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An operational framework for mortgage supply chains

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Abstract: Operations management in the mortgage banking industry requires a strategic framework that takes into account the industry's volatility, operational complexity and unique customer model. The foundation of this framework begins by (re)defining the mortgage lender's customer to include the capital markets. This paper proposes a novel model for managing mortgage banking operations, a model that uniquely reveals two different but intricately related supply chains in mortgage operations. The proposed dual-direction supply chain model offers speed and flexibility with one supply chain and integration and market knowledge with the other – the combination of which is critical to developing an effective hedge against uncertain demand. In addition, the paper incorporates legislation recently passed by Congress and its implications to our models. The paper offers concrete suggestions on how to apply various improvement strategies within the proposed model for efficient yet responsive operations in the mortgage banking industry.

Keywords: financial services; mortgage banking; operations; framework; supply chains.

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1 Introduction

Over the past few years, financial turbulence has been eminent, especially in the housing market. As what became infamously known as the 'sub-prime mortgage meltdown' led investor confidence to deteriorate, stock markets to plunge, and hedge funds to collapse, panic took over the world market. Consequently, all eyes focused on the mortgage banking industry. This paper provides a comprehensive primer on mortgage banking operations and discusses every aspect of the mortgage value chain, an understanding of which is germane to any discussion regarding the near systemic collapse of the mortgage industry.

Research in supply chain management has traditionally been centred on the manufacturing sector and a few mainstream service partners such as wholesalers and retailers. In these types of industries, the customer frequently is downstream from the operation. However, there are cases in the service sector, such as mortgage banking, where customers can be located upstream as well as downstream, creating a dual-direction supply chain (Zsidisin et al., 2000). In this paper, we first discuss the conventional value chain model to mortgage banking operations where the primary customer is the borrower. Then, in light of the creation of mortgage-backed securities (MBS), we propose a new operational framework for mortgage supply chains, namely a split supply chain with customers on both ends of the chain. The objective of this paper is to provide a new operational framework to mortgage supply chains and not to provide an explanation for the recent 'sub-prime mortgage meltdown' and the consequent worldwide recession.

The rest of the paper is designed the following way. Section 2 provides a comprehensive primer on mortgage banking operations. Section 3 analyses the mortgage banking value chain with a SIPOC model and explains the transformation in the industry due to the introduction of secondary markets. Section 4 explains the new proposed split-chain model for mortgage banking. Section 5 offers managerial suggestions and recommendations based on this new framework. Section 6 discusses the implications of new regulations while Section 7 provides future research directions. Section 8 concludes the paper.

2 Mortgage banking: a primer

The mortgage banking industry is comprised of two markets: the primary market and the secondary market.

2.1 Primary market

2.1.1 Loan processing

In the primary mortgage market, mortgage companies (as well as savings and loans, commercial banks, credit unions, and state and local housing finance agencies) lend funds to residential and commercial borrowers. Loan processing actually includes several stages, including application, underwriting and closing. During these stages, several important functions are performed. The two most important are:

1 the collection of documents that confirm information about the borrower and the collateral

2 the collection of data required for closing the loan.

During the application stage, a potential borrower expresses interest in a lender's mortgage product, and initial data is gathered by the lender's loan officer. This situation applies to retail origination; in wholesale scenarios, a broker will originate the loan on behalf of the lender. Wholesale mortgage banking increased in popularity during the 1980s and 1990s, as brokers learned they could achieve economies of scale in the pooling, securitisation and servicing of mortgages (Hutto and Lederman, 2003). According to the Housing and Urban Development Office, by 2001, brokers produced approximately 55% of all mortgage originations.

2.1.2 Underwriting

An underwriting process follows the application process. An underwriter works on behalf of the lender and determines the riskiness of a potential mortgage loan. The underwriting process attempts to assess three areas of risk: collateral risk, capacity risk, and character risk.

Collateral risk is determined by reviewing a property's appraisal and also calculating the borrower's loan-to-value (LTV) ratio. An independent appraiser compares the collateral to other recently sold properties in the nearby area. Based upon the specific property features and the comparable values, the appraiser assigns an appraised value to the property. The appraisal therefore provides an estimation of the property's value, which can be used as a proxy to estimate what the lender could expect to collect if the borrower foreclosed on the property. The appraised value is also combined with the loan amount to determine the borrower's LTV, a ratio that indicates the estimated amount of equity the borrower will possess at the time of closing. An LTV ratio greater than 80% (where the borrower possesses less than 20% equity) generally requires that the borrower purchase private mortgage insurance (PMI) to protect the lender from default. The majority of secondary market investors establish maximum LTV ratios to minimise risk in the loans they are purchasing; most lenders will try to adhere to these thresholds within their own product guidelines to ensure the saleability of the loans they are originating.

Capacity risk measures the borrower's ability to repay the funds being loaned to them. In order to determine capacity risk, a key ratio used in the underwriting process is known as the debt-to-income (DTI) ratio. An underwriter analyses a borrower's specific DTI ratio to determine his or her capability to pay down the debt. The obligations considered in the DTI ratio include but are not limited to: housing debt, credit card debt, child support/alimony, unsecured lines of credit and home equity lines. Gross income is used to provide the ratio's denominator and can include salaries, salary related income (bonuses, etc.), or income from child support and alimony. Acceptable DTI ranges vary by investor, although 36% of effective gross income is currently standard for most conventional loans (Hutto and Lederman, 2003). However, investors, and by extension lenders, can adjust their programme guidelines (including required DTI ratios) at any time to increase their comfort level with a particular level of capacity risk. The higher the borrower's DTI, the more difficult it will be for a borrower to pay down his or her mortgage loan.

In addition to DTI, an underwriter will also consider other variables when determining the borrower's capacity to pay, including cash reserves and other liquid assets. An underwriter also calculates the funds required for loan closing, based upon the borrower's desired down payment, closing costs and loan origination fees.

Character risk assesses the borrower's willingness to repay his or her debt. Obviously, simply because a borrower has the capacity to pay does not mean that he or she necessarily will. Underwriters are trained to determine the borrower's willingness to pay, using the assistance of several automated fraud and credit assessment tools. Credit history is particularly important in determining character risk. When reviewing a borrower's credit history, an underwriter looks for evidence of slow payments, credit inquiries, bankruptcies or previous foreclosures, all of which could indicate high default risk.

2.1.3 Closing

The underwriting process takes into consideration the risk associated with both the borrower and the property being purchased. Should the underwriting process lead to an approval of the mortgage loan, the borrower obtains the lender's funds through the closing process. Prior to closing however, borrowers will 'lock' their loan, essentially reserving their right to a particular interest rate. Once a loan is locked, it kicks off various risk management activities and economic decisions related to preparing that loan for a sale in the secondary market.

During the closing process, which is facilitated by a closing agent, often an attorney or a title company representative, the borrower signs multiple documents, including but not limited to: note, security instrument and compliance disclosures. These documents explain the terms of the debt, including the interest rate being charged to the borrower and the length of the note. They represent the borrower's acknowledgement of the debt and pledge the property as security for the funds being loaned. The collateral documentation, which includes the security instrument and the mortgage note, are used by the lender to prove right of foreclosure should the borrower default on the loan.

The significance of closing lies in the transition of the title from the seller to the buyer of the property. The lender also establishes its various legal repayment, collateral and default rights at this time (Hutto and Lederman, 2003). The mortgage lien does not come into existence until closing occurs. If a loan is improperly closed, with either inaccurate

documents or inaccurate data, the closing could result in an 'unsaleable' loan, which is essentially a loan that cannot be sold in the secondary market. In these situations, the loan would either be retained on the lender's own balance sheet, or sold at as discount as a 'scratch and dent' loan. It is important to note that both improper closing and sloppy underwriting can result in loans having to be sold at a discount, or not having any potential for sale at all, regardless of cost.

2.2 Secondary market

In the secondary market, the mortgage loans originated in the primary market are sold to investors as whole loans (where the debt owner also owns the servicing rights) or pooled as MBS. Secondary market investors and conduits include government-sponsored entities (Fannie Mae, Freddie Mac and Ginnie Mae), commercial banks, private investment banks, pension funds, insurance companies, securities dealers and other financial institutions. These parties provide liquidity for the mortgages originated through primary market transactions by establishing a marketplace for selling and buying those mortgage liens. For instance Fannie Mae, a government sponsored entity (GSE), ensures that funds for mortgages are available to the end consumer, the homebuyer, by freeing up the lender's portfolio. The lender, in turn, can use the cash received from the mortgages Fannie Mae buys to offer additional mortgages to potential homeowners. In addition, the secondary market assists the flow of capital from areas with excess cash to those with capital deficits. It also reduces the geographical spread in interest rates offering standardised rates to borrowers regardless of location. The standardisation of rates has essentially commoditised the mortgage product and allowed investors to mitigate regional risks of loss.

2.3 Critical internal functions

A mortgage lender will always have its own internal secondary marketing group (hereinafter referred to as 'capital markets group' or CMG) to manage the transactional activities required to conduct business in the secondary market. CMG is generally responsible for loan sales, shipping, delivery, pricing, risk management, hedging and pipeline management. The critical factor for success in all of these factors is accurate data provided through the origination process in the primary market transaction. The collective LTV and DTI ratios, in addition to other credit and collateral characteristics, are used to determine the risk profile of a lender's mortgage pipeline. Such determinations ultimately drive the economics for a lender by impacting the hedging and pricing decisions for a particular loan or pool of loans. The data is also critical to balancing the limits of the lender's warehouse, which is the collection of loans awaiting sale to a secondary market investor. It can help predict the marketability of that loan in addition to the time that will be required to prepare it for a secondary market sale.

CMG's main goal is to preserve the value of the mortgage pipeline for sale in the secondary mortgage market. The pipeline refers to all locked loans that, upon closing, enter the lender's warehouse of 'available-for-sale' loans. Consequently, as a natural by-product of its value preservation function, risk management is a large component of CMG. The types of risks managed by CMG include: interest rate risk, product risk, credit risk, fallout risk and basis risk.

Interest rate risk refers to the possibility that interest rates will change between the time a borrower 'locks' the price of his or her loan and the time the lender is able to sell that loan to a secondary market investor. The greater that gap, the more interest rate risk increases. When a market disappears for a particular loan type, product risk occurs. Consequently, the alignment of borrower needs with investor requirements is a delicate balance that a mortgage lender must constantly try to achieve. Credit risk is the likelihood of default by an investor (also known as counterparty risk). Fallout risk refers to the certainty that some applicants will never close their loan after locking, for reasons which include failure to qualify and adverse interest rate movement. Finally, basis risk represents the difference between the market movement of mortgage prices and the derivative used to hedge them. Basis risk is a certainty unless prices for the hedged asset and its derivative change in perfect harmony with one another.

2.4 Servicing the loans

Mortgage loans can be sold into the secondary markets either servicing retained or servicing released. With servicing released loans, a lender sells both the mortgage itself and the right to service that mortgage. The activities included in servicing include collecting the monthly mortgage payments and maintaining the escrow account from which taxes and insurance are paid.

With servicing retained loans, the original lender sells the mortgage loan to a secondary investor, but retains the mortgage servicing rights (MSRs) and collects the servicing fees associated with the account. MSRs have resulted in an important paradigm shift regarding risk management in mortgage banking. Lenders realised that the servicing fees acquired from a mortgage loan represent lucrative income. The profitability associated with MSRs thus encouraged lenders to sell more of their mortgages into the secondary markets with servicing retained in order to free up capital for new loans. Consequently, many lenders lost a sense of obligation to look for the highest quality borrowers, since the debt would no longer be retained as a risk on the lender's own balance sheet. Thus, over time, creditworthiness became less and less of a concern.

3 Operations management in mortgage banking

The development of the secondary market for the mortgage industry represented a critical turning point in two important ways. First, it enabled the transformation of individual financial assets into liquid and tradable capital market instruments. By extension, mortgage lenders acquired the ability to free up capital on their balance sheets, which allowed them to originate more primary mortgage sales and/or remove risky assets from their portfolio. Secondly, and more germane to the topic of this paper, the emergence of the secondary market created a completely new value chain for the mortgage industry, one that is split with customers on both ends of the chain.

3.1 The SIPOC model

A SIPOC diagram, often used in process improvement initiatives, provides a holistic, process-oriented view of the entire organisation. SIPOC identifies the suppliers, inputs, processes, outputs and customers involved in achieving an organisation's goals. The

importance of the SIPOC is predicated on the assumption that any successful company must be completely in tune with the needs of its customers. Correctly identifying and segmenting those customers is an inherent requirement for building products and services that meet these customers' needs. Not knowing who the true customers are, or incorrectly classifying them, can lead to a complete misalignment in an organisation's overall strategy and ensuing decisions around operational structure, processes and resources.

Prior to the development of the secondary markets, a SIPOC analysis of the mortgage business reveals the positioning of the borrower as the ultimate customer. Depository institutions, such as banks, and mortgage lenders would provide financing from their own balance sheets to creditworthy customers. The origination, underwriting and closing processes then resulted in primary mortgage sales, which lenders retained in their own portfolios (Jacobides, 2005). Customer satisfaction was measured by the level of contentment experienced by the borrowers throughout the origination, closing, and servicing stages of their loan.

The emergence of the secondary market altered the mortgage industry's SIPOC in several key ways. First, it introduced a new input into the model by providing an additional source of financing for new mortgage originations: secondary market liquidity. Selling mortgages into the secondary market freed up a lender's warehouse line and allowed it to extend more loans to new borrowers.

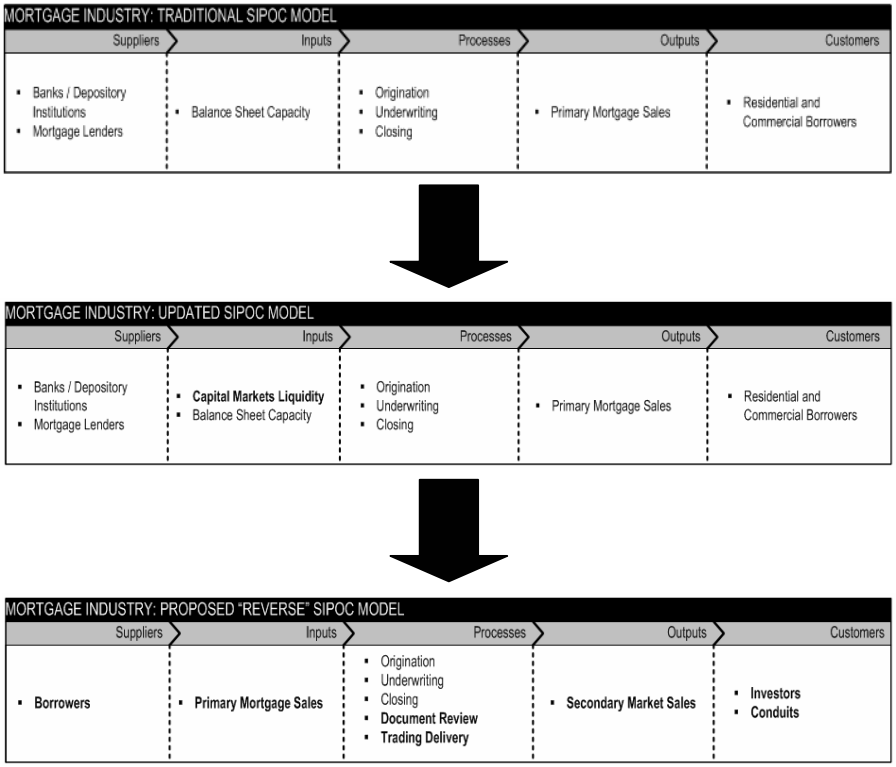
It is important to note, however, that the development of the secondary market did more than simply upgrade the traditional SIPOC model with the inclusion of a new input. Had this been the case, the mortgage chain's demand side would still be exclusively focused on the borrower of funds. As the purchaser of primary market originations, the investor at the very least, supplements, and at the very most, completely redefines, the 'customer' in the mortgage industry.

Repositioning the investor as the downstream customer in the mortgage industry's SIPOC model is the key to developing an effective framework for mortgage banking operations. It suggests something much more than needing to simply update traditional customer satisfaction and relationship management metrics. Instead, it completely splits the mortgage industry's value chain by providing a reliable source of demand knowledge, knowledge which is critical to effectively managing the uncertainty and volatility that characterise the entire industry. Demand knowledge existed in the traditional SIPOC model as well; however, it naturally revolved around the borrower of funds, the only customer in the traditional model. Such knowledge then translated itself into product developments and enhancements that these borrowers would embrace.

3.2 Transformation of the mortgage industry SIPOC

Figure 1 illustrates the transformation of the traditional SIPOC model into what we are calling the 'reverse SIPOC' model. In the traditional model, the major input into the mortgage lending process is the lender's own balance sheet capacity. Without the secondary market, the lender had to finance all of its own originations and retain those mortgages in its portfolio (ultimately restricting the number of mortgage loans that could potentially be offered by the primary lender). The traditional SIPOC model is primary-market centric, with the positioning of residential and commercial borrowers as the ultimate industry customer. Consequently, the important processes involved in the SIPOC model are the processes related to completing that primary market transaction.

Figure 1 Mortgage SIPOC model – transformation process



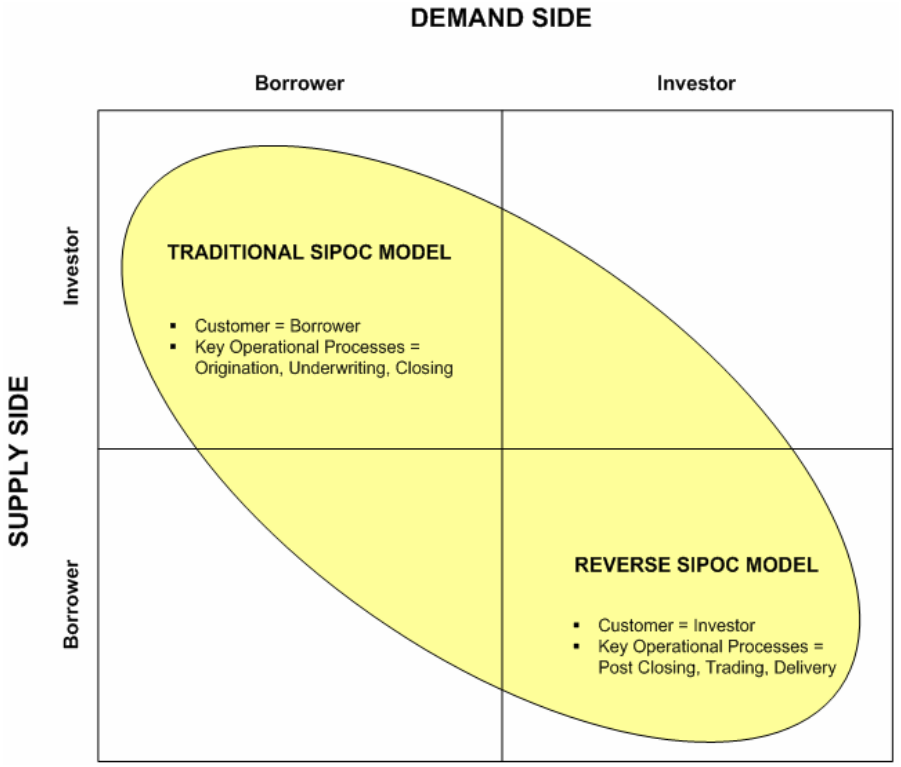
With the emergence of the secondary market, the first transformation in the SIPOC model occurs. In the updated SIPOC model in Figure 1, an additional input is visible. The liquidity provided by the capital markets offers lending institutions another source of capital that can, in turn, be extended to primary mortgage borrowers. In this stage of the transformation, the mortgage customer is still defined as the residential or commercial borrower to which an institution is lending funds in the primary market.

However, the transition of the traditional SIPOC model continues with the elevation of the secondary market investors as an additional customer in the SIPOC model. Because their method of providing capital is through the actual purchase of primary market originations, secondary market investors are ultimately as important a client as the borrower whose loan they are purchasing. Consequently, as Figure 1 shows, several new investor-related processes are elevated in importance: post closing, trading and loan delivery, all of which are critical to facilitating the secondary mortgage sale transaction.

The inclusion of secondary market investors as a key customer in the mortgage industry is the first step toward developing the proper operational framework. Correct identification of the customer leads to correct identification of demand knowledge, knowledge which is critical to structuring a company's operations in a way that is best

positioned to meet their overall business strategy. Figure 2 compares the traditional and the reverse SIPOC models with respect to their supply and demand.

Figure 2 Comparison of traditional and reverse SIPOC models (see online version for colours)



3.3 Understanding the mortgage industry's supply chain

Fisher (1997) showed, understanding the nature of a product's demand is essential to the effective management of its supply chain. Hence, unique attributes of the mortgage product should first be identified to design an appropriate supply chain. Using Fisher's classification, at the simplest level of comparison, mortgages can be likened to primarily 'innovative' products, or products that are characterised by high profit margins and volatile demand. Volatility is inherent to the industry. As an innovative product, one of the most vital purposes of the mortgage supply chain is to remain attuned to demand knowledge and be able to react quickly to changes in the market.

Classifying the mortgage product is a prerequisite for identifying the critical functions its supply chain needs to serve. A supply chain's physical function is to convert raw material into finished goods. First, in the mortgage industry, the physical function can be construed as any of the following, all of which must be addressed by the mortgage company's supply chain:

1 the origination of a mortgage loan from lender capital

2 the conversion of a primary market sale into a secondary market sale

3 the transformation of an individual financial asset into a liquid and tradable capital markets instrument.

A second and equally important function of supply chains is market mediation, which ensures that the variety of products produced, matches customer needs and wants. Consequently, the importance of the reverse SIPOC model is again highlighted here, as an underlying assumption in Fisher's framework is that the customer is accurately defined.

How would an inaccurate or incomplete definition of a customer lead to poor market mediation? In the traditional SIPOC model, the demand would be purely defined by the different lending products and financing options the borrower was seeking. While important in its own merit, understanding the borrower's demands accomplishes little in achieving marketability in the secondary market. Mortgage lenders must understand the demands presented to them by the investors who provide the end liquidity in the capital markets. For innovative products information flows from the marketplace to the chain, and reading market signals correctly and being able to react quickly during the product's short lifecycle is critical (Heikkila, 2002). With the reverse SIPOC model, it becomes clear that positioning the investor as the downstream customer is the first step toward establishing an operational hedge against uncertainty in the mortgage industry, by positioning the secondary markets as the true barometer of demand knowledge.

The need for speed and flexibility underscores the importance of timely and accurate communication in the mortgage supply chain. Communication would support a backwards integration, with the market (or its proxy, the investors) communicating demand to the mortgage lender. The lender's internal communications should then follow this intuitive flow: from the previously discussed internal CMG outward to production channels and operations partners. The production channels and operations partners combined form the coalesced supplier base for secondary market sales. In essence, they are providing the primary market sales required to conduct secondary market sales. The key to making this combined supplier base successful is ensuring that they continue to receive the real-time and constant demand knowledge that is flowing in from the secondary market.

4 Supply chain functionality

The physical function of this new dual-direction supply chain is entirely focused on the conversion of a primary market sale (the act of originating a residential or commercial loan) into a secondary market sale (the act of selling and delivering that loan to a capital markets investor). And, the market mediation function of the supply chain is to ensure that the products originated in the primary markets meet the demands of buyers in the secondary markets. How does a mortgage lender optimise its supply chain to most effectively serve both its physical and market mediation functions? And, how does this optimisation allow a lender to protect itself from the mortgage industry's natural volatility?

Figure 3 The mortgage sub-chains (see online version for colours)

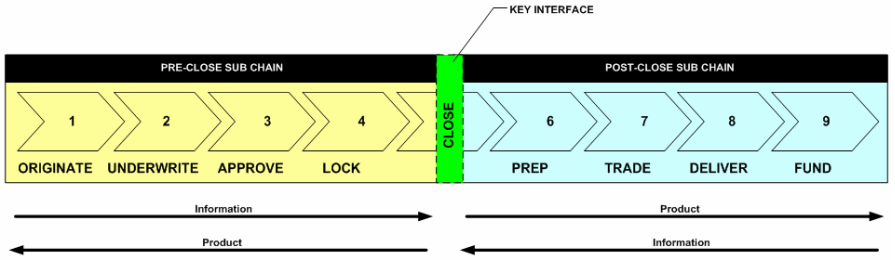
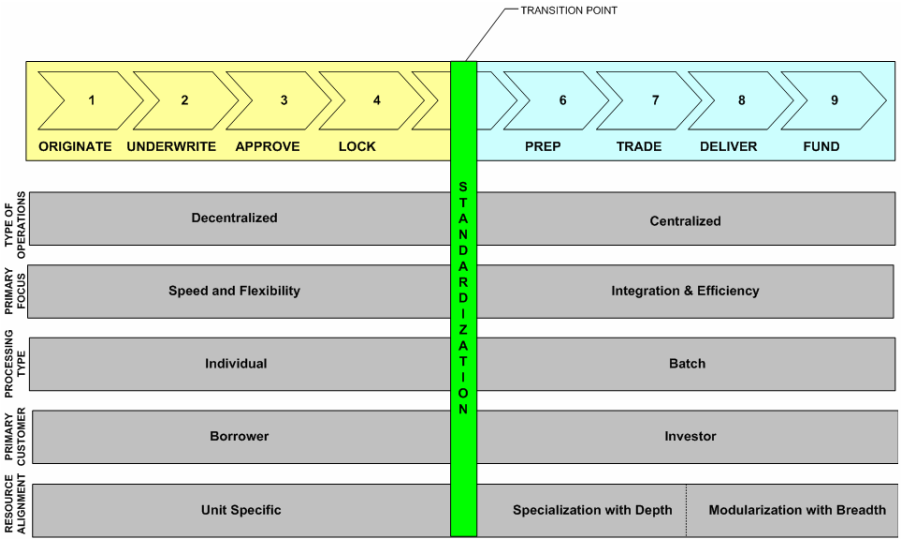


Figure 4 Key differences in two sub-chains (see online version for colours)



At this point, it is beneficial to further dissect the split supply chain into two sub-chains hereinafter referred to as the *Pre-Close Sub-Chain* and the *Post-Close Sub-Chain* as displayed in Figure 3. These require vastly different operational strategies, that when combined, offer a comprehensive approach to effective operations management in the mortgage industry. Figure 4 demonstrates key differences between the sub-chains. Various optimisation strategies can be applied to improve speed and flexibility in the nine supply chain processes; the correct strategy depends on the unique attributes and specific purposes associated with each step. These nine processes, and their basic definitions, are noted below (Cummings, 1997):

1 Origination (includes Application) – identifying a prospective borrower for a mortgage loan.

2 Underwriting – determining credit, collateral and character risk.

3 Approval – approving the borrower based upon the underwriting process.

4 Lock – 'reserving' a specific interest rate based on current market rates and a specified 'lock in' period.

5 Close – providing funds and generating a lien for the property; transferring legal ownership of the property.

6 Prep – imaging, indexing and reviewing all the documents and data associated with the mortgage loan and preparing the loan for sale in the secondary markets.

7 Trade – securing interested secondary market buyers and accepting a bid for a package of loans.

8 Deliver – undergoing collateral review and due diligence on the loans.

9 Fund – providing payment for the loans.

4.1 The Pre-Close Sub-Chain

The Pre-Close Sub-Chain is focused on the procurement of a primary mortgage sale and contains Steps 1 through 4. Consequently, it is borrower-centric. As data is gathered from the borrower, it is pushed down the supply chain and into the secondary marketing process. This data is used to begin hedging the pipeline and minimise the aforementioned market, interest rate and basis risks.

It is important to note that in the Pre-Close Sub-Chain, mortgage loans are processed individually. Each loan is originated, underwritten, approved, locked and closed on its own; the processing does not involve any batching. Further, geographic proximity to both the borrower and property are important in this sub-chain, given the need to determine the credit, collateral and character risks at this stage of the mortgage lending process. The Pre-Close Sub-Chain will function better as information is readily available. If the borrower and the property are located close to the originator of the loan, information gathering will be less taxing than if these groups were located in different states. An originator, who has expert knowledge of land areas, will more easily be able to understand both the constraints and values of the goods and services they are providing. Thus, these two features – proximity to the borrower and individual processing – are particularly important in designing the correct operational structure.

The required proximity to the borrower and the individual processing of a mortgage loan is best served with decentralised operations allowing localised decision-making and control. The number of parties often involved in Pre-Close Sub-Chain, including but not limited to the borrower, attorney (or title company), settlement agent, lender, and county/state (for document recording), provide a strong argument against centralisation of operational processes, especially given the need for locality-specific processes and contacts. Integration into the local community and connections with the builders are the key success drivers. The focus of the business is on sales and client relationship management. The appropriate incentives are high powered and agents are paid in commissions more than in salaries (Jacobides and Winter, 2005). Minimal hand-offs, localised decision-making and borrower proximity lend themselves to a flexible and customer focused process.

While decentralisation is the preferred approach in Pre-Close Sub-Chain, it is important to note that decentralisation does not mean each processing unit (such as a

retail branch of a depository institution) is exempt from following standardised guidelines for originating, underwriting, and closing a loan. The impact of standardisation – and lack thereof – is discussed in a later section of this paper. Standardisation of the information about the borrower and the property, as well as the mortgage documents obtained during the application and closing processes are critical for a seamless transition from the Pre-Close into the Post-Close Sub-Chain.

4.2 The Post-Close Sub-Chain

The Post-Close Sub-Chain is focused on the conversion of the primary market sale into a secondary market sale and contains Steps 6 through 9. Consequently, this sub-chain is focused on the secondary market investor. Demand knowledge is collected from the external market and pushed inwards toward the production and sales channels for the primary markets. The operational focus almost immediately shifts from decentralisation to centralisation.

A key differentiator between the Pre-Close and Post-Close Sub-Chains is that in the latter, products are no longer individually processed. Loans are reviewed, prepped for secondary market sale, traded and delivered in packages. Due to this transition from individual to batch processing, decentralisation does not offer the operational synergies and economies of scale that can be realised through centralising these major activities into one back office function. Additionally, process improvement methodologies oriented toward a mass production environment have an opportunity for application in the Post-Close Sub-Chain, given this Sub-Chain's similarity to a traditional manufacturing operation environment. Finally, resource allocations and organisational structures should be determined with care, taking into consideration each process area's need to be efficient and integrative, as well as the overall supply chain's need to be flexible and responsive.

5 Creating the operational framework

Now that we have a comprehensive view of the nature of supply and demand as well as the structure of the mortgage supply chain, we can provide a detailed discussion for the components of the operational framework to offer immediate, tangible impact to the managers of mortgage lenders.

5.1 Data management strategy

The breadth of data generated in the origination and servicing processes, combined with the importance of that data in driving the economics of a loan, underscore the importance of a robust data management strategy for every mortgage lender. However, consolidation often pushes lenders to operate using multiple legacy systems, which then results in unreliable and inconsistent data entry. Furthermore, without standardisation of data associates in the two different sub-chains could even define simple terms (such as 'loan saleability') differently. Managers should ensure that a well maintained business lexicon is accessible to, and used by, all associates in order to protect data integrity and standardisation. Standardisation of data is just as important as standardisation of documents in order to ensure a seamless transition between the two sub-chains.

Data management strategy should also include policies and procedures related to data entry and edits, and identify owners of data at every stage of a loan's life cycle. Controls should be established and monitored to ensure compliance. A data management 'champion' should be made accountable for ensuring data quality throughout the supply chain, as well as investigating and remedying root causes of any data quality issues. Finally, an overall data governance team consisting of key cross-functional leaders and led by the data management champion can help protect and refine the lender's data governance structure and ensure that changes to data management methodologies align with the organisation's overall business strategy.

5.2 Process management

Traditional process improvement techniques would apply particularly well in the Post-Close Sub-Chain, given its mass production nature. In order to reduce a lender's basis risk, minimising this sub-chain's delivery cycles times are critical to financially protecting the lender. At a macro level, reporting should exist that enables managers to ensure the timely migration of loans through their respective processes. The management team should define the acceptable range of time it takes for loans to move through the Post-Close Sub-Chain. Loans that are not moving or have not moved sufficiently within a specified time frame should be included on an exceptions report for management review. Cycle time reduction could be achieved through standard process management approaches like theory of constraints (TOC), lean, and pull processing.

TOC can be applied to improve the back office processing required to prepare, review, trade and deliver a loan. TOC improves throughput by identifying system bottlenecks and subordinating the system around them (Goldratt, 2004). Additionally, although a more disciplined and quantitatively based methodology such as Six Sigma may still be inappropriate for the Post-Close Sub-Chain (the sub-chain is still predicated on too much demand volatility to benefit from a statistically driven variance reduction strategy), mortgage companies can apply select concepts from 'lean' to eliminate waste in their back office processes. Finally, a 'pull' system for loan processing can be implemented with technology that allows for real-time market demand knowledge and manipulation of workflows.

At a micro level, the processing of individual loans should be broken down into measurable and digestible components that allow for minimal variability. The complexity of mortgage documentation prohibits a completely repeatable and identical review process; however, a review can be decomposed into several 'micro' steps that can be executed with much more precision and accuracy. The granularity of tasks then allows for both easier training as well as the establishment of realistic and measurable benchmarks that can be used for performance management and immediate visibility of both process and outcome variations.

5.3 Organisational structure and resource management

The appropriate use of resources is extremely critical to improving velocity of loans through the mortgage supply chain. Resources must be aligned in such a manner that they can quickly respond to changing market demand. If several organisational units are involved in the Post-Close Sub-Chain, specific positions should be created to ensure the

timely passage of loans throughout the entire post-closing and delivery process. These resources would serve as 'case managers' wholly responsible for the successful conversion of a primary market sale into a secondary market sale. In essence, they would track individual loans through the various batch processes to monitor cycle times and ensure loans were not just moving through the various post-closing and delivery stages, but ultimately out of them.

Subject matter complexity and required investor/product knowledge grow increasingly with each step in Post-Close Sub-Chain, as the mortgage loan moves closer to the investor. There is a direct correlation between proximity to the secondary markets and the amount of agility required to effectively respond to incoming demand knowledge. An underlying assumption in the recommendations below is that the lending organisation is too large to cost-effectively dedicate single resources to the entire end-to-end process of preparing and delivering a loan. Consequently, the overarching organisational structure is presumed to be one where some level of functional segregation of duties is required.

In the prepping processes (Step 6 in the Post-Close Sub-Chain), investor contact is still minimal. At this stage, resources are collecting the documents from the Pre-Close Sub-Chain, and preparing them for delivery. Market demand knowledge and product knowledge are only critical insofar as their ability to dictate the priority in which loans are processed. An 'assembly line' structure may still be appropriate in this area, with resources that are functionally aligned and have well-defined, narrow scope of responsibilities. Specialisation in a 'vertical slice' of the overall process helps break down the subject matter complexity for lower skilled, lower cost resources. Training programmes should focus on the overall goal for the entire Post-Close Sub-Chain, the function of which is the conversion of a primary market sale into a secondary market sale. However, the components of those training programmes should decompose individual functions into tangible, concrete and digestible steps to support the strong need for specialisation in this area.

In the delivery and funding processes (Steps 7 through 9 in the Post-Close Sub-Chain), the lender's resources are working directly and daily with the investors, and hence, knowledge of market demand becomes critical. As the end conduit to the investor, resources in these areas should be extremely well versed in the product they are delivering, the processes through which they are delivering and the investor to whom they are delivering. Communication of their demand knowledge, as they acquire it from the investor, should again flow backwards in the supply chain toward the operations partners and production channels. These communications then drive the priorities for processing loans in the post closing areas, and for originating primary mortgage sales in the production channels. Lastly, functional alignment may not prove fruitful in this area due to the need for wide breadth of process and subject matter knowledge. Consequently, training should focus less on specialised skill-sets and more on broader cross-training that allows resources to nimbly respond to specific market demands. A modular team format, in which groups of resources can be transplanted nimbly according to investor demand, may be best suited to provide the required agility in this area.

To accurately forecast staffing needs in the Post-Close Sub-Chain is particularly difficult. Pipeline volumes (loans committed to customers by virtue of 'rate locks') can provide some indication of closed loan volumes to come, but sudden or unanticipated market movements or faulty assumptions (in terms of how many customers will actually close on their loans) can make those forecasts relatively weak. Therefore, the staffing

goal in the Post-Close Sub-Chain should be adequately preparing for uncertainty rather than perfectly staffing to demand.

Managers can accomplish this feat by staffing more to their peaks than to their valleys, and ensuring that resources are cross-trained to nimbly exchange job responsibilities as needed to meet ever-changing market demand. This is likely a more expensive option that staffing to a 'baseline' (or constant and predictable) volume and supplementing with contract assistance; however, it is important to recall that in the Post-Close Sub-Chain, responsiveness trumps cost effectiveness in terms of importance.

The complex nature of mortgage documents, which is the focus of this Sub-Chain, also lends itself more to diversely trained associates who can transfer job responsibilities with a relative amount of flexibility and ease. The necessary temporary reallocations of permanent associates to meet changing market demand can be facilitated through an organisational model that is less functionally aligned and more process oriented. Associates should therefore be incented on their ability to understand and perform multiple functions, rather than on their ability to build expertise in a specific subject matter area.

5.4 Quality management

In the mortgage industry, quality could be defined in multiple ways, all of which are arguably important:

- quality of *data* – as previously mentioned, standardised underwriting decisions and reliable data are critical to a liquid secondary market
- quality of *investor relationships* – with the development of the capital markets, the value of partnerships with investors cannot be underestimated
- quality of *borrowers* – as the recent sub-prime mortgage crisis of 2007 has shown, lending funds (in part due to lax lending strategies) to under qualified borrowers can have a detrimental effect on the global economy
- quality of *service* – when pricing does not differentiate a lender from its competitors, a lender must be able to offer a value proposition in other ways.

These four quality elements are interrelated and mutually symbiotic. Data quality is not important if underwriting decisions are not leading to prudent lending. Borrower satisfaction is important if and only if borrowers make their payments in a timely fashion and refer financially qualified applicants to the lender. Investor relationships only matter if there are front-end originations that can be sold in the secondary market. Accordingly, in the mortgage industry, a quality management programme must assume a holistic approach.

Traditionally, most quality metrics in the mortgage industry have only focused on quality of service which has been somewhat facilitated by the popular JD Powers Service Awards in the industry. The introduction of a new customer in the reverse SIPOC model requires that the definition and measurements of quality in mortgage banking be adjusted accordingly. The definition of quality will need to be expanded to, at a minimum, include investor satisfaction as a quality metric. How quickly was a lender able to facilitate the delivery process? Did the final 'pool' of loans meet the investor's expectations and

support the assumptions on which their bid was offered? Was the investor satisfied with the quality and speed of the operational review and due diligence performed on their loans?

Additionally, quality of data and underwriting will be just as critical to ensuring a mortgage lender's success. The number of lenders and hedge funds that have collapsed after gambling on poorly underwritten loans are a testament to the criticality of sensible lending practices. Quality, then, should not be the responsibility of a specific department of function within a mortgage company, but ingrained into the day-to-day responsibilities of each associate – whether that associate is a loan officer, an underwriter, or a back office processor. Quality metrics should be included in each associate's performance metrics as appropriate. Production channels should be measured on the quality of their originations, internal CMG associates should be measured on the quality of their investor relationships, and all units should be measured on the quality of the data they input into the systems, data which essentially connects each unit and drives important financial decisions every day. Support groups – internal or external – may be used to conduct customer satisfaction surveys or benchmarking research to help each department measure and continue to improve the quality metrics that are vital to their part of the business. An enterprise-wide quality scorecard should be developed and shared just as frequently as earnings releases. In this manner, quality then becomes a natural part of a mortgage lender's business processes and operations.

5.5 The importance of standardisation

The key interface between the two sub-chains is the closing process. Closing represents the transition in the process from a borrower-centric to investor-centric model. While closing is the physical function that represents turning point in the mortgage supply chain, standardisation is what ultimately connects the two uniquely different sub-chains and allows a seamless transition. Standardisation also allows for the efficient batch processing of lengthy and complex mortgage paperwork in the Post-Close Sub-Chain. Additionally, standardisation enables investors to make informed decisions about the loans they are purchasing in the capital markets; without standardisation, their purchases are characterised more by uncertainty than by a calculated level of risk (Green and Wachter, 2007). Without standardisation, mortgages cannot be commoditised into a trading instrument.

In fact, Cummings (1997) argues that the following two key requirements must exist for a liquid secondary market:

1 standardisation

2 information about performance and risk.

Mortgage contracts and underwriting standards must both meet an industry level standard. Investors must also have reliable information and be able to make certain assumptions based upon the standardised underwriting criteria in order to make informed purchased decisions. Hence, all outputs from the Pre-Close Sub-Chain must be standardised in order for the following to all hold true:

1 the two sub-chains create a cohesive supply chain rather than distinct diametrically opposed processes

2 investors can make informed decisions and assumptions regarding their secondary market sales, and thus support liquidity in the capital markets

3 batch processing can efficiently and cost effectively occur in the Post-Close Sub-Chain.

Standardised processes, however, cannot exist without accountability. Resources within the Pre-Close Sub-Chain must be held accountable for developing the standardisation procedures (with guidance from the Post-Close Sub-Chain), in addition to adhering to such procedures. From a pure process perspective, one can effectively minimise the number of 'touches' required on a loan by ensuring it is compliant with all internal and external protocol before it transitions from the Pre-Close Sub-Chain to the Post-Close Sub-Chain. Then, a quality control (QC) sampling process can be implemented in the Post-Close Sub-Chain to ensure that the Pre-Close Sub-Chain produced documentation and data that met the lenders' standardisation requirements. Loans that fail this QC process can be individually evaluated on an exception basis, and feedback can be provided to the Pre-Close Sub-Chain accordingly. Organisational structures should take into account the need to enforce standardisation and penalise products that do not meet the lenders' criteria. Loans that do not meet the standardised underwriting or closing guidelines are likely to be unsaleable in the capital markets, and hence, the cost of illiquidity must be diffused across the accountable parties.

However, it is important to note that there may be ties between regular standards, regulation, and legislation, especially with regard to the sub-chain models (both Pre- and Post-). Given a more dynamic and complex US financial market, the sub-chains may experience some disruptions. As the mortgages were repackaged and sold to investors, this secondary market was not tightly regulated for US mortgages – meaning there was a lack of regulation in the Post-Close Sub-Chain process. On the other hand, depository institutions, such as banks loaning money to consumers (potential homeowners), are highly regulated entities, with regulators constantly scrutinising the activities of these financial institutions – portraying stricter regulation in the Pre-Close Sub-Chain model. Although there may be tighter regulation in this sub-chain, regular (or the same) standards are not present as the US system currently is decentralised with several different regulatory bodies each responsible for supervising different (and sometimes the same) depository institutions (such as the Office of the Comptroller of the Currency, Federal Reserve Bank, Office of Thrift and Supervision, and state supervisors). Even though tighter standards could be achieved through greater regulatory control over the secondary market, increased standards across the board may be needed in the primary market. Since a myriad of regulatory bodies oversee depository institutions, insurance companies, and securities firms in the US' decentralised structure, implementation of regular standards with decentralised structure may create challenges in the Pre-Close Sub-Chain model. The decentralised nature of the US regulatory oversight may be a blocking agent to achieving such congruencies. In spite of this, implementing the same standards across the board (with both internal and external protocols) in both of the individual sub-chains could potentially be achieved through external regulation. Currently, there has been a huge push to centralise the US regulatory oversight structure (meaning finding a best-practice method to combine regulators of banks, savings and loans, thrifts, securities, and insurance industries) which may facilitate regular standards across Pre- and Post-Close Sub-Chain models. Furthermore, legislation of the mortgage banking industry can and will affect all aspects of the supply chain.

6 Recent legislation

Public policy measures in the secondary market related to mortgage banking have been around for years, namely since the 1930s, in order to promote home ownership through programs such as the Federal Housing Administration (FHA). Just within the past year, however, a myriad of bills directly addressing problems stemming from the housing crisis were introduced in the House and Senate. These bills attempted to thwart credit market problems caused by the housing crisis.

6.1 Implications of the Housing and Economic Recovery Act of 2008

The most predominant legislation, making an effort to garner stimulus to the housing market, is the Housing and Economic Recovery Act of 2008, which was signed into law in late July. The main feature of this legislation, as related to our model, provides a federal guarantee to lenders on refinanced mortgages (with certain stipulations on refinancing for certain qualified borrowers). This provision is embedded in the section that allows for the aid of $300 billion in FHA-backed loans to help struggling homeowners. However, lenders must be willing to accept a significant write-down – or haircut, the difference between the actual asset's market value and the lending side's loanable value – on their existing mortgages and refinance into FHA guaranteed mortgages. Specifically, a lender must be willing to accept 90% of the market value of the home and a 10% equity cushion is left in the new mortgage. The borrower of the mortgage loan will also incur penalties, as they cannot pull out the 10% equity cushion until a number of years have passed.

Mortgage banking dynamics are changing with this Act, namely to the end consumer in the primary market as well as the lender and indirectly to the investor in the secondary market. Consequently, will this new legislation, implemented in October 2008 and scheduled to sunset in 2011, disrupt the flow that lenders as well as homeowners play in the operations of the mortgage banking industry?

The borrower benefits from this legislation as they are able to convert their existing, unaffordable loan into a 30 year, fixed, government guaranteed loan (however, their ability to pull the equity out of this deal immediately is stymied). But how does this translate into operations management? The legislation creates another input into the model – a split-chain in which at closing, the chain splits back to the originator as well as the investor. With a write-down of the loan, the originator of the loan will then create different terms for a new mortgage and the investor will not lose as much money given that a foreclosure was foregone by a refinancing of the loan terms. In other words, the legislation will help benefit the originator and borrower as well as the investor in the secondary market, provided this government guarantee can be analysed from a 'discount' perspective (not accounting for implications on taxpayers). The lender is choosing to take a discount on the amount of the loan and in return, the lender does not lose the entire amount of the loan that may be in danger of foreclosure (this legislation also has strict requirements on a borrower's qualifications to refinance into these loans). The legislation provides a catalyst for the needs of the consumers in the primary market, which ultimately translates into the lender's demand knowledge. That is, the lender knows, given its financials and the number of mortgages near default, exactly how many mortgages it is willing to take a haircut on in order to keep the flow of the supply chain

moving without disruptions; and this may mean accepting a 'discount.' The investor side becomes more convoluted. First, the Government National Mortgage Association (Ginnie Mae), a government agency housed in the US Department of Housing and Urban Development, provides a secondary market for FHA loans. Ginnie Mae is a conduit that purchases loans, packages them into securities and then sells them to investors. Most mortgages securitised as Ginnie Mae MBS are guaranteed and backed by the government. By creating a directly guaranteed channel from the borrower to the lender and ultimately to the investor, the legislation is creating a 'push' process (especially with a $300 billion aid and a government guarantee in the event of default) with the consumer and lender in the primary market and the investor in the secondary market. Some may believe that this last step to the investor may create a pull process, as it is not implicitly certain that the security will be pushed onto the investor. However, it is fair to state that since there is a government guarantee backing the loan (or security once pooled), meaning a less risky investment, the investor is more likely to have the instrument pushed onto them. This takes into account the reverse SIPOC model where the investor's current demand may favour less risky investments, given the state of this volatile housing market during the present economic turmoil.

As with the constant and drastic change in the housing market as well as the credit markets, this new legislation falls into a category not yet explored in the US, leaving uncertainty in the supply chain. It would be easy to say that both the primary and secondary markets would greatly benefit from this legislation, however, it is hard to predict the likelihood that the lender will indeed take a cut in the price of the loan to be refinanced. Furthermore, the borrower may not be willing to refinance and would rather default on their home. This leaves demand uncertainty on the part of both the lender as well as the investor. The goal of this legislation, in part was to help 400,000 struggling homeowners, which will remain to be seen. The addition of more funds into the market may not translate into a smooth supply chain in the mortgage banking industry, but it does provide options that could potentially aid in smoothing flows of the process, if risks are taken into consideration.

This new legislation also diminishes inventory, to a certain degree. By providing a government guaranteed conduit to facilitate the flow of less risky mortgages in the market, the pile of inventory, namely mortgage loans, that are stacked on the books of the lenders now have the opportunity to be refinanced and pushed into the secondary market where lenders can then free up their balance sheets as investors can purchase government guaranteed securities. In essence, the $300 billion in funding recreates the appetite for investors in regards to the original mortgage loans.

Lastly, this new legislation will create a treasury backstop for the government sponsored enterprises (GSEs), in other words, the Treasury will lend Fannie Mae and Freddie Mac the funds needed to sustain them. Taking a step back, the secondary market houses the GSEs of Fannie Mae and Freddie that securitise mortgages and issue MBS, providing lenders with a more liquid asset to hold or sell. Thus, the legislation will create more investor confidence and risk measures will need to be taken into consideration in the supply chain. Ultimately, investors and lenders may be more willing to participate in market transactions in the mortgage industry.

7 Further research directions

This paper provides a comprehensive primer on mortgage banking operations and presents an operational framework for the mortgage supply chain. By reviewing the supply chain process in the mortgage industry, three main research topics emerge that are worthy of further investigation:

1 customer satisfaction metrics for secondary market investors

2 implications of e-mortgages

3 effects of increased regulations on the mortgage industry's supply chain.

What types of customer satisfaction metrics should exist to measure the effectiveness of a mortgage lender with its capital markets partners? Customer surveys frequently used to gauge satisfaction in the primary markets may be inadequate, as an investor's experience is often driven by far more than just customer service. It is impacted by product quality, pricing and long-term profitability of a relationship. Customer management in the secondary markets will require that lenders be able to accurately measure investor satisfaction levels, attribute both satisfaction and dissatisfaction to the correct drivers, and effectively use that knowledge to focus their efforts on the areas that need the most attention.

A change in technology, such as e-mortgages may change the supply chain framework. Clemons and Hitt (2000) already provide an excellent study on the effects of the internet on the front end of the supply chain (i.e., origination). More research is needed to understand the indirect effects of electronic origination on warehousing operations. Are there opportunities to eliminate certain steps within prepping and delivery, once these processes become digitised? When the focus shifts to fully digitised data, how much can technology such as optical character recognition (OCR) assist mortgage lenders to automate mortgage operations?

More legislation impacting the housing industry is slated to come out in 2009 that will no doubt have an influence in both the Pre- and Post-Close Supply Chains. The rising number of foreclosures will inevitably lead to tighter regulations and governmental controls in the originations area. Such policies will probably lead to more disclosures and paperwork that could further convolute an already complex process. Additionally, where federal intervention is lacking, state specific regulations are becoming more prominent. Investors are also becoming increasingly particular in both their interpretation and application of such proposed regulatory changes, as well as with their own underwriting and due diligence reviews. How will mortgage lenders remain responsive to, and compliant with, multiple emerging regulations and policies that are specific to a particular region, product, investor or demographic profile? Will legislative changes in the mortgage industry disrupt supply chain movement? Inevitability, the effects of new legislation on mortgage operations are yet to be determined, however our split-chain model encapsulates the nature of the latest mortgage legislation where there is a disruption in the supply chain subs, as write-downs will redirect the flow on both the Pre- and Post-Close Sub-Chains.

7.1 Regulation

Moreover, the financial turmoil has actively raised serious concerns about the nature of financial regulation and whether the regulatory industry should be consolidated. The report issued by the President's Working Group on Financial Markets in March of 2008 addressed that one of the underlying causes of the financial turmoil is the lack of underwriting standards for subprime mortgages. The working group proposed reforming specific parts of the mortgage origination process, which includes, but not limited to

1 stronger government oversight of entities originating and funding mortgages (this would include the primary market and consequently the secondary market)

2 stronger consumer protection rules by the Federal Reserve in terms of disclosures and transparency to homebuyers – the primary consumer

3 coordination of the rules among all types of mortgage originators – a form of standardisation.

Furthermore, the working group recommended improving investors' contributions to market discipline. According to the group, secondary market investors failed to gather adequate information as well as perform comprehensive risk assessments on the complex instruments related to the mortgage market. One suggestion is increased communication and information sharing between investors and underwriters of securitised credits addressing risk characteristics of the mortgages, including the underlying asset pools, both initially as well as on an ongoing basis. These suggestions imply that the reverse SIPOC model holds true in this changing and unchartered financial market and needs to accompany the traditional SIPOC model to promote better methods in operations management of the mortgage banking industry – a distinction that has not been addressed during the height of sub-prime lending. This joint model not only focuses on a dual customer approach to quality and relationship management but also focuses on demand knowledge of both the consumer (homebuyer) as well as the investor (in the secondary market).

8 Conclusions

In this paper, we developed an operational framework for the mortgage supply chain. We began this exercise by analysing the industry's overall value chain, which led us to the recognition that the relatively recent emergence of the secondary markets required us to redefine the customer in the mortgage industry. Then establishing the need for a mortgage lender to remain responsive and nimble, due to the uncertainty of demand that defines the industry, two distinct sub-chains within the mortgage supply chain were identified that require different operational strategies. The first sub-chain focuses on the primary market transaction, and given the geographic spread of most lenders' footprints as well as the individual processing of loans, decentralisation remains critical to creating locally-sensitive operations. The second sub-chain focuses on secondary market transactions and processing immediately converts to a batch mode during this stage.

The intent of the reverse SIPOC model and the dual supply chains is not for this framework to be utilised in isolation, or to imply that the secondary market and its investors are the only customers in the mortgage industry. Rather, the reverse SIPOC

model should supplement the traditional SIPOC model to promote a hybrid operations management methodology that considers a dual customer approach to quality and relationship management. Further, the repositioning of investors, from the supply side of the value chain to the demand side, elevates key considerations regarding the importance of 'demand knowledge' in mortgage operations processes.

Undoubtedly, the mortgage industry is at a pivotal crossroads. Increased governmental scrutiny over lending practices combined with hesitation and conservatism in the capital markets is painting a dramatically different picture of our future lending landscape. Given the recent sub-prime events of 2007, it is acceptable to assume that more than technology and innovation, a lender's ability to practice profitable yet inherently prudent lending practices will impact its ability to survive in the mortgage industry. However, regardless of what additional legislation or investor requirements bring, one fact remains clear. More than ever, survival will be dependent upon a lender's operational ability to respond quickly to constantly shifting market demand. An accurate understanding of that market demand, and more importantly the capability to swiftly act on it, will be critical to every mortgage lender's success going forward.

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