fair Market Rent (FMR) for 354 metro areas and 2,350 non-metropolitan county areas in the United States. The FMR values are most important to Section 8 voucher holders because they must find a unit renting below the FMR (or pay the difference). FMRs are also important to landlords participating in the Section 8 voucher program because those FMR values determine the reimbursement rate to participating landlords. The FMR values are set at the 40th percentile of the rent distribution, though they can be higher in cities where the voucher holders are having difficulty finding a landlord who will accept them. The 40th percentile rent is drawn from the distribution of rents of all units occupied by recent movers (renter households who moved to their present residence within the past 15 months). Public housing units and units less than 2 years old are excluded. FMRs are benchmarked to census and AHS, supplemented by CPI and a random-digit dialing survey.

Median Tax Rates (www.bus.wisc.edu/realestate/resources/resdownl.asp)
Another useful series available on the Wisconsin website is the median tax rates as a percentage of house value. The user cost of capital is adjusted by the tax rate.

A.5 Interest Rates

After house prices, interest rates are probably the most important "price" that balances the supply and demand in the housing market.

FRED II data from the St. Louis Federal Reserve (research.stlouisfed.org/fred2/)
There are many sources of interest rates, but FRED II seems to be the most convenient and comprehensive for historical series. The interest rates are provided for many different maturities of securities (mostly government or agency debt) as well as different frequencies (weekly, monthly, quarterly). The FRED data keep expanding. Currently, the database has over 3000 U.S. economic time series with macroeconomic data on banking, business, consumer prices, employment and population, gross domestic products, monetary aggregates, producer price indexes, etc.

Monthly Interest Rate Survey (MIRS) (www.fhfb.gov/MIRS/MIRS.htm)
The Federal Housing Finance Board collects interest rate data from participating financial institutions. There is some concern that changes in the financial marketplace have made the MIRS survey less representative, though the market is highly competitive so that the MIRS results are probably still useful. No FHA or VA loan data are included.

Freddie Mac Mortgage Interest Rate Data (www.freddiemac.com)
Freddie Mac regularly surveys financial institutions to get average mortgage interest rates. This may be the most accurate source of mortgage interest data. It is widely shared and used in market modeling.

A.6 Housing Finance

Beyond mortgage interest rates, there is a great deal of information about mortgages and the flow of credit has a large impact on both sides of the housing market (supply and demand).

Home Mortgage Disclosure Act (HMDA) data (www.ffiec.gov/hmda/default.htm)
The Federal Financial Institutions Examination Council collects mortgage information from medium and large financial institutions. These data are used for regulatory exams on mortgage discrimination. It includes both acceptances and rejections. There were approximately 42 million loan records reported for 2003 by 8,121 financial institutions (banks, savings associations, credit unions and other mortgage lending institutions). HMDA data are also quite useful as a measure of the market, particularly for low-income borrowers because the income is reported as well as the census tract of the property. A major drawback of the HMDA data is the lack of house value information (no LTV) or the credit score, which are critical measures of risk.

Residential Finance Survey (RFS) 2001 (www.huduser.org/datasets/rfs.html)
The RFS is a HUD survey with data collected by Census about the financing of non-farm, residential properties. The purpose of the survey is to measure the levels of residential mortgage debt to determine whether sufficient credit is available to the mortgage markets. The survey is actually part of the decennial census (last done in 1991) and the latest sample contains 68,000 properties. The sample is stratified to over-sample large properties, particularly multifamily properties. Both property owners and mortgage lenders are

interviewed resulting in more accurate information. Results are reported for 4 Census regions and a few large states.

Survey of Consumer Finances (www.federalreserve.gov/pubs/oss/oss2/scfindex.html)
The Survey of Consumer Finances (SCF) is a triennial survey of assets and liabilities of U.S. families. The survey includes about 4,500 families from every income level. Though a useful cross-section, the sample is too small for much geographical subdivision.

Property Owners and Managers Survey (POMS)
(www.census.gov/hhes/www/housing/poms/poms.html)
POMS is the best source of financial data from the owners of rental housing. Rental properties are a major source of affordable housing, so the survey asks a range of financial questions of property owners or on-site supervisors. The sample includes about 16,300 housing units based on the 1993 AHS national sample. The mailed questionnaire asks for information on maintenance, management practices, tenant policies, financial aspects of rental property ownership, and owner characteristics. Unfortunately, missing data have undercut the usefulness of this data set.

The State of the Nation's Housing – Harvard University Joint Center for Housing Studies
(www.jchs.harvard.edu/publications/markets/son2004.pdf)
This annual report provides topical commentary and analysis of current housing markets as well as a standard set of time series data.

A.7 Regulation Measures

The following list contains most of the known indexes of regulatory measures aggregated to the MSA level. It is difficult to capture the many dimensions of regulation in a single index value, and yet for analysis purposes it is also difficult to include many highly correlated dimensions. Therefore, economists will continue to look for ways to measure the degree of regulation as it would affect the supply of housing, particularly affordable housing. For the purposes of regulatory impact analysis, the degree of regulation may affect how a local market responds to a new regulation. The differences in response between markets may be due to the existing layers of regulation as much as the new regulation itself. Therefore, it may be necessary to consider the existing regulations in predicting the impact of new regulations.

Much of the information in this section comes from Saks, Raven E., 2004, "Job Creation and Housing Construction: Constraints on Employment Growth in Metropolitan Areas," Joint Center for Housing Studies, Working Paper Series, W04-10, December 2004.

Wharton Urban Decentralization Project

Linneman, Peter, Anita Summers, Nancy Brooks, and Henry Buist, 1990 "The State of Local Growth Management," Wharton Real Estate Center Working Paper 81.

Regional Council of Governments

Segal, David and Philip Srinivasan, 1985 "The Impact of Suburban Growth Restrictions on U.S. Housing Price Inflation, 1975-1978," *Urban Geography* 6(1):1-26.

International City Management Association

Fiscal Austerity and Urban Innovation

Clark, Terry Nichols and Edward G. Goetz, 1994 "The Antigrowth Machine," in *Urban Innovation: Creative Strategies for Turbulent Times*, edited by Terry Nichols Clark. Thousand Oaks, CA: Sage Publications.

National Register of Historic Places (www.cr.nps.gov/nr/)

American Institute of Planners, 1976, *Survey of State Land Use Planning Activity*, Washington, D.C.: Department of Housing and Urban Development.

Jud, G. Donald and Daniel T. Winkler, 2002 "The Dynamics of Metropolitan Housing Prices," *Journal of Real Estate Research* 23 (Jan-April): 29-45.

Hwang, Min and John M. Quigley (2004) "Economic Fundamentals in Local Housing Markets: Evidence from U.S. Metropolitan Regions," Fisher Center for Real Estate and Urban Economics, Institute of Business and Economic Research, Working Paper W03-005, February.

Malpezzi, Stephen (1996) "Housing Prices, Externalities, and Regulation in the U.S. Metropolitan Areas," *Journal of Housing Research*, 7, 209-241.

Appendix B: Quantitative Analysis of Uncertainty

One aspect of subdividing markets is the increase in uncertainty or volatility in the elasticity estimates. Over broad markets at the regional or national level, the local variation tends to average out. Even at the national level, however, there is uncertainty, especially over time. Ideally, a housing impact analysis in concert with an RIA would estimate a probability distribution of outcomes. For each economic outcome, there would be a probability of that outcome. The expected value outcome, then, is the sum of each projected outcome multiplied by its predicted probability. The probability of each endogenous outcome is based on the probability distributions for each exogenous input in the estimation model. We recognize that estimating probabilities requires a much more detailed level of analysis, which can be justified for regulations exceeding $1 billion economic impact.

A middle-ground approach, particularly when it is difficult to quantify the uncertainties, is to provide a range of outcomes and associated scenarios. Another compromise approach is to do a sensitivity analysis. Even if all the uncertainties are not accounted for in the model, it can be very helpful to the policymaker to see how much the final outcome varies with changes in key parameters. Typically, one parameter is varied at a time to make explicit the impact of that sole change. In reality, parameters are jointly determined and a more complete sensitivity analysis would test the variation of correlated parameters changing in coordination. For example, interest rates and regional house prices could be projected over a range of combinations and then the model could estimate regulatory impacts for the submarket of interest, such as affordable housing.

Hoesli (2005) provides an example of how Monte Carlo simulations can be used to cope with the risk and uncertainty of future cash flows and discount rates on commercial property. The basic concept is to create a model that calculates the present discounted value for a property based on expected rents and ultimate resale value. A single valuation requires estimates for parameters including the discount rate. Estimate the distribution for each of those parameters and then run the model for different draws of the parameters. Each simulation produces a point estimate of the present discounted value. If the simulation is repeated enough times, it produces a smooth distribution of point estimates. The mean point estimate has a standard error as an indication of reliability and the extent of the distribution can highlight the range of possible values with corresponding probabilities. Rodda et al. (2004) provides another example of stochastic modeling applied to FHA-insured reverse mortgages.

Appendix C: Measuring Benefits in the Context of Housing

In cost-benefit analysis, benefits are increased resources or utility to society. Gains are more narrowly defined as increased income or utility to some persons within society transferred from other persons in society (USEPA, 2000a, pp. 59-112). A housing impact analysis is ultimately concerned with both benefits to society and gains to subgroups or individuals. The measurement of benefits and gains is essentially the same, but gains are more inclusive because they include transfers that do not change the resources available to society. Most capital gains from house price appreciation do not represent benefits to society. The capitalization of clean air and better schools do increase house prices. But, there are no more houses. Rather, the owners of existing houses have more wealth, and the buyers are the losers in that they have to pay more for the same house. However, if the owner borrows against her capital gain and adds an extension to her house, then the gain has been translated into a real economic benefit. In and of themselves, gains do not count as benefits to society, but gains can be transformed into benefits.

The primary approach to quantifying benefits is by the concept of willingness-to-pay (WTP) or the maximum amount that an individual would pay for the improvement. The payment does not have to be realized. A cost-benefit analysis goes beyond expected cash flows to include accrued benefits and thus the phrase willingness-to-pay rather than simply payments. Individuals certainly vary in their valuation, as shown in a downward-sloping demand curve. The benefit to society is the sum of all of those valuations. A related concept is the willingness to accept compensation (WTA), which is the minimum amount that an individual would accept to forego the improvement. The problem with WTA is that there are no market transactions to quantify WTA analogous to prices, which reveal WTP. For practical purposes, willingness-to-pay based on prices for similar goods or services is the measurement metric.

One issue that frequently arises in environment valuation is how to measure benefits for things like clean air or uncrowded parks for which there is no market. A similar problem arises in housing development in that it is much harder to measure what people would be willing to pay to slow down development. In other words, development is easier to measure than non-development. The benefits of slower development, in terms of less crowded streets or smaller schools, are dispersed and not directly paid for by town residents. On the other hand, future residents may be willing to pay for a benefit, but their preferences usually do not count, especially if existing residents are willing to prevent the development that would include more residents. The issue of how much an individual is willing-to-pay is interrelated with whose preferences get counted.

Another challenge with willingness-to-pay is the impact of income. Rich people are able to pay more than poor people, so the cumulative social benefit is tilted toward the preferences of the rich. Actual markets share this “undemocratic” influence of income. The concern is that affordable housing may be under-rated because the amount that low-income people are willing to spend on housing is tied to their income. Presumably, a very different land use pattern would exist if households' willingness-to-pay decisions were based on equal income. In reality, cost-benefit analyses focus on the existing residents and their expected income. One reason for emphasizing subgroup analysis for low-income households is that their "needs" for housing often exceed their willingness-to-pay for housing out of current or expected income.

There are four methods of benefit valuation:

- Market value,
- Revealed preference,
- Stated preference, and
- Benefit transfer.

The market value or price is the least speculative and works well when the benefit is a factor of production or purchased as a consumer good/service. Revealed preference uses market data on recent choices to value benefits. Putting a value on housing can be challenging because no two are alike (heterogeneous good). Even if they were structurally identical, the value depends on the location relative to work, stores, schools, etc. The most common approach for valuing housing is hedonic pricing models. In a hedonic model, the log of house price is regressed on a set of variables controlling for quality, structure and location. Hedonic pricing models value the components of a housing bundle assuming the housing market is in equilibrium (Rosen, 1974; Brown and Rosen, 1982; Bartik, 1987, 1988; Cropper, Deck and McConnell, 1988; Ekeland, Heckman and Nesheim, 2004). Hedonic models have become widely used, in part, because they are so easy to estimate with available data. Traditionally, hedonic models have focused on structural and neighborhood characteristics with the assumption that longer suburban commutes are offset by larger houses and yards. Within budget constraints, a household maximizes utility by moving to a house that has the preferred bundle and how much that person is willing-to-pay depends on the components of the bundle. Sometimes it is assumed that recent movers more accurately reflect the equilibrium condition in the housing market.

Hedonic wage studies regress wages on employee and job characteristics (Viscusi, 1992 and 1993). By including the risk of death or injury among the job characteristics, the regression reveals how much workers must be compensated to accept the job risks. Wage studies are also useful to determine the value of lost wages according to a worker's age, experience and education. One benefit from regulation might be a reduction in disability and a large portion of the benefit is in the form of recovered wages.

Averting behavior models measure how much people spend to defend against a hazard (such as protective gear). In equilibrium, the marginal cost of the hazard should equal the willingness-to-pay to prevent, or at least avoid, the hazard. Under that equilibrium condition, WTP equals the sum of averting expenses, mitigating expenses, lost time and lost utility from pain and suffering.

Unfortunately, many of these items are difficult to value and, ideally, the costs should include both individual and collective or community risk reduction strategies. Cost of illness studies estimate the cost of treating illness and determine the expected cost of illness by multiplying the cost of treatment by the probability of getting the illness. However, this approach undervalues the disutility of pain (by valuing it at zero).

Another class of revealed preference models are recreational demand models that measure how much time and money an individual is willing to spend when traveling on a recreational trip. If the household is willing to spend a great deal to reach a remote location, then that cost is a lower bound on what the recreation is worth to that person. The underlying presumption is that the person could have chosen lots of other alternatives, so his selection of that particular option shows he prefers that option relative to the others. Recreational demand models are usually some form of discrete choice model (such as multinomial logit) and fit within the broader class of random utility models (RUM).

In a random utility model, the probability of choosing a particular housing option depends on the factors that give utility to the consumer (the structural features of the unit) or that affect the budget constraint (consumer income, or price of alternative units relative to prices for non-housing goods). The underlying framework comes from random utility models in which the consumer chooses a product that gives her the highest utility. We cannot directly measure the consumer's utility function, but we can discern which type of housing was chosen given the consumer's preferences, income and relative prices.

In Greene's (2003) notation with the linear random utility model, let the choice be between a and b.

$$U^a = x'\beta_a + \varepsilon_a \quad \text{and} \quad U^b = x'\beta_b + \varepsilon_b$$

where U^a is the utility of buying a, x measures the unit's characteristics (likely to be a vector of characteristics), β_a is the preferences for characteristic x and ε_a is the random component in the choice. Then the probability that the consumer chooses a over b is given by:

$$\begin{aligned}\Pr ob[Y=1 \mid x] = \Pr ob[U^a > U^b] &= \Pr ob[x'\beta_a + \varepsilon_a - x'\beta_b - \varepsilon_b > 0 \mid x] \\ &= \Pr ob[x'(\beta_a - \beta_b) + \varepsilon_a - \varepsilon_b > 0 \mid x] \\ &= \Pr ob[x'\beta + \varepsilon > 0 \mid x]\end{aligned}$$

This is standard discrete choice model estimated with a logit for a binary dependent variable or multinomial logit (MNL) for a dependent variable with more than two choices. The model is estimated with maximum likelihood and the elasticities vary with x, the independent variables. Anas and Chu (1984) give equations for the elasticities. McFadden (1984) and Greene (2003) give more comprehensive explanations of random utility models and discrete choice models.

Commercial software packages, such as Stata, have automated the calculation of marginal effects and elasticities (mlogit and mfx). The MNL models are sometimes used to combine choice of location or neighborhood and type of residence using either a nested logit approach (Tiwari, 2000) or a sample selection correction (Ioannides and Zabel, 2004). Cho (1997) subdivides the city into high and low-income submarkets. Tiwari (2000) notes that price elasticities of demand vary widely (-0.03 to –5.1) with generally lower (more negative) elasticities for owner-occupied than rental units. Berry, Levinsohn and Pakes (1995) emphasize that price elasticities will be biased towards zero if the model does not allow for unobserved product characteristics (often by the inclusion of a random coefficient). A common feature of elasticity estimates from MNL models is that they can vary significantly depending on the particular model form, specification and data. The results are difficult to generalize and, therefore, a customized model needs to be estimated for each location or particular application.

Stated preferences. If it is not possible to value a benefit from either market values or revealed preferences, it may be necessary to do a contingent valuation (CV). In essence, a contingent valuation is a survey that asks respondents to state their highest willingness-to-pay for an item under various hypothetical situations (Breffle, Morey and Lodder, 1998; Stevens et al., 2000; Alonso, 2002; Navrud and Ready, 2002). The shift from actual to hypothetical situation corresponds to a reduction in the importance of the budget constraint. The respondent can fill out the survey by answering what she would do if she had the money, which is likely to be different from what she did do within her current income. One form of contingent valuation is conjoint analysis in which the respondent makes choices between different attributes and prices in many pair-wise comparisons. A potential problem with the piecemeal approach is that stated preferences are not consistent or logical. One way to avoid inconsistencies is by a contingent ranking in which the respondent orders a set of commodities according to her preferences. CV surveys can be quite expensive to conduct, in part, because they require OMB clearance and careful sampling to produce reliable results. Despite the challenges of collecting and analyzing data from contingent valuation surveys, it is the only established way for estimating non-use values.

Benefit Transfer. If the data do not exist for market valuation or revealed preference models and the researcher lacks the time and money for a stated preference survey, the remaining alternative is benefit transfer. The researcher becomes something like an appraiser who estimates the value of a property by finding the closest comparable properties and then adjusting the value according to remaining differences. Under benefit transfer, the researcher turns to existing studies with similar situations. No one study will be a perfect match, so the researcher has to adjust the values for the differences in the characteristics of the population and risks being valued. Confidence in the results can be raised by making comparisons with a number of existing studies. There is no formula for this type of meta-analysis. Benefit transfer valuations are convincing when the adjustments seem reasonable and the results are not contrived to get a convenient answer.

Mortality Risks. Regulations are often designed to save lives and a major portion of the expected benefit is associated with the value of those saved lives. The value of a statistical life (VSL) ranges widely depending on the method of analysis and there is a large literature from which to choose (Krupnick, 2002). Wage-risk analysis estimates how much more is earned in risky jobs. The estimates range from $0.7 million to $16 million in 1997 dollars (USEPA, 2000a, pp 87-90; Viscusi, 1993). Contingent valuation surveys ask people to estimate their willingness-to-pay to avoid risks. The range of estimates from these surveys is $1.5 million to $4.6 million. A meta-analysis by EPA concludes the estimates follow a Weibull distribution with a mean of $5.8 million in 1997 dollars (USEPA, 1997).

One way to understand the variation in VSL is to recognize the various adjustment factors. Values of life vary with age in an inverted U pattern peaking at the mean age. Health is another adjustment factor with WTP declining with baseline health. Quality-adjusted life years (QALY) is a way of adjusting VSL estimates according to the age and remaining years that a person could be expected to live from the baseline period. The latency period is another adjustment factor. Avoiding immediate death is valued more than delayed death.

Morbidity risks value non-fatal health effects. The cost of illness (COI) approach is based on solid health data, but likely underestimates an individual's willingness-to-pay to avoid the illness. EPA offers two handbooks for valuing morbidity risks: *Cost of Illness Handbook* (2000b) and *Handbook for Non-Cancer Valuation* (1999a). Stated preference and averting behavior methods can augment the cost of illness estimates, but the more comprehensive measures can lead to double-counting.