# CONVERGENCE IN GLOBAL MANUFACTURING COMPENSATION COSTS: AN INTERNATIONAL TRADE PERSPECTIVE

by

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To Ellie, Phoebe, Graham and Lucy

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# CHAPTER 1:

# INTRODUCTION

Convergence in compensation costs, taking place over time and across countries, is an important issue in the economic literature from a theoretical and an applied perspective. Several key theoretical models in economics point to convergence in wages, including the Solow macroeconomic growth model and Heckscher-Ohlin models of international trade. These theories can be tested by looking for evidence of convergence in cross-country data. Economic agents have a substantial interest in whether these theories hold true in practice, including multinational corporations seeking low-cost locations for global manufacturing operations.

The first paper in this study explores the empirical evidence for convergence in global compensation costs in the manufacturing sector for a set of thirty-three developed and developing countries. Evidence of convergence in compensation costs is apparent for selected groups of countries, with three distinct convergence clubs identified.

These clubs are used in the second paper to identify the factors contributing to similar compensation cost outcomes within each group. The study is undertaken in the context of a multiple-cone Heckscher-Ohlin trade model. In that framework, GDP per capita and compensation costs should grow at a similar pace for countries that are established within a cone. Gaps between GDP per capita and compensation cost growth would only be observed for countries in transition from one cone to another, and should be associated with shifts in the composition of trade and of implied capital/labor ratios. A regression model is developed to test for the presence of multiple cones in the data.

Finally, a country-specific exploration of compensation cost growth is undertaken for Mexico, which has demonstrated weaker than average compensation cost growth compared with the other developed and developing countries in the data set. Two explanatory factors are considered that are often cited with regard to Mexican manufacturing performance. Data on Mexican versus Chinese import penetration and the extent of Mexico's intra-industry trade with the U.S. are evaluated for their relative influence on Mexican compensation growth over the past decade.

Taken together, these papers will help to address the question of whether, and by what mechanisms, the expansion of global trade in recent decades has driven factor price equalization in the manufacturing sector.

# CHAPTER 2:

# EVALUATING CONVERGENCE IN GLOBAL MANUFACTURING COMPENSATION COSTS

## Section 1: Convergence in Context

Literature on cross-country convergence has focused largely on macroeconomic convergence, that is, in GDP per capita. Traditional Solow growth models, after adjustments for differing levels of technology, population growth and saving rates, predict convergence in macroeconomic growth rates. Such convergence has been demonstrated empirically for developed markets, with weaker results for groups of emerging markets. Such results are sometimes described as defining convergence "clubs".

In the theoretical formulations of the macroeconomic growth literature, a key mechanism driving convergence is the dissemination of technological progress across countries. If macroeconomic convergence is to occur via technology sharing, one way in which the dissemination of technology takes place is likely to be via multinational firms, as they seek out the lowest-cost sources of production to supply output to their global customers. By replicating technological advances, either through investment in capital equipment or intellectual property such as manufacturing processes, multinational firms are a key potential facilitator of the transfer of technology across countries.

What does this imply for wages? In the standard Solow model, if a steady state exists with absolute convergence in per capita macroeconomic growth rates, wage rates should also move toward convergence at the point where technology has been fully disseminated and all countries have reached diminishing production returns (after accounting for exogenous differences in population growth and saving rates, as these models typically do). Testing of the wage convergence component of these models has not been widely undertaken, due in part to data limitations. While the Penn World Table (PWT) and other large, cross-country datasets have been widely used to evaluate macro growth convergence, no such data sets exist with comparable cross-country data on wages.

This chapter tests for the presence of convergence in wages using data on hourly manufacturing compensation costs from the U.S. Bureau of Labor Statistics. Although the number of countries covered is much smaller than the PWT, the country coverage is relatively diverse in terms of compensation cost levels, including both high- and low-cost countries. The data also are rigorously evaluated to be comparable across countries by accounting for all forms of compensation: wages, holiday time, and other employer-paid benefits.

The test used is a new econometric technique proposed by Philips and Sul (2007) and applied by those authors to demonstrate the presence of convergence at the macroeconomic level among groups of developed and emerging markets. The results that will be developed in this paper suggest that there is evidence of convergence in wages for selected groups of countries within the dataset.

A comparison of the Phillips and Sul approach with other existing methods of testing for convergence is also presented, with some important distinctions for the conclusion of convergence depending on the technique used. The paper concludes that the new technique is a useful contribution to the convergence debate, but that it has its own shortcomings. It remains the case that no single approach provides a conclusive answer to the question of convergence. Taken together, however, the different approaches offer a fairly robust picture of the dynamics behind convergence in global compensation costs.

## Section 2: Convergence Conditions Defined

One of the conventional approaches to evaluating macroeconomic convergence is based on the Solow model, which posits economic growth as a function of initial income levels and the capital stock. With total output Y a function of capital (K) and labor (L), and the production function assumed to exhibit constant returns to scale and diminishing marginal product of both inputs, we can write the production function as $y = f(k)$ where lowercase letters indicate a variable per unit of labor.

With such a production function, a regression equation can be specified of the general form:

$$g_{i,t} = k + \beta \log y_{i,t} + \gamma Z_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where g is the growth rate of per capita (assumed equal to labor force) income for country i; y is the level of per capita income; Z represents control variables, typically population growth rates and/or saving rates; and $\beta < 0$ indicates convergence in per capita income growth.

This formulation, presented as above by Durlauf, Kourtellos and Tan (2005) and similarly by others, follows from the theory that diminishing returns to capital limits the growth rate of more developed, i.e. higher income, countries, while less developed countries in the process of augmenting their capital stock benefit from a faster rate of growth, thus driving eventual convergence. This form is characterized as "absolute convergence", in the sense that the model predicts growth rates in all countries would equalize over time once the steady state level of capital is achieved. Less restrictive formulations of this hypothesis, including Mankew, Romer and Weil (1992), allow for "conditional" convergence, or convergence of this type after allowing for differences in the control variables, which may include population growth rates, saving rates, human capital development and others. These approaches to the convergence question will generally be referred to from here forward as "beta" convergence, in either absolute or conditional form.

A second approach looks for declining variance of income across countries over time as a measure of convergence. This approach, referred to as "sigma" convergence, has resulted in some key findings in the growth literature. Sala-i-Martin (1996) and others have identified evidence of sigma convergence for samples of developed countries over time, but the hypothesis is generally rejected for a full sample including developed and emerging markets.[1]

Finally, time series tests of convergence utilize unit root tests or look for trends in the cross-country differences in output that demonstrate time-invariant autocorrelation. An early version of this approach appears in Bernard and Durlauf (1995) and has been extended in subsequent studies. As pointed out in Durlauf et al. (2005), studies based on this approach tend to reject the notion of convergence, other than for pairings or very specific groups of developed markets.

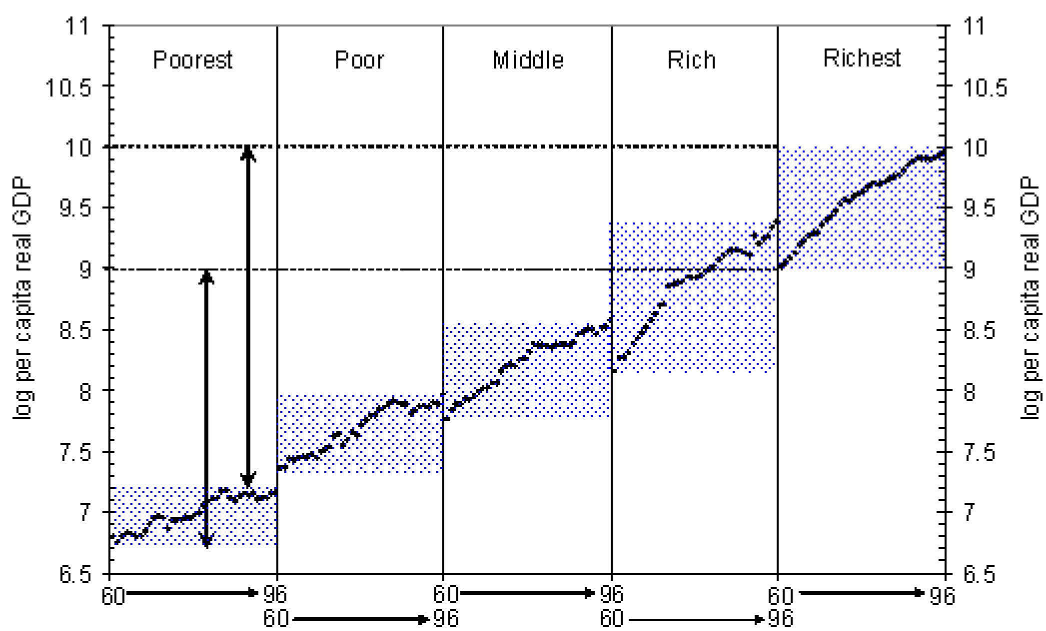
[1] Sala-i-Martin (2006) uses a combination of per capita GDP and within country data on income dispersion to demonstrate that sigma convergence can be shown for individual incomes. Population-weighted data produce similar results favoring convergence.

A new convergence test presented by Phillips and Sul (2007) combines properties of both the sigma and time series approaches. This test will be described in detail in Section 6 and applied to test for convergence in compensation costs in Section 7. The results are compared with other convergence approaches in Section 8.

## Section 3: Stylized Facts on Growth and Compensation Convergence

Discussions of global convergence in macroeconomic growth rates often include an illustration of the progression of world economic growth, such as that shown in Phillips and Sul (2005) and reproduced below as Figure 2.1. The data, from the Penn World Table, cover the period 1960 through 1996, and countries are grouped by stage of development, as measured by initial income levels.

Figure 2.1: Progression of GDP per Capita in Penn World Table Data



One immediate point of interest is the smooth progression that is suggested by this presentation of the data. Nonetheless, the continuum of growth in per capita GDP does not in itself imply convergence; in fact, if nations did follow a constant path of per capita GDP gains, convergence would not be possible as higher income countries would continually outpace lower income countries.

Looking more closely at the chart, there is some evidence of beta convergence between the rich and richest countries as indicated by the height of the shaded areas, i.e. a steeper slope of the path for the rich country group versus the richest, leading them to "catch up". However, there is little to suggest sigma convergence which would be indicated by a fall in the arrowed distance, i.e. the gap between richest and poorest countries at the beginning and end of the period.

A parallel illustration can be drawn for cross-country labor compensation in the BLS data set, also using initial compensation to establish the groupings. The complete list of countries and their rankings are shown in the Appendix.

Given the smaller country sample (33 countries versus 88) and slightly shorter time series (32 years versus 37), we might not expect to see as much evidence of convergence, but in fact the outcome is quite similar to the macro growth picture. Using the two-group case shown in Figure 2.2, a smooth trend can be identified with some evidence of convergence as the slope of the lower tier line is steeper than for the upper tier, as shown numerically in Table 2.1 (the evaluation of sigma and beta concepts will be roughly equivalent for a two grouping case, i.e. the distance between starting and ending point for the two tiers). A four-group approach is shown in Figure 2.3, and generates a less continuous outcome. However, this case does show evidence of beta convergence between the bottom and low groups, and the middle and top groups, with the lower of each pairing demonstrating a steeper slope. Interestingly, this formulation also suggests sigma convergence, which has not generally been the conclusion in studies of macro growth data, with the gap between the bottom and top group narrowing from the beginning to the end of the period. Table 2.1 summarizes the numerical equivalent of the shaded areas and arrows in Figure 2.1, for the 2- and 4-group cases. Note that these metrics are calculated from the raw data, not econometrically estimated, and are presented to demonstrate the general characteristics of the BLS data as compared with the Phillips and Sul illustration above. These calculations will be revisited later in the chapter, and applied to the econometrically identified country groups, to further illustrate the different conclusions that may be drawn using these alternative approaches.

Figure 2.2: Progression of Log(Comp) Data for Two Country Tiers

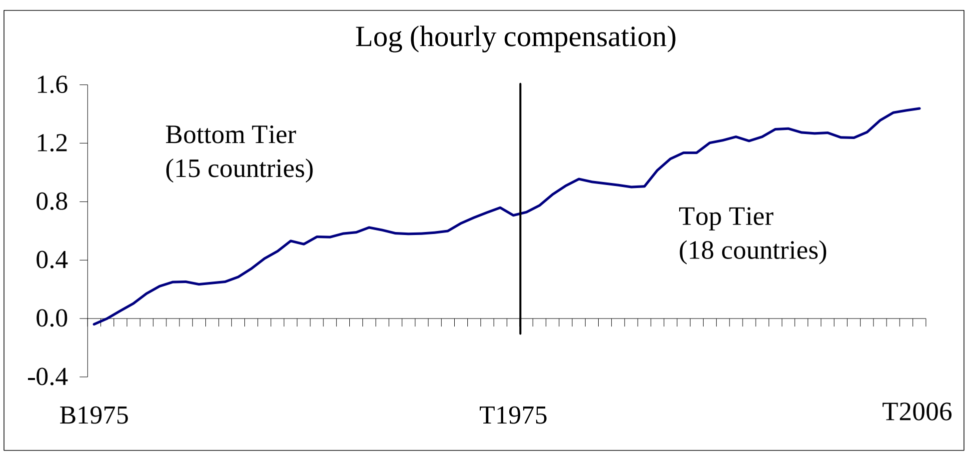


Figure 2.3: Progression of Log(Comp) Data for Four Country Tiers

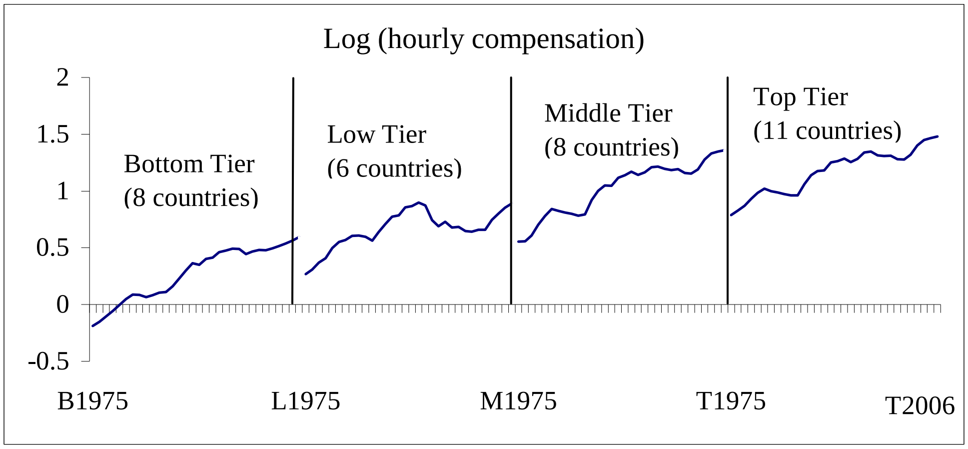



Table 2.1: Beta and Sigma Summary Statistics for BLS Data – Bottom/Top and Bottom/Low/Middle/Top Groups

| | Two Country Groups | | Four Country Groups | | | |
|---|---|---|---|---|---|---|
| | B2006-B1975 | T2006-T1975 | B2006-B1975 | L2006-L1975 | M2006-M1975 | T2006-T1975 |
| Beta Convergence | 0.796 | 0.733 | 0.783 | 0.623 | 0.804 | 0.693 |
| | T1975-B1975 | T2006-B2006 | T1975-B1975 | T2006-B2006 | | |
| Sigma Convergence | 0.744 | 0.680 | 0.976 | 0.886 | | |

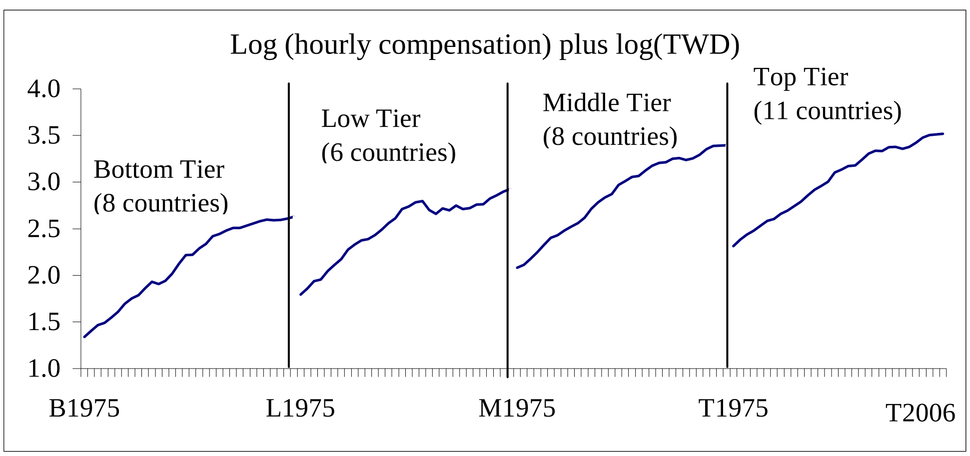
| | Four Country Groups - Adjusted for TWD Changes | | | |
|---|---|---|---|---|
| | B2006-B1975 | L2006-L1975 | M2006-M1975 | T2006-T1975 |
| Beta Convergence | 1.291 | 1.131 | 1.313 | 1.201 |
| | T1975-B1975 | T2006-B2006 | | |
| Sigma Convergence | 0.976 | 0.886 | | |

Beta convergence illustrated by a larger 1975-2006 change for low income countries versus high income

Sigma convergence illustrated by a lower variance across high and low income countries in 2006 vs. 1975

The data sample is slightly skewed toward richer countries, with 18 versus 15 observations and 5 of the emerging markets' data beginning only in the 1990s. This likely reflects the better quality and availability of compensation cost data for these nations. However, there is a pattern of wage growth with a slowdown in the 1990s period that seems to be replicated to some degree across all four groups. This is in part a reflection of the use of compensation costs measured in U.S. dollars. Taking the log of the trade-weighted U.S. dollar and adding it to the compensation series smoothes out most of this variation and is shown in Figure 2.4. This mutes the calculation of beta convergence in Table 2.1, though the overall conclusion is the same, and does not impact the sigma convergence result since each country data point is being adjusted by the same factor in a given year. Since the results in this paper will be more closely related to the sigma convergence concept, in that the relevant variable will be based on relative compensation cost across countries for a given point in time, the use of local currency versus U.S. dollar data should not affect the outcome. Therefore, data in U.S. dollars will be used to facilitate the discussion and comparison of cross-country differences at any given time point without loss of validity.

Figure 2.4: Log(Comp) Adjusted for Changes in Trade-Weighted U.S. Dollar




Valuing labor costs at PPP versus market rates

The question of PPP versus market exchange rates is also a key consideration in any study of cross-country data. For purposes of the current chapter, it is closely related to the broader question of what dynamic is expected to drive convergence in labor costs for the countries studied. Stated simply, PPP compensation costs would reflect the variable of interest for a labor market participant evaluating where to offer his or her services. Labor migration would be the dynamic of convergence in this case.

Market exchange rates, by contrast, would be the variable of interest for an employer evaluating the cost of labor across markets to determine their allocation of capital to produce a good or service that includes some component designated for export. (If capital is being allocated to a country to support purely domestic production for the domestic market, exchange rates in any measure would have little impact on the decision.) The convergence dynamic under consideration in this paper is capital allocation, similar to the technology diffusion theories of macroeconomic convergence. Therefore market exchange rates will be used as the basis for the compensation costs used in convergence tests.

As a cross-check however, convergence tests were conducted on the whole sample, and on two-tier and four-tier groups based on PPP compensation cost rankings, to evaluate how this difference might drive the study results. The rankings of 2006 compensation costs using PPP exchange rates are shown in the Appendix for reference. While the PPP adjustment for exchange rates does alter the country rankings, and therefore the composition of the tiers, the conclusions regarding convergence were not significantly different. The lowest and top tiers still failed to demonstrate convergence, and in fact the results for the middle two tiers were also weaker than in the non-PPP data. This result may be taken in support of the hypothesis that the behavior of employers, rather than labor market participants, is the driving force in cross-country convergence in labor costs, at least for this sample of countries.

## Section 4: Trade Theory Implications for Convergence in Wages

Barro and Sala-i-Martin (1997) formally introduce trade and FDI to the neoclassical Solow model as a mechanism for technological dissemination, which allows for conditional convergence where follower countries are able to "catch up" to more developed countries because of the relative ease of adopting technology versus creating it.

Another approach to understanding the relationship between trade and compensation costs comes from the Heckscher-Ohlin framework. In particular, the theoretical result of factor price equalization due to trade has historically resulted in what is termed a "single cone" H-O model, where factor endowments across countries are relatively similar. In extensions of H-O to allow for multiple cones, due to differing endowments or behavior, the assumption of global factor price equalization no longer holds. Deardorff (2001) presents several examples of a multi-cone H-O model which provide additional insights for the actual patterns of trade and factor prices that we observe in real world data. Importantly for purposes of this analysis, most neoclassical growth models, including Solow and extensions by Stiglitz (1970), are more consistent with multi-cone steady states. Factor price equalization may occur within cones, but not across cones. In such a world, we would not expect to see the lowest income countries converging with the highest income countries if they are not likely to occupy the same cone of specialization. This result would be consistent with the presence of "convergence clubs" in the macro literature, and also turns out to be a very similar conclusion to our observations from the compensation cost data in this paper.

The multi-cone model is also interesting in the context of countries "jumping" from one cone to another. In the BLS data, countries in the lower two tiers and upper two tiers show some propensity to switch groups, as shown in the Appendix table on country rankings, and significant changes occur in ranking within the tiers over this 30 year time period. However, there is very little movement between the lower two tiers and the upper two. Japan and New Zealand are the only two countries that cross that boundary in this dataset. This observation would be consistent with cones of specialization in which the lower and upper income countries are moving toward factor price equalization within each group, but not globally.

The mechanisms by which trade may influence convergence outcomes are explored in more detail in Chapter 3. For now, it suffices to keep in mind that trade theory offers a reason to expect convergence in wages across countries over time, under certain conditions which differ in some cases from the conditions imposed by macro growth theory.

## Section 5: Characteristics of Existing Empirical Tests for Convergence

Traditional beta and sigma tests for convergence suffer from some shortcomings that are especially important when considering cross-country panel data.

Beta convergence is implied when lower initial income countries grow more rapidly than high income countries. However, this condition only implies convergence if there is a single steady state. An alternate possibility is that low income countries grow more rapidly but converge to a different (lower) steady state than high income countries. One such model is suggested by Azariadis and Drazen (1990) by introducing increasing social returns to scale from investment in human capital. The result is multiple steady states which depend on the initial stock of capital being above or below a certain threshold. More generally, the ability of lower income countries to "catch up" to higher income countries requires a steady state of capital accumulation to be approached, which in reality is an implausible assumption. If higher income countries continue to develop more advanced technologies and capital stock, the bar for lower income countries to converge is set ever higher.

Sigma convergence looks for the compression of variation in cross-country per capita incomes over time. In earlier growth literature, sigma convergence was sometimes asserted to be a subset of beta convergence, i.e. beta convergence implies sigma convergence will hold, but this is not in fact true. This question became subject to dispute in reference to Galton's fallacy of regression towards the mean, attributed to the example of Francis Galton's 19th century analysis of the height distribution of the children of tall and short fathers. Galton observed that the sons of tall fathers tended to be tall, but not on average as tall as their fathers, and similarly for the sons of short fathers. He mistakenly concluded this to be evidence of height regressing to the mean, when in fact it was due to the normal distribution of height outcomes. In the context of growth convergence, this concept has been used to demonstrate that a declining slope of the average growth curve (i.e. beta convergence) does not necessarily imply a compression in the variance across countries over time, or vice versa. This topic is discussed at some length in the context of the convergence debate in Quah (1993) and elsewhere, and it has become an accepted principle of the growth literature that beta and sigma convergence are not equivalent measures.

A specific limitation of sigma convergence approaches, which is important for the current analysis, is that it does not provide a rigorous mechanism to evaluate convergence among subsets of countries, except by running the convergence test on ad hoc groupings and comparing the results.

A common shortcoming to both beta and sigma approaches is that neither allows for an examination of the transitional behavior of cross-country growth differentials, which can help to address the Lucas assertion that currently observed income inequality is only a transient result of global industrialization (2002).

In this context, the Philips and Sul approach provides two important advantages. First, they allow for variation in the exogenous factors both over time and across countries, which may better reflect reality. Second, the introduction of a relative transition parameter describes the behavior of individual countries over time and allows for the possibility that these parameters may diverge for individual countries over certain periods without nullifying the conclusion of overall convergence. These two contributions will be presented in more detail along with the outline of the model in Section 6.

## Section 6: A New Framework for Empirical Tests of Convergence

Several factors motivate the introduction of a new time series test of convergence. First, empirical research using improved panel data sets has highlighted the importance of heterogeneous agent behavior in evaluating macroeconomic outcomes. Econometric theory is expanding to better support these types of studies, with one important direction of the literature focusing on models with a common factor and idiosyncratic effects, i.e.

different agents having different response functions to a given exogenous variable. Early and influential examples of this approach include Temple (1999). This type of approach has also become a useful course of work to expand empirical evidence around the convergence debate in the macro growth literature.

Such studies take a model of a form similar to:

$$X_{it} = \delta_i \mu_t + \varepsilon_{it} \qquad (2)$$

where $\mu_t$ represents the common component of the variable of interest, $X_{it}$, and can be applied generally as the aggregate behavior of $X$ across all $i$, or may specifically be modeled as the response to a common external factor such as a prevailing interest rate. The factor $\delta_i$ represents the heterogeneous agent's response to the factor $\mu_t$. Phillips and Sul expand this approach by introducing a time-varying $\delta_{it}$ to capture the idiosyncratic effects of the common parameter, $\mu_t$, for agent $i$ over time. In the context of a macroeconomic growth model, for example, $\mu_t$ could be technological change and $\delta_{it}$ would represent a country's facility in adopting new technology, and this is allowed to evolve over time as countries become more or less efficient at adopting new technologies. This facility could evolve due to trade, investment in human capital, and so forth.

Phillips and Sul also introduce a relative transition parameter, $h_{it}$, the calculation of which is shown below. This parameter captures each country's share of average income, and it's evolution over time maps out a transition curve for each economy relative to the other countries in the dataset. This is a valuable contribution in that it can be used to empirically estimate the speed of convergence as well as test whether convergence is present in the data.

The convergence test is based on an equation of the form:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log(\log(t+1)) = a + b\log t + u_t \qquad (3)$$

where

$$H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1)^2, h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} X_{it}} \qquad (4)$$

and using a fraction of the total time series *T*, with a sample of around 0.3*T* recommended to focus on the behavior of the series as it approaches its limit. For purposes of this paper, *i* represents countries and *X* is labor compensation per hour. The value $h_{it}$ by definition will average 1 across all *i* for any time *t*, and if the variance of $h_{it}$ converges toward zero as *t* increases, then the series $X_{it}$ demonstrates convergence. Formally, a t-statistic on the coefficient *b* that is less than -1.65 leads to a rejection of the null hypothesis of convergence at the 5% level.

Note also that, if $\mu_t$ is treated as a common external factor, then $h_{it}$ can be shown to equivalently trace the relative idiosyncratic factor $\delta_{it}$ so that:

$$h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}}{\frac{1}{N}\sum_{i=1}^{N} \delta_{it}} \qquad (5)$$

which means that values of the transition parameters $h_{it}$ can be interpreted as measuring the path of the factors $\delta_{it}$ for the countries converging to a common δ over time. This property of the model will be applied in a later section.

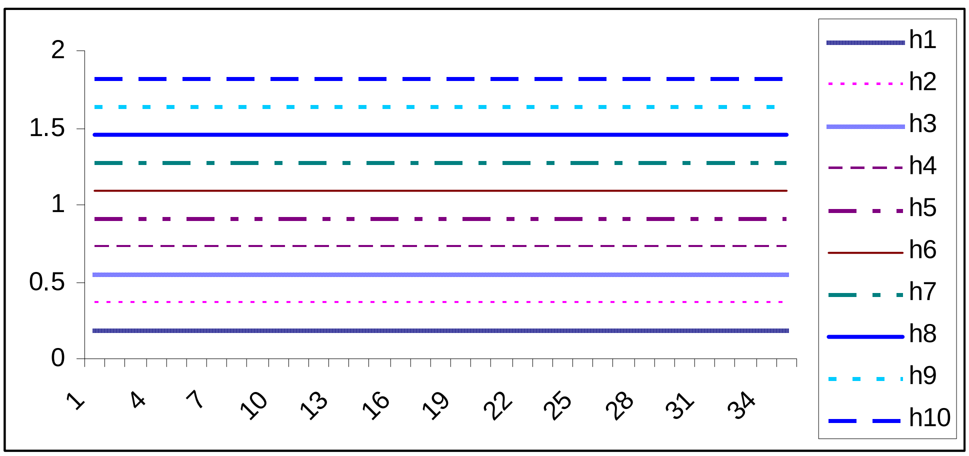
Although Phillips and Sul present detailed derivations of the time series and other properties of their "log *t*" test, as they refer to their enhancement, some of the key properties of the regression equation and test results may not be immediately intuitive.

These properties, and some potential shortfalls of this approach, may best be demonstrated using a few stylized examples.

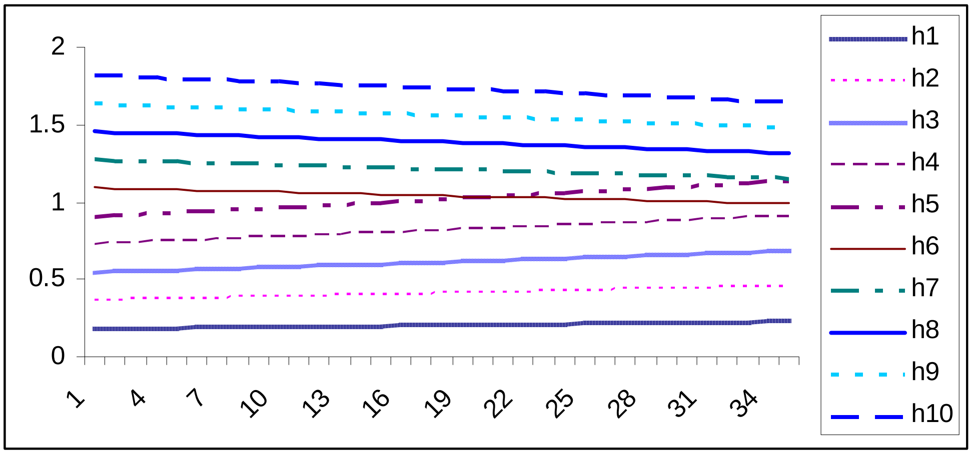
To that end, I construct a sample of 10 countries, with initial compensation cost of 10 for country 1, 20 for country 2, and so on up to cost of 100 for country 10. Applying different growth paths to these 10 countries for 35 time periods and conducting the log *t* test can help provide a better sense of what behavior constitutes "convergence" under the properties of this test. The charts of $h_{it}$ for four specific examples are shown in Figure 2.5.

Figure 2.5: Illustration of $h_{\text{it}}$ Paths under Four Growth Scenarios

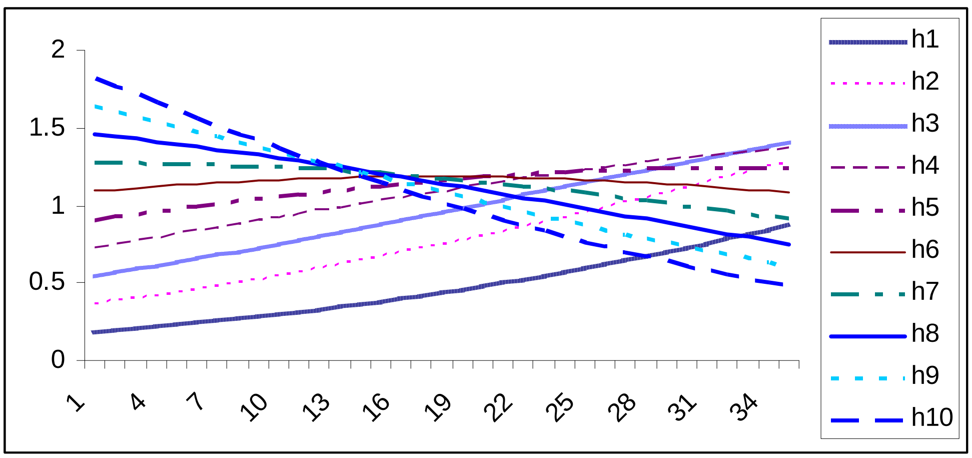
Example 1: No change in variance or level of compensation



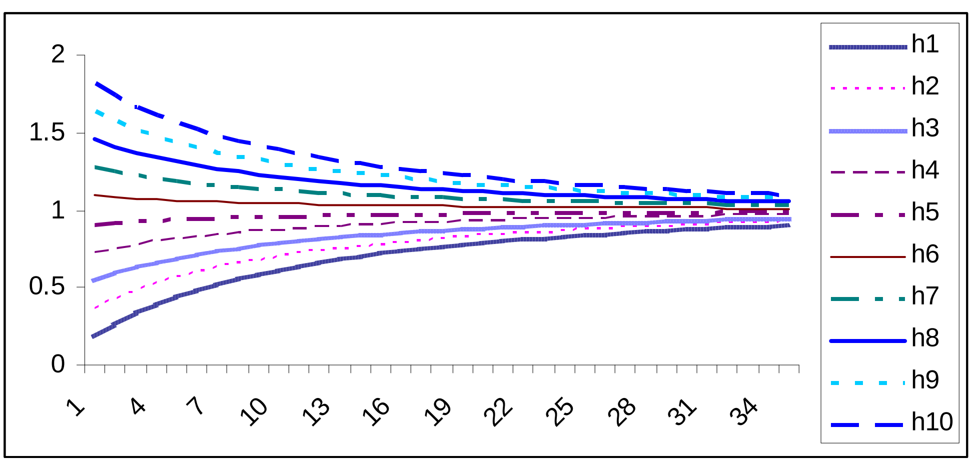
Example 2: Bottom Half Grows at 6%, Top Half Grows at 5%




Example 3: Country 1 Grows at 10%, Country 2 at 9%, …Country 10 at 1%




Example 4: Variance is Compressed over Time



The dependent variable $H_t$ is constructed as the variance of all the $h_{it}$ at time $t$ as above. The ratio of $H_1$ to $H_t$ then becomes part of the left hand side variable in the regression equation. This variable is charted in Figure 2.6 for each of the four cases considered here, with the results summarized in Table 2.2. The first example is an extreme case where neither the level nor variance of compensation changes over time. In this case, $H_1/H_t$ equals 1 for all time periods, and the log $t$ test clearly fails to demonstrate convergence. Example 2 imposes a form of catch-up, with the bottom five countries growing at 6% annually and the top five growing at just 5%. In this example, the faster growth rate for the poorer countries is not sufficient to overcome the initial inequality, and the gap between rich and poor continues to expand over time, failing to show convergence. Note that this case would be considered convergence in the beta formulation.

Example 3 imposes a more substantial catch-up assumption, with the lowest country growing at 10%, the second lowest at 9%, and so on up to the richest country growing at 1% over the 35 time periods. This example generates changes in rank among the countries, with the lowest country actually displacing the highest in rank by the end of the period, and the countries in the middle originally becoming the highest in the final rankings. It is also important to note that the final variance in this case is materially higher than in the initial period, which means that this case would not be an example of convergence using a traditional sigma test. This example does pass the convergence test using the log $t$ approach, with a t-statistic of $-1.0>-1.65$ as required at the 5% significance level.

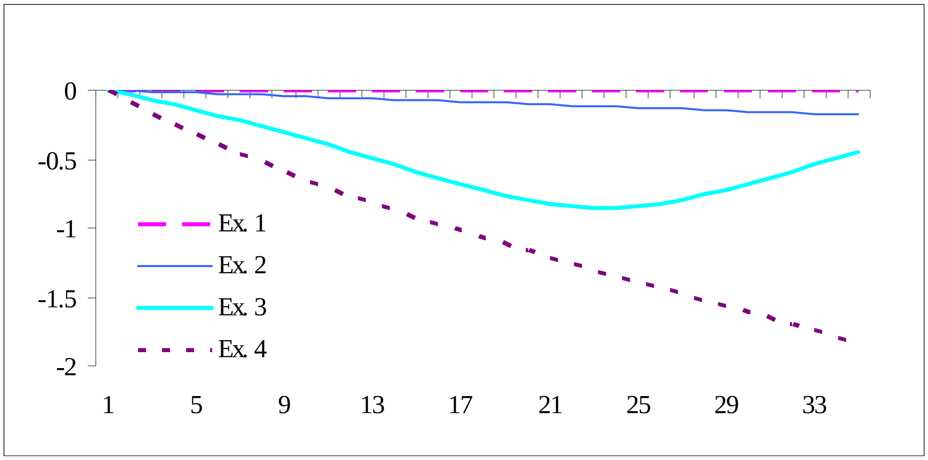
Example 4 uses a compression in variance across the countries, but no changes in rank. This case does not pass the log *t* convergence test, despite having a lower variance at time 35 as compared with the initial period (and thus passing a convergence test using the sigma approach).

These examples illustrate the sensitivity of the log *t* test to the relative growth performance of each country in the dataset. Simply reducing the gap among countries (as in the sigma definition) is not sufficient to demonstrate convergence. And the relatively weak acceptance of convergence in Example 3 reflects the consideration that countries also must stabilize in a new growth paradigm; if the same uneven growth patterns were extended further over time, the falling behind of the originally high-income countries would eventually eliminate the convergence property for this case as well.

Table 2.2: Results of Convergence Test Using 4 Stylized Examples

| | **Country 1 Beginning/Ending Compensation** | **Country 10 Beginning/Ending Compensation** | **Coefficient on Log t** | **t-Statistic** | **Passes Covergence Test** | **Beta Convergence** | **Sigma Convergence** |
|---|---|---|---|---|---|---|---|
| Example 1: All countries have same growth rate in every period | 10 / 15 | 100 / 150 | -0.61 | -97.3 | No | No | No |
| Example 2: Top Five Countries grow at 5%; Bottom Five Countries grow at 6% | 10 / 73 | 100 / 525 | -1.26 | -68.6 | No | Yes | No |
| Example 3: Bottom Country grows at 10%, Top Country grows at 1% | 10 / 256 | 100 / 140 | -0.57 | -1.0 | Yes | Yes | No |
| Example 4: Compress standard deviation from time 1 to time 35 | 10 / 205 | 100 / 250 | -6.08 | -38.4 | No | Yes | Yes |

Figure 2.6: Log($H_1/H_t$) Under Four Examples




The examples also raise some questions about the log *t* test, however. Example 4 would appear on the surface to be a case that we would want to see classified as convergence, and it would be according to a traditional sigma test. But it does not meet the criteria outlined by Phillips and Sul. This is an important consideration, and indicates that no single convergence test that is in the toolkit today offers a definitive answer to the convergence question. I will return to this question in a direct comparison of the various convergence approaches and their application to the BLS data later in the paper.

A key advantage of the Phillips and Sul approach, as discussed in the previous section, is the ability to track the relative convergence of countries using the individual $h_{it}$ paths, or "transition parameters". The four charts above showing the transition parameters $h_{it}$ for the 10 hypothetical countries in these examples offer a simple way to capture the dynamics underlying the log *t* test results. It becomes apparent that Example 3, which demonstrates convergence using the log *t* test, includes a relatively steady pace of transition, whereas in Example 4, there is a rapid move toward convergence in the early period but the pace slows significantly by the middle of the period and prevents true "catching up". The exploration of such transition parameters will offer a useful tool for evaluating the convergence results in the BLS data, and are discussed in Section 9.

Section 7: Empirical Results

This section presents empirical results using the log *t* test for the purpose of evaluating the presence of convergence in labor compensation costs. Tests were conducted on data from the International Labor Comparisons section of the U.S. Bureau of Labor Statistics (BLS), including total hourly compensation costs for manufacturing workers in 33 countries.

Because of the cross-country sample underlying the variance statistic, the errors in the estimated regression are likely to demonstrate heteroskedasticity, and a heteroskedastic-consistent (HC) estimator is required for the estimation. The White estimator is used for purposes of this analysis, which does not alter the value of the coefficient but does produce consistent standard errors, which is important since the t-statistic is the basis for the convergence test.

A first regression was applied to the full country sample. Not surprisingly, as with the typical results in the macroeconomic growth literature discussed in Section 3, convergence was rejected for the full 33 country data set, with a t-statistic of -16.2, well below the threshold of -1.65.

Tests for convergence were then conducted for the other subgroups illustrated earlier in this paper. For the two group case, high and low, the low country group did not pass the convergence test, with a t-statistic of -9.8. Similar to results in the macroeconomic growth literature, the high country group did pass the convergence test, though just marginally, with a t-statistic of -1.53.

The results for the four tier case would be expected to show improved results, by further distilling the countries into related groups. The countries in the middle tier clearly passed the convergence test, with a t-statistic of 3.9, while the low tier failed by a small margin with a t-statistic of -1.83. Neither the top nor the bottom tiers were close to demonstrating convergence, as shown in Table 2.2. This is surprising in the sense that the top group of countries is usually considered to be the most similar in terms of economic development and other fundamentals and thus the most likely to converge in the macro literature.

Table 2.3: Results of Convergence Test for Four Country Tiers

| | Coefficient on Log t | t-Statistic | Implies Convergence |
|---|---|---|---|
| Top | -0.88 | -2.63 | No |
| Middle | 4.21 | 3.94 | Yes |
| Low | -0.29 | -1.82 | No |
| Bottom | -1.88 | -3.99 | No |

These results suggest that the clustering algorithm used by Phillips and Sul to establish "convergence clubs" is a similarly relevant concept for labor compensation as it is for macroeconomic growth, since the composition of the country groups does seem to influence the conclusion regarding convergence. For example, if we simply looked at the two group case, we might conclude that the high income countries converge while the low income countries do not. But further disaggregating these results into four equal tiers, we observe that it is the middle group of markets, rather than the highest or lowest income countries, that shows the strongest evidence of convergence. Rather than using ad hoc groupings in a search for convergent subgroups, the use of a clustering algorithm will provide a systematic method for identifying which subgroups of countries demonstrate convergence properties.

## Identifying Convergence Clubs

A useful corollary to the log *t* test is the potential to apply it iteratively for the identification of convergent subgroups within a dataset. The procedure is outlined in detail in Phillips and Sul (2007) and is based on the assumption that there is a core group of countries that demonstrate convergence. Starting from the highest two countries in the data sample, one country at a time is added and the log *t* regression is run. The initial core group of countries is chosen to maximize the t-statistic, always subject to the minimum t = -1.65 to ensure convergence is present. The maximization of the t-statistic gives a high degree of confidence in convergence for these markets. Additional countries can then be added to this subgroup, again adding one member at a time and running the log *t* test up to the point that the t-statistic reaches -1.65 and the group is complete. A higher threshold can be used for the t-statistic in this second round if there is a priori theoretical or empirical evidence to question the likelihood of a country's membership in the group. This consideration will be relevant for some of the countries in the current data set.

The initial results of applying the clustering algorithm are presented in Table 2.4. Three convergent groups can be identified based on a strict application of the algorithm.

There are 7 countries remaining that are not able to be included in one of these three clubs.

The detailed composition of the clubs is listed in the Appendix. Club 1 is composed primarily of small, northern European nations that have the highest manufacturing wages in the country set. With the exception of Austria and Belgium, these countries were all at the top of the country rankings in both 1975 and 2006. This grouping will be identified as the "High Wage" group.

Club 2 is surprisingly large, and consists of countries from diverse regions and, in the aggregate, substantially different levels of compensation even in the final period. The spread from lowest to highest compensation for the members of this club in 2006 is from $7.65 for Portugal to $29.90 for Finland. This group includes the United States, as well as key markets in Europe and Asia. As will be shown in the next section, this country set may be broken into two convergence clubs, labeled the "Industrial Core" and the "Catching Up".

Club 3 consists of Hong Kong and Taiwan and will be labeled the "China Moons". Of the 7 remaining unallocated markets, all but two of them are countries that had truncated data availability. This issue will be addressed later in this section.

Table 2.4: Results of Clustering Algorithm

| | Number of Members in Core Group | t-statistic for Core Group | Number of Members in Club | t-statistic on Addition of Final Member | t-statistic on Next Closest Country Not Included |
|---|---|---|---|---|---|
| Club 1 "High Wage" | 3 | -0.15 | 7 | -0.19 | -1.95 |
| Club 2 Full | 9 | 5.7 | 17 | 4.8 | 1.2 |
| Club 2 Top Tier "Industrial Core" | 9 | 5.7 | 10 | 4.2 | 3.4 |
| Club 2 Lower Tier "Catching Up" | 5 | 6.9 | 7 | 2.4 | 0.8 |
| Club 3 "China Moons" | 2 | 0.9 | 2 | 0.9 | -3.7 |

Decomposing Club 2

There does appear to be relevant information in looking beyond a "country-blind" application of the t-test, and taking into account the economic characteristics of the clubs. This is of particular interest for the large middle grouping of countries in the data set. To explore this question, a series of t-tests was generated from multiple starting points for the lower tier of countries in the second identified club. Table 2.5 shows the country-by-country results of the t-tests for these markets.

The first set of t-statistics illustrates the results when these countries are added sequentially to Club 2, forming the full 17-country club. Although the t-statistics are valid for these countries to be included, all the way though the addition of Portugal at 4.8, the development status of those markets in the original core of the club as compared with those at the lower end of the group is certainly distinct, in addition to the dispersion of compensation levels already noted. Further, the t-statistics show a pattern of falling, then increasing again as the tests progress through the lower tier of markets. This also suggests that there may be another "core" group, with a higher degree of convergence, nested within this sub-tier.

If, instead of adding these countries to the existing core group, a new group is created beginning with the first non-core country Japan, a striking result emerges. The first two members of the new group, Japan and Spain, pass the log *t* test but with a very low t-statistic, suggesting that these two countries do not form a strong "core" for the lower tier. Beginning instead with Spain and Greece, the t-statistic improves, and rises even more if Greece and Korea are taken as the starting point. This might argue for inclusion of Spain in the upper tier. However, returning to the results in the first column, Spain marks the low point of the t-statistics in the Full Club 2 progression.

These results suggest Spain is very much on the cusp of the upper "Industrial Core" and the "Catching Up" groups. Looking at the underlying compensation cost data for Spain supports this conjecture. Table 2.6 shows the average growth in compensation for each convergence club, and the individual growth rates for countries in the Industrial Core and Catching Up groups. Spain's growth rate is higher than the average for the industrial core countries, where only two markets (the UK and Ireland) have growth rates equal to or higher than Spain's. On the basis of historical performance, and the fact that Portugal is another member of the group, I will include Spain in the "Catching Up" club. However, either grouping can be justified based on the test results. Any further results dependent on this categorization will be tested for their sensitivity to the allocation of Spain in the group.

Table 2.5: Illustration of Iterative Testing for Club 2 Sub-Tier

| | T-statistic Results Adding to Club 2 Core | New Group Beginning with Japan/Spain | New Group Beginning with Spain/Greece | New Group Beginning with Greece/Korea |
|---|---|---|---|---|
| Japan | 4.2 | n/a | n/a | n/a |
| Spain | 3.4 | -0.7 | n/a | n/a |
| Greece | 3.6 | -0.4 | 0.2 | n/a |
| Korea | 7.1 | 0.8 | 5.1 | 4.3 |
| New Zealand | 5.5 | 0.6 | 6.8 | 5.5 |
| Israel | 5.9 | 0.4 | 6.9 | 6.2 |
| Singapore | 6.3 | -0.3 | 3.3 | 3.1 |
| Portugal | 4.8 | -0.9 | 2.4 | 1.7 |
| Hong Kong | 1.2 | **-1.8** | 0.8 | 0.4 |
| Taiwan | **-2.2** | | 0.2 | 0.0 |

Memo: T-statistic for Hong Kong/Taiwan Stand Alone Group 0.9

Remaining Unallocated Markets

The Unallocated Markets are difficult to assess due to the limited data series for several of these markets. The Czech Republic, Hungary, Poland, Brazil and the Philippines all have compensation cost data that begin at 1991 or later. For example, the Czech Republic actually would have passed the log *t* test to become the 18th member of the large version of Club 2. But because the Czech data only cover the period from 1995 forward, and given the substantial drop in the t-statistic when that market was added to the club, it was not included even though the t-statistic did meet the -1.65 threshold. This is another example where it may make sense to use applied judgment in overriding the blind test results, in this case, the shortened data series leading to a higher test threshold for a country's addition to a convergence club.

These remaining markets are of significant economic interest, however, in seeking to address the question of newly emerging markets and the potential path for compensation costs in these countries to grow over time. As an attempt, a series of log *t* tests was conducted on the shortened data series, with the full acknowledgement that these results are less robust. Nonetheless, there may be information to glean even from this limited look at the data. In fact, the log *t* test on the shortened time series supported the hypothesis of convergence for all of the remaining countries, with t-statistics ranging from 5.4 to 13.6. While we would want to apply a higher threshold for the t-statistic in the case of this limited data series (from just 1997 through 2006) the 13.6 t-statistic may still point to a core convergent group among these countries that consists of Poland, Hungary, the Czech Republic, Hong Kong and Taiwan. Interestingly, Brazil and Mexico do not show strong evidence of convergence, nor do the Eastern European countries taken as a stand alone group. These results, as well as the decomposition of the initial large Club 2, points to a conclusion that will be explored more fully in the next section, that is the relevant economic grouping for compensation cost convergence does not appear to be geographic.

The shorter time series results do suggest that there may be economic factors driving more rapid convergence in the period since the mid-1990s. For example, as globalization became more pronounced due to broader trade agreements and technological advances over this period, compensation gaps across countries may have begun to close more rapidly. Further, the global economy faced significant economic shifts in the mid-1990s, many of which directly affected the emerging markets in the low country group. These include the Mexican peso devaluation in 1994, the Asian financial crisis in 1997, and a redrawing of the political and economic map in Europe during this time. As the global economy recovered from these setbacks and entered a period of more or less uninterrupted and aligned economic expansion, outcomes might be more likely to show convergence. This hypothesis will be examined in Section 8, using the transition paths traced out by the variable $h_t$, termed the "transition parameter" by Phillips and Sul.

## Section 8: Tracing Country Transition Paths

The results in the preceding section are of empirical interest, but an additional goal of this analysis is to apply these results in understanding the patterns of wage convergence. In that regard, we will examine the transition parameter $h_{it}$, and illustrate how these parameters compare against emerging and developed markets in the data sample. These transition parameters capture the performance of compensation costs in each market relative to the average of all others in the sample at time $t$, and can be interpreted as indicating the speed of convergence. Charting these "transition parameters" over time thus illustrates the path that convergent countries follow, and can also highlight where other countries may have fallen behind.

Figure 2.7 shows the transition parameters for the key convergence clubs and unallocated countries. Although Norway seems to accelerate somewhat as compared to its peers, the relationship among the High Wage markets is quite consistent, with relatively flat curves other than for Austria, which offers an illustration of catching up, as the country moved up from 21st in the 1975 income rankings to join this top tier of countries in compensation cost by 2006 (see data in the Appendix for country compensation costs and rankings in first and final periods).

In contrast, the Industrial Core group shows a much less consistent path, particularly in the first half of the period. The curves for the U.S., Canada and Australia peak in the mid-1980s, while countries like the UK, Ireland and Japan start near the low end of the group but move up by the end of the period. The starting and ending points for the group give a visual illustration of convergence, in this case taking relatively independent paths to arrive at a similar end point.

The visual indication from the transition parameters also seems to confirm splitting out the Catching Up countries from the Industrial Core. The Catching Up group of countries follow a similar transition path, with the possible exception of Korea which seems to demonstrate a more marked uptrend. But the final distribution of countries is not significantly more compressed than in the initial period.

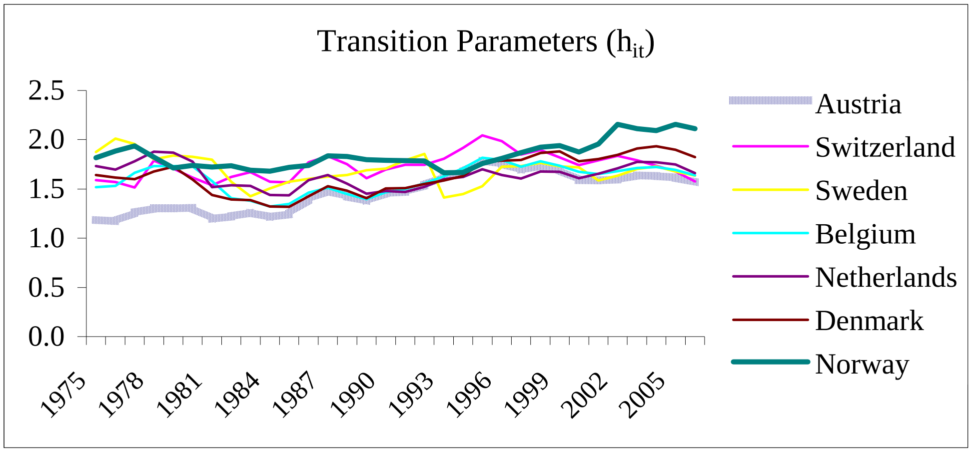
The Unallocated Markets clearly have a lower level of relative compensation costs than even the Catching Up group, making it difficult to anticipate a path for these markets to converge with the other groups over any foreseeable time period. But they also demonstrate very divergent growth paths within the group, with Singapore and Sri Lanka having very flat transition curves, Mexico and Brazil demonstrating a downward trend after initially higher performance, and the Eastern European markets showing some upward trend, based on a relatively short data sample.

The case of Brazil's downward shift in compensation costs can be attributed in part to that country's massive currency devaluation in 1999, but Mexico's performance before the 1994 peso devaluation suggests the pre-devaluation peak in Brazil was also inflated by economic conditions leading up to the currency crisis. In other words, many of the same imbalances that generated the currency overvaluation and decline also contributed to a distortion of labor compensation costs. This is a topic that has been explored elsewhere in the literature, but additional work could be done on these questions in future research.

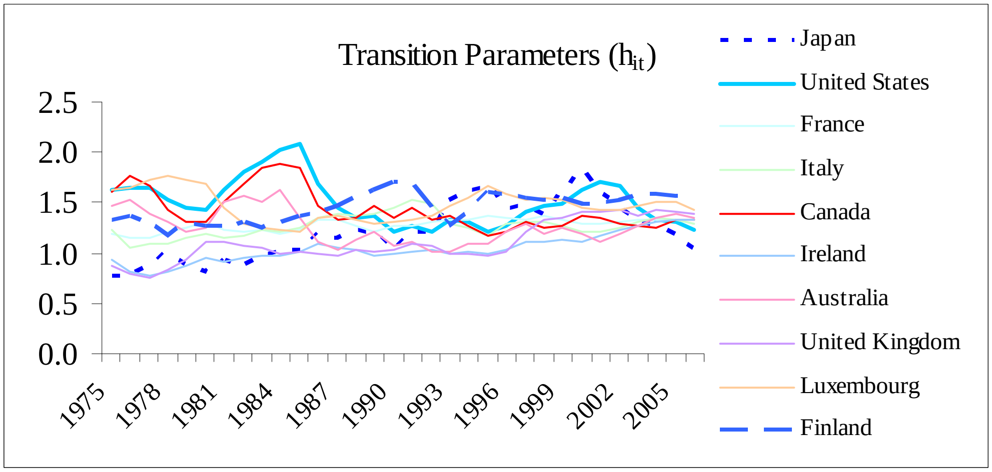
Given the relatively small sample of emerging markets in this dataset, it is likely that key convergence relationships are being omitted here. For example, a key competitor of Mexico in many of its destination markets is China. Mexico's downward trend in compensation costs could be associated with the growing trade presence of China over the past two decades. Although compensation cost data for China are very limited, it is clear from the available data that current compensation costs in China are still well below those in the Mexico. Lett and Bannister (2006) estimated manufacturing compensation in China at $0.67 per hour in 2004, just 27% of compensation costs in Mexico. Thus, we might expect continued restraint in the growth of Mexican compensation costs as Mexican firms compete with Chinese manufacturing sources for production sourcing. This hypothesis is studied more closely in Chapter 4.

Figure 2.7: Transition Parameters for Convergence Clubs and Unallocated Countries

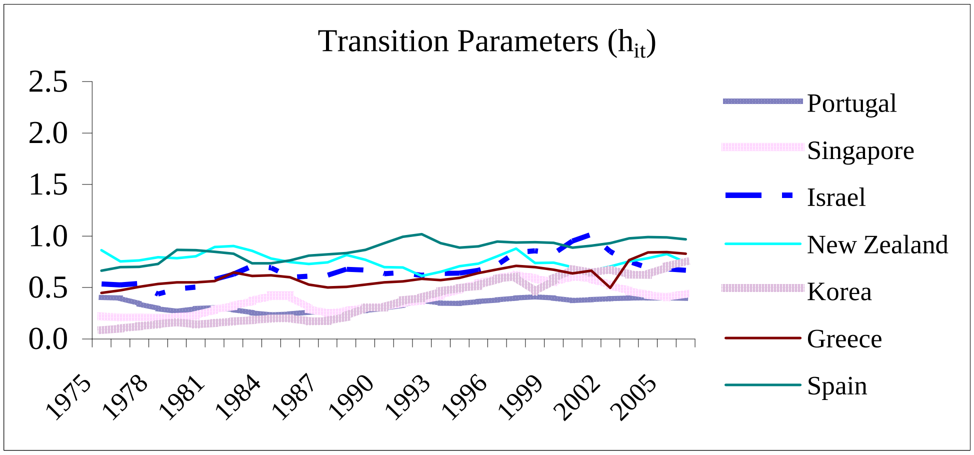
High Wage



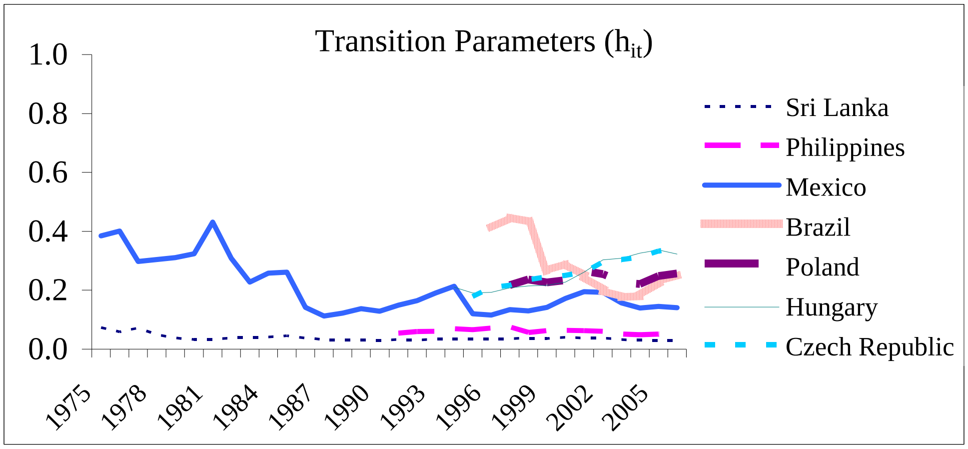

Industrial Core




Catching Up



Unallocated Countries




Section 9: Comparison of Results with Other Convergence Methods

Returning to the comparison of this convergence test approach to other methods discussed in Section 5, we can now compare the outcome of the log *t* test to the sigma and beta approaches to see what conclusions we might draw using any one of these tools.

The log *t* test provides a robust answer to a fairly narrow question related to convergence; that is, to identify groups of countries which have demonstrated a propensity to converge to a common steady state in response to a universal external factor such as technology. This identification is a useful addition to the toolkit of economists exploring these questions. It also provides guidance on the speed of convergence within groups, as illustrated by the transition curves in the previous section, but it does not offer a direct answer to the question of how quickly the groups might converge with each other. However, this section will show that the combination of the log *t* test and other approaches can generate a fairly robust picture of the dynamics underlying global convergence in compensation costs.

The group average data in Table 2.6 can be used to illustrate the beta and sigma results for convergence between the same country groups identified using the log *t* test, including the decomposition of the second large club into the Industrial Core and Catching Up groups. Beta convergence between groups would be indicated if the growth rate for the lower income countries exceeded that for the higher income countries. This does emerge in the data, although there is not a significant difference between the highest and lowest growth groups. In fact, the lowest income countries, the Unallocated Markets, actually have the lowest average rate of growth in compensation. Unfortunately, these results are skewed by the truncated data set for several of these countries as discussed previously. The Catching Up countries do demonstrate a higher average growth rate than the Industrial Core and High Wage groups above them, which points to beta convergence of these groups.

Taking the growth rates in Table 2.6 and applying them to the clubs identified using the log *t* test we can generate estimates of the time to convergence among the groups. For the Catching Up countries, with an average annual growth rate of 7.4% as compared with 5.6% for the Industrial Core and High Wage groups, average compensation costs for these markets would catch up to the Industrial Core countries in 38 years, and would overtake the High Wage countries in 53 years.[2] For the China Moons, the time to catch up would be 58 years to the Industrial Core, and 68 years to the high wage countries. Of course, the assumption of a constant growth rate over this entire period is questionable in a Solow-type world, as compensation cost growth likely would slow as the developing countries encounter diminishing returns to capital over time.

---

[2] Years to convergence are measured from the conclusion of the existing data set, which ends in 2006, taking group average compensation costs for each of the clubs and extending the series at the average annual rate of change shown in Table 6.

That assumption would put these estimates at the early end of a potential range of catch up times.

Sigma convergence, as measured by the gap between low and high wage country groups, has mixed evidence in this dataset. The data in Table 2.6 show the average compensation levels for each group, which do not show evidence of compressed convergence among any of the groups. In addition, offline calculations of the within group variance for each group also strongly refutes convergence; the variance from initial to final period is elevated in every case. However, using compensation costs as a percent of the next highest country group, the Catching Up group does show evidence of closing the gap with the Industrial Core, as do the China Moons with the Catching Up. It is notable, however, that the Industrial Core has not gained any ground on the High Wage group over this time period.

For the beta convergence case, where there is some evidence of convergence, we do not have a rigorous method of grouping countries to identify convergence clubs. One attempt might be to rank countries by growth rate; as the data in Table 2.6 suggest, this would result in some significant reclassifications of key markets. The UK's relatively high wage growth, for example, would lead us to allocate this market to one of the lower, Catching Up, groups. On the other hand, markets such as Portugal, with low wage levels but also a relatively slow rate of growth, might not be identified as convergent at all.

These results illustrate that, despite the potential for mixed signals on convergence identified using the constructed data examples in Section 4, the iterative log *t* test does offer a useful tool to identify country relationships that cannot be captured using either of the other approaches.

Table 2.6: Group Average Data for Identified Convergence Clubs

| | Group Average Growth Rate | Group Average Compensation in 1975 USD | Group Average Compensation in 2006 USD | Comp Cost as % of Next Higher Group (1976) | Comp Cost as % of Next Higher Group (2006) |
|---|---|---|---|---|---|
| High Wage | 5.6% | 6.2 | 33.4 | n/a | n/a |
| Industrial Core | 5.6% | 4.8 | 25.7 | 78% | 77% |
| Catching Up | 7.4% | 1.7 | 13.3 | 36% | 52% |
| China Moons | 8.2% | 0.6 | 6.1 | 32% | 46% |
| Unallocated Markets | 4.2% | 0.9 | 3.9 | n/a* | 64% |

*Group average reflects truncated data series for some of these countries

| Memo: By Country | | Average Annual Growth Rate in Compensation |
|---|---|---|
| Catching Up | Portugal | 5.3% |
| | Singapore | 7.8% |
| | Israel | 6.2% |
| | New Zealand | 4.9% |
| | Korea, Republic of | 13.1% |
| | Greece | 7.5% |
| | Spain | 6.7% |
| Industrial Core | Japan | 6.4% |
| | United States | 4.5% |
| | France | 5.7% |
| | Italy | 5.6% |
| | Canada | 4.7% |
| | Ireland | 6.7% |
| | Australia | 5.1% |
| | United Kingdom | 7.0% |
| | Luxembourg | 4.9% |
| | Finland | 5.9% |

## Section 10: Conclusions and Areas for Further Research

This paper adds to the convergence literature in two ways. First, techniques previously utilized to examine global macroeconomic convergence are applied to data on cross-country labor compensation costs. This is an important extension of the macroeconomic convergence literature, as wage convergence is an important corollary of key growth models, notably the Solow model and its extensions.

Second, the introduction of the "log *t*" convergence approach, first presented and applied to economic growth data by Phillips and Sul, generates new insights into the grouping of countries by stage of development and growth paths. The results may be more rigorous than existing sigma and beta approaches in identifying convergence clubs.

A final consideration is that, whatever technique is applied, the conclusion of convergence in economic growth or compensation costs has a distinct meaning in the economic literature, and must be explained carefully in the communication of convergence results to other interested parties. The examination in this paper, for example, was carried out in nominal USD terms under the hypothesis that actions by multinational firms are a key driver of convergence in wage costs. While the fact that the cost gap between the Catching Up and Industrial Core countries narrowed by 16 percentage points between 1976 and 2006 may be of significant interest to economists, a multinational firm looking for cost advantages in the global market likely would still see the 48% cost differential between these two groups in 2006 as a worthwhile opportunity to pursue. When economists assert that absolute cost differentials are unlikely to persist over time, due to the theoretical and empirical results examined in this paper and by others, it may sometimes be overstated in the context that is most important to individual market agents.

An equally important set of considerations for applied economic research, but one that is less often studied (in large part due to data limitations), are the offsets to absolute cost advantage, namely productivity growth, quality of labor force and of output, and so on. These factors have been examined to some extent in the trade literature, primarily in small samples of markets and in panels of plant- or firm-level data. These considerations are important from both a theoretical and applied perspective, as they likely represent a key reason that convergence does not materialize as quickly as standard growth and trade models might imply.

Appendix

| Country | 2006 Total Hourly Compensation (US$) | 2006 Rank (1 = Lowest) | 1975 Total Hourly Compensation (US$) | 1975 Rank (1 = Lowest) |
|---|---|---|---|---|
| Sri Lanka | 0.54 | 1 | 0.28 | 1 |
| Philippines | 1.07 | 2 | N/A | 4 |
| Mexico | 2.75 | 3 | 1.46 | 10 |
| Brazil | 4.91 | 4 | N/A | 12 |
| Poland | 4.99 | 5 | N/A | 7 |
| Hong Kong SAR | 5.78 | 6 | 0.75 | 5 |
| Hungary | 6.29 | 7 | N/A | 9 |
| Taiwan | 6.43 | 8 | 0.38 | 3 |
| Czech Republic | 6.77 | 9 | N/A | 8 |
| Portugal | 7.65 | 10 | 1.53 | 11 |
| Singapore | 8.55 | 11 | 0.84 | 6 |
| Israel | 12.98 | 12 | 2.02 | 14 |
| New Zealand | 14.47 | 13 | 3.27 | 17 |
| Korea, Republic of | 14.72 | 14 | 0.32 | 2 |
| Greece | 16.1 | 15 | 1.69 | 13 |
| Spain | 18.83 | 16 | 2.52 | 15 |
| Japan | 20.2 | 17 | 2.97 | 16 |
| United States | 23.82 | 18 | 6.16 | 28 |
| France | 24.9 | 19 | 4.49 | 20 |
| Italy | 25.07 | 20 | 4.64 | 22 |
| Canada | 25.74 | 21 | 6.11 | 27 |
| Ireland | 25.96 | 22 | 3.51 | 19 |
| Australia | 26.14 | 23 | 5.6 | 24 |
| United Kingdom | 27.1 | 24 | 3.35 | 18 |
| Luxembourg | 27.74 | 25 | 6.21 | 29 |
| Finland | 29.9 | 26 | 5.06 | 23 |
| Austria | 30.46 | 27 | 4.5 | 21 |
| Switzerland | 30.67 | 28 | 6.03 | 26 |
| Sweden | 31.8 | 29 | 7.12 | 33 |
| Belgium | 31.85 | 30 | 5.76 | 25 |
| Netherlands | 32.34 | 31 | 6.58 | 31 |
| Denmark | 35.45 | 32 | 6.23 | 30 |
| Norway | 41.05 | 33 | 6.9 | 32 |

**Country Tiers Using PPP Exchange Rates, 2006 Rankings**

Bottom Tier

- Sri Lanka
- Korea, Republic of
- Philippines
- Hungary
- Japan
- Mexico
- Czech Republic
- Hong Kong
- Poland

Low Tier

- Sweden
- Israel
- Brazil
- Denmark
- Norway
- Taiwan
- Singapore
- New Zealand
- Portugal

Middle Tier

- Switzerland
- Australia
- Canada
- Greece
- United States
- Spain
- Ireland

Top Tier

- France
- Italy
- Luxembourg
- Finland
- Austria
- Belgium
- Netherlands
- United Kingdom

**Composition of Convergence Clubs**

High Wage

| | |
|---|---|
| C.^ | Norway |
| C. | Denmark |
| C. | Netherlands |
| | Belgium |
| | Sweden |
| | Switzerland |
| | Austria |

China Moons

| | |
|---|---|
| C. | Hong Kong |
| C. | Taiwan |

Industrial Core

| | |
|---|---|
| C. | Finland |
| C. | Luxembourg |
| C. | United Kingdom |
| C. | Australia |
| C. | Ireland |
| C. | Canada |
| C. | Italy |
| C. | France |
| C. | United States |
| | Japan |

Unallocated Countries

Sri Lanka
*Philippines
Mexico
*Brazil
*Poland
*Czech Republic
*Hungary

*Truncated data availability

Catching Up

| | |
|---|---|
| C. | Spain |
| C. | Greece |
| C. | Korea, Republic of |
| C. | New Zealand |
| C. | Israel |
| | Singapore |
| | Portugal |

^ Core Members of Each Club Labeled 'C.'

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# CHAPTER 3:

# CONVERGENCE IN A MULTI-CONE HECKSCHER-OHLIN FRAMEWORK

## Section 1: Approaches to the GDP/Wage Gap

Economic historians have generated a robust debate regarding GDP per capita versus wage growth in the early industrial period. However, relatively few studies have been conducted on the differential between GDP and wage growth in the more recent economic era. Of these studies, most have emphasized the quantification of the GDP/wage differential. Attempts to explain the reasons for divergent GDP and wage growth have focused on the accounting factors (i.e. labor force participation rates) and proxies for productivity growth.

A second strand of the economic literature that is relevant to the GDP/wage growth question is the development of dynamic Heckscher-Ohlin models as a tool to evaluate the conditions under which the model's standard conclusions apply in a multi-period setting. Of particular relevance for this paper are those studies that address factor price equalization. The results of such models are generally mixed, and very sensitive to which of the static model assumptions are maintained or relaxed in the dynamic setting.

This paper melds these two areas of exploration, and provides additional insights on the relative performance of GDP and wage growth by constructing an econometric framework, based on the dynamic Heckscher-Ohlin literature, and demonstrating that the mixed results of prior studies may be attributable to the restrictions of a single-cone model. The paper concludes that the way in which countries are grouped may significantly influence conclusions as compared with prior studies. A key feature of this study is allowing for differences in determinant factors across countries in different stages of development and within different cones of specialization. This approach leads to a trade-theoretical explanation for observed cross-country differences in GDP and wage growth.

## Section 2: Globalization, GDP and Wage Growth

Much of the work in Chapter 2 took analysis previously conducted on macroeconomic growth rates and applied it to labor compensation costs, to which I will refer for convenience as wages. A second, related question is the degree to which wage growth tracks macroeconomic growth. As discussed in the previous chapter, growth theory points toward equalization of GDP growth and compensation to factors of production in a steady state, but under what conditions would we expect to see a different real-world outcome? This question is interesting for several reasons.

First, while broad economic growth measures are relevant in comparing the performance of nations as a whole, the behavior of individual market participants, be they firms or consumers, will be driven by other component variables such as wages. As such, looking at the paths of these specific variables can help to explain the reasons for macroeconomic convergence or lack thereof, in addition to simply identifying its presence.

Second, the distribution of GDP between labor and other factors of production is important in understanding the standard of living for individuals within a nation. This is a priority in many of the economic history studies on this subject. Although welfare effects are not a focus of the current study, the results of this chapter could be extended to address such questions. To undertake such a study, data adjusted for PPP rather than market exchange rates might be more appropriate. However, in the context of a multi-cone model of international trade, this paper will illustrate that gaps between nominal GDP and wages are not only possible but likely, as countries move between cones of specialization. This framework will also help to explain some of the results that are observed in the data.

Finally, one reason that GDP may be used more frequently than wages in studies of relative national performance is that GDP data are readily available for a wider set of countries and over longer periods of time. If we can garner a better understanding of the relationship between GDP and wages for a reasonable representative sample of markets, we may be able to use existing data on GDP and other explanatory variables to infer something about current or future wage rates in a broader sample of markets.

Work by economic historians has addressed this question for pre-industrial Europe, where a persistent gap between real wage growth and per capita GDP has been identified and studied in fairly great detail (though without a consensus on its explanation). The parallel with early European economies may be of particular relevance for today's emerging markets. In particular, an examination of the economic history literature regarding wages and GDP could offer insights into the path that large, emerging industrial economies such as China may be following today.

However, the parallels between early economic history and modern times are not often addressed directly in the economic literature. In their 1999 book, O'Rourke and Williamson make this point, comparing the period of rapid globalization in the late 19th century with that at the end of the 20th century:

> As economists today debate globalization issues, they treat the phenomenon as if it is unique to our time, seemingly unaware of how directly the first great globalization boom speaks to the second. A conversation between the two is long overdue.

Studies on this question applied to modern economies have looked at the relationship between GDP per capita and wages, but with a focus on quantifying the gap, measuring the contribution from accounting factors such as labor force participation, and identifying proxies for productivity growth to explain growth differentials. However, these studies do not address the reasons why such differentials may emerge or persist. I will return to this question with the trade-theoretical framework in Section 3.

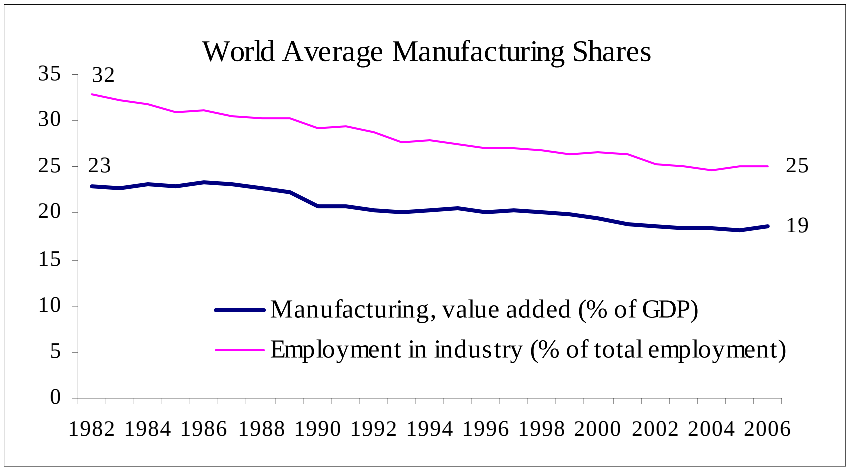
One common element in studies by economic historians and other researchers in this area is the use of a national accounts framework to illustrate conditions under which convergence in macroeconomic growth would imply convergence in wages as well. Angeles (2007) derives such a framework in some detail to explore the GDP/wage gap in pre-industrial Europe. Warner (2006) uses a similar approach in a study of occupational wages and GDP in modern economies. Warner concludes that GDP per capita exceeding wage growth for a particular occupation or sector, such as manufacturing, can be explained by a few broad factors falling out of the basic national income accounting framework. The key factors are (1) rising labor force participation; (2) faster growth in other sectors' wages, or in profits; and (3) migration of labor toward other sectors with higher wages.

Rising labor force participation is determined to be a key factor in both of these studies, and in most other studies in this area. It also is relatively easy to account for empirically. However, labor force participation does not appear to explain the entire GDP/wage gap, leading to the focus of other studies on measuring and evaluating productivity growth as the secondary force.

Following the principle that labor is compensated at its marginal product, one underlying explanation of the forces above would be that productivity growth in the slower wage growth sector is slower than the aggregate rate of productivity growth for the economy. However, this productivity shortfall does not appear to be the case in the performance of manufacturing, where for example U.S. manufacturing productivity has grown on average 1.7 percentage points more quickly than in the overall nonfarm business sector since 1990. The data for other developed markets are similar; such a breakdown of productivity growth by sector is less readily available for the emerging markets. However, as shown in Figure 3.1, overall manufacturing productivity also appears to have risen as evidenced by the 7 percentage point decline in employment in industry as compared with a 4 point decline in manufacturing output.[3]

[3] Data in figure 3.1 are the unweighted average of manufacturing share of output and employment in industry for the 33 countries in the BLS data set on international compensation costs.

Figure 3.1: Manufacturing Output and Employment




The capital/labor ratio is another key factor that is relevant both to the productivity growth discussion and also the trade framework, to the extent that it reflects the endowment of each country and indicates the direction of comparative advantage. Its role may be different depending on the country's stage of development. In the development stage, incremental capital may be added to support the addition of more workers into the manufacturing sector. To the extent these workers are coming from a less productive sector, such as agriculture, the additional capital would add to both overall and manufacturing sector productivity, and raise the wage once changes in labor force participation are accounted for. If the capital represents a labor-saving technology, such as might be expected in the more capital-abundant developed markets, then labor demand in the manufacturing sector would decline along with wages, potentially leading to an exodus of workers from the sector as labor shifts to more attractive opportunities.

Either of these cases would imply the relationship between the GDP/wage gap and capital formation should be positive.

To fully explain shifts in labor force participation, capital formation, and GDP and wage growth, however, we need to move beyond the national accounts framework and apply a robust theoretical model of growth and factors of production. To this end, trade theory and, in particular, studies extending the standard Heckscher-Ohlin model to a dynamic environment offer a useful starting point.

## Section 3: Heckscher-Ohlin Models and Convergence

Trade theory would seem to be a natural source of more detailed explanations for the mechanism by which convergence may or may not occur. In particular, the standard Heckscher-Ohlin (HO) result of factor price equalization (FPE) offers a direct parallel to the question of wage convergence. A recent resurgence of interest in dynamic HO models - that is, combinations of static HO models with multi-sector growth models - confirms the appeal of this approach. These models explore what happens when countries with different initial endowments interact over time. However, across the growing literature on dynamic HO models, there is a wide range of conclusions regarding the robustness of the FPE result depending on the particular set of assumptions that are imposed.

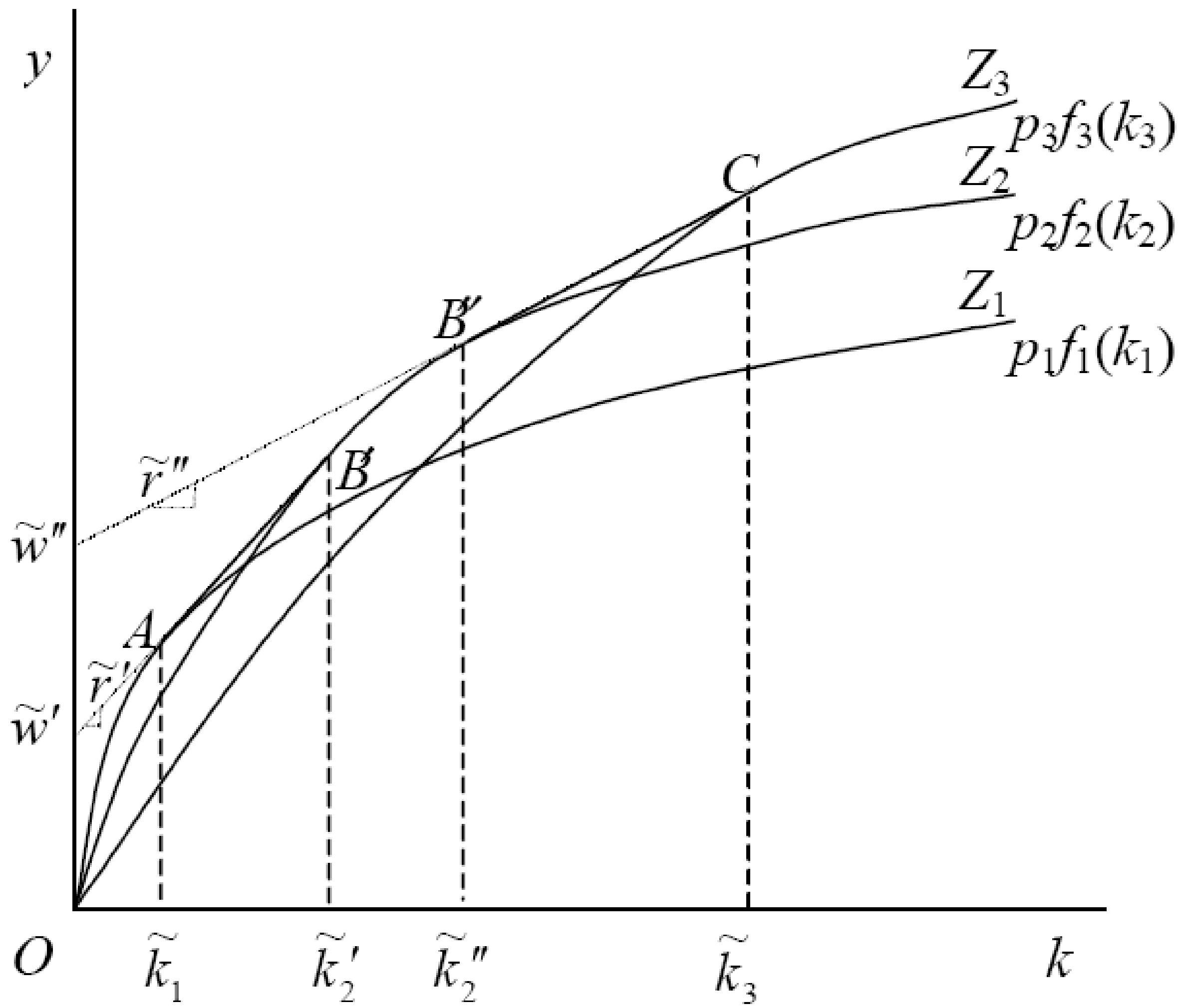
In fact, FPE itself is sometimes imposed as an assumption on these models, generally resulting in multiple steady states in which initial endowments are the determinant of where a particular economy will converge. In other cases, conditions are established such that initial endowments become irrelevant to the conclusion of convergence after the initial period or periods. For example, Chatterjee and Shukayev (2006) show that the introduction of uncertain technological shocks can reverse the conclusion of income convergence as compared to a deterministic dynamic model, which generates income convergence even with large differences in initial endowments. Others, such as Ventura (1997) and Bajona and Kehoe (2008), look at the relationship between factor endowments, specialization, and convergence and conclude that the elasticity of substitution among traded goods determines whether income levels will converge. Further, Bajona and Kehoe construct an example where countries' income levels may not converge under an imposed assumption of factor price equalization, but also may converge when factor price equalization is not assumed. This is a special case, but it illustrates the variability of outcomes that are derived from the theoretical literature on dynamic HO models.

The result of factor price equalization due to trade has historically resulted from what is termed a "single-cone" HO model, where factor endowments across countries are relatively similar. All of the dynamic HO models cited above are single-cone frameworks, and as noted result in varying conclusions regarding factor price equalization. However, in extensions of HO to allow for multiple cones, due to differing endowments or behavior, the assumption of global factor price equalization no longer holds. Deardorff (2001) presents several examples of a multi-cone HO model which provide additional insights for the actual patterns of trade and factor prices that we observe in real world data. Importantly for purposes of this analysis, he also shows that most neoclassical growth models, including Solow and extensions by Stiglitz (1970), are more consistent with multi-cone steady states. Factor price equalization may occur within cones, but not across cones. This is consistent with the presence of "convergence clubs" in the macro literature, and also turns out to be a very similar conclusion to the observations from the wage data in this paper.

Formally extending the results of dynamic HO models to a multi-cone framework, while analytically daunting, likely would cloud the results even further. However, as noted by Schott (2003) and others, ignoring the potential for multiple cones of specialization may lead us to inaccurate conclusions regarding wages and globalization. For example, Bajona and Kehoe (2006) show that international borrowing and lending generates factor price equalization regardless of the assumption of overlapping generations or infinitely-lived consumers. In a multi-cone case, this conclusion would not hold and could lead to the conclusion of a GDP/wage gap in the process.

To illustrate this difference, consider a simple illustration of a multi-cone HO model (Figure 2.2, reproduced from Deardorff (2001)) in which we retain labor rigidities across countries but allow for international borrowing and lending as in Bajona and Kehoe's analysis. In the multi-cone case, it is possible for GDP to rise in the more labor-intensive trading partner without an increase in wages. Assume two countries, Country 1 being labor-abundant and producing goods $Z_1$ and $Z_2$, and Country 2 being capital-abundant and producing goods $Z_2$ and $Z_3$. Country 2 can take advantage of the higher return to capital in Country 1, and shifts some of its allocation of capital there without moving outside of its cone. At the margin, this increases the output of Country 1, which may be produced for local consumption or for export to Country 2. Wages do not change in either country, since each is still within its cone. This result requires other limitations on capital mobility to avoid complete equalization of returns to capital and labor. But even if we allow for that possibility, the equalization takes place at different country endowments, which is different than the single-cone case in Kehoe's example where equalization of returns to capital and labor can occur at any factor endowment within the cone.

Figure 3.2: Illustration of Two-Cone Heckscher-Ohlin Model



Section 4: Regression Tests of Heckscher-Ohlin Models

Several recent papers have noted the limitations of single-cone models in capturing the observed patterns of trade and income across countries. In addition to Deardorff's review of growth models and support for multi-cone HO models, noted previously, there is a growing literature of empirical studies that either directly or indirectly address the question of multiple diversification cones.

A range of papers on intra-industry trade, including Davis and Weinstein (2001), Bernard, Jensen and Schott (2006), and Redding (2002), address the question of multiple cones indirectly, by demonstrating that aggregate industry data may mask important relationships between factor endowments, technology and factor prices.[4] Papers looking at the elasticity of substitution as a key driver may also be interpreted as providing support for the multi-cone framework. More direct evaluation of multi-cone cases has been undertaken by Schott (2003) and Bernhofen (2007), among others, with differing conclusions regarding the evidence for multi-cone steady states.

These papers are similar in that they tend to focus on decomposing trade data in order to support evaluation of the factor proportions framework coming from HO theory. Their contribution is important in identifying limitations of the constant-technology assumption for countries with different initial endowments. As Schott notes, output in a relatively labor-intensive manufacturing sector such as apparel may rise with capital accumulation for a labor-abundant country, but fall for a capital abundant one. This observation also is consistent with the identification of convergence clubs in Chapter 2,

[4] This feature of intra-industry trade dynamics will also be relevant to the analysis in Chapter 4 of variations in Mexican wage growth in subsectors of the manufacturing industry.

as groups of countries are identified approaching common steady states due to their similar adaptation to a common external factor such as technology.

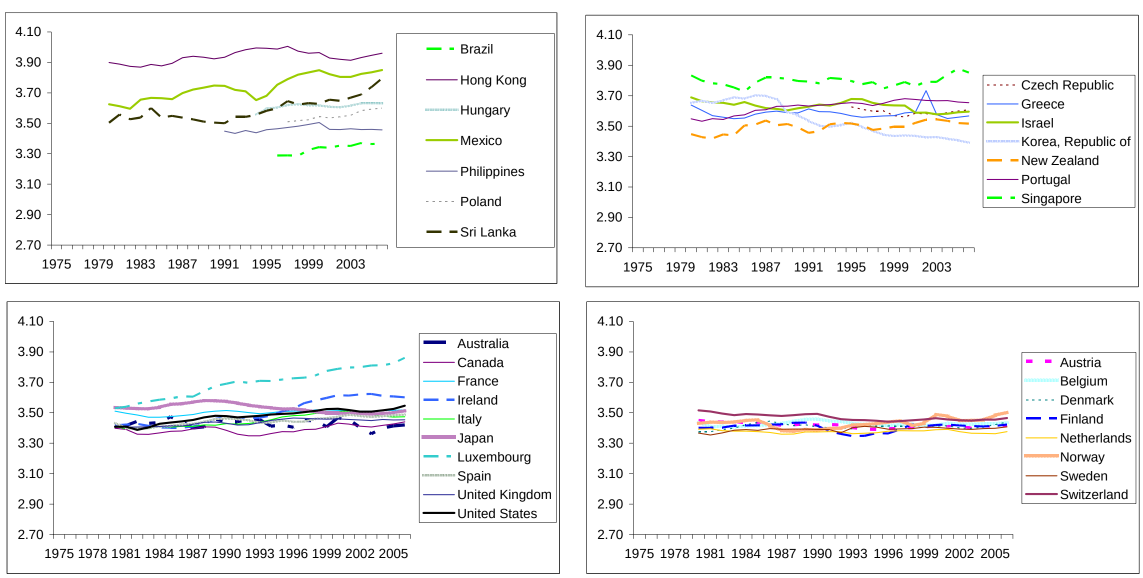
This paper utilizes such insights, but takes a different approach to the convergence question by looking at highly aggregated data for three sectors: manufacturing, agriculture, and services. This approach is further guided by utilizing information on groups of countries where there is a priori evidence of convergence in manufacturing wages. These groups can be broadly thought of as potential "cones" of diversification, within which factor price equalization should hold. Once the cones have been established, I examine the relationship between determinants of GDP and manufacturing wages for each group. If these groups do represent multiple cones of diversification with different factor endowments and potentially different productive technologies across cones even for the same sector, we would expect to see variation in the influence of these determinants on GDP and manufacturing wages across groups. In fact, that is a conclusion of the analysis.

## Section 5: Characterization of GDP and Labor Cost Data

The first Appendix table summarizes the average annual growth in GDP per capita and labor compensation costs in manufacturing (referred to for simplicity as wages) for the 33 countries in the dataset, grouped into the wage convergence clubs determined in Chapter 2. It is striking that the average ratio of GDP growth to wage growth is quite close to 1 for most of these markets, notably in the more developed markets of the High Wage and Industrial Core groups. Taking into account the Heckscher-Ohlin model implications, these data suggest that most of the developed markets may be closer to a steady state level in their trade and production profiles. There are notable exceptions among the unallocated markets, although the time series data for several of these countries, such as Brazil, are available only from the mid-1990s. Even in the Industrial Core, however, Ireland, Luxembourg and most notably, the United States, are relative outliers with higher GDP growth relative to wages. Greece, Korea and Israel stand out in the Catching Up group as having higher wage growth relative to GDP.

If we are interested in convergence issues, time series characteristics of these data will also be important. Figure 3.3 shows log (GDP per capita/labor cost) for the 33 countries in the BLS dataset and World Bank data on GDP per capita. For purposes of illustration, the countries are grouped into four groups, ranked from lowest to highest wages, parallel to the progression of wage levels in the convergence clubs.

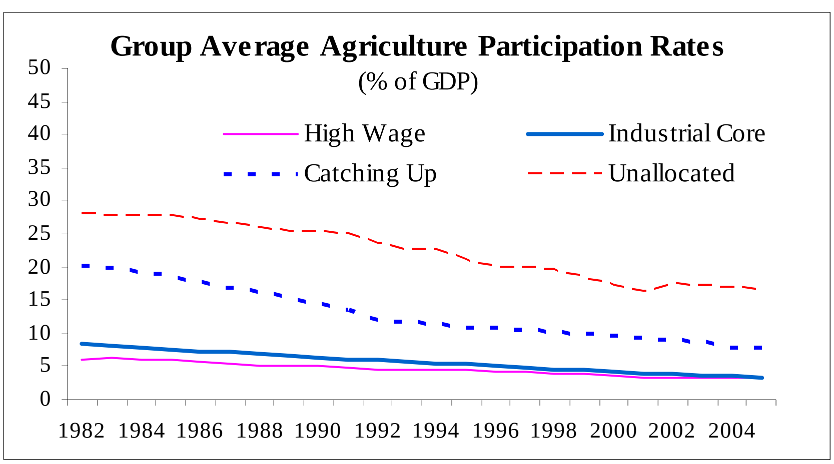
Figure 3.3: Log(GDP per worker/Compensation Costs) Tiered by Final Wage Levels

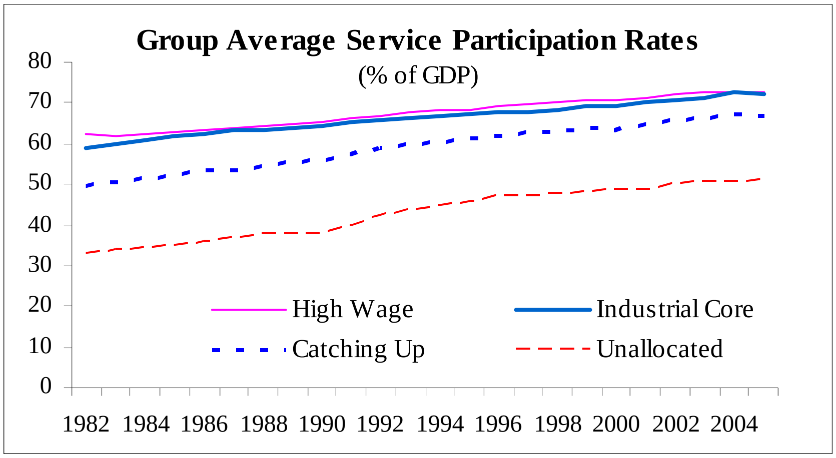


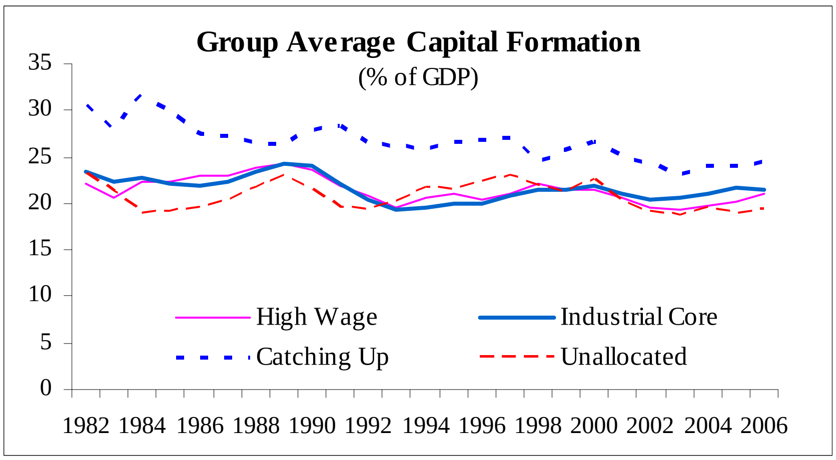
These data suggest that countries with higher wages have reached a period of greater stability in the relationship between GDP per capita and manufacturing wages, as evidenced by the bottom right panel. The second tier of countries in the bottom left panel are more closely clustered, but still appear to be in a period of rising GDP relative to wages. The data for the lower wage countries are much more dispersed, but with most markets demonstrating a similar trend of elevated GDP per capita growth.

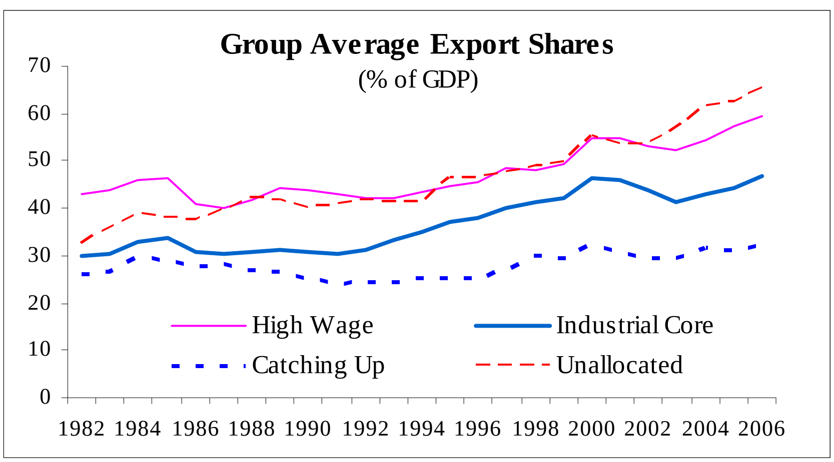
While these observations are interesting, a more important question for purposes of this analysis is the reason for these differences in relative growth rates of GDP and wages. To address that question, World Bank data were also collected on labor force participation rates; percent of labor force employed in manufacturing, agriculture and services; capital formation (as % of GDP); and exports (as % of GDP) for each country. The rationale for including each of these factors is discussed in more detail in Section 6. Figure 3.4 shows how the key variables develop for the three convergence clubs and unallocated markets. The second table in the Appendix illustrates how these variables differ across the individual countries in this dataset.

Figure 3.4: Historical Performance of Explanatory Variables by Country Grouping




Group Average Service Participation Rates
(% of GDP)
80
70
60
50
40
30
20
10
0
High Wage
Industrial Core
Catching Up
Unallocated
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004


Group Average Capital Formation
(% of GDP)
35
30
25
20
15
10
5
0
High Wage
Industrial Core
Catching Up
Unallocated
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006


Group Average Export Shares
(% of GDP)
70
60
50
40
30
20
10
0
High Wage
Industrial Core
Catching Up
Unallocated
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006

Labor force dynamics are relatively similar, particularly the pattern of increasing labor force participation in services. The lower wage countries also have, as expected, much higher labor force participation rates in agriculture at the start of the period, but across the board we observe a decline in this metric for both developed and emerging markets.

Capital formation as a percent of GDP is also surprisingly similar across the groups. This similarity will be noted again in examining the relative difference in capital formation as a driver of GDP/wage gaps in the different groups. The unallocated markets and High Wage countries have on average the highest exports as a percent of GDP, although the unallocated markets have a more pronounced upward trend than the High Wage. The Catching Up countries have a surprisingly flat trend for export shares, a fact that will be noted later in evaluating the regression results.

An interesting aspect of the data in the Appendix table is the extent of within-group variation, especially in the middle set of markets which correspond to the large convergence club 2 in the previous chapter. It raises an important consideration, which is the potentially different path by which each country may reach a particular tier in the wage distribution. In other words, one size does not fit all in explaining the forces for or against convergence in GDP and wages. This issue will be addressed further in the analytical results with the application of country-specific coefficients and fixed effects. But at a high level, this observation suggests that the decomposition of this group into the Industrial Core and Catching Up markets may help to clarify the GDP/wage dynamics and the existence of two distinct cones within that larger group.

Section 6: Regression Framework

There are two estimation exercises undertaken in this section. The first is a simple regression of manufacturing compensation on GDP per worker, to test for the presence of a GDP/wage gap and evaluate its size. The second exercise is the estimation of causal factors for the GDP/wage gap. These results are then interpreted within the HO multi-cone framework.

As noted previously, in a Solow growth model steady state growth in wages and GDP should equalize. In the context of a regression of wages on GDP, as in (1) below, this implies the coefficient on GDP should not be significantly different from 1.

$$\log(\text{Manufacturing Compensation}) = a + b \log(\text{GDP/worker}) + \mu \qquad (1)$$

The regression results in Table 3.1 show that this is not the case for the full sample. GDP in this regression was calculated as GDP per labor force, to control for the effect of changing labor force participation rates on relative GDP performance.

In the sample of 32 countries from the Bureau of Labor Statistics dataset, the coefficient on log(GDP) was 0.926 implying that compensation cost growth averages just 93% of growth in GDP per capita. This coefficient was significantly different from 1, with a t-statistic of 12.1.

When the compensation cost convergence clubs from Chapter 2 are used as the basis for the regression, the resulting coefficients are very different across subgroups of this sample. For the highest wage countries that made up the "High Wage" club, the coefficient on GDP is not significantly different from 1. However, among the Industrial Core group and the unallocated markets, the gap is statistically significant, with GDP growing more quickly than wages in both cases. For the Catching Up markets, the coefficient is slightly greater than one, and it just meets the criteria for statistical significance at the 5% level (t-stat of 2.3 versus critical t-value of 2.04 with 30 degrees of freedom). These results support the broad hypothesis that countries in different stages of development generate different economic outcomes, and in particular that the clubs identified in Chapter 2 do demonstrate some distinct characteristics. However, stage of development is clearly not the only factor, as the Industrial Core countries have a larger GDP/wage gap than both the High Wage countries above them and the Catching Up countries below. This suggests that there are economic characteristics beyond income level that differ across these identified groups. This observation will be important when considering the explanatory factors for GDP/wage differentials in each set of markets.

Table 3.1: Results of Regressing log(Manufacturing Compensation) on log (GDP/worker)

| | **Coefficient on GDP** | **t-statistic against Ho: coeff=1** | **Regression R-squared** |
|---|---|---|---|
| Full Sample | 0.926 | 12.1 | 0.991 |
| High Wage | 1.000 | 0.0 | 0.989 |
| Industrial Core | 0.840 | 19.5 | 0.957 |
| Catching Up | 1.026 | 2.3 | 0.967 |
| Unallocated Markets | 0.805 | 12.9 | 0.990 |

The relationship between GDP per capita and wages can provide useful insights about the forces driving convergence, as pointed out by O'Rourke and Williamson (1999) and others. For example, if migration is the key driver of convergence, then GDP per capita would rise more quickly than GDP per worker in countries receiving an influx of labor, and wage rates would fall relative to capital or land shares of income. With technological advance driving convergence, returns to both labor and capital could rise. If trade is driving convergence, then the assumption of a single- or multiple-cone HO framework will have important implications for whether wages rise relative to expansion in GDP. In this section, I will focus on a HO-based framework to address some of these questions.

In contrast to studies that attempt to disaggregate trade data in order to identify evidence of specialization or factor content, I start with a broad characterization of a three-good HO model in which the goods in question correspond to three aggregated sectors of the economy: agriculture, services, and manufacturing. This broad decomposition has been utilized in previous theoretical and empirical trade studies, most notably Hertel (1997). It can be justified, in part, by assuming labor is more mobile within a sector than across sectors.

Such a construction, however, requires ranking the relative capital intensity of the three sectors. Agriculture is ranked, without much debate, as the most labor-intensive. The service sector is often cited as being the next most labor-intensive, but this categorization is not entirely clear. Many "cottage industry"-type service providers, such as barbers, lawn care services, and so on, would fit this conclusion. But if we focus in particular on the tradable service sector as most relevant to this study, we have to consider today's advanced professional service industries (such as radiology providers in health care) which make intensive use of computers and other high-cost equipment. I will begin with an assumption of tradable services being the most capital-intensive.

To establish an analytical framework that addresses some of these questions, it is first important to take into account the influence of changes in labor force participation on wages. By using GDP per labor force in the GDP/wage variable on the left hand side of the equation, I have a proxy for overall productivity, as well as controlling for the effect of an increase in the supply of labor relative to the population, which would cause wages to grow more slowly than GDP per capita (i.e. the ratio of GDP to wages would increase). This is a direct implication of the national accounts framework noted in Section 1.

However, keeping in mind the three sector framework, other aspects of labor force participation may influence manufacturing wages. The impact of a move of labor out of agriculture and into industry may be large enough for some markets, especially newly developing markets, to influence relative wages between the agricultural and manufacturing sectors. Similarly, developed markets may be experiencing a move out of manufacturing and into service sectors that would be significant. With a priori assumptions about the relative productivity in one sector versus another, growth theory provides some indication on the sign of these variables in our estimation, due to the effect such transitions would have on labor productivity in the industrial sector and for the economy overall. For example, in the case of a transition from agriculture into manufacturing, we could expect productivity in the manufacturing sector to go down as these workers are incorporated into the labor force, due to training costs and a less applicable skill set. This would imply slower growth for manufacturing wages if workers are paid their marginal product. At the same time, we would expect a net improvement in GDP per worker, as these workers are more productive in the manufacturing sector than they were in agriculture. Both of these factors would suggest a negative sign on agricultural labor force participation, as overall productivity in the economy rises (higher GDP/worker) and productivity in manufacturing falls (lower wages).

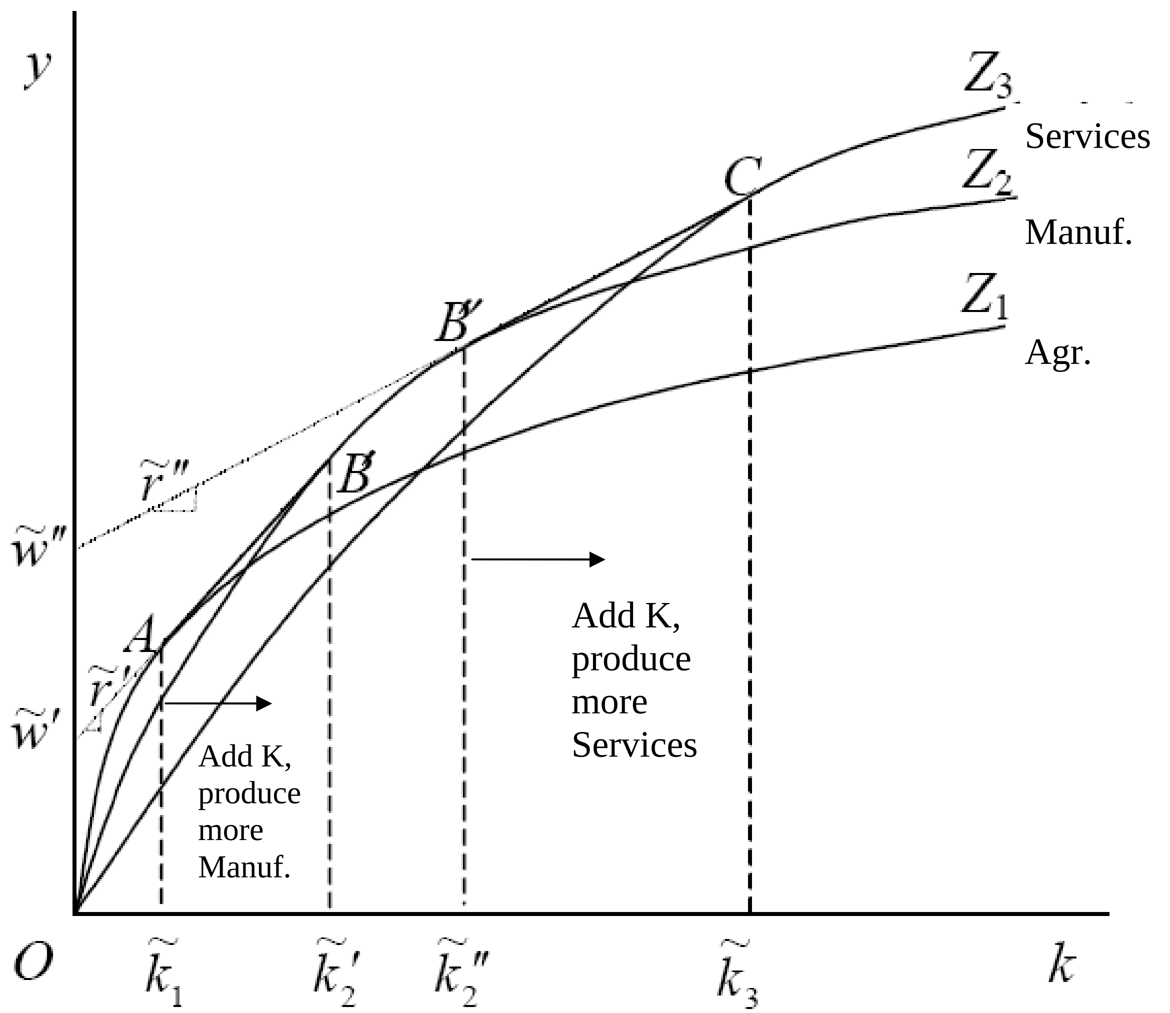
Capital formation is assumed to increase investment in industry in order to raise production, either via new investment capacity or technological improvements in production processes. Through either increased demand for labor, or increased productivity of existing workers, these actions would tend to bid up wages. As overall GDP/worker would also rise, the direction of the relationship between the GDP/wage ratio and capital formation is ambiguous.

However, if we put these variables in the context of a three-sector HO model as described above, with all countries operating along their production frontier and some set of convergence clubs or "cones of specialization", the expected relationships between these variables becomes clearer. Figure 3.5 repeats the diagram from Deardorff (2001) but with the three sector characterization imposed. As a starting point, manufacturing has been ranked as the good of intermediate capital-intensity, but the conclusions are easily translated to an alternative ranking. One possible alternative would be to use agriculture, labor-intensive manufactures and capital-intensive manufactures as the three sectors, building on the "export ladder" theories of trade and development. Of course, by design this is an oversimplification, as any individual country does not, for example, abandon agriculture by the time it achieves efficiency in the production of capital-intensive manufactured goods. But for purposes of examining macro-level data, these general characterizations may serve to capture the broad trends that are taking place over time and across countries.

For countries in the lower cone in Figure 3.5, producing a mix of agricultural and manufactured products, adding capital will lead to an increased production of manufactured goods as the country moves toward a higher capital-labor ratio. Output (and possibly exports) would increase as a result of the additional productive resources being utilized. Labor force participation rates in agriculture might fall, but wages should remain unchanged, if the country remains within the FPE range of the cone (between endowments $k_1$ and $k_2'$). Thus the relationship between capital formation and GDP/wages becomes unambiguously positive for countries in this cone. For countries in the upper cone, additional capital would increase the production of services, again with no change in wages, the relationship between capital formation and GDP/wages should be positive.

Variables to capture trade-specific factors are also incorporated. Under the standard comparative advantage result that a country exports the good it produces most efficiently, a rise in the export share of GDP should be associated with an increase in GDP per worker. The sign on exports in the estimation, however, depends on the impact of increased trade on the denominator, wages. Applying the Stolper-Samuelson theorem that trade should benefit a country's abundant factor, we would expect wages to rise in tandem with GDP per worker if the country is labor-abundant relative to others in its cone. This last part is important in the context of a multi-cone model, and I will return to it in a moment. If the country is capital-abundant, wages would not rise as quickly as GDP per worker, and the sign on exports would be unambiguously positive[5].

Figure 3.5: A Three-Sector Heckscher-Ohlin Model Illustrated




[5] This conclusion would become more complicated if we tried to include a consideration of human capital embodied in the labor force. Although the wage data capture only production workers in manufacturing, not management or other professional workers in the sector, it remains possible that there are differences in the degree of human capital embodied in the labor force across countries in the data set, based on education/skill levels, etc.

Using the pooled time series/cross section data set described in Section 4, these elements are incorporated into the regression:

$$\log(GDP/worker) - \log(ManfComp) = \beta_1\, agr + \beta_2\, serv + \beta_3\, capital + \beta_4\, exports + \mu \qquad (2)$$

where GDP/worker is nominal GDP per worker in USD; ManfComp is nominal USD hourly compensation costs in manufacturing; agr and serv are the shares of the total labor force in the agriculture and services sectors, respectively; capital is capital formation as a percent of GDP; exports is the export share of GDP; and $\mu$ is an error term [6].

Given the cyclical momentum in GDP and compensation data, it is also appropriate to include time period dummies, to allow for potential serial correlation in the error term, $\mu$, across periods. These dummies are included for periods 1981-2005, but are not shown in (1) for ease of exposition.

As in any panel data evaluation, once the variables of interest have been established it is necessary to consider the potential for fixed effects in the cross-section units, in this case, cross-country. If countries are likely to have structurally different responses to any of the right hand side variables, omitting these fixed effects from the regression structure may generate biased estimates of their coefficients. Alternatively,

[6] An export value index was also included in preliminary model estimations to capture the presumed impact on wages of exporting higher value-added products. This line of thinking is consistent with work estimating the factor content and productivity embedded in exports. For example, Hausman, Hwang and Rodrik (2005) have shown that what they term the "income level" of a country's exports, measured by the relative productivity of traded goods, can affect subsequent growth. However, the coefficient on this variable was highly insignificant, and it resulted in a loss of country data since several markets did not have data available for any time periods. As a result, it was dropped in subsequent model runs. Foreign direct investment was also used in early iterations of the regression equation, but was insignificant in all cases. Capital formation is a broader measure, capturing both externally financed capital (FDI) and domestically financed, so it appeared that FDI did not add material information to the results.

we may consider country-specific coefficients for some of the variables, which would take the place of country fixed effects if the variation in the variables is not large across countries and over time. This feature of the panel data will be utilized in evaluating the regression results below.

## Section 7: Regression Results

The summary results from a preliminary analysis with cross-country fixed effects are shown in Table 3.2. The full results, including country fixed effects and time dummy values, are shown in the Appendix. The coefficient on service sector participation is negative and is significant, consistent with a move of less-productive service sector workers into manufacturing over time.[7] The coefficient on agriculture participation is not significant. This result likely is due to the relatively larger representation of developed markets in the full data sample, for which shifts out of agriculture already were completed in periods prior to this time series.

Among the trade variables, exports and manufacturing exports both are positive and significant, indicating that production workers in manufacturing, on balance, do not capture a proportional share of the gains from trade. Capital formation is also positive and significant, suggesting that wages do not benefit as much as overall productivity from additions to the capital stock. These results are consistent with the data in Table 3.1, which showed GDP/worker for the full sample growing more quickly than manufacturing wages.

[7] The sign on service sector participation may be positive if the shift taking place is toward greater employment in the more physical- and human-capital intensive service industries. This possibility will be discussed in greater detail in the results for individual convergence clubs.

Table 3.2: Regression Results Using Full Sample
Dependent Variable: log (GDP per capita/Manufacturing compensation costs)

| **Full Sample Results** | **Coefficient** | **t-Statistic** | **Probability** | **Significant at 5% level** |
|---|---|---|---|---|
| Constant | 3.4154 | 73.3196 | 0.0000 | y |
| Participation in Agriculture | 0.0007 | 0.9088 | 0.3638 | n |
| Participation in Service Sector | -0.0029 | -3.9542 | 0.0001 | y |
| Capital Formation | 0.0016 | 2.3083 | 0.0213 | y |
| Exports | 0.0017 | 8.0462 | 0.0000 | y |

Regression R-squared: 0.9346

However, these aggregate results are difficult to interpret in a HO world, even a single-cone one, as labor in some (labor-abundant) countries should benefit from increased trade. Again thinking of the results in Table 3.1, the countries in the Catching Up group (with wages growing slightly faster than GDP/worker in the aggregate) would appear to be a likely candidate for such a condition. This observation points again in the direction of decomposing the full set of countries into appropriate sub-groupings for further analysis.

## Results for Convergence Clubs

A central hypothesis of this chapter is that, if the convergence clubs identified in Chapter 2 can be taken to represent HO cones of specialization, then the direction and significance of the explanatory variables of the gap between GDP and wages may differ substantially across these groups. The data in Table 3.1 did show a difference in the size of the GDP/wage gap among the groups, and not solely as a progression of income levels. This section will demonstrate that the impact of the explanatory variables in (1) also differs in meaningful ways across the three identified convergence clubs and unallocated markets.[8] A summary of the regression results by group is in Table 3.3.

High Wage

This club is composed of seven northern European countries, with the highest nominal wage rates among the four identified groups.

The coefficients on both agriculture and service sector participation are negative and significant, but with the coefficient on agricultural participation almost twice as large as service sector participation in influencing manufacturing wages relative to GDP growth. This outcome is surprising, and may be due to the offsetting effects of low- and high-productivity workers within the service sector. As lower productivity workers leave service sector employment and move into manufacturing, overall economic productivity should rise, while productivity in the manufacturing sector may fall due to the influx of less-skilled workers. This generates the observed negative coefficient on service sector participation rates. By contrast, if labor force participation rates are rising in the service sector due to the expansion of highly productive, physical and human capital intensive industries, overall economic productivity could rise more quickly than productivity in the manufacturing sector, leading to a positive relationship between service sector employment and the GDP/wage gap for manufacturing workers. This effect would be an offset to the negative sign on service sector participation. The smaller coefficient, also by about half, on services versus agricultural participation rates is observed for the Industrial Core group as well.

[8] The fourth club, composed of Hong Kong and Taiwan, is not shown in this analysis as the World Bank does not publish country data for Taiwan. Hong Kong is grouped with the unallocated markets for purposes of this section.

Table 3.3: Regression Results by Convergence Club
Dependent Variable: log (GDP per capita/Manufacturing compensation costs)

| **High Wage** | **Coefficient** | **t-Statistic** | **Probability** | **Significant at 5% level** |
|---|---|---|---|---|
| Constant | 3.9470 | 50.4381 | 0.0000 | y |
| Participation in Agriculture | -0.0115 | -4.2697 | 0.0000 | y |
| Participation in Service Sector | -0.0064 | -5.6212 | 0.0000 | y |
| Capital Formation | -0.0001 | -0.0629 | 0.9499 | n |
| Exports | 0.0008 | 1.2743 | 0.2050 | n |

Regression R-squared 0.8627

| **Industrial Core** | **Coefficient** | **t-Statistic** | **Probability** | **Significant at 5% level** |
|---|---|---|---|---|
| Constant | 3.3648 | 41.1540 | 0.0000 | y |
| Participation in Agriculture | -0.0068 | -4.4437 | 0.0000 | y |
| Participation in Service Sector | -0.0034 | -2.3393 | 0.0203 | y |
| Capital Formation | 0.0063 | 11.1137 | 0.0000 | y |
| Exports | 0.0015 | 4.2992 | 0.0000 | y |

Regression R-squared: 0.9404

| **Catching Up** | **Coefficient** | **t-Statistic** | **Probability** | **Significant at 5% level** |
|---|---|---|---|---|
| Constant | 3.0556 | 9.3092 | 0.0000 | y |
| Participation in Agriculture | 0.0036 | 1.5375 | 0.1267 | n |
| Participation in Service Sector | -0.0029 | -0.8182 | 0.4148 | n |
| Capital Formation | -0.0002 | -0.1928 | 0.8474 | n |
| Exports | 0.0020 | 2.2238 | 0.0280 | y |

Regression R-squared: 0.7972

| **Unallocated Markets** | **Coefficient** | **t-Statistic** | **Probability** | **Significant at 5% level** |
|---|---|---|---|---|
| Constant | 3.3764 | 80.6711 | 0.0000 | y |
| Participation in Agriculture | -0.0051 | -3.3112 | 0.0013 | y |
| Participation in Service Sector | 0.0025 | 1.6617 | 0.0998 | n |
| Capital Formation | 0.0086 | 8.3877 | 0.0000 | y |
| Exports | -0.0007 | -3.1352 | 0.0023 | y |

Regression R-squared: 0.9839

The negative sign on these labor force coefficients is not inconsistent with a position within a cone of specialization for these markets. However, the other results point in a different direction. Capital formation and exports are not significant influences on the GDP/wage gap for this group, indicating that manufacturing wages rise at a comparable rate to GDP/worker in response to increased trade and to capital stock expansion. This outcome is consistent with the outcome for this group in Table 3.1, which showed a coefficient not significantly different from 1 in a regression of wages on GDP/worker, and suggests that wage growth is not fixed in this group. Thus, the bulk of the evidence points to this group being in transition outside of a Heckscher-Ohlin cone of specialization, as factor price equalization does not appear to be locking in wage growth.

Industrial Core

For this group, which includes developed markets such as the U.S., Canada, UK and other major European markets, the results in Table 3.1 showed a coefficient on GDP/worker that was less than 1. Thus, we may have an initial hypothesis that these countries are within an HO cone of specialization, where wage growth is fixed and does not rise in tandem with GDP/worker.

All of the explanatory variables in regression (2) are significant for this group, and support this initial hypothesis. The coefficients on agricultural and service sector participation rates demonstrate the same relationship as described for the High Wage markets above. The significant negative signs on labor force participation rates for both of these sectors indicate that, as labor is being allocated to its most productive uses, GDP rises but wages may be fixed by the forces of factor price equalization.

The sign on capital formation is positive, also consistent with a position within an HO cone, where increases in capital formation drive higher GDP growth, while wages remain fixed by FPE.

The sign on exports is positive, indicating that wage earners do not capture the benefits from increased trade. Again, if these countries sit within an HO cone, the benefits from trade should accrue to the abundant factor under Stopler-Samuelson conditions. Thus, we can conclude that these markets are relatively capital abundant compared to other trading partners within the cone.

Catching Up

This group of markets includes a geographically diverse group of newly-industrialized nations, from Spain and Ireland in Western Europe, to Singapore and Korea in Asia-Pacific, and Israel and Greece on the Mediterranean. For this group, the signs on the labor force participation rates and capital formation were not significant, indicating either that manufacturing wages are growing in tandem with GDP/worker for changes in these variables, or that the movements in these variables over time were not large enough to generate a significant coefficient.

The only variable that does enter with significance in the regression equation is the export share. This result is surprising for this group, given that the Catching Up markets demonstrated strong wage growth in manufacturing, with a coefficient slightly greater than 1 on log(GDP/worker) in Table 3.1. It seems that manufacturing wages are benefitting during the transition period for these countries, though not directly from increased trade. It is notable that the R-squared for the regression on these markets is much lower than for any other group, also suggesting less overall explanatory power of Equation 1 to capture the reasons for the GDP/wage gap for this group of countries.

Returning to the consideration of HO cones of specialization, there are two ways to characterize the regression results. The first potential explanation is that these countries are in the same cone of diversification with the Industrial Core group, but at the lower end; that is, they are labor abundant relative to the other members of the group. This would explain the relative strength of manufacturing wages relative to GDP/worker, as wages move in the direction of FPE with the more developed markets of the Industrial Core. But it is inconsistent with the positive sign on the export variable. It could be that, in the early stages of development, domestic demand for manufactured goods is growing so strongly in these markets that it absorbs goods that would otherwise be exported, thus skewing the results for the export variable. This conjecture is supported by the data in Figure 3.4, which showed a relatively flat export share of GDP for these markets as compared with all three of the other groups.

An alternative explanation is that these markets are moving along a path between two cones, possibly on the cusp of joining the Industrial Core in that cone of specialization, so that they have not yet achieved the optimal capital-labor allocation between sectors and factor price equalization. This conclusion would be broadly consistent with the lack of significance in the coefficients on capital formation and labor force participation. It is also worth noting that these markets weakly passed the convergence test in Chapter 2, and thus could have been grouped as a single convergence club with the industrial core.

Based on these mixed results, it is plausible to conclude that this group of markets was in the process of transitioning between cones to join the Industrial Core countries sometime during the period covered by this study. Follow-up evaluation of this group of markets in the future with a longer time series could confirm this conjecture.

Unallocated Markets

This group is composed of lower-wage emerging markets including Brazil and Mexico in Latin America, Sri Lanka and Singapore in Asia, and Eastern European markets such as Hungary and the Czech Republic. These markets did not form a convergence club in terms of wage growth, and so it may be inappropriate to attempt to represent them as a diversification cone. In addition, several of the markets have truncated data availability, from just the mid-1990s onward, so the comparison with the other market groups is not completely parallel. However, the estimation of equation 1 does represent a fairly good fit based on the regression R-squared, so the coefficients may still give some information regarding the influence of trade on GDP growth and wages in these markets.

Agricultural sector participation has a negative coefficient and is significant, consistent with expectations, but the service sector participation rate was not significant for these markets. Although the underlying data in Figure 3.4 do show a trend toward rising service sector participation in these markets, the same as for the other three groups, there may not be sufficient flows of labor between services and manufacturing to enter into the estimation with significance. This also suggests that these markets may be in an HO cone where trade is concentrated between the Agriculture and Manufacturing sectors, with service sector activity still focused on non-tradable services.

The capital formation variable was positive and significant for these markets, consistent with growing GDP and fixed wages as we would see within an HO cone. The sign on exports was negative and significant, indicating that the benefits from trade accrue to labor in these markets, consistent with labor-abundant endowments.

Table 3.4 provides a summary of the conclusions for each group of markets in the context of the multi-cone Heckscher-Ohlin framework. While not all of the results are conclusive, in particular the mixed results for the Catching Up markets, it is apparent that there are different dynamics at work for each of the country groups with regard to GDP, wages, capital-labor allocation and trade. These dynamics appear to be quite consistent with a multiple-cone Heckscher-Ohlin view of the data.

Table 3.4: Summary of Regression Results from Multiple-Cone HO Perspective

| | **From Regression (1)** | **From Regression (2)** | | |
|---|---|---|---|---|
| | **Estimated Ratio of Wage Growth to GDP** | **Labor** | **Capital** | **Trade** |
| High Wage | 1.000 | Shifts in both Agriculture and Service sectors | Capital formation not significant | Exports not significant |
| | **Multi-Cone HO Implication: In transition out of upper cone, with emphasis on service sector trade** | | | |
| Industrial Core | 0.840 | Shifts in both Agriculture and Service sectors | Capital formation generates positive GDP growth (wages fixed) | Capital benefits from increased trade |
| | **Multi-Cone HO Implication: In upper segment of cone trading in Manufacturing and Services** | | | |
| Catching Up* | 1.026 | Shifts in participation by sector not significant | Capital formation not significant | Capital benefits, but trade share fairly flat* |
| | **Multi-Cone HO Implication: Likely on leading edge of cone trading in Manufacturing and Services** | | | |
| Unallocated Markets | 0.805 | Shifts in Agriculture are significant | Capital formation generates positive GDP growth (wages fixed) | Labor benefits from increased trade |
| | **Multi-Cone HO Implication: In lower cone trading in Agriculture and Manufacturing** | | | |

* Wage growth/GDP >1 shows labor benefits in the aggregate, but no explanatory variable in the model captures this effect on wages.

Additional Characteristics

Studies examining the effect of trade on wages generally use two types of measures of trade openness. The first is export volume, similar to the regressions above. The second common approach is to use a policy-based measure of trade openness. Such measures are usually based on a point in time, or have very limited time series availability. Since many cross-country studies of the impact of trade on growth or wages are static, rather than dynamic, they are able to incorporate such time-insensitive characteristics in their estimation. That is a limitation in the dynamic approach used here.[9]

However, recognizing that the results above may be better informed by understanding domestic labor market conditions, as well as trade policy, data from the World Bank "Doing Business" survey and the Heritage Foundation/Wall Street Journal "Index of Economic Freedom" were collected for evaluation. These surveys each cover over 180 countries and provide measures of the business and policy environment in the areas of legal protections, regulation, and social conditions. The Appendix shows these rankings in detail. It is interesting to note, among the 181 countries covered in the World Bank survey, all but one of the countries covered in this study fall in the top half of countries with regard to trade flexibility (the lowest being Brazil ranked at 92).

[9] It may be possible to include one time-invariant dummy variable if we can eliminate the country fixed effects. This can be done if one or more of the other explanatory variables have limited variation across countries and over time, thus taking on the role of a country fixed effect in the regression estimation.

This observation makes the positive coefficients on the export variables in regression (2) even more striking, as it suggests that growth in trade does not benefit manufacturing workers in the Industrial Core and Catching Up countries.[10]

The rankings for ease of employing workers vary much more widely, with 16 of the 31 countries in the sample falling in the bottom half of countries globally. These countries are shown in Table 3.5, and include a selection of markets from the highest and lowest wage groups. The rankings are not significantly different using data from the Heritage index.

Table 3.5: Selected Data from World Bank Survey of Labor Conditions

**Countries in Lower Half of World Bank Ease of Employment Rankings**

| | Rank |
|---|---|
| Israel | 92 |
| Netherlands | 98 |
| Norway | 99 |
| China | 111 |
| Sweden | 114 |
| Brazil | 121 |
| Philippines | 126 |
| Finland | 129 |
| Greece | 133 |
| Mexico | 141 |
| France | 148 |
| Korea | 152 |
| Taiwan, China | 159 |
| Spain | 160 |
| Portugal | 164 |
| Luxembourg | 167 |

↓ Higher number implies less flexible labor market

Unfortunately, these annual survey data go back less than a decade, and so it is not possible to include them in the regression equation or compare results over time.

[10] This conclusion applies only to hourly production workers, on which the data are based. It may be that non-production workers in manufacturing (management, other professionals) do benefit from expanded trade. It also does not parse out which parties benefit from the returns to capital. Production workers may also be stockholders in their companies, for example.

Further work with this variable might be of use when considering the relative over-performance of manufacturing wages in the High Wage countries relative to the Industrial Core, as noted previously.

Section 8: Examination of Country Fixed Effects

Another aspect of the regression results that may help clarify the existence and composition of convergence clubs, or cones of specialization in the HO framework, are the country fixed effects. In the context of the current model, the fixed effects capture the country-specific influences on the GDP/wage gap. Looking at the results from the full sample regression, we might expect to see the fixed effects ranked from highest to lowest wage countries, and grouped according to the convergence clubs. Table 3.6 shows that this is not the case. The fixed effects themselves, in this formulation, also do not show a consistent pattern. Countries having positive fixed effects include members of all four convergence clubs, ranging from Norway, a member of the highest wage group, to Japan from the Industrial Core group, and Poland from the unallocated group.

Although this result may not make sense in a single-cone HO model, it is not necessarily inconsistent with a multi-cone world. If what matters for the GDP/wage gap is a country's position relative to others within its diversification cone, then the dispersion of country fixed effects in the full sample may mask a pattern of relationships within countries in the various cones. The lines in Table 3.6 show that the ranking of country fixed effects are relatively unchanged when moving from the full sample estimation to the four group-specific ones. The exception to the preservation of rankings is the High Wage group, where Norway moves substantially, and the fixed effects for the other markets in this group are so closely clustered that small changes affect the rankings materially.

Table 3.6: Tracking of Fixed Effects Ranking from Full Sample to Individual Group Estimations

| | Fixed Effect | | Fixed Effect |
|---|---|---|---|
| BELGIUM--C | -0.1525 | NETH--C | -0.0587 |
| PHIL--C | -0.1434 | BELGIUM--C | -0.0192 |
| AUSTRIA--C | -0.1319 | NORWAY--C | -0.0157 |
| BRAZIL--C | -0.1276 | DENMARK--C | -0.0067 |
| NETH--C | -0.1234 | SWEDEN--C | -0.0017 |
| FINLAND--C | -0.1114 | AUSTRIA--C | 0.0006 |
| SWEDEN--C | -0.1015 | SWITZ--C | 0.0849 |
| ITALY--C | -0.0704 | | |
| IRELAND--C | -0.0700 | FINLAND--C | -0.0817 |
| SWITZ--C | -0.0683 | ITALY--C | -0.0439 |
| SPAIN--C | -0.0591 | CANADA--C | -0.0379 |
| DENMARK--C | -0.0551 | UK--C | -0.0246 |
| CANADA--C | -0.0524 | JAPAN--C | -0.0090 |
| KOREA--C | -0.0432 | IRELAND--C | -0.0024 |
| UK--C | -0.0297 | FRANCE--C | 0.0434 |
| CZECH--C | -0.0252 | US--C | 0.0508 |
| POLAND--C | -0.0142 | AUSTRALIA--C | 0.0707 |
| SRILANKA--C | 0.0006 | LUX--C | 0.1222 |
| JAPAN--C | 0.0106 | | |
| SING--C | 0.0179 | KOREA--C | -0.2305 |
| FRANCE--C | 0.0215 | SING--C | -0.1403 |
| NORWAY--C | 0.0267 | SPAIN--C | -0.1326 |
| HUNGARY--C | 0.0301 | PORT--C | -0.0532 |
| US--C | 0.0459 | ISRAEL--C | -0.0189 |
| AUSTRALIA--C | 0.0654 | GREECE--C | 0.1460 |
| PORT--C | 0.0712 | NZ--C | 0.3218 |
| NZ--C | 0.0913 | | |
| GREECE--C | 0.1068 | BRAZIL--C | -0.3133 |
| LUX--C | 0.1217 | CZECH--C | -0.1983 |
| ISRAEL--C | 0.1218 | HUNGARY--C | -0.1542 |
| MEXICO--C | 0.2260 | POLAND--C | -0.1307 |
| HK--C | 0.2464 | PHIL--C | -0.0479 |
| | | SRILANKA--C | 0.0671 |
| | | MEXICO--C | 0.1004 |
| | | HK--C | 0.1835 |

Lines for the unallocated markets are omitted for clarity, but only Hungary and the Philippines change rank by more than one position.

It is also worth noting that the country fixed effects are, in general, quite small relative to the size of the regression coefficients, averaging just 2.4% of the regression coefficient value in the full sample case. Eliminating them, however, substantially reduces the regression R-squared, for example from 0.93 to just 0.46 in the full sample case. Given the relatively small variation in some of the right hand side variables in the estimation, it is likely that these fixed effects, though small, are capturing important information about time-insensitive country characteristics such as land mass and geographic location that are often found to be significant in static examinations of the trade-income relationship.

## Section 9: Conclusions and Areas for Further Research

The regression results in this chapter lend further support to the view that key conclusions of the HO model are supported by the available data, as interpreted within the context of a multiple cone model. In particular, with the groupings of markets that demonstrated evidence of convergence in Chapter 2, this chapter provides additional support to the identified clubs by demonstrating significant differences in the interaction between GDP growth, wages and the explanatory variables. It is noteworthy that these effects can be identified even using broad macroeconomic data, and a generic three-sector trade model. Further research to meld this analytical approach with more narrowly defined groupings of sectors and industries may help to clarify the results even further.

This chapter also speaks to some aspects of the trade and inequality debate, to the extent that production workers in manufacturing seem, on average, to capture less of the benefit from trade than overall economic growth benchmarks. This result is not solely observed among the developed markets, and in fact appears most prominently for the two middle wage groups. The results for the High Wage countries and the lowest wage group of unallocated markets do not demonstrate this effect. This distinction may provide a direction for further research on the question of who benefits from trade.

Appendix

| | | Average Annual Comp Growth 1975-2006 | Group Average Growth Rate | Group Average Comp in 1975 | Group Average Comp in 2006 |
|---|---|---|---|---|---|
| 1 | Sri Lanka | 2.1% | 2.5% | 0.9 | 3.9 |
| 2 | Philippines | 3.2% | | | |
| 3 | Mexico | 2.1% | | | |
| 4 | Brazil | -1.6% | | | |
| 5 | Poland | 6.7% | | | |
| 6 | Hong Kong SAR | 6.8% | | | |
| 7 | Hungary | 7.3% | | | |
| 8 | Czech Republic | 9.4% | | | |
| 9 | Portugal | 5.3% | 7.4% | 1.7 | 13.3 |
| 10 | Singapore | 7.8% | | | |
| 11 | Israel | 6.2% | | | |
| 12 | New Zealand | 4.9% | | | |
| 13 | Korea, Republic of | 13.1% | | | |
| 14 | Greece | 7.5% | | | |
| 15 | Spain | 6.7% | | | |
| 16 | Japan | 6.4% | 5.6% | 4.8 | 25.7 |
| 17 | United States | 4.5% | | | |
| 18 | France | 5.7% | | | |
| 19 | Italy | 5.6% | | | |
| 20 | Canada | 4.7% | | | |
| 21 | Ireland | 6.7% | | | |
| 22 | Australia | 5.1% | | | |
| 23 | United Kingdom | 7.0% | | | |
| 24 | Luxembourg | 4.9% | | | |
| 25 | Finland | 5.9% | | | |
| 26 | Austria | 6.4% | 5.6% | 6.2 | 33.4 |
| 27 | Switzerland | 5.4% | | | |
| 28 | Sweden | 4.9% | | | |
| 29 | Belgium | 5.7% | | | |
| 30 | Netherlands | 5.3% | | | |
| 31 | Denmark | 5.8% | | | |
| 32 | Norway | 5.9% | | | |

Ranked from lowest to highest compensation costs in 2006

Shaded areas reflect convergence clubs (and Unallocated Markets ranked 1-8)

## World Bank Data for Potential Drivers of GDP/Labor Compensation Cost Gaps

| Countries (sorted by 2006 Compensation per hour) | GDP per capita (nominal USD) | | Labor Compensation per Hour (nominal USD) | | % Employed in Agriculture | | Exports (% of GDP) | | Capital Formation (% of GDP) | | FDI Net Inflows (% of GDP) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | 2006 | 1975 | 2006 | 1980 | 2005 | 1975 | 2006 | 1975 | 2006 | 1975 | 2006 |
| Sri Lanka | 281 | 1,422 | 0.28 | 0.54 | N/A | 33 | 27 | 30 | 16 | 27 | 0.0 | 1.7 |
| Philippines | 354 | 1,363 | N/A | 1.07 | 52 | 37 | 21 | 46 | 31 | 14 | 0.8 | 2.0 |
| Mexico | 1,489 | 8,062 | 1.46 | 2.75 | 26 | 15 | 7 | 32 | 24 | 22 | 0.5 | 2.3 |
| Brazil | 1,144 | 5,640 | N/A | 4.91 | N/A | 21 | 8 | 15 | 27 | 17 | 1.1 | 1.8 |
| Poland | N/A | 8,962 | N/A | 4.99 | N/A | 17 | N/A | 40 | N/A | 20 | N/A | 5.6 |
| Hong Kong, China | 2,251 | 27,709 | 0.75 | 5.78 | 1 | 0 | 83 | 205 | 23 | 22 | N/A | 22.6 |
| Hungary | 1,040 | 11,212 | N/A | 6.29 | N/A | 5 | 41 | 78 | 38 | 25 | N/A | 5.4 |
| Czech Republic | N/A | 13,927 | N/A | 6.77 | 13 | 4 | N/A | 76 | N/A | 27 | N/A | 4.2 |
| Portugal | 2,035 | 18,398 | 1.53 | 7.65 | 27 | 12 | 17 | 31 | 23 | 22 | 0.6 | 3.8 |
| Singapore | 2,506 | 31,028 | 0.84 | 8.55 | 1 | 0 | N/A | 246 | 40 | 20 | 5.1 | 17.7 |
| Israel | 3,571 | 20,156 | 2.02 | 12.98 | 6 | 2 | 33 | 44 | 31 | 19 | 0.4 | 10.1 |
| New Zealand | 4,175 | 25,206 | 3.27 | 14.47 | 11 | 7 | 23 | 28 | 27 | 25 | 1.1 | 7.5 |
| Korea, Rep. | 608 | 18,344 | 0.32 | 14.72 | 34 | 8 | 27 | 43 | 29 | 30 | N/A | 0.4 |
| Greece | 3,483 | 27,667 | 1.69 | 16.10 | N/A | 12 | 15 | 19 | 64 | 26 | N/A | 1.8 |
| Spain | 3,138 | 27,760 | 2.52 | 18.83 | 19 | 5 | 13 | 26 | 30 | 31 | 0.6 | 1.6 |
| Japan | 4,448 | 34,194 | 2.97 | 20.20 | 10 | 4 | 13 | 14 | 33 | 23 | N/A | -0.2 |
| United States | 7,519 | 43,968 | 6.16 | 23.82 | 4 | 2 | 9 | 11 | 17 | 19 | 0.2 | 1.4 |
| France | 6,775 | 36,642 | 4.49 | 24.90 | 9 | 4 | 19 | 27 | 23 | 21 | 0.4 | 3.6 |
| Italy | 3,957 | 31,403 | 4.64 | 25.07 | 14 | 4 | 20 | 28 | 24 | 21 | 0.3 | 2.1 |
| Canada | 7,354 | 38,947 | 6.11 | 25.74 | 5 | 3 | 22 | 38 | 25 | 22 | 2.0 | 5.4 |
| Ireland | 2,897 | 51,666 | 3.51 | 25.96 | 18 | 6 | 40 | 81 | 22 | 27 | 1.7 | -0.4 |
| Australia | 6,859 | 34,937 | 5.60 | 26.14 | 7 | 4 | 15 | 20 | 26 | 27 | 0.5 | 3.7 |
| United Kingdom | 4,166 | 39,227 | 3.35 | 27.10 | 3 | 1 | 25 | 29 | 19 | 18 | 1.4 | 5.9 |
| Luxembourg | 8,590 | 88,638 | 6.21 | 27.74 | 6 | 1 | 95 | 177 | 14 | 18 | N/A | 304.9 |
| Finland | 6,191 | 40,000 | 5.06 | 29.90 | 13 | 5 | 22 | 44 | 35 | 21 | 0.2 | 2.5 |
| Austria | 5,256 | 38,878 | 4.50 | 30.46 | N/A | 6 | 30 | 58 | 24 | 21 | 0.2 | 0.0 |
| Switzerland | 9,112 | 50,831 | 6.03 | 30.67 | 7 | 4 | 30 | 47 | 27 | 22 | N/A | 7.1 |
| Sweden | 9,315 | 42,266 | 7.12 | 31.80 | 6 | 2 | 28 | 51 | 25 | 18 | 0.1 | 7.1 |
| Belgium | 6,619 | 37,356 | 5.76 | 31.85 | 3 | 2 | 52 | 88 | 23 | 22 | 1.5 | 15.7 |
| Netherlands | 6,748 | 40,517 | 6.58 | 32.34 | N/A | 3 | 49 | 74 | 22 | 20 | 1.3 | 1.1 |
| Denmark | 7,825 | 50,657 | 6.23 | 35.45 | N/A | 3 | 30 | 52 | 22 | 23 | 0.7 | 1.2 |
| Norway | 8,127 | 71,866 | 6.90 | 41.05 | 8 | 3 | 36 | 46 | 37 | 22 | 0.7 | 1.4 |

Shaded areas represent convergence clubs/unallocated markets group

**Full Sample Results of Regression Equation 1**

Dependent Variable: log (GDP per capita/Manufacturing compensation costs)
Method: Pooled Least Squares
Sample (adjusted): 1980 2005
Cross-sections included: 32
Total pool (unbalanced) observations: 692
White cross-section standard errors & covariance (d.f. corrected)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 3.4154 | 0.0466 | 73.3196 | 0.0000 |
| AGR? | 0.0007 | 0.0008 | 0.9088 | 0.3638 |
| SERV? | -0.0029 | 0.0007 | -3.9542 | 0.0001 |
| CAP? | 0.0016 | 0.0007 | 2.3083 | 0.0213 |
| EXP? | 0.0017 | 0.0002 | 8.0462 | 0.0000 |
| EXPMANF? | 0.0019 | 0.0003 | 5.5859 | 0.0000 |
| YR1981 | 0.0029 | 0.0025 | 1.1460 | 0.2522 |
| YR1982 | -0.0009 | 0.0025 | -0.3504 | 0.7262 |
| YR1983 | 0.0086 | 0.0043 | 2.0121 | 0.0446 |
| YR1984 | 0.0136 | 0.0041 | 3.3102 | 0.0010 |
| YR1985 | 0.0182 | 0.0046 | 3.9345 | 0.0001 |
| YR1986 | 0.0221 | 0.0052 | 4.2760 | 0.0000 |
| YR1987 | 0.0261 | 0.0060 | 4.3548 | 0.0000 |
| YR1988 | 0.0284 | 0.0056 | 5.0917 | 0.0000 |
| YR1989 | 0.0308 | 0.0054 | 5.6769 | 0.0000 |
| YR1990 | 0.0271 | 0.0055 | 4.9144 | 0.0000 |
| YR1991 | 0.0266 | 0.0068 | 3.8957 | 0.0001 |
| YR1992 | 0.0286 | 0.0081 | 3.5205 | 0.0005 |
| YR1993 | 0.0331 | 0.0090 | 3.6847 | 0.0002 |
| YR1994 | 0.0335 | 0.0090 | 3.7289 | 0.0002 |
| YR1995 | 0.0405 | 0.0089 | 4.5564 | 0.0000 |
| YR1996 | 0.0393 | 0.0092 | 4.2481 | 0.0000 |
| YR1997 | 0.0398 | 0.0092 | 4.3383 | 0.0000 |
| YR1998 | 0.0381 | 0.0096 | 3.9626 | 0.0001 |
| YR1999 | 0.0407 | 0.0098 | 4.1496 | 0.0000 |
| YR2000 | 0.0462 | 0.0098 | 4.7232 | 0.0000 |
| YR2001 | 0.0464 | 0.0103 | 4.4954 | 0.0000 |
| YR2002 | 0.0516 | 0.0113 | 4.5681 | 0.0000 |
| YR2003 | 0.0465 | 0.0118 | 3.9443 | 0.0001 |
| YR2004 | 0.0490 | 0.0121 | 4.0602 | 0.0001 |
| YR2005 | 0.0589 | 0.0119 | 4.9584 | 0.0000 |
| Fixed Effects (Cross) | | | | |
| _AUSTRALIA--C | 0.065381 | | _LUX--C | 0.121662 |
| _AUSTRIA--C | -0.13191 | | _MEXICO--C | 0.226019 |
| _BELGIUM--C | -0.15249 | | _NETH--C | -0.12339 |
| _BRAZIL--C | -0.1276 | | _NZ--C | 0.091256 |
| _CANADA--C | -0.05243 | | _NORWAY--C | 0.026747 |
| _CZECH--C | -0.0252 | | _PHIL--C | -0.14339 |
| _DENMARK--C | -0.05514 | | _POLAND--C | -0.0142 |
| _FINLAND--C | -0.11143 | | _PORT--C | 0.071241 |
| _FRANCE--C | 0.021515 | | _SING--C | 0.01788 |
| _GREECE--C | 0.106751 | | _SPAIN--C | -0.05905 |
| _HK--C | 0.246382 | | _SRILANKA-- | 0.000587 |
| _HUNGARY--C | 0.030091 | | _SWEDEN--C | -0.10146 |
| _IRELAND--C | -0.06997 | | _SWITZ--C | -0.0683 |
| _ISRAEL--C | 0.121753 | | _UK--C | -0.02975 |
| _ITALY--C | -0.07038 | | _US--C | 0.045924 |
| _JAPAN--C | 0.010575 | | | |
| _KOREA--C | -0.04323 | | | |

| | | | |
|---|---|---|---|
| R-squared | 0.9346 | Mean dependent var | 3.512614 |
| Adjusted R-squared | 0.928268 | S.D. dependent var | 0.134961 |
| S.E. of regression | 0.036146 | Akaike info criterion | -3.71715 |
| Sum squared resid | 0.823137 | Schwarz criterion | -3.31043 |
| Log likelihood | 1348.134 | F-statistic | 147.5912 |
| Durbin-Watson stat | 0.299655 | Prob(F-statistic) | 0 |

**World Bank Doing Business Rankings for Countries in the Data Sample (Sorted by Trading Across Borders)**

| Economy | Ease of Doing Business Rank | Starting a Business | Dealing with Construction Permits | Employing Workers | Registering Property | Getting Credit | Protecting Investors | Paying Taxes | Trading Across Borders | Enforcing Contracts | Closing a Business |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Singapore | 1 | 10 | 2 | 1 | 16 | 5 | 2 | 5 | 1 | 14 | 2 |
| China | 4 | 15 | 20 | 20 | 74 | 2 | 3 | 3 | 2 | 1 | 13 |
| Denmark | 5 | 16 | 7 | 10 | 43 | 12 | 24 | 13 | 3 | 29 | 7 |
| Finland | 14 | 18 | 43 | 129 | 21 | 28 | 53 | 97 | 4 | 5 | 5 |
| Sweden | 17 | 30 | 17 | 114 | 10 | 68 | 53 | 42 | 6 | 55 | 18 |
| Norway | 10 | 33 | 66 | 99 | 8 | 43 | 18 | 18 | 7 | 7 | 3 |
| Israel | 30 | 24 | 120 | 92 | 160 | 5 | 5 | 77 | 9 | 102 | 39 |
| Korea | 23 | 126 | 23 | 152 | 67 | 12 | 70 | 43 | 12 | 8 | 12 |
| Netherlands | 26 | 51 | 94 | 98 | 23 | 43 | 104 | 30 | 13 | 34 | 10 |
| United States | 3 | 6 | 26 | 1 | 12 | 5 | 5 | 46 | 15 | 6 | 15 |
| Japan | 12 | 64 | 39 | 17 | 51 | 12 | 15 | 112 | 17 | 21 | 1 |
| Ireland | 7 | 5 | 30 | 38 | 82 | 12 | 5 | 6 | 18 | 39 | 6 |
| Austria | 27 | 104 | 46 | 50 | 36 | 12 | 126 | 93 | 19 | 13 | 20 |
| France | 31 | 14 | 18 | 148 | 166 | 43 | 70 | 66 | 22 | 10 | 40 |
| New Zealand | 2 | 1 | 2 | 14 | 3 | 5 | 1 | 12 | 23 | 11 | 17 |
| United Kingdom | 6 | 8 | 61 | 28 | 22 | 2 | 9 | 16 | 28 | 24 | 9 |
| Taiwan, China | 61 | 119 | 127 | 159 | 26 | 68 | 70 | 100 | 30 | 88 | 11 |
| Luxembourg | 50 | 69 | 40 | 167 | 118 | 109 | 113 | 14 | 31 | 2 | 48 |
| Portugal | 48 | 34 | 128 | 164 | 79 | 109 | 38 | 73 | 33 | 34 | 21 |
| Switzerland | 21 | 52 | 32 | 19 | 13 | 12 | 164 | 19 | 39 | 32 | 36 |
| Poland | 76 | 145 | 158 | 82 | 84 | 28 | 38 | 142 | 41 | 68 | 82 |
| Belgium | 19 | 20 | 44 | 37 | 168 | 43 | 15 | 64 | 43 | 22 | 8 |
| Canada | 8 | 2 | 29 | 18 | 32 | 28 | 5 | 28 | 44 | 58 | 4 |
| Australia | 9 | 3 | 57 | 8 | 33 | 5 | 53 | 48 | 45 | 20 | 14 |
| China | 83 | 151 | 176 | 111 | 30 | 59 | 88 | 132 | 48 | 18 | 62 |
| Czech Republic | 75 | 86 | 86 | 59 | 65 | 43 | 88 | 118 | 49 | 95 | 113 |
| Spain | 49 | 140 | 51 | 160 | 46 | 43 | 88 | 84 | 52 | 54 | 19 |
| Philippines | 140 | 155 | 105 | 126 | 97 | 123 | 126 | 129 | 58 | 114 | 151 |
| Italy | 65 | 53 | 83 | 75 | 58 | 84 | 53 | 128 | 60 | 156 | 27 |
| Hungary | 41 | 27 | 89 | 84 | 57 | 28 | 113 | 111 | 68 | 12 | 55 |
| Greece | 96 | 133 | 45 | 133 | 101 | 109 | 150 | 62 | 70 | 85 | 41 |
| Mexico | 56 | 115 | 33 | 141 | 88 | 59 | 38 | 149 | 87 | 79 | 23 |
| Brazil | 125 | 127 | 108 | 121 | 111 | 84 | 70 | 145 | 92 | 100 | 127 |

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# CHAPTER 4:
# EXPLAINING WEAK GROWTH IN MEXICAN MANUFACTURING COMPENSATION

## Section 1: Motivation for the Study

As noted in Chapter 2, Mexico is a relative outlier in terms of compensation cost performance in recent decades. The markets in the BLS compensation cost dataset demonstrated average annual cost growth of 3.4% over the 1975-2006 period, while nominal manufacturing compensation in Mexico averaged just 2.1% annual growth. As compared to the other low-wage markets in the dataset the performance gap is even wider, with average annual compensation cost growth of 4.2% for the unallocated markets with which Mexico was grouped in the analysis. Mexico's cost growth was, in fact, the slowest of any single country for which data were available for the full 30-year period (Brazil, with data from 1996 onward, was the only slower-growing market). Mexico began the period near the top of the lower tier of markets, but fell toward the bottom of the group by 2006, displaced by countries in Eastern Europe and Asia. Mexico fell in the country rankings by 7 positions; it may be worth noting that only the U.S. fell by a greater distance over this period (down 10 positions).

The phenomenon of Mexico's stagnating growth has not been ignored in the economic literature, but most studies of Mexico have compared it with other Latin American markets or the NAFTA countries. Considering the importance of country groupings identified in the preceding two chapters, this paper looks at a different relationship to address this question. Popular publications have noted China as a key threat to jobs everywhere from the U.S. and Europe to Asia and Latin America. The economic literature has also begun to address this question more rigorously. This chapter adds to this growing strand of the literature by examining the influence of China on Mexico, and specifically on Mexican wages, through Chinese import competition in Mexico's biggest export destination, the U.S.

Lack of time series data on many macroeconomic variables for China, notably wage costs, may have limited the ability of researchers to address this question to date. This paper uses an indirect approach to estimating the influence of lower Chinese wages on Mexican wages, by taking a combination of industry-level compensation data for Mexico (available from 1992-2006 for 22 industry groups) and industry-level data on U.S. trade with both Mexico and China. This approach allows for an exploration of overall trends in Mexican wages, as well as identifying key sectors which may be influencing the overall results.

A second relevant strand of the literature is the study of intra-industry trade (IIT), especially that portion of IIT generated by "outsourcing" or "offshoring" activities. Most of the studies to date on Chinese import competition have looked at trade shares without consideration of this phenomenon. Given the prominence of maquiladora industries in Mexico's manufacturing sector over this period, as well as work on IIT by Feenstra and Hansen (2001) showing that outsourcing may widen the skilled-unskilled wage gap, it may be necessary to control for this type of activity when estimating China's influence on Mexican wages.

The analysis in this paper does show evidence of increased Chinese import penetration in the U.S. putting downward pressure on Mexican wage growth in some key manufacturing industries. However, the impact is considerably less widespread, in terms of the number of sectors influenced, when the high level of IIT between Mexico and the U.S. is accounted for. Further, the hypothesis in Feenstra and Hansen that outsourcing is detrimental to unskilled labor in the country to which production is outsourced is only partially supported, with several sectors demonstrating a positive relationship between wages and IIT.

Section 2 – Mexico's Economic and Wage Growth in Global Perspective

This section presents some of the key facts regarding Mexico's often-cited economic underperformance, even among other emerging markets. While Mexico has experienced a series of devaluations and debt crises in the past, so have markets such as Chile, Brazil, Russia, and a wide group of Asian markets in the wake of that region's 1997 financial crisis. Most of these markets are not considered economic underperformers, despite the near-term impacts of their respective crises. Several of these markets also share Mexico's reliance on a commodity-export base, and the resulting tendency for boom-bust cycles of economic growth associated with the volatility in global commodity prices.

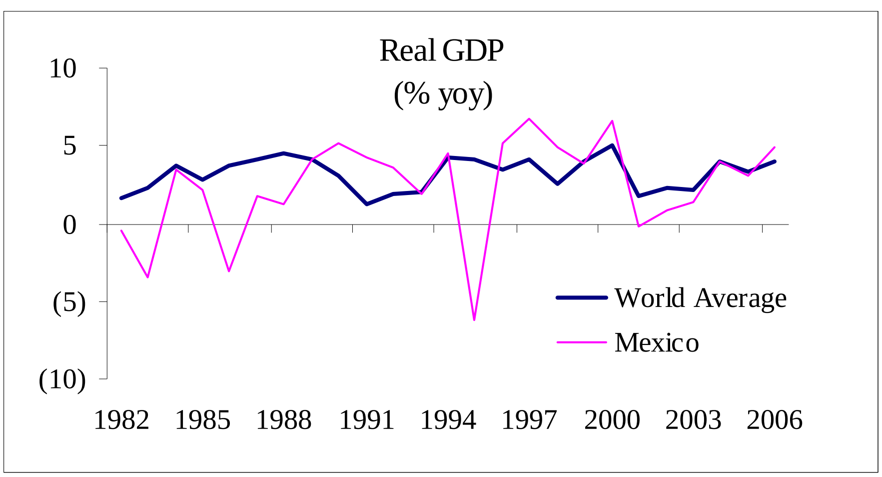
Mexico's real GDP growth has fallen short of a (non-weighted) average of selected developed and developing global markets in the last three decades, by 0.8 percentage points in real local currency terms from 1982 through 2006.[11,12] However, as

[11] In nominal USD terms, Mexico's GDP averaged 1.8 percentage points lower than the same world average over 1982-2006.

Figure 4.1 illustrates, that weak average performance is influenced by the severe recessions induced by currency devaluations and external debt crises, notably in 1982 and 1994, and the global collapse in commodity prices in 1986-87. Since the 1994 currency devaluation, Mexico has largely avoided such crises, and economic growth has tracked more closely to the sample average.

Growth in manufacturing labor compensation in Mexico, however, has lagged behind the average for the same set of global markets by 2.4 percentage points. This development was illustrated in the GDP/wage gaps in Chapter 3, which showed Mexico's average growth in GDP per capita at twice the rate of growth of labor compensation costs over 1976-2006, the biggest gap for any developed or developing market in the data set other than Sri Lanka (and excluding the truncated 10-year data set for Brazil).

Figure 4.1: Real GDP Growth for Mexico versus Rest-of-World Sample

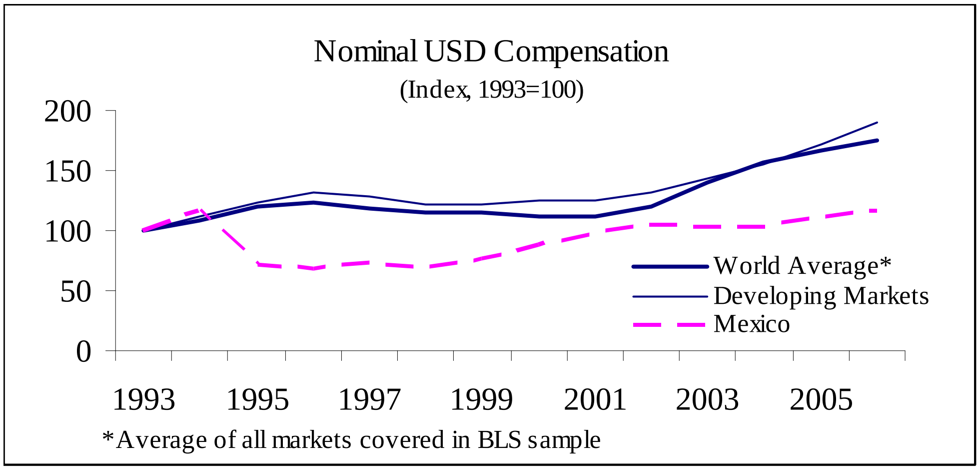


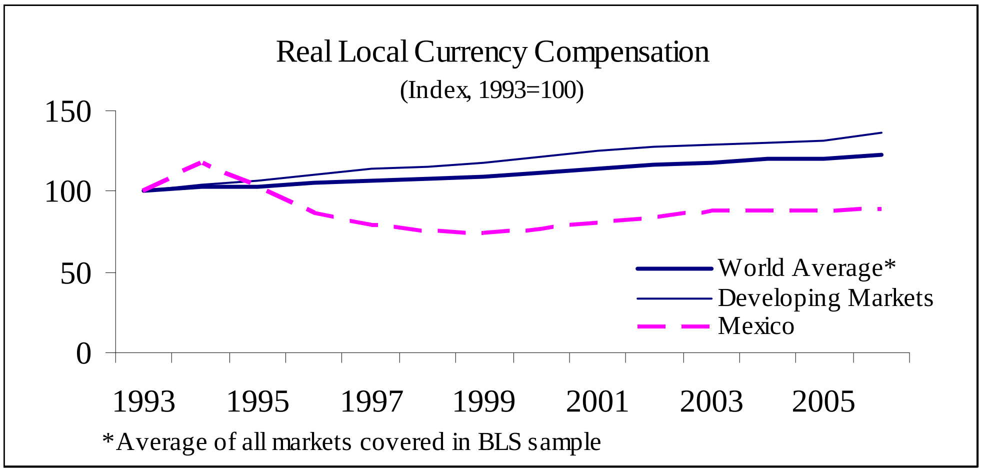

[12] The World Average used here comprises the 34 countries in the BLS dataset on labor compensation costs. This construction is used to ensure comparability of the measures presented in this section with the results of the regression analysis later in this paper. The countries are listed in Section 1 of the Appendix.

Over the 15-year time span to be studied in this paper, the growth in compensation in Mexico has averaged -0.9% in real local currency terms, as compared with 1.5% growth for the sample average.[13] Figure 4.2 shows indexed historical compensation cost data in both real and nominal USD terms, comparing Mexico to the rest-of-world sample as a whole and with the other low-wage markets in the sample, primarily in Eastern Europe and Asia.[14] In addition to the weaker cost growth over the period, Mexico's compensation cost growth has also been somewhat countercyclical, particularly in nominal USD terms, as compared to the rest-of-world average. One possible reason for this is the relationship of oil prices to Mexico's economic performance as an oil exporter relative to the rest of the countries in this dataset, mostly importers of oil. Oil price spikes would be correlated with periods of weak growth for other global economies, but strong performance for Mexico and vice versa when prices crash. Time period dummies in our estimation should at least partially control for this issue, assuming no disproportionate effects of oil prices across different sub-sectors of Mexican manufacturing. In addition, oil as a share of Mexican exports has declined over time, from about 80% in 1980 to just around 10% by the mid-2000s, which seems to match the relatively smaller differences in GDP growth in the later years of Figure 4.1.

[13] In nominal local currency terms, the measure to be used in this paper as a measure of the cost foreign firms face in sourcing production to Mexico (shown later in Table 2) the difference is similar, with Mexico growing just 1.6% and the rest of the sample 3.4%. This is a gap of -1.8 points versus -2.4 points in real local currency terms.
[14] Low-wage markets in this calculation are Brazil, Poland, Hungary, Czech Republic, Israel, Korea, Singapore, Philippines, Sri Lanka and Taiwan.

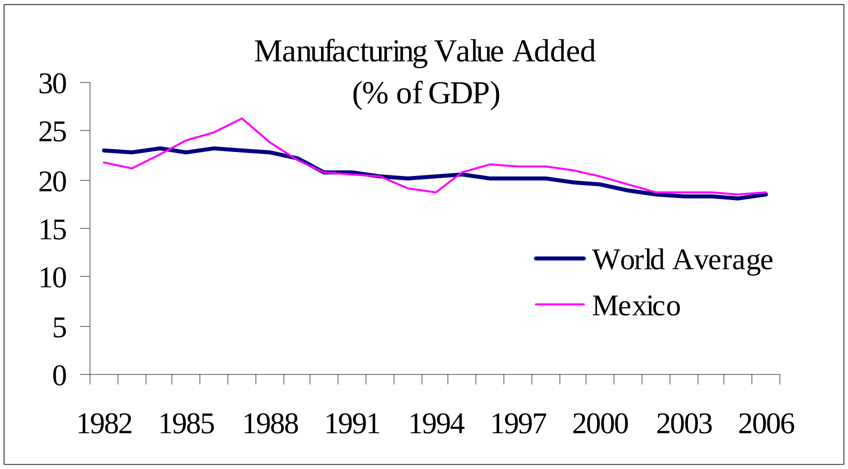
Figure 4.2: Compensation Costs for Mexico versus Rest-of-World Sample




An additional consideration in examining manufacturing wage performance specifically is the relative importance of the manufacturing sector in the Mexican economy compared with other world markets. Figure 4.3 shows the development of manufacturing value-added as a percent of GDP for Mexico and the world average. It shows Mexico had a relatively high manufacturing share in the periods following major peso devaluations (1987 and 1994), but on average has followed a declining trend similar to the rest of the world. Thus, manufacturing wage performance does not appear to be related to a disproportionate manufacturing sector presence in the Mexican economy.

Figure 4.3: Manufacturing Value Added for Mexico versus Rest-of-World Sample




Mexico's economic and political history has certainly played a part in generating these outcomes, as well as its unique (among emerging markets, but shared with Canada) geographical proximity to the U.S. market.

With regard to aggregate wage growth, macro trends were emerging over these decades that also contributed to Mexico's wage stagnation. In addition to policy efforts to suppress nominal wage growth and inflation following the 1994 peso crisis, Mexico faced a significant expansion of the labor supply due to the maturation of a baby boom generation born during the peak growth years of the 1970s, which began entering the labor force in the 1990s. As well, female labor force participation increased due to cultural trends as well as the need to support family incomes during the 1980 and 1990 economic crises. On net, the labor force was expanding by about 1 million individuals per year by the time NAFTA was implemented in the mid-1990s (Polaski, 2004).

The issue of wage differentials is addressed in Hansen (2003) as it relates to the relative skill mix of Mexican labor since NAFTA. Hansen concludes that wage dispersion in Mexico has increased since NAFTA, and that regional differences in access to FDI and migration have also contributed to the aggregate result. Polaski also points out that, even for workers with university degrees, real wages fell between 1993 and 2000. Labor productivity growth is not a likely explanation for falling real wages, as productivity has been relatively robust over this period. Manufacturing productivity rose by nearly 60% from 1993 to 2003, while wages declined in real terms from the beginning to the end of this period.

For purposes of this paper, the contribution of export activity to Mexican wage growth is of particular relevance. Since 1982, Mexico's manufacturing exports have expanded rapidly, supported by a process of trade liberalization and attraction of Foreign Direct Investment (FDI). From 1982 to 2004, according to the World Bank, Mexico received $200 billion in FDI from the U.S. alone, about half its total FDI over this period and up to 20% of its gross capital formation. These investments were concentrated in the manufacturing sector including, but not limited to, the developing maquiladora sector. Mexico's non-oil exports grew an average annual 13.4% over this period.

Despite this rapid expansion of export activity, Palma (2005) and others point out that Mexico's macro economy in general, and its manufacturing sector in particular, have seen limited benefit. Palma cites the deceleration of GDP growth in the period following trade liberalization, from a nearly 9% annual rate in 1970-1981 to just 2% in the following two decades. Employment growth, wage growth and manufacturing activity all decelerated. While some of this decline can be attributed to more conservative policy management, particularly the inflation-fighting policies instituted after the 1994 peso crisis, there does seem to be evidence that the rise in exports in recent decades contributed less to Mexico's real GDP and wage growth than in earlier periods.

Polaski also points out that the structure of Mexico's export industries and, to some extent, government currency policy to maintain a weak peso, encouraged the location of final assembly operations in Mexico with extensive use of imported components. This was the central premise of the maquiladora manufacturing program, for example. This structure meant that final assembly export operations did not generate significant spillovers to the domestic supply chain. Imported components may be a significant difference with respect to China, which had protections for domestic industry and a higher domestic content of supply chain.[15] China also encouraged FDI projects to enhance technology sharing and improve infrastructure and raw material capacity, as well as promoting export-oriented FDI (Long, 2005).

A full study of the differences between Mexican and Chinese FDI policies is beyond the scope of the current paper. But such policy differences likely had an influence on the significantly different outcomes that can be observed with regard to intra-industry trade for each country with the U.S.

## Section 3 – The Influence of Intra-Industry Trade

As noted above, an additional consideration regarding Mexican manufacturing wages is that Mexico is relatively open to imported components, both through the maquiladora sector and in its manufacturing activities in general, so that the expansion of

[15] Although some of the local-content restrictions had to be abandoned for China's WTO accession in 2001, these policies would have been in place for most of the period studied in this paper. Further, the domestic content of exported production remained high even after WTO entry. Long (2005) points out that the two different models of processing trade, PTI (processing trade using imported materials) and PTS (using materials supplied by clients), saw the domestic content of Chinese exports rise from 17.3% and 18.5% respectively in 1993 to 23.3% and 31.4% by 2003.

trade actually may have dampened wage growth for production workers in Mexico by reducing net demand for labor across the supply chain. This assertion runs somewhat counter to standard trade theory, which would suggest that opening a market such as Mexico to trade should benefit low-skilled labor in the labor-abundant trading partner.

However, Hanson and Harrison (1999) note that Mexican tariff reductions in the 1984-90 trade liberalization period were largest in the most labor-intensive sectors of the Mexican economy. They assert that, if trade protection was initially higher in labor-intensive sectors, and if these tariff changes were passed through to goods prices, then Stolper-Samuelson effects would suggest an increase in the relative wage of skilled labor. They also note that this observation does not hold in the subsequent, post-NAFTA period, however, where larger tariff reductions took place in skill-intensive sectors.

The literature on intra-industry trade may provide some additional insights into why expanded trade might have dampened Mexican wage growth in the post-NAFTA period. The IIT literature focuses most often on outsourcing of production, and on skilled and unskilled wage differentials in the developed markets from which production is transferred. For example, Feenstra and Hansen (2001) present a model that demonstrates that trade in intermediate inputs (i.e. outsourcing) may have the same impact of widening the skilled-unskilled wage gap as skill-biased technological change. Slaughter (2001) also addresses this question for the U.S., focusing on elasticity of production and nonproduction labor in specific sectors. He found that demand for production labor, assumed to represent less-skilled labor, became more elastic in industries with more outsourcing and with more technological change, as measured by investment in computers and other high-tech capital. Campa and Goldberg (1997) addressed this question for a set of developed markets and manufacturing subsectors (including the U.S., Canada, U.K. and Japan).

Fewer papers have looked at these questions for the emerging markets to which production is transferred. However, intra-industry trade may have a dampening effect on wages in the destination country as well. Feenstra and Hansen (1997) note that, in a case where firms outsource their least skill-intensive production to a labor-abundant country, the average skill intensity and therefore the premium to skilled wages may rise in both the source and destination countries. This would occur if the less-skill intensive production being outsourced is nonetheless more skill-intensive than the average in the labor-abundant country. Supporting this hypothesis, they find that 45% of the increase in Mexico's nonproduction wage share of manufacturing over 1975-88 was due to production moving into foreign-owned assembly plants, taken as a proxy for outsourced production.

For China and Hong Kong, Hsieh and Woo (1999) find that 45-60% of the increase in nonproduction wage share for Hong Kong manufacturing industries can be attributed to outsourcing of manufacturing to China. However, they do not address the impact on wages in the destination country, i.e. China.

It is important to note that the theoretical results regarding IIT and unskilled wages are not unambiguous. First, the conclusions are primarily developed based on outsourcing activities; however, not all IIT is outsourcing. But for developing countries like Mexico the data are not detailed enough to permit detailed estimates of outsourcing as a subset of total intra-industry trade. This paper has some advantage in that area, as the trading partners in question are Mexico and the U.S. We can utilize the existing evidence on outsourcing of production for the U.S. manufacturing activities in these sectors to make some inferences about whether a high IIT ratio for Mexico represents outsourcing. Further, there is fairly robust evidence that foreign-owned firms pay higher wages (for example, Aitken, Harrison and Lipsey, 1997 and Brown, Deardorff and Stern, 2004) although there is only limited evidence that this flows through to aggregate wage levels in the host country. However, at the disaggregated level, this effect might be large enough to support higher wages in a particular sector or region where foreign ownership is most intensive.

To explore whether intra-industry trade helps explain the stagnation in Mexican manufacturing wages, data were gathered on exports to, and imports from, the U.S. for both Mexico and China, and for the U.S. with the world as a whole. These data were used to construct an index of intra-industry trade for each country and manufacturing sub-sector. The index takes a value of 0 when no intra-industry trade is present, and 100 if all trade is intra-industry.[16] These data are summarized in Table 4.1.

[16] Index calculation 100*[(X+M)-|X-M|] / (X+M), commonly referred to as a Grubel-Lloyd index; this index may capture both trade in differentiated final products (the traditional concept of intra-industry trade) as well as trade in intermediate inputs depending on the breadth of industry subgroups used in its construction. See Campo and Goldberg data in Appendix Section 2 which show how intensively imports are represented in both U.S. consumption and production in 1995.

Table 4.1: Intra-Industry Trade with the U.S. by Manufacturing Subsector

| | Intra-Industry Trade Index by Sector - Average 1996-2005 | | | | |
|---|---|---|---|---|---|
| | World | Mexico | O/(U) World | China | O/(U) World |
| Leather | 19.0 | 81.4 | 62.4 | 1.3 | (17.7) |
| Textiles | 36.6 | 72.9 | 36.2 | 2.5 | (34.1) |
| Furniture | 38.7 | 43.6 | 4.9 | 1.8 | (36.9) |
| Wood | 38.9 | 91.5 | 52.6 | 6.7 | (32.2) |
| Food, Beverage and Tobacco | 46.5 | 50.6 | 4.1 | 2.8 | (43.8) |
| Primary Metals | 55.4 | 96.7 | 41.3 | 53.7 | (1.7) |
| Motor Vehicles and Parts | 57.3 | 58.9 | 1.6 | 34.5 | (22.9) |
| Nonmetallic Minerals | 57.7 | 69.8 | 12.2 | 11.2 | (46.5) |
| Fabricated Metals | 76.9 | 85.9 | 9.1 | 9.6 | (67.3) |
| Computers and Electronics | 77.3 | 62.7 | (14.7) | 20.0 | (57.3) |
| Paper | 82.6 | 42.4 | (40.2) | 69.3 | (13.4) |
| Plastics | 86.3 | 35.9 | (50.4) | 91.7 | 5.3 |
| Chemicals | 93.0 | 44.5 | (48.5) | 91.3 | (1.7) |
| Machinery | 96.4 | 94.1 | (2.2) | 69.0 | (27.4) |
| Electrical Equipment/Appliances | 98.3 | 95.0 | (3.2) | 34.9 | (63.4) |

O/(U) denotes country index Over/(Under) world value for that sector

There are some significant differences in the Intra-Industry Trade (IIT) indices across manufacturing industries based on the aggregate U.S. trade data in the first column. Unfortunately, the aggregation of trade data across both developed and emerging market trading partners likely creates some blurring of the two forms of intra-industry trade, with developed markets more likely to represent trade in differentiated final products, and emerging markets likely to include a larger share of imported intermediate inputs. More directly relevant to this paper is how the indices for Mexico and China in any given sector compare to each other and to the world aggregate.

Mexico has a significantly higher IIT index than the world aggregate in Leather, Textiles, Wood and Primary Metals, and slightly higher than the aggregate in four other categories.

When comparing these data to the results for China, the differences are striking. China has a significantly lower IIT index versus the world aggregate in every industry category except Plastics, and also has a higher index than Mexico in Chemicals and Paper. Certainly, the geographical proximity of Mexico to the U.S. contributes to this result, while China imports components to its manufacturing facilities from its regional trading partners such as Hong Kong, as noted in Hsieh and Woo (1999).

Incorporating these data into a time series model thus may help to identify whether Mexico's IIT performance in certain sectors is a contributing factor to stagnant wage growth, either in addition to or in place of an effect due to Chinese import penetration in the U.S. market. Campa and Goldberg note for the developed markets in their paper that cross-industry trends in IIT do not seem to change much over time (i.e. those sectors that have high IIT at the start of the time series tend to remain high and vice-versa). However, over the period under consideration in this paper there are some notable shifts in the relative position of Mexico versus both China and the world in some sectors, which may generate worthwhile time series estimates. These historical data are shown for selected sectors in the Appendix Section 3.

## Section 4 – Data Sources and Characteristics

Compensation data come from the U.S. Bureau of Labor Statistics (BLS), International Labor Comparisons program, and cover hourly workers in manufacturing production. Both local currency and U.S. dollar compensation measures are available. U.S. dollar costs were used for purposes of this analysis, with the perspective that international location decisions may be a key driver of cross-country wage pressures, and these decisions would be made by multi-nationals using a common global currency. Compensation includes both direct wage payments and other benefits, including holiday pay, and payments for social security, health care or other social program contributions that may be made by employers in support of employees on their payroll. The data for Mexico cover all types of manufacturing workers, and include both maquiladora and non-maquiladora production workers.[17] Data are available by NAICS (North American Industry Classification System) codes from 1992-2005.

Trade data come from the U.S. International Trade Statistics dataset published by the U.S. Census Bureau, which publishes data beginning in 1996 on trade with the U.S. by country for 1- 2- and 3- digit SITC (Standard International Trade Classification) codes. The two classification systems were matched by the author, using a mapping shown in the Appendix Section 4. For most manufacturing sub-sectors, the mapping was relatively clear between the two systems.

[17] The differential treatment of maquiladora trade was significantly reduced upon implementation of NAFTA rules in 1994; however, these types of production facilities remained a significant presence in Mexico's manufacturing environment through most of the period under study. Maquiladora production is most concentrated in the automotive production, textiles and electronics sectors.

Table 4.2: Average Annual Growth in Compensation Costs 1992-2005 (Nominal USD)

| | Mexico | BLS Sample Average* | Mexico Over/(Under) Average |
|---|---|---|---|
| Food, Beverage and Tobacco | 0.9 | 3.0 | (2.1) |
| Textiles | 1.0 | 3.9 | (2.9) |
| Leather | (0.1) | 3.5 | (3.6) |
| Wood | 1.0 | 4.2 | (3.2) |
| Paper | (0.2) | 2.5 | (2.7) |
| Chemicals | 2.8 | 4.0 | (1.2) |
| Plastics | 0.7 | 3.4 | (2.7) |
| Nonmetallic Minerals | 2.1 | 3.4 | (1.3) |
| Primary Metals | 1.6 | 2.4 | (0.8) |
| Fabricated Metals | 1.7 | 2.2 | (0.5) |
| Motor Vehicles and Parts | 2.0 | 3.7 | (1.7) |
| Computers and Electronics* | 3.8 | 3.3 | 0.5 |
| Electrical Equipment/Appliances | 3.7 | 2.8 | 0.9 |
| Furniture* | 2.4 | 2.1 | 0.3 |
| Machinery | 2.4 | 3.3 | (0.9) |
| All Manufacturing | 1.6 | 3.4 | (1.8) |

* Country and dates covered are not consistent across all sub-sectors;
Furniture and Computers in particular have smaller country samples

Table 4.2 summarizes the compensation cost data for Mexico and the rest of the 33 countries in the BLS data set for these 15 sectors and the manufacturing aggregate. There are 3 sectors for which Mexico's compensation costs grew more quickly than the sample average, Computers and Electronics, Electrical Equipment and Appliances, and Furniture. For all others, the shortfall in Mexican wage growth ranged from (0.5) to (3.6) percentage points. This variation suggests that there are cross-industry dynamics that are worth exploring empirically, which is a key objective of this paper.

Section 5 – Regression Framework

The initial estimation seeks to identify the relationship between increased Chinese export penetration in the U.S. market and Mexican compensation for hourly manufacturing workers, and whether specific sub-sectors of manufacturing were disproportionately affected by Chinese trade.

To explore this question, the basic estimation equation was constructed as follows:

$$\log(MexComp_{it}) = \beta_0 + \beta_{1i} * \log(ChinaUSTrade_{it}/MexUSTrade_{it}) + \varepsilon_{it} \quad (1)$$

where MexComp is the hourly compensation for manufacturing workers by sector (i); ChinaUSTrade is the level of Chinese exports to the U.S. for each sector; MexUSTrade is the level of Mexican exports to the U.S. by sector; and $\varepsilon_{it}$ is an error term, which will be corrected with cross-section and period fixed effects where appropriate for these panel data to ensure a well-behaved residual.

The coefficient $\beta_{1i}$ would be negative and significant if the hypothesis holds that higher Chinese export penetration in the U.S. generates downward pressure on Mexican wages in sector i.

A similar estimation is to be conducted to evaluate the relationship between intra-industry trade and Mexican manufacturing wages. In this case, the explanatory variable is the ratio of the IIT index for Mexico and the world trade with the U.S. in each sector, shown in equation (2).

$$\log(MexComp_{it}) = \beta_0 + \beta_{1i}*(MexUSIIT_{it}/WorldUSIIT_{it}) + \varepsilon_{it} \quad (2)$$

The ratio of Mexican to World IIT captures the extent to which each industry subsector in Mexico contains a larger portion of outsourced production than the same sector in other countries[18]. As with the China trade variable, a negative coefficient would reflect a dampening effect on Mexican wage growth associated with higher intra-industry trade, a hypothesis consistent with Feenstra and Hansen's work on the impact of IIT on unskilled wages previously discussed in Section 3.

After evaluating these results independently, a final regression (3) will explore the combined effect of these two explanatory variables to determine whether there are complementary or offsetting effects from Chinese trade penetration and IIT.

$$\log(MexComp_{it}) = \beta_0 + \beta_{1i}*\log(ChinaTrade_{it}/MexTrade_{it}) + \beta_{2i}*(MexicoIIT_{it}/WorldIIT_{it}) + \varepsilon_{it} \quad (3)$$

The possibility of augmenting this combined regression with an interaction term will be discussed in Section 7.

## Section 6 – Regression Results

The first results come from the estimation of equation (1), testing the independent effect of Chinese trade penetration on Mexican manufacturing wages, and are shown in Table 4.3. The impact of Chinese export penetration is insignificant for 5 of the 15 sectors at the 10% confidence level. For the remaining 10 sectors that demonstrated significant coefficients at the 10% level, 8 of them were significantly negative,

[18] The regression was also estimated using the absolute level of the Mexican IIT index instead of this ratio, with similar results.

demonstrating the hypothesized relationship between increased penetration of Chinese exports in the U.S. market in these sectors and downward pressure on Mexican wages.

Table 4.3: Single-Variable Estimation with Chinese Trade Penetration

Dependent Variable: log(MexComp)
Regression R-squared: 0.8099

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.740 | 28.62 | 0.00 |
| Food, Beverage and Tobacco | 0.092 | 2.41 | 0.02 |
| Textiles | -0.514 | -4.72 | 0.00 |
| Leather | -0.103 | -5.56 | 0.00 |
| Wood | -0.328 | -7.87 | 0.00 |
| Paper | -0.190 | -1.42 | 0.16 |
| Chemicals | 1.255 | 9.65 | 0.00 |
| Plastics | -0.072 | -0.71 | 0.48 |
| Nonmetallic Minerals | 0.060 | 0.55 | 0.58 |
| Primary Metals | -0.341 | -5.89 | 0.00 |
| Fabricated Metals | -0.160 | -1.72 | 0.09 |
| Motor Vehicles and Parts | -0.112 | -5.17 | 0.00 |
| Computers and Electronics | 0.017 | 0.14 | 0.89 |
| Electrical Equipment/Appliances | -0.127 | -1.36 | 0.18 |
| Furniture | -0.386 | -4.56 | 0.00 |
| Machinery | -0.247 | -2.56 | 0.01 |

Shaded coefficients were insignificant at the 10% level

| **Fixed Effects (Period)** | |
|---|---|
| 1996--C | -0.292 |
| 1997--C | -0.223 |
| 1998--C | -0.271 |
| 1999--C | -0.177 |
| 2000--C | -0.028 |
| 2001--C | 0.100 |
| 2002--C | 0.176 |
| 2003--C | 0.182 |
| 2004--C | 0.219 |
| 2005--C | 0.314 |

The distribution of estimated sector impacts is shown in Table 4.4 relative to the level of compensation in each sector. It is interesting to note that the sign and significance of the coefficients does not seem to be related to the absolute level of compensation in a sector. The two sectors with positive and significant coefficients, Food and Beverages and Chemicals, sit at nearly opposite ends of the wage scale in Mexico. And negative and significant coefficients are observed for both high- and low-wage sectors, suggesting that the impact of Chinese import penetration on Mexican wages may not be unique to the low-wage, and presumably lower-skill, sectors of manufacturing.

Table 4.4: 2005 Compensation per Hour and Coefficient from Single-Variable Chinese Trade Estimation

| | Comp 2005 | Sector Coefficient |
|---|---|---|
| Wood | 1.57 | -0.328 |
| Textiles | 1.89 | -0.514 |
| Leather | 1.94 | -0.103 |
| Furniture | 1.95 | -0.386 |
| Food, Beverage and Tobacco | 2.15 | 0.092 |
| Paper | 2.42 | -0.190 |
| Plastics | 2.43 | -0.072 |
| Fabricated Metals | 2.44 | -0.160 |
| Nonmetallic Minerals | 2.87 | 0.060 |
| Computers and Electronics | 2.88 | 0.017 |
| Machinery | 3.19 | -0.247 |
| Electrical Equipment/Appliances | 3.19 | -0.127 |
| Motor Vehicles and Parts | 3.52 | -0.112 |
| Primary Metals | 3.86 | -0.341 |
| Chemicals | 5.20 | 1.255 |
| | | |
| Manufacturing Avg. | 2.64 | |

Shaded coefficients were insigificant at the 10% level

The results of an estimation of equation (2), the independent effect of IIT on Mexican wages, are shown in Table 4.5.

In this estimation, 13 of the 15 sectors demonstrate a significant coefficient at the 10% level, with all but one of these sectors also significant at the 5% level. However, the signs of the coefficients are mixed, with positive coefficients on 9 of the 13 significant sectors. These results provide limited support to the Feenstra and Hansen hypothesis.[19]

[19] It may be noted that the sectors that demonstrate negative coefficients appear to be among the less-skilled sectors, based on wage levels (these are the four lowest-wage sectors in Table 4). This observation could be taken to support the hypothesis that IIT acts similarly to skill-biased technological change on unskilled wages.

Table 4.5: Single-Variable Estimation with IIT Ratio

Dependent Variable: log(MexComp)
Regression R-squared: 0.97873

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.630 | 18.13 | 0.00 |
| Food, Beverage and Tobacco | -0.044 | -1.36 | 0.18 |
| Textiles | -0.115 | -6.05 | 0.00 |
| Leather | -0.050 | -5.67 | 0.00 |
| Wood | -0.135 | -9.64 | 0.00 |
| Paper | 0.190 | 2.55 | 0.01 |
| Chemicals | 1.701 | 21.13 | 0.00 |
| Plastics | 0.170 | 1.81 | 0.07 |
| Nonmetallic Minerals | 0.124 | 3.87 | 0.00 |
| Primary Metals | 0.267 | 11.96 | 0.00 |
| Fabricated Metals | 0.007 | 0.21 | 0.83 |
| Motor Vehicles and Parts | 0.398 | 10.57 | 0.00 |
| Computers and Electronics | 0.217 | 4.59 | 0.00 |
| Electrical Equipment/Appliances | 0.218 | 5.41 | 0.00 |
| Furniture | -0.205 | -5.97 | 0.00 |
| Machinery | 0.266 | 6.68 | 0.00 |

Shaded coefficients were insignificant at the 10% level

| **Fixed Effects (Period)** | |
|---|---|
| 1996--C | -0.273 |
| 1997--C | -0.206 |
| 1998--C | -0.238 |
| 1999--C | -0.147 |
| 2000--C | -0.007 |
| 2001--C | 0.118 |
| 2002--C | 0.174 |
| 2003--C | 0.169 |
| 2004--C | 0.163 |
| 2005--C | 0.247 |

Similar to the results for Chinese trade penetration related to compensation levels, the effect of the IIT variable does not appear on the surface to be related to the level of Mexican IIT by sector. Table 4.6 shows the coefficients from Table 4.5 alongside the IIT index for Mexico, and the ratio of Mexico to world IIT.

Table 4.6: Intra-Industry Trade and Coefficient from Single-Variable IIT Estimation

| | **Mexico IIT Index** | **Ratio Mexico/World IIT with U.S.** | **Sector Coefficient** |
|---|---|---|---|
| Plastics | 35.9 | 0.4 | 0.170 |
| Paper | 42.4 | 0.5 | 0.190 |
| Furniture | 43.6 | 1.1 | -0.205 |
| Chemicals | 44.5 | 0.5 | 1.701 |
| Food, Beverage and Tobacco | 50.6 | 1.1 | -0.044 |
| Motor Vehicles and Parts | 58.9 | 1.0 | 0.398 |
| Computers and Electronics | 62.7 | 0.8 | 0.217 |
| Nonmetallic Minerals | 69.8 | 1.2 | 0.124 |
| Textiles | 72.9 | 2.0 | -0.115 |
| Leather | 81.4 | 4.3 | -0.050 |
| Fabricated Metals | 85.9 | 1.1 | 0.007 |
| Wood | 91.5 | 2.4 | -0.135 |
| Machinery | 94.1 | 1.0 | 0.266 |
| Electrical Equipment/Appliances | 95.0 | 1.0 | 0.218 |
| Primary Metals | 96.7 | 1.7 | 0.267 |

Shaded coefficients were insignificant at the 10% level

The absolute level of IIT for Mexico does not seem to be related to the sign of the coefficients in this estimation. The four sectors with negative coefficients all have Mexico/World ratios greater than 1. However, sectors with Mexico/World IIT ratios both above and below 1.0, and both low and high Mexican IIT index levels, demonstrate positive coefficients in this summary. Another interesting observation is that Chemicals, with a relatively low absolute IIT index level and low ratio of IIT to the rest of the world, has by far the highest coefficient. This is also the highest compensation sector in the data set. With this exception, most of the positive coefficients are in a similar range of values.

We might also expect that sectors representing the heaviest or largest goods would represent an advantage for Mexico in terms of IIT with the U.S. due to its geographical proximity and the relationship of that to shipping costs. Yet in categories such as Machinery, Fabricated Metals and Motor Vehicles and Parts, Mexico has a similar IIT ratio relative to the rest of the world aggregate. This result may be capturing some impact of trade in differentiated final products between the U.S. and other developed countries, as well as trade in smaller components of these products.

The results of the combined estimation are shown in Table 4.7. The inclusion of the IIT variable substantially changes the conclusions regarding the impact of Chinese import penetration on Mexican wages by sector.

Table 4.7: Coefficients on Mexico Wages in Separate and Combined Regression Results

Regression R-squared: 0.9938

| | Separate Regressions | | Combined Regression | |
|---|---|---|---|---|
| | China Trade | Relative IIT* | China Trade | Relative IIT* |
| Food, Beverage and Tobacco | 0.0919 | -0.0444 | -0.0078 | **-0.0969** |
| Textiles | **-0.5141** | **-0.1155** | 0.0972 | **-0.1611** |
| Leather | **-0.1027** | **-0.0499** | **-0.0373** | **-0.0345** |
| Wood | **-0.3276** | **-0.1353** | 0.4469 | **-0.3843** |
| Paper | -0.1901 | 0.1896 | **-0.4111** | 0.3612 |
| Chemicals | 1.2546 | 1.7007 | 0.0514 | 1.5589 |
| Plastics | -0.0724 | 0.1703 | **-0.1440** | -0.0639 |
| Nonmetallic Minerals | 0.0599 | 0.1237 | -0.0101 | 0.0867 |
| Primary Metals | **-0.3409** | 0.2665 | **-0.0599** | 0.2053 |
| Fabricated Metals | **-0.1599** | 0.0071 | -0.0053 | -0.0342 |
| Motor Vehicles and Parts | **-0.1120** | 0.3981 | **-0.0527** | 0.2145 |
| Computers and Electronics | 0.0169 | 0.2169 | 0.0130 | 0.1531 |
| Electrical Equipment/Appliances | -0.1268 | 0.2179 | 0.1760 | 0.2677 |
| Furniture | **-0.3862** | **-0.2054** | -0.0056 | **-0.2475** |
| Machinery | **-0.2474** | 0.2663 | -0.0603 | 0.1811 |

*Relative IIT measured as ratio of Mexico IIT index to World Index with U.S. for each sector
Shaded coefficients were insignificant at the 10% level
Negative and signficant coefficients are shown in bold.

The results of the combined regression are shown in the right two columns of the table. The regression R-squared of 0.9938 passes an F test for an improvement in explanatory power at the 5% significance level as compared with either of the single-variable estimations, though by a much greater margin against the China-only estimation. At the sector level, as compared with the results of the independent regression on China trade on the left, six sectors changed in significance (three in each direction) and two sectors with significant coefficients demonstrated a change in the sign of the coefficient from negative to positive once IIT impacts were accounted for (Textiles and Wood). These results suggest that, while the impact of China trade cannot be fully dismissed, it is important to take into account factors specific to Mexico's production chain before arriving at any conclusion regarding China's impact. Consistent with the F test results for the overall regression significance, the coefficients for IIT in the independent and combined regressions were relatively less sensitive to the inclusion of the Chinese trade variable. Only two sectors, Food & Beverages and Plastics, changed sign or significance in the single-variable IIT regression versus the combined regression.

On balance, the combined regression results do provide some insights into the factors limiting Mexico's wage growth. Perhaps the most important conclusion is that, when differences across sectors are accounted for, there is no single explanation for the stagnation in Mexican manufacturing wages. On net the results in Table 4.7 offer at least a partial explanation, with a source of negative impact on wages identified for 9 of the 15 sectors studied, as summarized in Table 4.8.

Table 4.8:

**Sectors with negative wage impact from China Trade Penetration**

Leather
Paper
Plastics
Primary Metals
Motor Vehicles and Parts

**Sectors with negative wage impact from High IIT Relative to World**

Food, Beverage and Tobacco
Textiles
Leather
Wood
Furniture

*(Based on combined regression results)*

Other recent studies have explored similar questions with regard to competition between Mexican and Chinese exports, both at the sector level, as in this paper, and at the product level. Most have focused on the relationship between Chinese and Mexican exports, not wages. However, the results are similar in terms of the observation of substantial variation in the effect of Chinese competition on Mexico across export industries and products.

Feenstra and Lee (2007) look at export variety for China and Mexico across seven aggregated industry sectors, and find that China has narrowed the export variety gap with Mexico in four of the seven sectors. A summary of these data are shown in the Appendix Section 5. Although their industry categorization is slightly broader than the sectors studied in this paper, three of the seven sectors in their analysis (Paper & Plastics, Wood & Paper, and Machinery & Transport) encompass three of the five sectors observed to have a negative impact from Chinese trade penetration in Table 4.8 (Paper, Plastics, and Motor Vehicles & Parts). In the aggregate, their analysis finds that increased Chinese export variety to the U.S. is associated with a reduction in Mexican export variety.[20] They also conclude that increased Mexican export variety is not associated with a significant reduction in Chinese export variety to the U.S.

Gallagher and Moreno-Brid (2008) look at the dynamism of Mexican versus Chinese exports, as represented by a dynamic revealed competiveness metric which is the change in the share of U.S. imports represented by Mexican exports and by Chinese exports in a given sector. Sectors in which Mexico is increasing its share of U.S. imports are said to demonstrate dynamic competitiveness. If Mexico's share is falling and

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[20] Export variety is shown in several studies to be associated with higher productivity and GDP growth for the exporting country. See Funke and Ruhwedel (2001), Feenstra and Kee (2006), and Broda and Weinstein (2006).

China's is rising, that sector is said to be under a direct competitive threat from China. A partial threat is identified if both countries' shares are rising, but China's is rising faster. In the aggregate, Gallagher and Moreno-Brid find that 53% of Mexican exports were under partial or direct threat from Chinese competition during 2000-2005, up from 41.8% in 1997-2000. These changes are calculated at the product level, so it is difficult to make a direct comparison to the sector results in this study. For example, the Electrical Components category has one product each on the top 15 most and least dynamic exports list for Mexico. However, their results demonstrate again the micro-level differences in Chinese competitive pressure on Mexican exports.

Section 7 – Interaction Term

An additional question to be considered is whether the relationship between China trade and Mexican wages varies depending on the value of the intra-industry trade index, and conversely for IIT with regard to China trade. It might be hypothesized, for example, that a high IIT index for Mexico with the U.S. in a given sector could dampen the impact of Chinese trade penetration on wages by locking in trade relationships along the production chain, thus shielding the sector from Chinese competition. This would generate a positive coefficient on the interaction term.

To address this question, equation (3) was augmented with a simple multiplicative interaction term as shown in equation (4):

$$\log(MexComp_{it}) = \beta_0 + \beta_{1i}*\log(ChinaUSTrade_{it}/MexUSTrade_{it}) + \beta_{2i}*(MexicoUSIIT_{it}/WorldUSIIT_{it}) + \beta_{3i}*[\log(ChinaTrade_{it}/MexTrade_{it})*(MexicoIIT_{it}/WorldIIT_{it})] + \varepsilon_{it} \quad (4)$$

As a result, the interpretation of the coefficients on the other variables changes, so that $\beta_1$ now captures the full effect of China trade on Mexican wages only when the value of the IIT index equals its mean.[21] Thus, the total effect of China trade on Mexican wages now is calculated as:

$$\text{Total China Trade Effect on Sector i} = \beta_{1i} + \beta_3 * \frac{\sum_{t=1,...T} IIT_{it}}{T} \qquad (5)$$

where $\beta_1$ is the coefficient on China trade, $\beta_3$ is the coefficient on the interaction term and $IIT_{it}$ is the value of the Mexico/World IIT ratio for sector *i* at time *t*. Similarly, the total effect of intra-industry trade on Mexican wages is:

$$\text{Total China Trade Effect on Sector i} = \beta_{2i} + \beta_3 * \frac{\sum_{t=1,...T} ChinaTrade_{it}}{T} \qquad (6)$$

An estimation of equation 3 with a common (i.e. pooled time series/cross section) estimation of the interaction term generated a coefficient $\beta_3$ that was positive and significant at the 1% level. The high degree of significance of this coefficient in the pooled data offers some confidence in applying the common coefficient across all industry subsectors, in contrast to the results for the individual variables which were not significant on a pooled basis (as shown in the Appendix). The result of applying the calculations in (4) and (5) to the regression outcome is shown in Table 4.9.

[21] This interpretation is based on the centering of the IIT variable, i.e. taking the deviation from its mean as the dependent variable in calculating the interaction term. For China trade, the mean of the data values was very close to zero, and so this variable was not centered. The interpretation for this variable, then, is that the impact of IIT equals $\beta_2$ only when log(China trade) equals zero.

Table 4.9: Coefficients from Combined Regression with Interaction Term

| | China Trade | IIT | Interaction | Pure Effect plus Interaction Effect = Total China Trade | Total IIT |
|---|---|---|---|---|---|
| Food, Beverage and Tobacco | 0.014 | **-0.063** | 0.024 | 0.041 | **-0.049** |
| Textiles | 0.076 | **-0.185** | 0.024 | 0.125 | **-0.192** |
| Leather | **-0.054** | **-0.110** | 0.024 | 0.051 | **-0.146** |
| Wood | 0.400 | **-0.412** | 0.024 | 0.458 | **-0.429** |
| Paper | **-0.354** | 0.251 | 0.024 | **-0.342** | 0.246 |
| Chemicals | 0.080 | 1.453 | 0.024 | 0.092 | 1.448 |
| Plastics | **-0.121** | -0.122 | 0.024 | **-0.110** | -0.121 |
| Nonmetallic Minerals | 0.037 | 0.025 | 0.024 | 0.066 | 0.018 |
| Primary Metals | **-0.066** | 0.205 | 0.024 | **-0.023** | 0.212 |
| Fabricated Metals | 0.050 | **-0.108** | 0.024 | 0.078 | **-0.115** |
| Motor Vehicles and Parts | **-0.048** | 0.257 | 0.024 | **-0.023** | 0.283 |
| Computers and Electronics | 0.031 | 0.105 | 0.024 | 0.051 | 0.102 |
| Electrical Equipment/Appliances | 0.201 | 0.259 | 0.024 | 0.225 | 0.263 |
| Furniture | -0.002 | **-0.293** | 0.024 | 0.025 | **-0.301** |
| Machinery | -0.022 | 0.180 | 0.024 | 0.002 | 0.184 |

Shaded coefficients were insignificant at the 10% level
Negative and significant coefficients are shown in bold

Using the combined regression including this interaction term does not substantially change the results by sector as compared to the summary in Table 4.8. Four of the five sectors demonstrating a negative relationship between Chinese trade penetration and wages still do so when adding the interaction effect, but Leather manufacturing changes to a positive relationship. For IIT, the same five sectors still demonstrate a negative relationship between intra-industry trade and Mexican wages, and Fabricated Metals is added as a sixth sector with a significantly negative coefficient. The R-squared of the combined regression with the interaction term is 0.9942, versus 0.9938 in the combined regression without the interaction term. An F statistic for the significance of the difference between these two R-squared values is calculated at 10.069 which does not pass a significance test at the 10% level, and indicates that the addition of the interaction term does not add statistically significant explanatory power to the model. We may therefore be roughly indifferent between the results of the combined model with and without the interaction term. Despite the loss of one degree of freedom in the interaction model, the high degree of significance on the pooled cross-section time series coefficient on the interaction term does point to a relevant relationship between the explanatory variables. Nonetheless, it is worth reiterating that the broad conclusions by sector changed little between the two cases.

Section 8 – Evaluating the Direction of Causation

The results presented so far in this chapter capture a relationship between Chinese import penetration and Mexican wage growth, but do not demonstrate causation. In fact, it is possible to construct a plausible argument that causation between Chinese import penetration and Mexican wage growth runs in either direction. While Chinese competition may exert downward pressure on Mexican wages, as described previously in this paper and elsewhere, it could also be the case that low Mexican wages in some sectors serve as a buffer against Chinese competition in the U.S. market.

In the context of the estimation structure in this paper, the counter-argument has the benefit of producing an opposite sign to the initial hypothesis; that is, if lower Mexican wages acted as a buffer to Chinese competition, a positive relationship would be observed between the two variables. In fact, three sectors in the combined regression did demonstrate a positive and significant relationship. Lending further support to the alternative hypothesis, two of those sectors, wood and textiles, are the lowest-wage sectors in the study as shown in Table 4.4. This potential two-way causation between Mexican wages and Chinese import penetration may also explain why the sign on Chinese trade in the pooled regression results is so far from being significant, with or without the inclusion of the interaction term. However, it also represents an endogeneity problem for the estimation.

One possible alternative is to introduce an instrumental variable for Chinese export competitiveness that would not be affected by lower Mexican wages. Chinese exports to Europe may be considered as an instrumental variable meeting that criterion. To test this, the regression was estimated on the pooled data using European imports from China, as a share of total European imports, as the instrumental variable. The data were gathered from Eurostat. The results are shown alongside the other pooled estimation results in the Appendix.

This regression generates a coefficient on Chinese trade that remains far from significance, very similar to the non-IV regression on the pooled sample. The result for the IIT variable still is negative and significant in the pooled IV regression. This outcome may indicate that the European trade variable is not a perfect instrument for the impact of Chinese competitiveness. It is also possible that the sector-specific effects are being masked in the pooled estimation. To explore this question further, the single-variable Chinese trade equation (1) was estimated again using the IV estimator. The results are shown in Table 4.10.

Table 4.10: Single-Variable Estimation with IV for Chinese Competition Effect

Dependent Variable: log(MexComp)
Instrumental Variable: log(Chinese_EU_Imports/Total_EU_Imports)

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.897 | 6.65 | 0.00 |
| Food, Beverage and Tobacco | 0.204 | 1.73 | 0.09 |
| Textiles | **-1.385** | -2.77 | 0.01 |
| Leather | **-0.153** | -2.69 | 0.01 |
| Wood | **-0.539** | -3.53 | 0.00 |
| Paper | -0.529 | -0.80 | 0.43 |
| Chemicals | 1.472 | 3.14 | 0.00 |
| Plastics | 0.470 | 1.04 | 0.30 |
| Nonmetallic Minerals | -0.235 | -0.64 | 0.52 |
| Primary Metals | -0.206 | -1.11 | 0.27 |
| Fabricated Metals | -0.507 | -1.42 | 0.16 |
| Motor Vehicles and Parts | -0.054 | -0.82 | 0.41 |
| Computers and Electronics | 1.992 | 3.25 | 0.00 |
| Electrical Equipment/Appliances | 0.106 | 0.36 | 0.72 |
| Furniture | **-1.232** | -2.66 | 0.01 |
| Machinery | 0.009 | 0.03 | 0.98 |

Shaded coefficients were insignificant at the 10% level
Significant and negative coefficients in bold

This estimation generated seven significant sector coefficients, including four negative and three positive results. The persistence of both positive and negative sector coefficients suggests that the European trade IV is not sufficiently controlling for the endogeneity issue between Chinese import penetration and Mexican wages.

Taken together, the results in this section suggest that some sectors of Mexican industry may experience a negative relationship between Chinese trade and wages, but these results are far from robust. A longer time series of sector-specific data would help to address these questions more rigorously, as would the identification of additional instrumental variables for the effect of increased Chinese competition.

Section 9 – Conclusions and Areas for Further Research

If macroeconomic growth rates are one key determinant of labor cost growth, as studied in Chapters 2 and 3, then looking at industry-level factors as in this chapter may provide additional explanatory power, especially in the presence of endogeneity or omitted variables that can be an issue with broader macroeconomic studies (Hallak and Levinsohn 2003). In the case of Mexico, this chapter demonstrates that there are substantial differences in wage and export performance at a disaggregated level within the manufacturing sector. Looking at the data on this basis generates different conclusions regarding the influence of competition from China, and the impact of intra-industry trade on unskilled wages, than would be observed in the aggregate. However, as discussed in the previous section, even the disaggregated data may suffer from endogeneity issues. While this paper finds evidence of a negative impact on Mexican wages due to Chinese trade competition, that result is not universal across sectors of manufacturing. Similarly for intra-industry trade, wages in eight of the fifteen sectors studied appear to benefit from expanded IIT, although another five sectors were found to have a significantly negative relationship.

The methodology used in this chapter offers a potential avenue for research on other cross-country comparisons. The industry-level wage data within manufacturing are available for 34 countries in the International Labor Comparisons program, and the import and export data by SITC code used in this paper can be compiled for any country that trades with the U.S. and for many other markets using publicly available sources.

Appendix

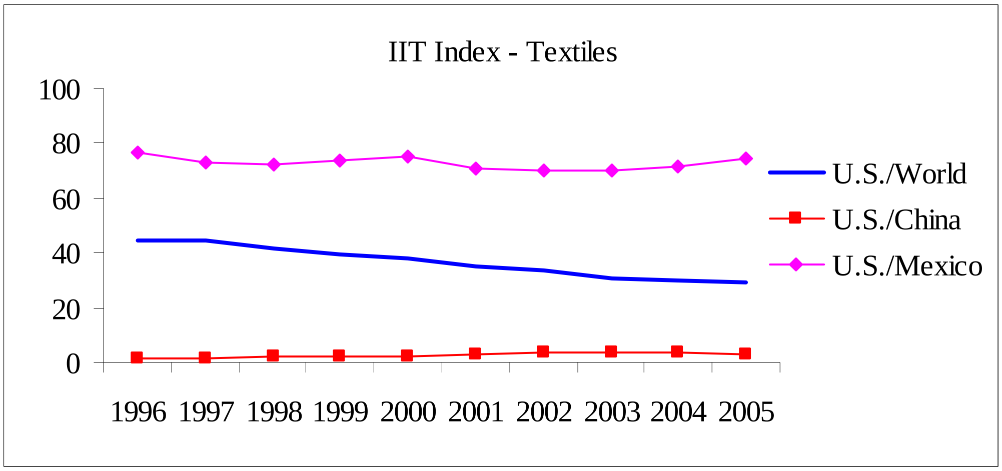
**Country Compensation Data from BLS International Labor Comparisons Program**

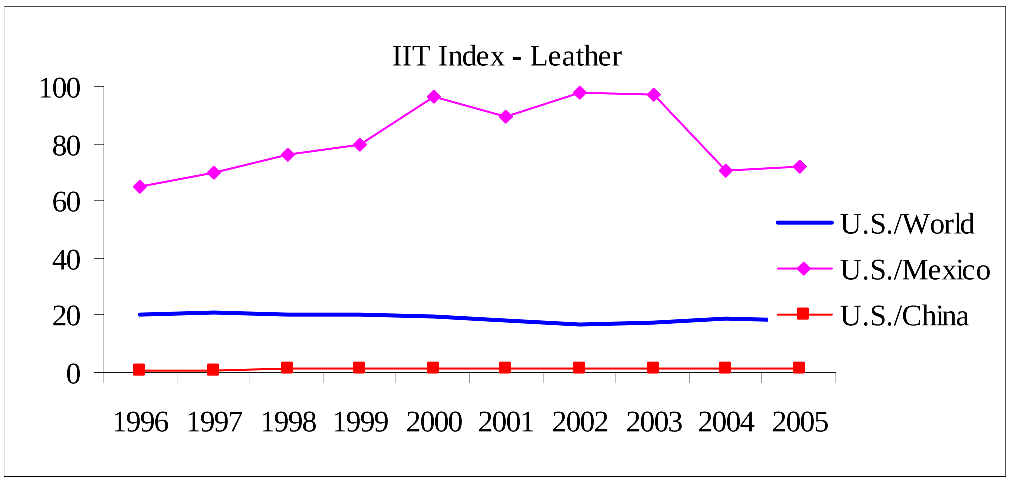
| Country | 2006 Total Hourly Compensation (US$) | 2006 Rank (1 = Lowest) | 1975 Total Hourly Compensation (US$) | 1975 Rank (1 = Lowest) |
|---|---|---|---|---|
| Sri Lanka | 0.54 | 1 | 0.28 | 1 |
| Philippines | 1.07 | 2 | N/A | 4 |
| Mexico | 2.75 | 3 | 1.46 | 10 |
| Brazil | 4.91 | 4 | N/A | 12 |
| Poland | 4.99 | 5 | N/A | 7 |
| Hong Kong SAR | 5.78 | 6 | 0.75 | 5 |
| Hungary | 6.29 | 7 | N/A | 9 |
| Taiwan | 6.43 | 8 | 0.38 | 3 |
| Czech Republic | 6.77 | 9 | N/A | 8 |
| Portugal | 7.65 | 10 | 1.53 | 11 |
| Singapore | 8.55 | 11 | 0.84 | 6 |
| Israel | 12.98 | 12 | 2.02 | 14 |
| New Zealand | 14.47 | 13 | 3.27 | 17 |
| Korea, Republic of | 14.72 | 14 | 0.32 | 2 |
| Greece | 16.1 | 15 | 1.69 | 13 |
| Spain | 18.83 | 16 | 2.52 | 15 |
| Japan | 20.2 | 17 | 2.97 | 16 |
| United States | 23.82 | 18 | 6.16 | 28 |
| France | 24.9 | 19 | 4.49 | 20 |
| Italy | 25.07 | 20 | 4.64 | 22 |
| Canada | 25.74 | 21 | 6.11 | 27 |
| Ireland | 25.96 | 22 | 3.51 | 19 |
| Australia | 26.14 | 23 | 5.6 | 24 |
| United Kingdom | 27.1 | 24 | 3.35 | 18 |
| Luxembourg | 27.74 | 25 | 6.21 | 29 |
| Finland | 29.9 | 26 | 5.06 | 23 |
| Austria | 30.46 | 27 | 4.5 | 21 |
| Switzerland | 30.67 | 28 | 6.03 | 26 |
| Sweden | 31.8 | 29 | 7.12 | 33 |
| Belgium | 31.85 | 30 | 5.76 | 25 |
| Netherlands | 32.34 | 31 | 6.58 | 31 |
| Denmark | 35.45 | 32 | 6.23 | 30 |
| Norway | 41.05 | 33 | 6.9 | 32 |

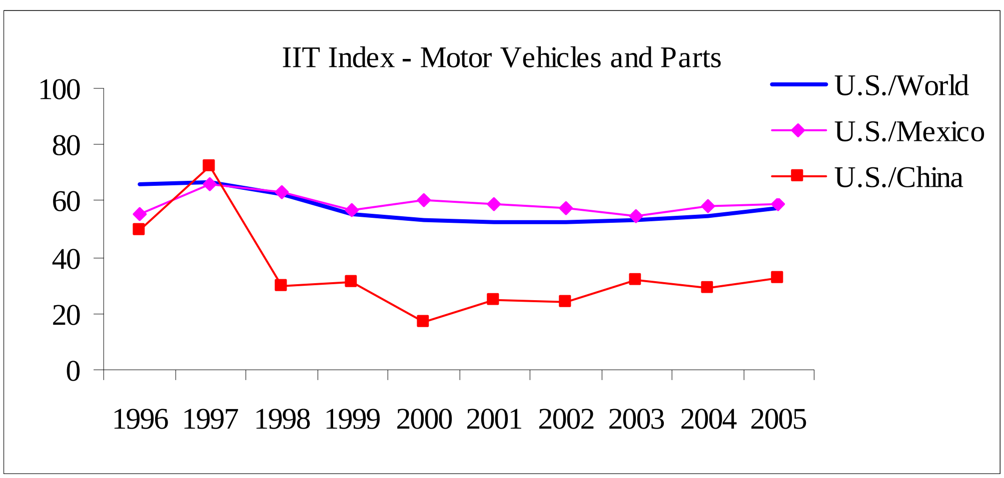
**Comparison of IIT Indices with Data on Import Intensity from Campo and Goldberg (1997)**

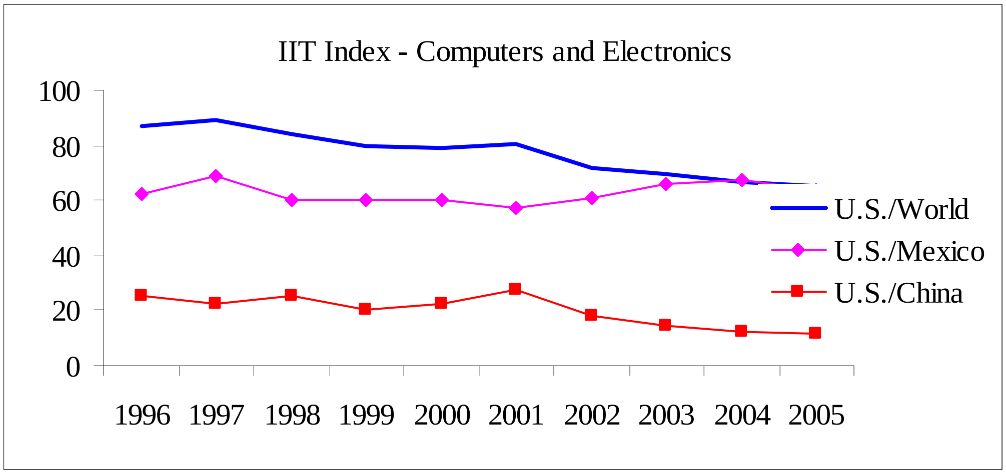
| | US Intra Industry Trade w/World (Avg. Index 1996-2005) | | Campo Goldberg - 1995 Data: % Production for Export | Imports % of Consumption | Imports % of Production |
|---|---|---|---|---|---|
| Leather | 19.0 | | 14.4 | 59.5 | 20.5 |
| Textiles | 36.6 | *Textile Mills* | 7.6 | 9.1 | 7.3 |
| | | *Apparel & Other Textiles* | 7.4 | 31.4 | 3.2 |
| Furniture | 38.7 | | 5.5 | 14.1 | 5.7 |
| Wood | 38.9 | | 7.6 | 10.3 | 4.3 |
| Food, Beverage and Tobacco | 46.5 | *Food Products* | 5.9 | 4.2 | 4.2 |
| | | *Tobacco* | 14.9 | 0.6 | 2.1 |
| Primary Metals | 55.4 | | 11.2 | 17.4 | 10.6 |
| Motor Vehicles and Parts | 57.3 | *Transportation Equipment* | 17.8 | 24.3 | 15.7 |
| Nonmetallic Minerals | 57.7 | | n/a | n/a | n/a |
| Fabricated Metals | 76.9 | | 7.9 | 8.5 | 8.7 |
| Paper | 82.6 | *Paper & Allied Products* | 9.0 | 10.0 | 6.3 |
| | | *Printing & Publishing* | 2.4 | 1.6 | 3.5 |
| Plastics | 86.3 | | n/a | n/a | n/a |
| Chemicals | 93.0 | | 15.8 | 11.0 | 6.3 |
| Machinery | 96.4 | | 25.8 | 27.8 | 11.0 |
| Electrical Equipment | 98.3 | *Electronic & Electrical Equip.* | 24.2 | 32.5 | 11.6 |
| Computers and Electronics | 77.3 | | | | |

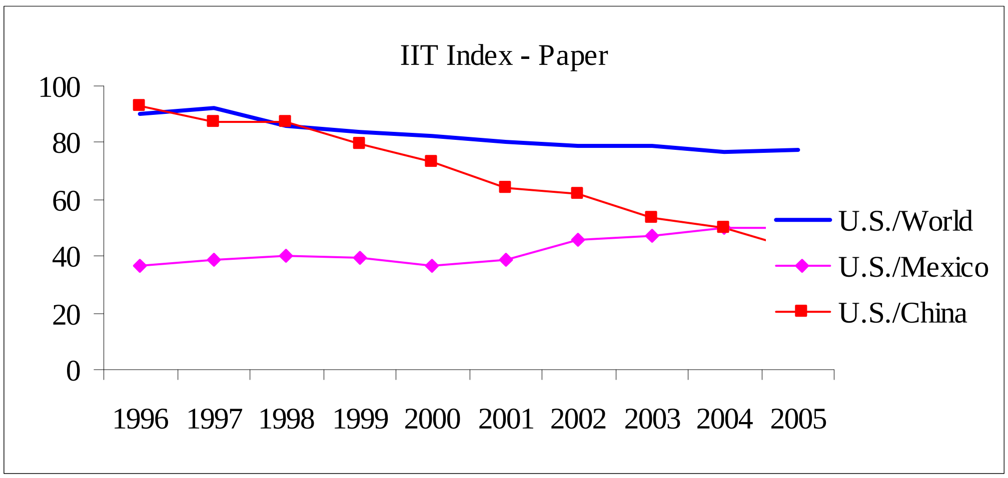
**IIT Indices for Mexico, China and World by Sector**

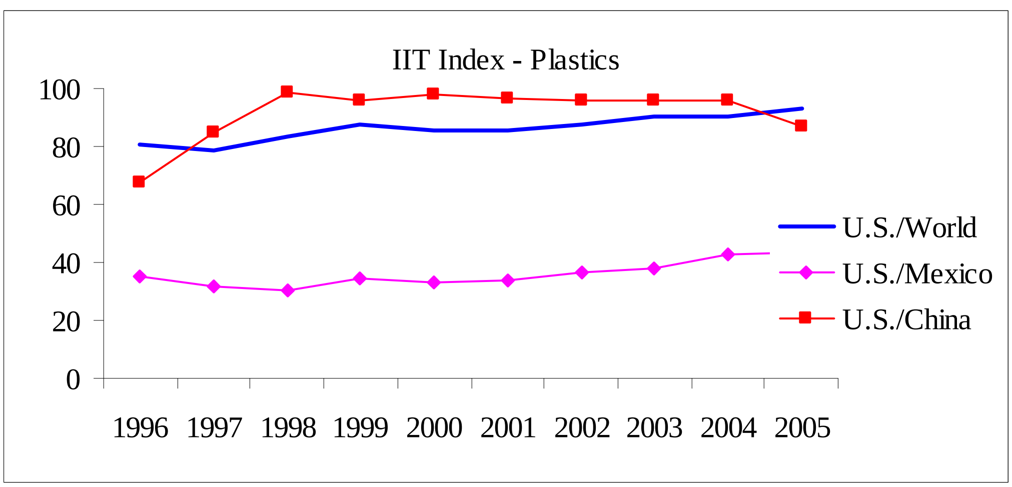



IIT Index - Computers and Electronics
100
80
60
40
20
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
U.S./World
U.S./Mexico
U.S./China


IIT Index - Paper
100
80
60
40
20
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
U.S./World
U.S./Mexico
U.S./China


IIT Index - Plastics
100
80
60
40
20
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
U.S./World
U.S./Mexico
U.S./China

## Mapping from NAICS to SITC Codes

| Sector Title | Eviews Variable Name Tag | NAICS Code | SITC Code |
|---|---|---|---|
| food, bev and tobacco mfg | _food | 311-312 | 00-12, 22 |
| textiles and textile products mfg | _text | 313-315 | 65, 84 |
| leather and allied products mfg | _leath | 316 | 61, 83, 85 |
| wood product mfg | _wood | 321 | 63 |
| paper manufacturing | _paper | 322 | 64 |
| chemical manufacturing | _chem | 325 | 51-56, 59 |
| plastics and rubber mfg | _plast | 326 | 57-58, 62 |
| nonmetallic minerals mfg | _miner | 327 | 66 |
| primary metal mfg | _primmet | 331 | 67-68 |
| fabricated metal mfg | _fabmet | 332 | 69 |
| motor vehicles and parts | _veh | 3361-3363 | 78 |
| transportation equipment | _transp | 336 | 78-79 |
| computer and electronic product mfg | _compu | 334 | 75-76, 87 |
| electrical equip and appliance mfg | _electric | 335 | 77 |
| furniture and related product mfg | _furn | 337 | 82 |
| machinery mfg | _machine | 333 | 71-74, 88 |

## Mexican and Chinese Export Variety

**Mexico's export variety to the U.S.**

| | Average | Agriculture | Textiles & Garments | Wood & Paper | Petroleum & Plastics | Mining & Metals | Machinery & Transport | Electronics |
|---|---|---|---|---|---|---|---|---|
| 1990 | 52.4 | 41.5 | 71.2 | 47.3 | 55.4 | 46.6 | 65.6 | 39.5 |
| 2001 | 66.7 | 50.9 | 82.6 | 63.2 | 72.7 | 56.4 | 75.8 | 65.6 |
| Growth rate | 2.2 | 1.9 | 1.4 | 2.6 | 2.5 | 1.7 | 1.3 | 4.6 |

**China's export variety to the U.S.**

| | Average | Agriculture | Textiles & Garments | Wood & Paper | Petroleum & Plastics | Mining & Metals | Machinery & Transport | Electronics |
|---|---|---|---|---|---|---|---|---|
| 1990 | 42.1 | 29.6 | 79.4 | 52.2 | 39.2 | 31.1 | 28.1 | 35.2 |
| 2001 | 63.3 | 34.0 | 87.6 | 65.2 | 70.3 | 55.1 | 62.7 | 68.1 |
| Growth rate | 3.7 | 1.3 | 0.9 | 2.0 | 5.3 | 5.2 | 7.3 | 6.0 |

Export Variety measured as % of U.S. import varieties covered by Mexican/Chinese exports
Feenstra and Lee (2007)

**Results of Pooled Estimation:**

**Combined Regression**

Dependent Variable: log(MexComp)

R-squared 0.9889

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.777 | 49.026 | 0.000 |
| China Trade | 0.006 | 0.277 | 0.782 |
| IIT Ratio | -0.030 | -2.646 | 0.009 |

| Fixed Effects (Cross Section) | | Fixed Effects (Period) | |
|---|---|---|---|
| Food, Beverage and Tobacco | -0.151 | 1996 | -0.257 |
| Textiles | -0.326 | 1997 | -0.191 |
| Leather | -0.254 | 1998 | -0.231 |
| Wood | -0.455 | 1999 | -0.144 |
| Paper | -0.018 | 2000 | -0.014 |
| Chemicals | 0.687 | 2001 | 0.107 |
| Plastics | -0.059 | 2002 | 0.175 |
| Nonmetallic Minerals | 0.039 | 2003 | 0.161 |
| Primary Metals | 0.380 | 2004 | 0.158 |
| Fabricated Metals | -0.108 | 2005 | 0.234 |
| Motor Vehicles and Parts | 0.315 | | |
| Computers and Electronics | 0.054 | | |
| lectrical Equipment/Appliances | 0.097 | | |
| Furniture | -0.349 | | |
| Machinery | 0.148 | | |

**With Interaction Term**

Dependent Variable: log(MexComp)

R-squared 0.9891

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.800 | 35.804 | 0.000 |
| China Trade | -0.003 | -0.133 | 0.894 |
| IIT Ratio | -0.052 | -2.760 | 0.007 |
| Interaction term | 0.008 | 1.450 | 0.150 |

| Fixed Effects (Cross Section) | | Fixed Effects (Period) | |
|---|---|---|---|
| Food, Beverage and Tobacco | -0.151 | 1996 | -0.260 |
| Textiles | -0.307 | 1997 | -0.193 |
| Leather | -0.265 | 1998 | -0.232 |
| Wood | -0.441 | 1999 | -0.143 |
| Paper | -0.028 | 2000 | -0.013 |
| Chemicals | 0.677 | 2001 | 0.107 |
| Plastics | -0.075 | 2002 | 0.175 |
| Nonmetallic Minerals | 0.042 | 2003 | 0.163 |
| Primary Metals | 0.400 | 2004 | 0.161 |
| Fabricated Metals | -0.106 | 2005 | 0.235 |
| Motor Vehicles and Parts | 0.312 | | |
| Computers and Electronics | 0.049 | | |
| Electrical Equipment/Appliances | 0.095 | | |
| Furniture | -0.347 | | |
| Machinery | 0.145 | | |

**IV Estimation**

Dependent Variable: log(MexComp); IV: log(China_EU_Trade)

R-squared 0.9890

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.816 | 27.346 | 0.000 |
| China Trade | 0.014 | 0.430 | 0.668 |
| IIT Ratio | -0.066 | -2.579 | 0.011 |
| Interaction term | 0.009 | 1.087 | 0.279 |

| Fixed Effects (Cross Section) | | Fixed Effects (Period) | |
|---|---|---|---|
| Food, Beverage and Tobacco | -0.125 | 1996 | -0.255 |
| Textiles | -0.305 | 1997 | -0.189 |
| Leather | -0.291 | 1998 | -0.228 |
| Wood | -0.448 | 1999 | -0.140 |
| Paper | -0.043 | 2000 | -0.012 |
| Chemicals | 0.660 | 2001 | 0.108 |
| Plastics | -0.080 | 2002 | 0.174 |
| Nonmetallic Minerals | 0.032 | 2003 | 0.160 |
| Primary Metals | 0.424 | 2004 | 0.155 |
| Fabricated Metals | -0.118 | 2005 | 0.226 |
| Motor Vehicles and Parts | 0.358 | | |
| Computers and Electronics | 0.042 | | |
| Electrical Equipment/Appliances | 0.101 | | |
| Furniture | -0.358 | | |
| Machinery | 0.152 | | |

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CHAPTER 5:

# CONCLUSION

Convergence in compensation costs is an important issue in the economic literature from a theoretical and an applied perspective. Central theories of macroeconomics and international trade point toward convergence in wages, which can be tested by looking for evidence of convergence in cross-country data. Economic agents have a substantial interest in whether these theories hold true in practice, including multinational corporations seeking low-cost locations for global manufacturing operations.

Chapter 2 demonstrated that the definition of convergence itself is open to debate. However, using the method proposed by Philips and Sul, there is evidence of convergence in compensation costs within three groups of countries.

The regression results from Chapter 3 provide support for a multiple-cone Heckscher-Ohlin view of global compensation data.

When considering country-specific factors, a different set of issues emerges. Data on Mexican versus Chinese import penetration and the extent of Mexico's intra-industry trade with the U.S. both have been cited as potential factors dampening Mexican compensation growth over the past decade. The results show that each of these factors has a negative relationship to Mexican wage growth for some manufacturing subsectors, but neither variable provides a universal explanation for weak Mexican compensation growth.

These papers provide some evidence for convergence in global compensation costs, particularly among countries producing a similar mix of goods due to their resource endowments. However, there is little evidence that the compensation cost gap between the highest and lowest cost countries will be closed over the foreseeable future. Based on the calculations in Chapter 2, it could take at least half a century before the lower-wage markets in the sample overtake the high-wage markets, even under the relatively generous assumption that the current rate of growth in the low-wage markets is sustained over that entire period.