

Financial Stability in the Aftermath of the Crisis:  
Don't Bank on the Oligopoly Model

by

Ian Cass

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## 1. Introduction

In the wake of the global financial crisis of 2007-2008, the banking systems in Canada and Australia have received praise for their soundness and resilience. This has brought much attention to their oligopoly market structures. The systems required only modest and temporary liquidity support and all major institutions stand largely as they did in early 2007.<sup>1</sup> In stark contrast, much has been written about the dangers of the complex incentive structure in a more competitive United States financial system, in which major banks took excessive risks. This activity generated toxic exposures that damaged bank balance sheets and resulted in substantial losses for many of the largest institutions. The systemic nature of these problems in a highly interconnected system led to broader economic consequences, which continue to plague the economy. Banking systems in Europe largely shared this experience.

The contrasting market structures of these banking systems have brought into focus the debate on the relationship between competition in banking and financial stability. The traditional hypothesis that prevailed through the early development of the literature, known as the charter value hypothesis, was that competitive banking markets have negative implications for stability.<sup>2</sup> Simply put, more competition means less profitable and less diligent banks. In the years leading

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<sup>1</sup> In Canada, there are five major banks: Royal Bank of Canada (RBC), Toronto-Dominion Bank (TD), Bank of Nova Scotia, Bank of Montreal (BMO), and Canadian Imperial Bank of Commerce (CIBC). In Australia, there are four major banks: Commonwealth Bank of Australia (CBA), Westpac Banking Corporation (Westpac), Australia and New Zealand Banking Group (ANZ), and National Australia Bank (NAB).

<sup>2</sup> See Keeley (1990).

up to the crisis, this view was being contested.<sup>3</sup> The debate has now evolved into a contentious literature on the theoretical and empirical relationships between competition, concentration, and financial stability that has become highly topical in the context of post-crisis reform.

The power of hindsight has prompted some economists to suggest that resilient financial systems in Canada and Australia were supported by less competitive and highly concentrated oligopolistic banking market structures. Proponents of this perspective believe that policy should focus on allowing the emergence of banking oligopolies that have proven resilient under current regulation.<sup>4</sup> This paper demonstrates that there is not adequate support for this position. It is far from clear that an oligopoly model will contribute to financial stability if adapted by systems elsewhere. Further, policy should not compromise the traditional efficiencies attributed to competition unless it is necessary and appropriate to do so.

The analysis acknowledges the traditional notion that it is possible for more competition in banking to have negative stability implications if left alone to guide bankers' incentives. However, it argues that it was the incentive structure allowed by the regulatory framework that undermined or supported financial stability. In the circumstances, it is premature to guide reform initiatives based on the position that less competitive and more concentrated oligopoly banking systems were more resilient in certain countries. Rather, the goals of policy makers should be to

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<sup>3</sup> See Boyd and De Nicoló (2005).

<sup>4</sup> See The Economist (2011, June), where this position is articulated by Franklin Allen.

encourage appropriate regulation that is in line with modern financial complexities and would force banks to internalize repercussions that their risk decisions have for the financial system. Such efforts would account for the competitive landscapes in the respective financial systems and would not result in a one-size-fits-all approach to financial reform.

This paper is structured as follows. Section 2 lays the groundwork for subsequent analysis through a discussion of the uniqueness of the banking sector. Section 3 reviews the competition-stability literature with the objective of highlighting its ambiguity and the need for further research. Section 4 considers the recent crisis experience in the U.S., Canada, and Australia. Section 5 acknowledges the market efficiencies attributed to competition and argues that the goals of stability and efficiency can be addressed in tandem by way of appropriate regulation and reform of ‘large and complex financial institutions’ (LCFIs). Section 6 concludes.

## **2. The Business of Banking**

Before examining the economic implications of banking system organization, it is important to acknowledge the reasons for the special treatment of banks in the economy and to consider certain policy measures that have developed as common responses to the fragile character of the industry.<sup>5</sup>

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<sup>5</sup> In this section we consider commercial banks in their traditional capacity of accepting deposits and channeling these pools into loans or alternative investments.

## **2.1 The Traditional Role of Banks**

In the economy, there are savers and borrowers. Savers look to earn a return in the present in exchange for postponing consumption to future periods, while borrowers expect to pay a premium in the future for the ability to consume in the present. The parties look to achieve their respective goals at the lowest possible cost.<sup>6</sup> Having regard to the differing needs and characteristics of savers and borrowers, and the presence of asymmetric information, the unassisted achievement of efficient intermediation is virtually impossible. Banks have addressed this market incompleteness by pooling deposits from savers and channeling them into loans to borrowers. Although financial conglomerates provide a growing number of services in current-day financial markets, they are, fundamentally, providers of liquidity that serve to intermediate between savers and borrowers.

## **2.2 Why Banking is Different**

Through the financial intermediation process, banks hold long term, illiquid assets and short-term liabilities. The nature of the business leads to sources of instability on both sides of the balance sheet.

On the liability side, the inherent maturity mismatch makes banks highly vulnerable to panics. At any time, but particularly during stressful economic times, banks can encounter liquidity crises if many depositors withdraw funds simultaneously. As Carlietti (2007) explains, if these withdrawals exceed the

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<sup>6</sup> The cost to a saver being the postponed consumption and the cost to a borrower being the interest paid on a loan.

amount of available short-term assets, a so-called ‘run’ may result, forcing the bank to prematurely sell illiquid assets. This can rapidly lead to insolvency if the liquidation of assets does not enable the bank to meet its current obligations. As became evident in the recent crisis, the distinction between illiquidity and insolvency during a panic is blurry and poses significant challenges for governments and regulators.<sup>7</sup>

Vives (2010) explains that such runs on deposits can be triggered by (i) events unrelated to fundamentals, or (ii) bad news related to the assets of the bank.<sup>8</sup> The former, referred to in the literature as the multiple equilibrium panic theory, is famously modeled by Diamond and Dybvig (1983) and forms the basis for a vast bank-run literature.<sup>9</sup> The latter asserts that crises are part of the business cycle and depositors withdraw funds when they anticipate forthcoming financial difficulties.<sup>10</sup>

This liability-side vulnerability is intensified by the systemic risk posed by the high degree of connectivity between financial institutions. Banks rely heavily on day-to-day activity in interbank markets with the result that instability within one bank can pose significant risk to others and, ultimately, to the greater economy. This problem is exacerbated by the fact that banks are generally very highly leveraged relative to firms in other industries.

Further, the intermediation process gives rise to a traditional agency problem between banks and depositors leading to instability on the asset side of the

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<sup>7</sup> See Goodhart (1987).

<sup>8</sup> See Gorton (1985) and Jacklin and Battacharya (1988).

<sup>9</sup> For a summary of the Diamond and Dybvig (1983) bank run model see Carletti (2007). See Diamond and Rajan (2001) for other bank run models. For a review, see Gorton and Winton (2003).

<sup>10</sup> Carletti and Vives (2008).



balance sheet. In combination with the long-term and opaque nature of bank assets, the wide dispersion of deposits across investors generates a moral hazard problem. Banks may behave less prudently in the investment of their funds as they are not, as a practical matter, subject to the scrutiny of depositors and can avoid paying appropriate compensation for the associated level of risk (Carletti, 2007).<sup>11</sup>

### **2.3 Policy Measures**

The fragile nature of banking calls for policy measures to assist in preventing systemic crises. The most prominent of these measures continues to be the capital requirements imposed upon banks designed by the Basel Committee on Banking Supervision. For many years, there has been a significant debate in the global banking community regarding the appropriate thresholds to be maintained in order to efficiently protect the banks and their stakeholders.

In addition, two central bank safety net arrangements have become commonplace in developed banking markets: (i) deposit insurance and (ii) access to lender of last resort (LOLR) facilities.

In most cases, bank runs are inefficient.<sup>12</sup> In order to prevent depositors from causing a self-fulfilling failure of a solvent bank, governments establish deposit insurance schemes that partially or fully guarantee debt in the event that a bank is unable to pay back deposits. This provides a sense of security to depositors and serves to prevent premature runs during periods of financial distress. When a bank

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<sup>11</sup> See Holmstrom and Tirole (1997) and Carletti (2004) for theoretical illustrations of the agency problem. Carletti (2007) provides a simplified model adapted from these papers.

<sup>12</sup> Information based runs may be efficient under certain circumstances (See Carletti, 2007, p.14).

run does occur, LOLR facilities, normally made available by the central bank, are designed to provide solvent institutions with temporary liquidity support “at a penalty rate and against good collateral” (Carletti, 2007, p. 15).<sup>13</sup> The objective is to allow banks to overcome short-term liquidity problems and lower the probability of failure and systemic crisis.

Deposit insurance and LOLR safety nets can lower the risk of crisis by providing reinforcement to both investors and institutions. Regrettably, these guarantees introduce further distortions into the decisions of financial entities and may aggravate the incentive problems they are designed to tackle by weakening market discipline.

Insured deposits reduce depositors’ incentives to monitor the asset quality of the bank and implicit or explicit subsidies pose a time inconsistency problem, which provoke banks to take excessive risks to grow their balance sheets and exert a suboptimal level of effort in monitoring borrowers.<sup>14</sup> In the aftermath of the recent subprime crisis, a popular literature has developed concerning the misaligned incentives resulting from the LOLR subsidies for institutions with systemic importance, appropriately designated “too-big-too-fail” (TBTF). By broadening the moral hazard problems along the intermediation chain, these distortions can increase the probability of failure.

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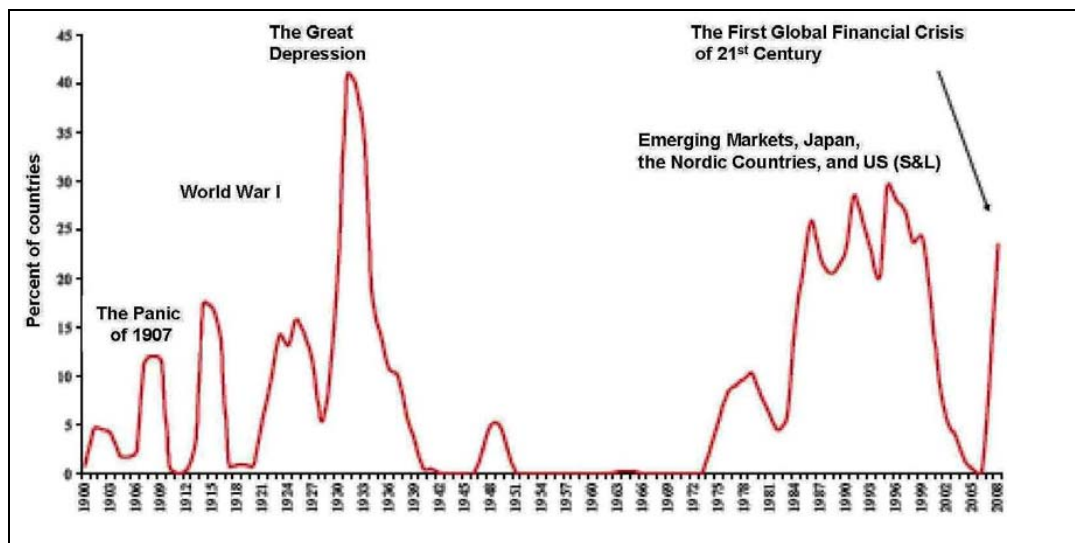
<sup>13</sup> Bagehot (1873) pioneered this idea.

<sup>14</sup> Vives (2008).

## 2.4 Relevant Historical Context

In the years following the Great Depression, when the stability of the financial system was the priority of policy makers, banks became tightly regulated and, to a great extent, were not subject to competition policy that applied to other industries. In the 1970s and 1980s, a wave of deregulation resulted in a liberalization of the banking environment, in which institutions were able to conduct business more freely, develop new products, expand the level and nature of their services, and move into new geographic markets (Mester, 2005).

**Figure 1:** Countries with Banking Crises, 1900-2008 (Weighted by Share of World Income)



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A significant development at this time was the abandonment of the separation between traditional commercial banking and capital market activity that had prevailed since the Great Depression. These changes led to a greater intensity of competition across banking markets and a coincident increase in bank failures and

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<sup>15</sup> Figure 1 Source: Vives (2010), Figure 1.

crises (Figure 1). This culminated with the crisis in 2007-2008. Understandably, the relationship between competition and stability has become highly topical as a result. The current state of our theoretical and empirical understanding of the competition-stability relationship is the topic of section 3.

### **3. The Competition-Stability Literature**

In the aftermath of the crisis, competition in banking is at the centre of policy debates on financial stability (Beck, 2008). The issue is whether competition policy should be applied to the banking sector or modified due to financial stability concerns (Carletti & Vives, 2009).

This section is organized as follows. First, it reviews the so-called ‘competition-fragility’ literature, which argues that competition has negative implications for stability in the system based on the traditional charter value hypothesis. Then, it reviews the more recent arguments to the contrary. Ultimately, this discussion brings to light the ambiguity in the debate in both theoretical and empirical contexts.

#### **3.1 The Theory**

##### *3.1.1 Competition-Fragility Hypotheses*

The competition-fragility argument proceeds through two distinct channels: (i) the impact of competition on risk-taking incentives, and (ii) the impact of competition on the probability of bank runs and system fragility.

(i) *Risk-taking Incentives*

The traditional line of reasoning, supported by a number of early theoretical contributions, is that more concentrated and less competitive banking systems result in a lower probability of failure and crisis by providing banks with capital buffers, referred to as ‘charter value’, that lower incentives to take aggressive risks (Marcus, 1984; Chan, Greenbaum, and Thakor, 1986; Keeley, 1990).

This type of argument has also been applied to a framework of relationship banking whereby lenders, in a more concentrated and less competitive system, earn monopolistic rents through information acquired by means of their lasting relationships with borrowers (Besanko and Thakor, 1993). At least by implication, less risk and a more profitable bank are byproducts of these relationships. On the other hand, lower rents, characteristic of a more competitive system, have been shown to reduce incentives for banks to properly screen borrowers (Boot and Greenbaum, 1993; Allen and Gale, 2000, 2004).

Models by Broecker (1990), Riordan (1993), and Gehrig (1998) also analyze the relationship between competition and screening incentives. The contributions of these authors suggest that more competition in a loan market with asymmetric information leads to a winner’s curse problem. This reduces the ability of each bank to screen borrowers and increases the credit flow to less than worthy borrowers.

For an illustration of this theoretical perspective see Appendix 1, which presents a model by Allen and Gale (2000), as adapted by Boyd and De Nicoló (2005) and Carletti (2007), demonstrating how competition increases bank risk-taking incentives. Essentially, this line of theoretical model implies that more

competition and concentration increase system fragility by inducing less diligent bank activity.

(ii) *Bank Runs and System Fragility*

Models have been developed which support the theory that competition and concentration increase fragility for reasons other than the encouragement of risk-taking. Allen and Gale (2000, 2004) present a model of contagion where it is shown that perfect competition may lower the incentives of banks to provide liquidity to a troubled bank in the interbank market, ultimately leading to widespread failure in the system. The authors show that in an imperfectly competitive banking sector the economy is not as susceptible to this form of contagion.<sup>16</sup> Similarly, Rochet and Vives (2004) develop a model of liquidity crises, possessing a unique Bayesian equilibrium, in which “there is a positive probability that a solvent bank cannot find liquidity assistance in the market” (p. 1). Allen and Gale (2000) also put forth the argument that a more concentrated system with a smaller number of banks reduces the supervisory burden of the financial system, contributing to the enhancement of stability.<sup>17</sup> These competition-fragility models imply that more competition increases financial system fragility by inducing less diligent bank activity and increasing the inherent vulnerability of the system to contagion.

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<sup>16</sup> The idea is that oligopolistic banks behave as though their actions affect the price of liquidity. In providing liquidity to the market, they can ensure the avoidance of their own failure. See Allen and Gale (2004).

<sup>17</sup> The authors cite the case of the United States, which has experienced greater incidence of crisis than more concentrated banking sectors.

### 3.1.2 *The Rebuttal*

The competition-fragility hypotheses outlined above assume that banks have exclusive control over their portfolio risk and effectively ignore the risk implications of borrower behaviour. The relationship between competition and stability becomes less conclusive when the models introduce a loan market that takes into account that borrowers may choose the riskiness of the investments undertaken with bank loans.<sup>18</sup>

Caminal and Matutes (2002) present a model in which borrowers face a moral hazard problem. To deal with the misaligned incentives, banks will typically rely on a combination of monitoring and credit rationing. In a less competitive system, a bank may rely on the better information derived from its market position and grant larger loans with less credit rationing than a bank might otherwise do in a competitive system. This may lead to a higher probability of failure if projects are subject to multiplicative shocks.

Boyd and De Nicoló (2005) show that lower interest rates prevalent in more competitive loan markets decrease the costs to borrowers, providing them with an increase in franchise value and a lower incentive to make risky investments. Given the downward pressure on lending rates, banks hold less risky portfolios in more competitive loan markets. This theoretical model, an extension of the Allen and Gale model presented in Appendix 1, provides a meaningful contrast to the charter value theory. This model is presented in Appendix 2.

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<sup>18</sup> For summaries, see Carletti (2007), Beck (2008), and Vives (2010).

The Boyd and De Nicoló (2005) model has more recently been extended to account for the fact that lower interest rates reduce bank revenues from non-defaulting loans. This has led a number of authors to suggest that the relationship between competition and stability is U-shaped and ambiguous (Martinez-Miera and Repullo, 2008; Hakenes and Schnabel, 2007).

Boyd, De Nicoló, and Smith (2004) also find an ambiguous relationship, but through a different channel. The authors present a general equilibrium model in which the banking industry is either monopolistic or competitive and the direction of the competition-stability relationship depends on monetary policy. If inflation is above (below) some defined threshold, competitive banking will result in a higher (lower) probability of crisis than a monopolistic sector.

Matutes and Vives (1996) make what is perhaps the most meaningful contribution to the competition-fragility rebuttal. The authors assert that “Competition is not the culprit for the fragile character of banking...Fragility comes from the coordination problem faced by investors that generates multiple equilibria, some of which may imply the collapse of institutions or the whole system” (Vives, 2008, p. 443). The important conclusion is that all banking systems, monopolistic or competitive, can suffer from fragility because the coordination problem in the deposit market occurs independently from the competitive structure (Carletti, 2007).<sup>19</sup>

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<sup>19</sup> As described by Beck (2008), the fact that the theory does not account for differences in competition across banking markets is a noteworthy flaw.



## 3.2 The Empirics

Ambiguity in a theoretical literature is often resolved for policy makers by robust empirical investigations. In the case of the competition-stability debate, however, the data provides mixed results.

### 3.2.1 *Measures of Competition and Stability*

The first difficulty in the empirical research is finding appropriate proxies to measure competition and stability.<sup>20</sup> As a proxy for competition, some studies use traditional measures of market structure that originate from the structure-conduct-performance paradigm, which links market structure to bank behaviour. These measures include concentration ratios, the Herfindahl-Hirschmann (HH) index, the total number of banks, and bank size. Other work relies on variables that measure contestability as a proxy for competition. These include barriers to entry and exit and activity restrictions. Lastly, economists can measure competition directly using the H-statistic or the Lerner index.<sup>21</sup> As a proxy for stability, authors use variables such as the z-score<sup>22</sup> or the non-performing loan ratio to measure individual bank distress and the correlation of stock returns or actual occurrence of crises to assess systemic risk. Each of these measures makes particular assumptions that impact our proxy for the intensity of competition and the level of stability.

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<sup>20</sup> OECD (2010) provides a good summary of the variety of measures used.

<sup>21</sup> The H-statistic is calculated by summing the estimated elasticities of revenue to factor prices. The Lerner index, a common measure in the industrial organization literature, is calculated as follows:  $L=(P-MC)/P$  where P is the market price and MC is the firm's marginal cost. See OECD (2010).

<sup>22</sup> Measured as the sum of the capital-asset ratio and return on assets (ROA), weighted by the standard deviation of ROA (OECD, 2010).

### 3.2.2 *Empirical Studies of the Competition-Stability Relationship*

The empirical literature assesses the competition-stability relationship by way of two approaches: (i) bank level studies on single countries and (ii) cross-country studies. Depending on this focus, the country and time period, and the choices of proxy for competition and stability, there can be a positive or negative relationship achieved. The result is a spectrum of inferences on the competition-stability relationship that depend heavily on the framework and assumptions of the authors.<sup>23</sup>

#### *(i) Bank Level Studies*

A number of studies conducted with respect to the U.S. market support the traditional charter value hypothesis that a greater intensity of competition, which occurred as a result of deregulation in the 1970s and 1980s, increased risk taking by banks (Keeley, 1990; Demsetz, Saidenberg, and Strahan, 1996). Studies conducted using data from other countries further support this hypothesis. For example, Jimenez, Lopez, and Saurina (2007), through an analysis of the Spanish banking sector, find that less competition (measured by the Lerner index) results in lower bank risk (measured by banks' loan-performance ratios).<sup>24</sup> Bordo, Redish, and Rockoff (1995) find that the oligopolistic Canadian bank structure meant higher profits and lower failure rates than in the United States. In a similar descriptive study, Hoggarth, Milne, and Wood (1998) find that banking in the United Kingdom was more competitive and less stable than in Germany. On the other hand,

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<sup>23</sup> For summaries, see OECD (2010), Vives (2010), and Beck (2008).

<sup>24</sup> Fungacova and Weill (2009) find similar results in the Russian banking sector.

Staikouras and Wood (2000) find that banking in Spain was more competitive and also more stable than in the Greek system. In analyzing these findings, however, it is important to be cautious given that the data was collected during a different, and largely more prosperous, economic time than that which exists today.

Another branch of the literature examines the impact of competition and concentration on stability by analyzing the effect of bank mergers on risk diversification. A number of these studies (Paroush, 1995; Benston, Hunter, and Wall 1995; Craig and Santos, 1997) suggest that mergers create larger banks with greater market power, which lead to gains from diversification. Other work, however, presents the conflicting view that bank consolidation increases, rather than decreases, the riskiness of bank balance sheets (Chong, 1991; Hughes and Mester, 1998). The latter certainly appears to be more consistent with the bank activity during the recent crisis.

#### (ii) *Cross-Country Studies*

More recently, cross-country studies have emerged with the availability of large time-series data sets. The most important contribution to date in this stream of the literature is made by Beck, Demiguc-Kunt, and Levine (2006) who analyze a data set of 69 countries and 47 episodes of crisis from 1980 to 1997 to assess whether the probability of crisis depends on the level of banking system concentration. The authors, after controlling for differences in regulatory policy, factors affecting competition, and economic condition, find that concentrated banking systems are less susceptible to systemic crisis because they allow for better risk diversification. Perhaps more important than what these authors find, however,

is what they do not find. Their results do not show support for the charter value hypothesis or for the proposition that supervision is made easier in a more concentrated system. The authors conclude that banking systems in which regulation does not restrict competition are less likely to suffer from fragility.

The conclusions of these studies are supported by a number of others that find an analogous positive relationship between competition and stability. Barth, Caprio and Levine (2004) find that more banking restrictions and entry barriers are associated with a higher probability of distress. Boyd, De Nicoló and Jalal (2009) discover a negative and significant relationship between competition and the probability of failure using the HH index. Schaeck, Citak and Wolfe (2006), using the H-Statistic measure, find that more competition makes banking systems less prone to crisis and increases the time to crisis. These studies, however, unlike Beck et. al. (2006), fail to find the same link between concentration and systemic distress.

Overall, cross-country work tends to support the notion that competition might have positive implications for stability but remains unclear on the relationship between concentration and stability. This leaves us with the important deduction that concentration may be a weak indicator of competition in banking markets and higher concentration might impact stability through channels other than a lack of competition (Beck, 2008).

### *3.2.3 The Importance of the Regulatory Framework*

As discussed above, many economists and policy makers have assumed that the process of liberalization and the resulting increase in competition led directly to instability and crises. A number of studies, however, provide evidence that the

competition-stability relationship in the banking sector depends on the prevailing regulatory framework (OECD, 2010).

Behr, Schmidt and Xie (2009) analyze a data set of 421 commercial banks across 61 countries and find that capital regulation reduces bank risk-taking incentives in countries with more competitive banking sectors. Studies of the Scandinavian and Japanese crises, as well as cross-country studies, find that the impact of liberalization on stability depends on the regulatory framework and the quality of the institutional environment.<sup>25</sup> Essentially, the evidence suggests that liberalization and competition do not need to result in fragility. The design of an appropriate regulatory framework that takes account of the impact of the market structure and level of competition on bank decision-making can mitigate this seemingly inflexible tradeoff. Along these lines, we discuss in section 4 how the weak regulatory framework in the United States provided its institutions with perverse incentives, leading to immense vulnerability in the system that was revealed when the subprime crisis occurred. Even with the liberalization and competition that characterized the banking sector in the decades leading up to the crisis, an up-to-date and strong regulatory framework would have prevented the near collapse of the overheated financial network.

### **3.3 Summary**

The theoretical models and corresponding empirical investigations allow us to draw important conclusions. First, a number of the relationships central to the

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<sup>25</sup> See Kanaya and Woo (2000); Drees and Pazarbasioglu (1998); Honkapohja and Koskela (1999).

competition-stability debate are not adequately understood. This poses a significant challenge in bringing robust measures of competition and stability to the data. In particular, the effects of concentration and bank size on stability must be considered separately from competition. However, a more concentrated banking sector often implies a less competitive environment and trouble in LCFIs was clearly at the heart of the crisis.<sup>26</sup> This suggests that attention should be directed at controlling the growth of complex institutions that exacerbate the TBTF problem and cause market distortions rather than directly targeting the level of competition or a particular market structure. Second, the existing studies provide ambiguous findings on the direct relationship between competition and stability. Third, it appears that appropriate regulation can mitigate potential negative effects of increased competition on stability.

Based on our current academic understanding, it would be *premature* to encourage the movement towards less competitive *or* highly concentrated banking systems, even though the relatively resilient systems in Canada and Australia seemingly exhibit these characteristics. Through a critical examination of country experiences in section 4, we find further support for this conclusion.

#### **4. Crisis Experience in the U.S., Canada, and Australia**

Without the luxury of being able to rely on a strong and harmonious academic literature for policy guidelines, this paper turns to a critical analysis of the recent crisis experience in the U.S., Canada, and Australia. The purpose of this

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<sup>26</sup> LCFIs are also popularly referred to as Systemically Important Financial Institutions (SIFIs).

section is to shed light on factors that contributed to the ultimate downfall or resilience of financial systems. In doing so, it reveals that the industrial organization of banking systems neither directly caused a crisis, nor prevented one, and vulnerabilities remain today in systems exhibiting a variety of market structures.

This section is organized as follows. First, it discusses the factors that generated financial instability leading up the crisis, with particular attention devoted to the damage caused by poorly regulated LCFIs. Although this section focuses specifically on the case of the U.S., European banks largely shared these experiences. For a brief discussion of the U.K. case, see Box 1. Second, it discusses the factors that contributed to the resilience of the Canadian and Australian systems and identifies vulnerabilities that remain in both the Canadian and Australian economies. This analysis provides further evidence that financial stability is not directly supported by any particular market structure, but by a regulatory framework that provides institutions in each market with appropriate incentives.

#### **4.1 The U.S. Experience: Growth of LCFIs and the New Banking Model**

The financial crisis followed the well-know sequence of a classic banking crisis: a credit boom, the formation of asset bubbles, a shock, and subsequent bust. In the U.S. and much of Europe, the depth and severity of the crisis was greatly amplified by a movement towards a concentrated system dominated by large financial conglomerates and guided by inappropriate and outdated regulatory policy. This framework encouraged institutions to change the banking model and grow their businesses by taking excessive risks, which fuelled the credit boom and caused immense systemic distress.

#### 4.1.1 *Consolidation and the Growth of LCFIs*

Following the liberalization of global banking markets in the 1970s and 1980s, a wave of consolidation ensued that changed the landscape of the financial services industry.<sup>27</sup> According to the Federal Deposit Insurance Corporation (FDIC), the number of FDIC insured commercial banks in the U.S. dropped from 14,507 to 6,544 between 1984 and 2010.<sup>28</sup> This decrease can be partly attributed to more than 12,000 bank mergers, of which more than 1,500 resulted from bank failures during this period.<sup>29</sup> This consolidation was accompanied by a dramatic increase in concentration. The total market share of the five largest deposits taking institutions more than tripled from 1992 to 2008, reaching 36 percent before the crisis (Figure 2). The share of assets held by the ten largest institutions also grew dramatically, increasing from 25 percent to 55 percent and the three largest banks (Citigroup, Bank of America, and JP Morgan Chase) each held assets over \$1.5 trillion at this time (Wilmarth, 2009).<sup>30</sup> Further, the business of these institutions grew dramatically in scope as commercial and investment banking institutions were combined.

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<sup>27</sup> The consolidation was exacerbated in the aftermath of the crisis. This is concerning to many who feel that crisis might have been an appropriate opportunity to break up many LCFIs. Instead, many got even bigger.

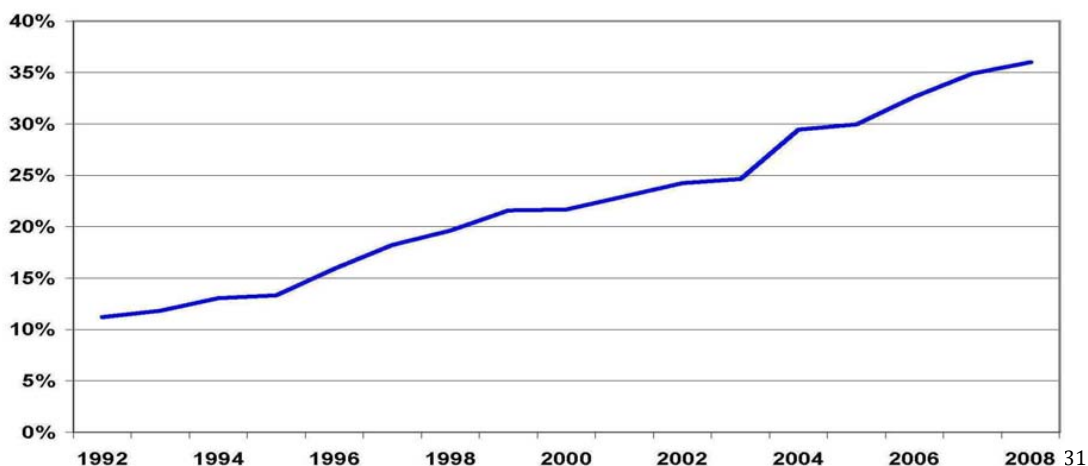
<sup>28</sup> FDIC (2011).

<sup>29</sup> It is interesting to note that of the 1,573 mergers involving failed institutions, 1,530 occurred between either 1984 and 1994 or 2008 and 2010. See FDIC (2011).

<sup>30</sup> This consolidation characterized much of the world's banking systems, particularly in Europe. For more details, see Wilmarth (2009) and Vives (2010). The issue is also discussed further later in this section.



Figure 2: Market Share of the Five Largest U.S. Banks in Percent of Total Assets



The proposed benefits of deregulation included (i) higher profits and returns to shareholders from economies of scale and scope, (ii) greater safety achieved through diversification, (iii) convenience for individuals and businesses of a one stop financial shop, and (iv) the ability of institutions to compete with larger foreign competition.<sup>32</sup> As a number of authors describe, however, the events of the crisis have demonstrated that these benefits proved to be pure fiction.<sup>33</sup>

#### 4.1.2 *The New Banking Model, Shadow Banking, and the Credit Boom*

The consolidation trend and growth of LCFIs was accompanied by a transition away from the traditional banking model to accommodate the

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<sup>31</sup> Figure 2 Source: Vives (2010), Figure 5. The data accounts for the merger of Wells Fargo and Wachovia in 2008.

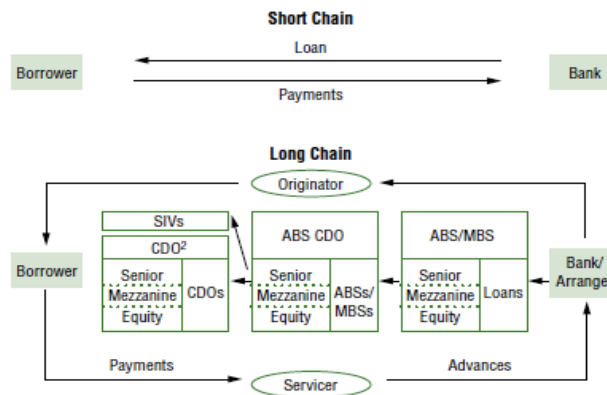
<sup>32</sup> See Mester (2005) and Wilmarth (2009).

<sup>33</sup> See Avgouleas (2009), Wilmarth (2009). It is interesting to note that currently, in August 2011, the solvency of some of the largest institutions remains in question (including Bank of America and Citigroup) and further quantitative easing might be necessary.

securitization of loans: a technique that, in theory, would benefit institutions, borrowers, and investors.

In the new ‘originate-to-distribute’ banking model, rather than holding mortgages and other loans on their balance sheets until maturity, banks would sell these assets to off-balance-sheet entities (OBSEs)<sup>34</sup>, through which the assets were pooled and packaged into a variety of asset-backed securities (ABSs) with different priorities for repayment. The ABSs were then sold to investors with different appetites for risk (Figure 3).

**Figure 3: Transition in the Banking Model**



Note: ABS = asset-backed security; CDO = collateralized debt obligation; CDO² = collateralized debt obligation-squared; MBS = mortgage-backed security; SIV = structured investment vehicle.

35

This process of securitization allowed banks to transfer risk to investors willing to bear it and replace illiquid assets with cash, thereby providing banks with a direct injection of liquidity to facilitate further extension of credit.<sup>36</sup> Investment banks

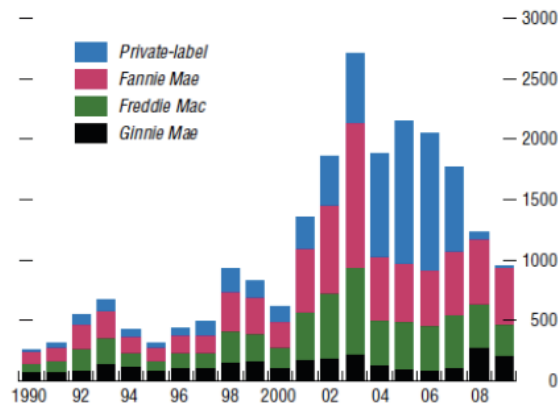
<sup>34</sup> These entities included Structured Investment Vehicles (SIVs), SIV-lites, and Asset Backed Commercial Paper Conduits (See IMF, 2008, Box 2.5).

<sup>35</sup> Figure 3 Source: IMF (2009, October), Figure 2.11.

<sup>36</sup> See Jaffee, Lynch, Richardson, and Nieuwerburgh (2009).

collected substantial fees for the arrangement and facilitation of these transactions.<sup>37</sup> The rapid growth of securitization, through the use of OBSEs, allowed banks to circumvent regulatory requirements. This led to the growth of the shadow banking system.

**Figure 4: U.S. GSE versus Private-label MBS Issuance (\$ Billions)**



Source: *Inside Mortgage Finance*.  
 Note: Government-sponsored enterprises include Fannie Mae, Freddie Mac, and Ginnie Mae. Data for 2009 through end-June.

38

On the one hand, effective use of the securitization model has substantial economic benefits. For example, government-sponsored enterprises (colloquially known as Fannie Mae, Freddy Mac, and Ginnie Mae) succeeded in the U.S. residential mortgage market in the 1970s by purchasing loans from banks and selling mortgage-backed securities (MBSs) to investors backed by implicit guarantees of repayment by the U.S. government (Okwongu and Sabry, 2009). This innovative model allowed millions of Americans to obtain loans and become homeowners (Coval, Jurek, and Stafford, 2009). The Canada Housing Trust has been successful in

<sup>37</sup> For an excellent account of the changing model of investment banking, see Morrison and Wilhelm (2007).

<sup>38</sup> Figure 4 Source: IMF (2009, October), Figure 2.7.

a similar capacity in the Canadian mortgage market. On the other hand, the crisis revealed that misuse of the securitization model has severe economic consequences.

As securitization spread rapidly to the U.S. private banking sector after 2000 (Figure 4), the model was abused by LCFIs driven by greed and a culture of short-termism. Lending standards began to deteriorate as institutions became increasingly separated (or so they thought) from the risks associated with their lending decisions and focused on growing the volume of business. The use and abuse of this model resulted in exponential growth in loan issuance and securitization of subprime mortgages (Table 1). Universal banks had effectively fuelled a massive credit boom by leveraging the shadow banking system. By the end of 2008, off-balance-sheet assets of the four largest U.S. banks (Bank of America, Citigroup, JP Morgan Chase, and Wells Fargo) totaled \$5.2 trillion dollars (Reilley, 2009).

**Table 1: U.S. Subprime Origination and Securitization, 2001-2006 (\$ Billions)**

	Subprime (\$)	Subprime MBS (\$)	% Securitized
2001	190	95	50.4
2002	231	121	52.7
2003	335	202	60.5
2004	540	401	74.3
2005	625	507	81.2
2006	600	483	80.5

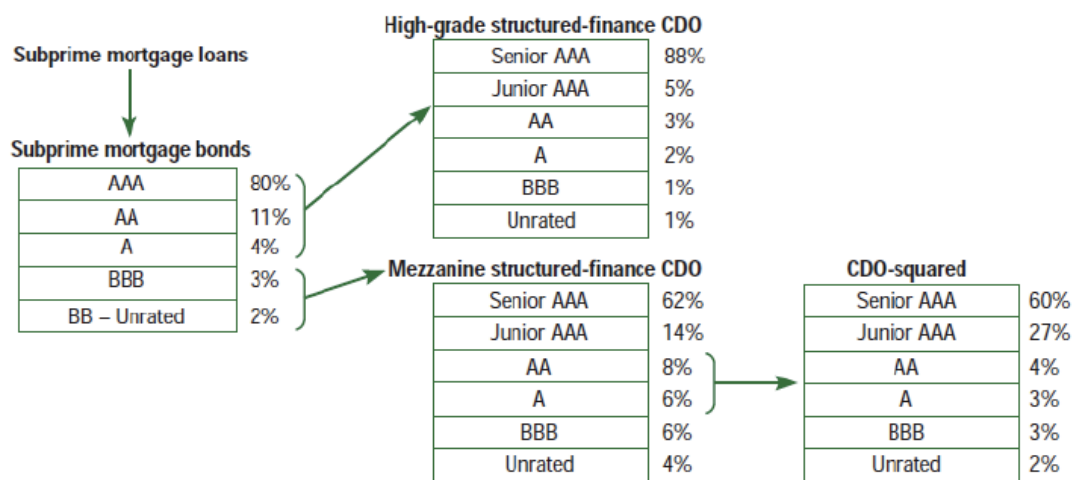
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Astonishingly, as credit was liberally extended to less than credit-worthy borrowers, the structured products created by these institutions through the securitization process became increasingly opaque and complex. See, for example, Figure 5, which illustrates the intricacy involved with the securitization of a pool of subprime

<sup>39</sup> Table 1 Source: Jafee et. al., Table 1.3. Not surprisingly, the top underwriters for these private-label MBSs from 2004 to 2007 were Lehman Brothers and Bear Stearns (Wilmarth, 2009).

mortgage loans into collateralized debt obligations (CDOs). These ill-understood products effectively allowed banks to boost their bets on the housing market by securitizing previously securitized loans.<sup>40</sup> The primary issuers of CDOs (Table 2) were LCFIs that became the most vulnerable institutions during the crisis. The growth in over-the-counter derivatives such as credit-default swaps (CDSs) and synthetic CDOs added to this complexity.

**Figure 5: The Complexity of Structured Financial Products**



Source: IMF staff estimates.  
 Note: CDO = collateralized debt obligation.

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When the U.S. housing bubble burst and investors doubted the quality of the loans underlying their securities, a run on the shadow banking system ensued. At this time, it was revealed that many OBSEs had implicit or explicit recourse to sponsoring banks.<sup>42</sup> It became evident that some banks had not used OBSEs to

<sup>40</sup> Rating agencies have taken extensive blame for masking this complexity by using their faulty models to provided AAA ratings to toxic structured products.

<sup>41</sup> Figure 5 Source: IMF (2008, April), Box 2.2.

<sup>42</sup> This occurred explicitly through liquidity lines (Brunnermeier, 2009) and implicitly due to reputational concerns (Gorton, 2005). Banks had further misused

isolate risk as intended, but rather to store it while they continued to extend credit in blatant circumvention of regulatory policy.

**Table 2: Book Runners of Worldwide CDOs (\$ Billions)**

	2004	2006	2007	2008
Citigroup	7	40	40	5
Merrill Lynch	16	54	38	5
Deutsche Bank	12	31	31	12
Barclays	0	18	28	2
Wachovia	11	24	24	2
Goldman Sachs	7	33	24	5
ABN Amro	0	5	23	1
UBS	8	22	20	0
Lehman Brothers	6	17	18	18
JP Morgan	7	22	18	3
Bear Stearns	7	25	16	0
Bank of America	4	23	15	2

43

The Basel I Accord required banks to hold capital of at least 8 percent of total assets but, by transferring assets off balance sheet, banks were able to take excessive risks to substantially grow the business while conforming to regulatory requirements (Brunnermeier, 2009). The ensuing losses were unrecoverable and government support of over \$6 trillion, in the form of liquidity assistance, capital infusions, troubled asset purchase programs, and financial guarantees of future losses, was required to prevent a complete collapse of an insolvent U.S. financial system (Wilmarth, 2010).<sup>44</sup> The bailouts confirmed the widespread notion that the institutions were too interconnected and too big to be allowed to fail.

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the model by retaining a large number of the highest rated structured products directly on their books. Banks were actually among the most active buyers of asset-backed securities (See Acharya and Schnabl, 2009, Table 2.2).

<sup>43</sup> Table 2 Source: Jaffee et. al. (2009), Table 1.4.

<sup>44</sup> Including Europe, the total government support was nearly \$9 trillion (Wilmarth, 2009).

Two major regulatory failures precipitated the massive credit boom that crippled the financial system when the U.S. housing bubble burst. First, the inability to foresee the need to properly regulate entities in the shadow banking system allowed institutions to hide the true extent of their exposures. This was perhaps the greatest single failure on the part of regulators. Second, policy effectively encouraged the formation of LCFIs. These institutions led the evolution to an opaque and highly interconnected system, infused credit into the system, and made complex bets on the housing market. There is also a notion that the size of LCFIs made them prone to a 'herd mentality', which "leads to homogeneous behaviour depriving the market from its natural stabilizers" (Avgouleas, 2010, p. 6).<sup>45</sup>

## **4.2 Canada and Australia**

The crisis experiences of Canada and Australia differed from those in other countries. While the large U.S. and European banks fell victim to a greed-driven culture described above, Canada and Australia appeared to shun this mentality and subsequently dodge much of the turmoil. The Canadian system, in particular, has received a great deal of attention in the international banking community as the World Economic Forum has ranked its banks the soundest in the world each year since 2009. Australian banks have followed closely behind, ranking third in the most recent 2010-2011 report.<sup>46</sup>

Section 4.2.1 argues that the relative resilience of the Canadian and Australian systems during the crisis was primarily a product of two factors. First,

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<sup>45</sup> For further discussion on the herd mentality, see Acharya and Yorulmazer (2008).

<sup>46</sup> See World Economic Forum (2010).

the strong supervisory and regulatory frameworks in which the banks operated fostered a culture of conservatism and prevented Canada and Australia from engaging in much of the dangerous lending and investing associated with the new banking model. This ensured that the Canadian and Australian banks were relatively sound when the U.S. housing bubble burst and, accordingly, were able to withstand, with modest liquidity support, the deterioration of global economic activity. Second, the Canadian and Australian economies were not beset by a housing crisis similar to the crisis that occurred in the United States and, therefore, were not forced to deal with the consequences of a prolonged collapse in housing markets. It was these factors, rather than the inherent oligopolistic market structures, that made the Canadian and Australian banking systems more resilient (at least to date).

Section 4.2.2 then discusses the current vulnerabilities in these systems. It is very important to recognize that Canadian and Australian housing prices were fuelled to a great extent by mortgage lending at low rates in the aftermath of the crisis. At present, any number of triggers might result in a correction of housing prices, which, combined with the expansion of household debt, may generate instability in these systems. In short, it is premature to suggest that the Canadian and Australian systems, which remained relatively sound through the U.S. crisis, would remain sound through a crisis of their own. The Canadian and Australian systems have not yet been appropriately tested.



#### 4.2.1 Resilience of the Canadian and Australian Systems to the U.S. Subprime Crisis

##### (i) Regulation, Supervision, and a Conservative Banking Culture

In Canada, all deposit-taking institutions and insurance companies are under the direct supervision of the Office of the Superintendent of Financial Institutions (OSFI).<sup>47</sup> OSFI has received praise for its principles-based approach to regulation and risk-based supervision that has fostered stability and prevented regulatory arbitrage that was rampant under the rules-based approach that prevailed in the United States. OSFI works aggressively but flexibly with banks and relies heavily on the banks' internal risk management practices to prove compliance (Northcott, Paulin, and White, 2009). Where internal bank practices are deficient, correcting this becomes a main priority. This contrast in approach was well articulated by TD Bank CEO Ed Clark: "The message in the U.S. is it's your responsibility to meet our rules. In Canada, the responsibility is to run the institution right. Julie (the head of OSFI) says (to the CEO): you are the chief risk officer of the bank" (Porter, 2010, p. 3).<sup>48</sup>

To illustrate this risk-based approach, OSFI required that Canadian banks maintain risk-based capital in excess of what is stipulated by international standards in the Basel II Accord. Banks were required to hold Tier 1 capital of 7 percent and total capital of 10 percent, while Basel II required only 4 percent and 8 percent respectively (Northcott et. al., 2009). In fact, before and throughout the

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<sup>47</sup> This includes investment-dealing arms, unlike in the U.S. system where investment firms were regulated independently by the Securities and Exchange Commission (Porter, 2010).

<sup>48</sup> For a discussion on flawed risk management systems in various countries that contributed to the severity of the recent crisis, see Milne (2008).

crisis, Canadian banks maintained Tier 1 capital far in excess of these requirements (Table 3). OSFI was equally concerned with the quality of bank capital, insisting that a minimum of 75 percent of Tier 1 capital be comprised of common equity (Porter, 2009).

**Table 3: Canadian Banks' Tier I Capital Ratios (April, 2009)**

BMO	BNS	CIBC	RY	TD	NA
10.3%	9.7%	11.5%	10.9%	10.4%	10.0%

<sup>49</sup>

OSFI also uses an asset-to-capital multiple<sup>50</sup> as an indicator of bank strength. The multiple is calculated by dividing total assets by total Tier 1 and Tier 2 capital. The maximum multiple is 20 in Canada and includes off-balance-sheet exposures. By contrast, the U.S. multiple is 33.3 for safer banks and 25 for others (IMF, May 2009). Further, the U.S. calculations include only Tier 1 capital and do not consider off-balance sheet assets. The OSFI approach ensured that each bank had an appropriate capital cushion at the time of the crisis given its risk.

This diligent supervision and regulation has proven to have beneficial incentive effects on banks. The rapid balance sheet expansion and reckless lending and investment activity that occurred in the U.S. and Europe did not occur in the Canadian system. Rather, the banks continued to rely on domestic deposits as a primary source of funding (Table 4) in contrast to the banks in the U.S. and Europe, which tapped wholesale markets extensively for no other reason than to rapidly grow their businesses. The big five Canadian banks all maintained deposit to asset

<sup>49</sup> Table 3 Source: Booth (2009), Table 1.

<sup>50</sup> Also referred to as a leverage cap.

ratios above 65.<sup>51</sup> Multivariate regression analysis by Ratnovski and Huang (2009) suggests that this retail funding structure was the strongest predictor of resilience through the crisis.<sup>52</sup>

**Table 4: Bank Depository Funding as a Percentage of Total Assets (Year-end, 2006)**

Bank	Country	Depository funding*	Value decline	Intervention
<b>Twelve most vulnerable</b>				
1 Hypo Real Estate Holding AG	GERMANY	24.0	97	Asset guarantees and public loans
2 Northern Rock Plc	UNITED KINGDOM	28.7	100	Nationalized
3 Deutsche Bank AG	GERMANY	34.1	81	
4 BNP Paribas	FRANCE	36.7	65	
5 Citigroup Inc	USA	37.8	94	Capital injection, asset guarantees
6 HBOS Plc	UNITED KINGDOM	41.0	100	Capital injection (part of Lloyds)
7 Société Générale	FRANCE	42.0	74	
8 Banca Monte dei Paschi di Siena SpA	ITALY	44.1	68	
9 Dexia	BELGIUM	44.9	89	Nationalized
10 DnB Nor ASA	NORWAY	45.4	74	
11 Danske Bank A/S	DENMARK	46.3	78	
12 Commerzbank AG	GERMANY	47.0	89	Capital injection
<b>Rest of the sample</b>				
13 JP Morgan Chase & Co.	USA	47.3	50	
14 Barclays Plc	UNITED KINGDOM	47.7	85	
15 Bank of America Corporation	USA	47.9	87	Capital injection, asset guarantees
21 National Australia Bank	AUSTRALIA	51.7	53	
24 Commonwealth Bank of Australia	AUSTRALIA	53.4	46	
26 HSBC Holdings Plc	UNITED KINGDOM	54.9	41	
28 Credit Suisse Group	SWITZERLAND	55.6	66	
30 Capital One Financial Corporation	USA	57.3	80	
32 Lloyds TSB Group Plc	UNITED KINGDOM	58.7	78	Capital injection
33 Royal Bank of Scotland Group Plc (The)	UNITED KINGDOM	59.3	96	Capital injection, asset guarantees
44 Wachovia Corporation	USA	62.8	100	Failed, acquired by Wells Fargo
46 UBS AG	SWITZERLAND	64.1	79	Capital injection
48 Wells Fargo & Company	USA	64.4	47	
<b>51 Royal Bank of Canada RBC</b>	<b>CANADA</b>	<b>65.1</b>	44	
<b>52 Banque de Montreal-Bank of Montreal</b>	<b>CANADA</b>	<b>65.2</b>	53	
54 Australia and New Zealand Banking Group	AUSTRALIA	65.4	54	
<b>57 Toronto Dominion Bank</b>	<b>CANADA</b>	<b>67.9</b>	43	
<b>60 Canadian Imperial Bank of Commerce</b>	<b>CANADA</b>	<b>68.2</b>	54	
<b>64 Bank of Nova Scotia (The) -</b>	<b>CANADA</b>	<b>71.4</b>	42	
68 Westpac Banking Corporation	AUSTRALIA	74.1	38	
69 Washington Mutual Inc.	USA	74.6	100	Failed, taken over by FDIC

It is commonly claimed that conservative regulation in the mortgage market also contributed to the resilience of the system.<sup>54</sup> All Canadian bank mortgages with a loan-to-value ratio in excess of 80 percent must be insured. The Canada Mortgage and Housing Corporation (CMHC), a Crown corporation, provides approximately 70

<sup>51</sup> In addition, OSFI specifies liquidity guidelines that require banks with more than 10% of their funding coming from wholesale sources to maintain appropriately highly liquid assets on their balance sheet (Ratnovski and Huang, 2009).

<sup>52</sup> See Ratnovski and Huang (2009), Table 5 for results.

<sup>53</sup> Table 4 Source: Ratnovski and Huang (2009), Table 4.

<sup>54</sup> See Lea (2010).

percent of all mortgage insurance and is fully guaranteed by the government.<sup>55</sup> Private insurers provide the rest. The Canadian government also provides a 90 percent guarantee to private insurers and all mortgages that secure residential mortgage backed securities guaranteed by CMHC must be fully insured. Further, mortgage interest is not tax-deductible and borrowers are fully liable for their loans (Northcott et. al., 2009).

Regulators in Canada have also been unwilling to accept the notion that the banks need to grow in scale in order to become world-class and actively compete with larger international rivals. In 1998, the government of Canada rejected two proposed mergers involving four of the country's big five banks; one between RBC and BMO and another between CIBC and TD. As expressed by Milne and Neave (1998), it is important that regulation be designed to encourage competitiveness while satisfying prudential concerns.

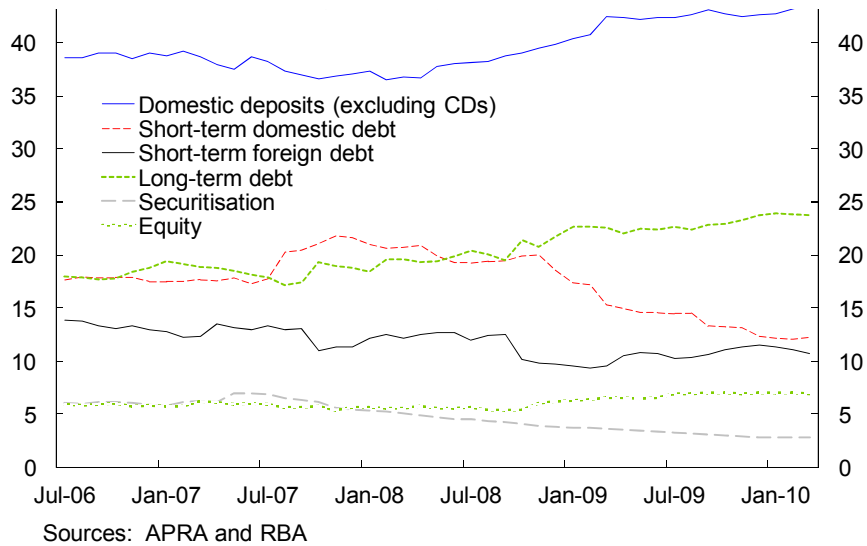
In Australia, the corresponding supervisory body is the Australian Prudential Regulation Authority (APRA). APRA has taken a similar proactive and principles-based approach to OSFI and has contributed to the resilience of the Australian banking system. APRA has been diligent at conducting stress tests and subsequently strengthening the capital requirements based on the riskiness of bank loan portfolios. In 2004, APRA introduced higher risk weights on loans with low documentation (RBA, 2009) and in 2006 tightened its capital composition requirements (Bologna, 2010). This led to more prudent behaviour by banks and ensured they were well capitalized during the crisis when markets dried up. Figure

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<sup>55</sup> The data in this paragraph is from Kiff (2009).

6 below, as well as the data in Figure 4, suggests that some Australian banks relied heavily on domestic deposits in similar fashion to Canadian Banks.<sup>56</sup>

**Figure 6: Australian Banks' Funding Composition (Percent of Total Funding and Equity)**



57

Although there is no government owned mortgage insurer in Australia, the regulatory framework fosters a similarly conservative mortgage market.<sup>58</sup> For example, the Australian Uniform Consumer Credit Code allows courts to invalidate mortgage agreements where it is deemed that the lender could have reasonably known that the borrower would be unable to satisfy the terms of the loan. Further, as in Canada and in contrast to the U.S., mortgages are full recourse and households cannot simply turn in the keys to escape the loan obligation. As a result, the non-

<sup>56</sup> As discussed later in this section, Australian banks also relied heavily on offshore borrowing. This discrepancy may be partly attributed to loose definitions of depository funding applied by Australian officials that mask the true extend of bank exposures.

<sup>57</sup> Figure 6 Source: Bologna (2010), Figure 15.

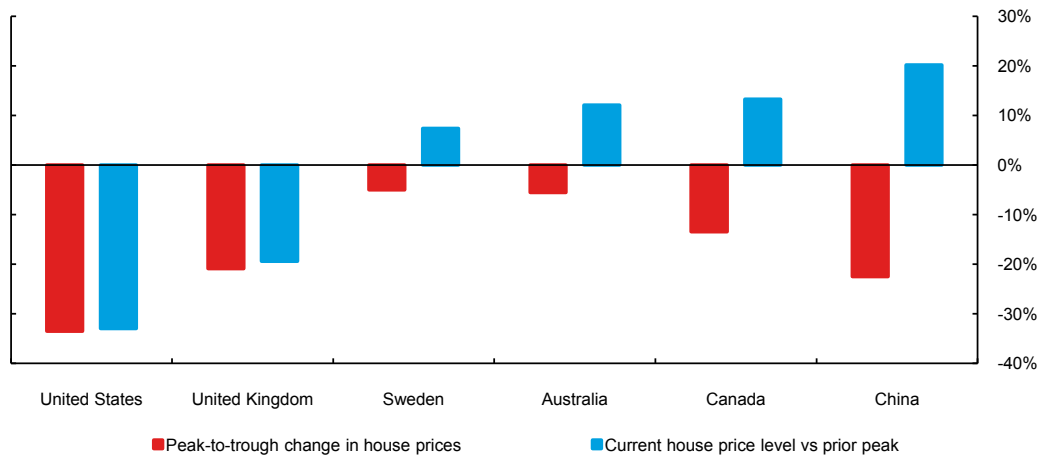
<sup>58</sup> Recently, Australia has considered adapting a model similar to CMHC.

conforming housing loan market in Australia accounted for only 1 percent of the market in 2007 (RBA, 2009).

Australia also maintains a ‘four pillars’ policy that prevents mergers between any of its big four banks.<sup>59</sup> Despite being widely unpopular among the big banks, perhaps this conservative merger policy contributed to the stability of both the Canadian and Australian systems by preventing the banks from sliding down the slippery slope that led to the dangerous banking activity in the U.S. and Europe.

(ii) *Avoiding a Housing Crisis*

Figure 7: Peak-to-Trough Changes in Housing Prices



Source: S&P/Case-Shiller, Halifax plc, Stastics Sweden, Australian Bureau of Statistics, Canadian Real Estate Association, and CEIC Data Co. Ltd

60

Beyond the strong regulatory and supervisory framework, the resilience of Canadian and Australian banks also resulted from the success that the governments and central banks in both countries had in reflating their respective housing

<sup>59</sup> See Durie and Gluyas (2009).

<sup>60</sup> Figure 7 Source: Bank of Canada (2011), Chart 3.

markets after experiencing brief setbacks during the onset of the global recession, as shown in Figure 7 (Van Onselen, 2011, Feb. 24).

In Canada, this was achieved through a number of policy measures. Most notably, the Bank of Canada (BoC) lowered interest rates to record lows in order to stimulate borrowing and spending (Figure 8). The government also introduced new rules to govern CMHC lending criteria. This included the introduction of the zero-deposit, 40-year mortgage, as well as instructions for CMHC to approve high-risk borrowers in order to stimulate the economy. Loan approval rates for these high-risk mortgages increased significantly from 33 percent in 2007 to 42 percent in 2008.<sup>61</sup> CMHC had planned to reduce this lending back to 33 percent by 2009, but approval rates stood at 41.3 percent in mid-2010 (CMHC, 2010). The amount that Canadians were able to borrow also increased. In 2008, the government provided liquidity assistance to banks by introducing an Insured Mortgage Purchase Program (IMPP) whereby the government purchased \$125 billion of CMHC insured mortgages (nearly 15 percent of outstanding mortgages in Canada).<sup>62</sup> As part of the 2009 Budget, the government instituted the Home Renovation Tax Credit, allowing families to claim a 15 percent credit on the portion of eligible expenditures exceeding \$1,000 but not exceeding \$10,000.<sup>63</sup>

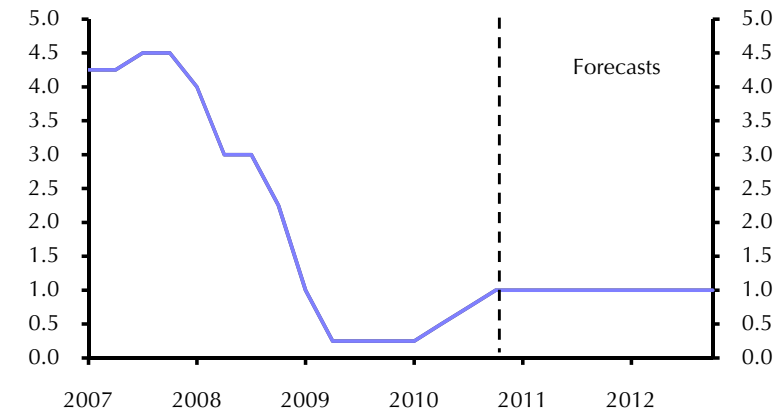
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<sup>61</sup> Data from Van Onselen (2010, Nov. 10). Many Canadians were granted loans between \$500,000 and \$800,000 provided their household income was \$110,000 and \$170,000.

<sup>62</sup> For a complete description of the IMPP program by the Parliament of Canada, see Nadeau, J-F (2009).

<sup>63</sup> See Department of Finance Canada (2009).

**Figure 8: Bank of Canada Overnight Lending Rate Target**



Sources – Thomson Datastream & Capital Economics

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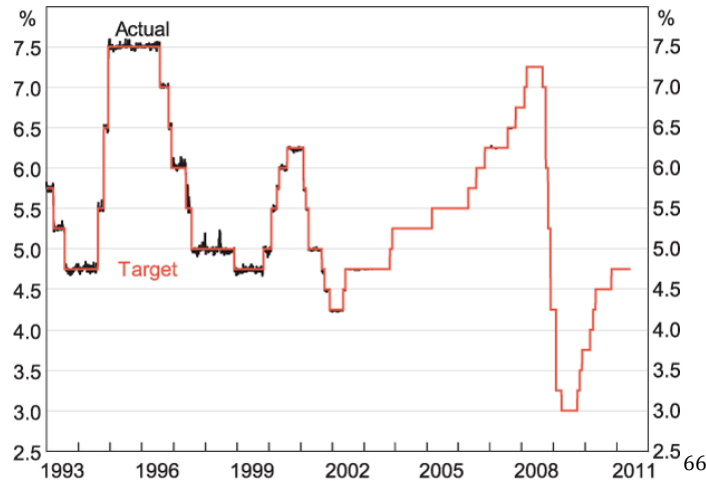
In Australia, the Reserve Bank of Australia (RBA) lowered interest rates in similar fashion to combat the effects of the global recession (Figure 9). The government also boosted the housing market by increasing the first time homeowner's grant, providing cash handouts to households, and relaxing rules regarding foreign ownership of real estate (Van Onselen, 2010, Feb.24). In addition, the Australian government introduced a number of guarantee schemes designed to support confidence in the system and banks' access to funds.<sup>65</sup> As explained by the OECD (2010), the government introduced a guarantee of all retail deposits up to \$1 million and introduced a temporary wholesale funding guarantee that allowed banks to raise wholesale funding, both onshore and offshore, backed by a 5-year government guarantee. The government also provided liquidity support for the residential MBS market.

<sup>64</sup> Figure 8 Source: Capital Economics (2011), Canada Economic Outlook, Chart 8.

<sup>65</sup> See Schwartz (2010).



Figure 9: Reserve Bank of Australia Cash Rate



While these policy decisions may have contributed to the resilience of the Canadian and Australian systems by supporting the housing markets during stressful global economic times, the systems now remain vulnerable to a correction in housing prices, primarily as a result of the consequential high levels of household debt. These oligopolistic systems that performed soundly during the U.S. subprime crisis might not be so resilient should a housing crisis occur much closer to home.

#### 4.2.2 Vulnerabilities that Remain in the Canadian and Australian Systems

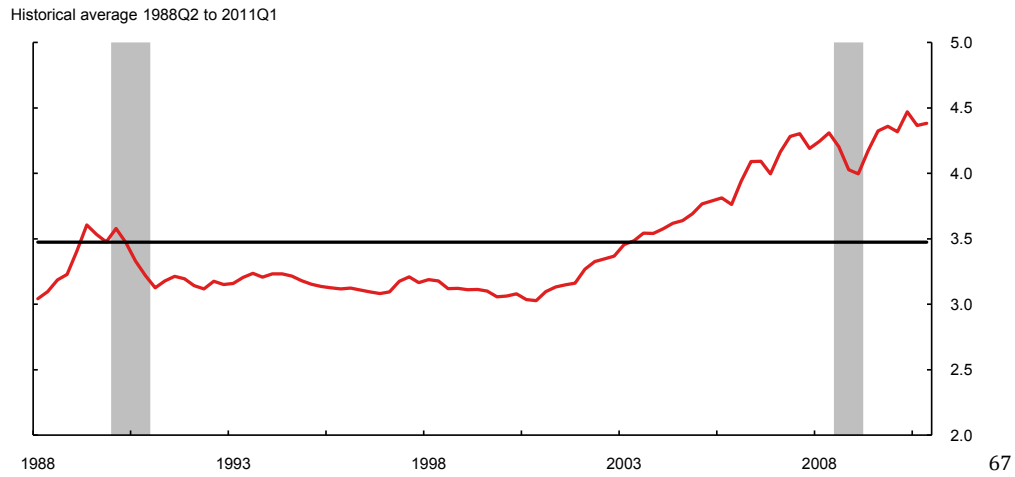
As shown above in Figure 7, Canadian house prices have risen 31 percent since they fell briefly during the last recession and, mid-way through 2011, stand 13 percent above the pre-crisis peak. In comparison to the recession of the early 1990s where it took 12 years for residential investment to regain its pre-recession level, house prices had surpassed their pre-crisis peak within 18 months of the recent crisis (BoC, 2011). Currently, house prices are nearly 4.5 times the average

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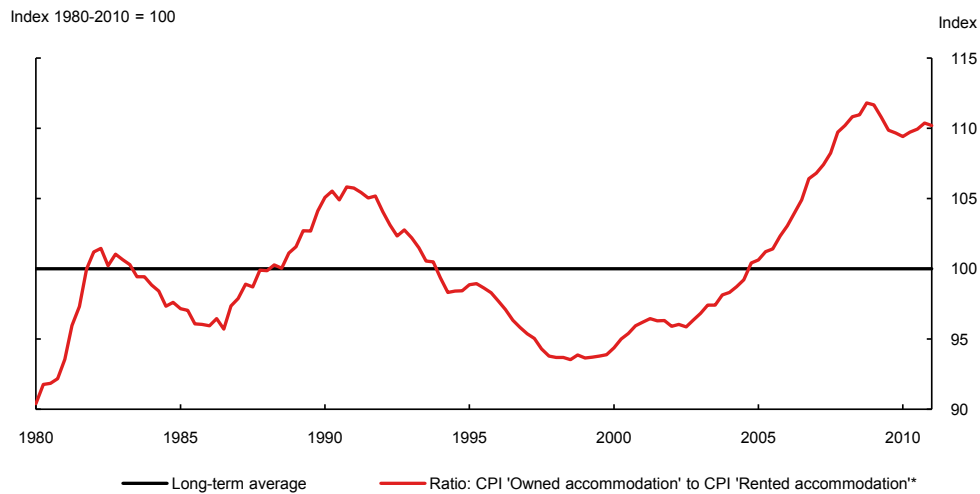
<sup>66</sup> Figure 9 Source: Reserve Bank of Australia (2010).

household disposable income and house price-to-rent ratios continue to climb, as shown by Figures 10 and 11 below.

**Figure 10: Canadian Real House Price to Household Disposable Income Ratio**



**Figure 11: Monthly Cost of Ownership versus Renting in Canada**



\* Owned accommodation is comprised of mortgage interest cost, replacement cost (NHPI), property taxes, homeowners' and mortgage insurance, and homeowners' maintenance, repairs & other expenses. Rented accommodation is comprised of rent and tenants' insurance, maintenance, repairs and other expenses.

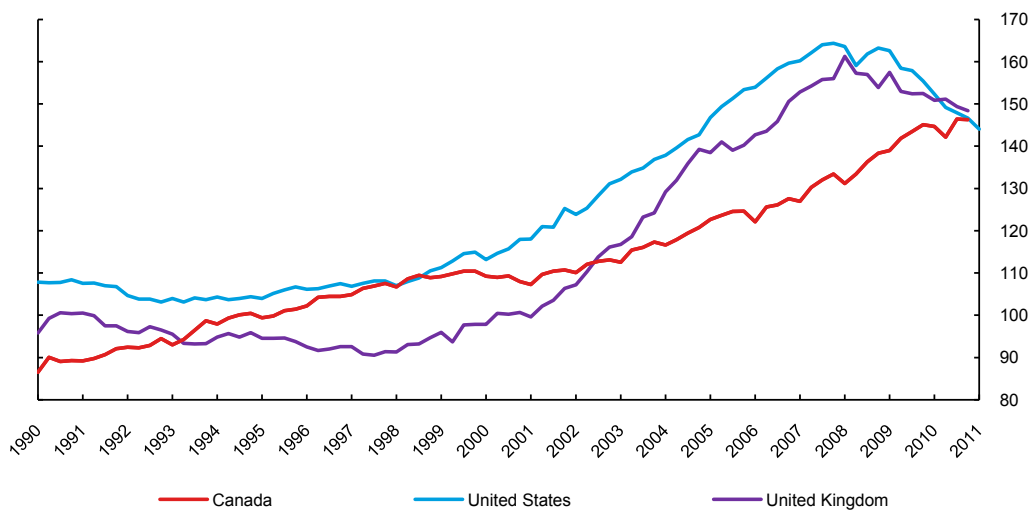
58

<sup>67</sup> Figure 10 Source: BoC (2011), Chart 6.

<sup>68</sup> Figure 11 Source: BoC (2011), Chart 8.

This growth is largely a result of the policies described above in Section 4.2.1, particularly the near zero interest rate environment that allowed banks to infuse a large amount of credit into the housing market. Over the past decade, housing-related debt has grown by more than 150 percent to \$1.3 trillion and Canadians now carry debt-to-income ratios as high as those in the U.S. and the U.K (Figure 12).

**Figure 12: Household Debt to Personal Disposable Income Ratios**



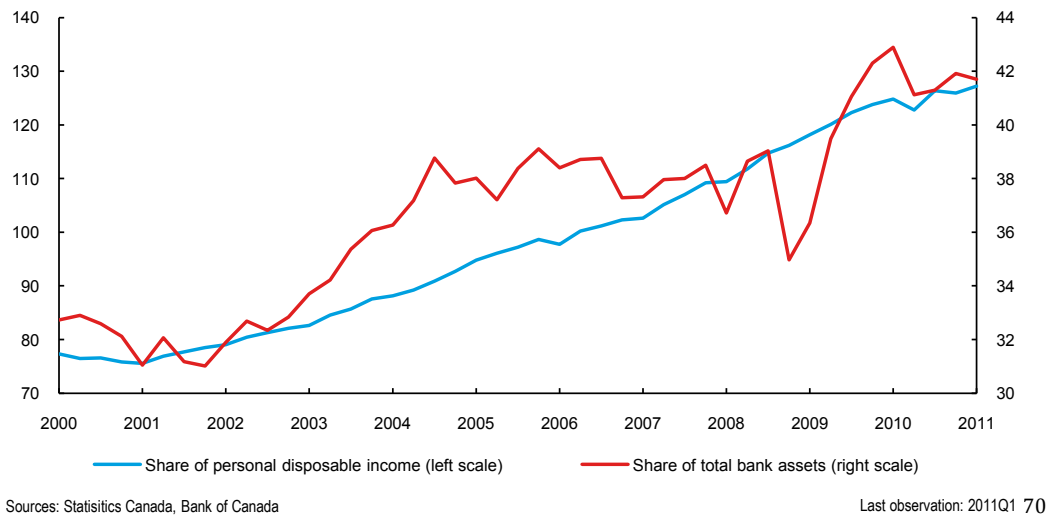
Source: Statistics Canada, U.S. Federal Reserve, U.K. Office for National Statistics

Last observation: Canada and U.K.:2010Q4, U.S.: 2011Q159

Perhaps of greatest concern is the fact that mortgage debt is the largest asset-class exposure for Canadian banks (Figure 13). Real estate loans now comprise over 40 percent of bank assets. As BoC Governor Mark Carney warns, “the central position of housing assets and liabilities on the balance sheets of both households and financial institutions means that any housing excesses could generate important vulnerabilities in the financial system” (BoC, 2011).

<sup>69</sup> Figure 12 Source: BoC (2011), Chart 9.

**Figure 13: Canadian Bank Exposures to the Housing Market**

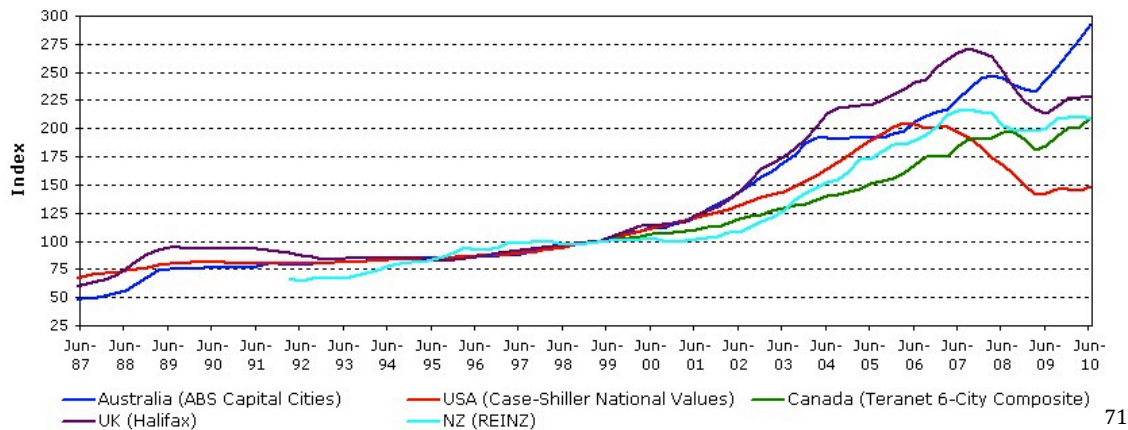


Due to the direct involvement of the government in the mortgage market through CMHC, this vulnerability could extend to the taxpayer in the event of a significant decrease in housing prices, such as the 25 percent correction (approximately what occurred in the U.S.) predicted in a recent report by Capital Economics (2011). This might overwhelm highly indebted families who, suddenly, find themselves unable to meet their loan obligations. This trouble would be further exacerbated by an increase in interest rates by the BoC. This increase might, in fact, be the most dangerous trigger for a correction. At that time, the chartered banks would turn to CMHC. However, CMHC is highly undercapitalized and, consequently, would have difficulty absorbing significant losses. According to their 2009 Annual Report, CMHC had \$9.3 billion of shareholder capital and \$473 billion of insured loans (Van Onselen, 2010, Nov. 10). At the same time, investors holding bonds issued by the Canada Housing Trust and secured by insured residential mortgage

<sup>70</sup> Figure 13 Source: BoC (2011), Chart 2.

portfolios would also be looking to the federal government guarantee. In similar fashion to the U.S. government sponsored enterprises, CMHC relies on a strong housing market with low levels of default and transfers credit risk to the taxpayer.

**Figure 14: Residential House Price Indices (March 1999=100)**



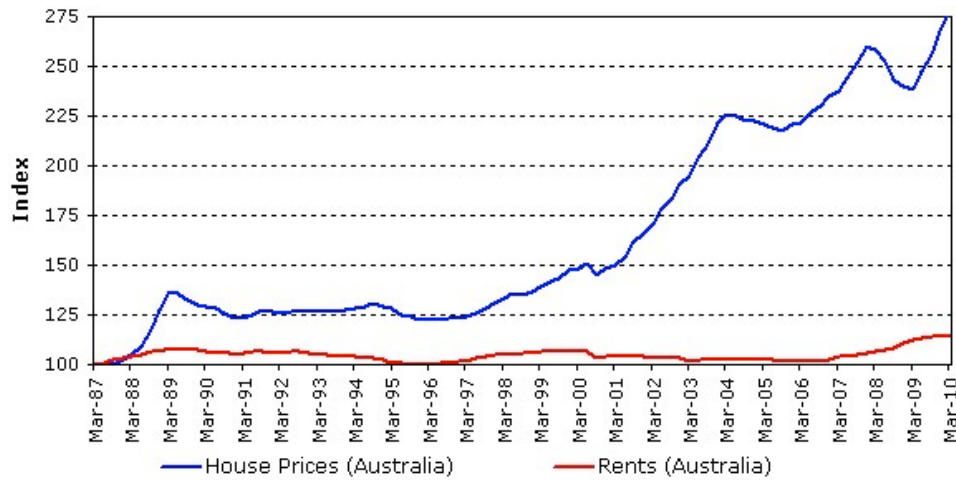
71

In Australia, house prices have also increased significantly since the brief setback at the onset of the recession in 2008. In fact, Australian house prices have increased more dramatically than in any other country (Figure 14). House price-to-rent ratios have also significantly diverged. The Australian Bureau of Statistics reports that real house prices have risen 165 percent since 1987, while real rents have increased only 15 percent in the same period (Figure 15). As in Canada, this increase in housing prices has largely been debt-fuelled, “fulfilling one of the key ingredients of an asset bubble” (Van Onselen, 2010, Sept. 27). The ratio of Australian mortgage debt to household disposable income has increased from 32 percent in 1990 to 142 percent in mid-2010 (Figure 16). Mortgage debt has also increased from 20 percent to 88 percent of GDP during the same 20-year period. Using price-

<sup>71</sup> Figure 14 Source: Van Onselen (2010, Sept. 27).

to-rent and price-to-income ratios, both the Economist and the IMF have found the Australian housing market to be highly overvalued relative to other OECD countries.<sup>72</sup>

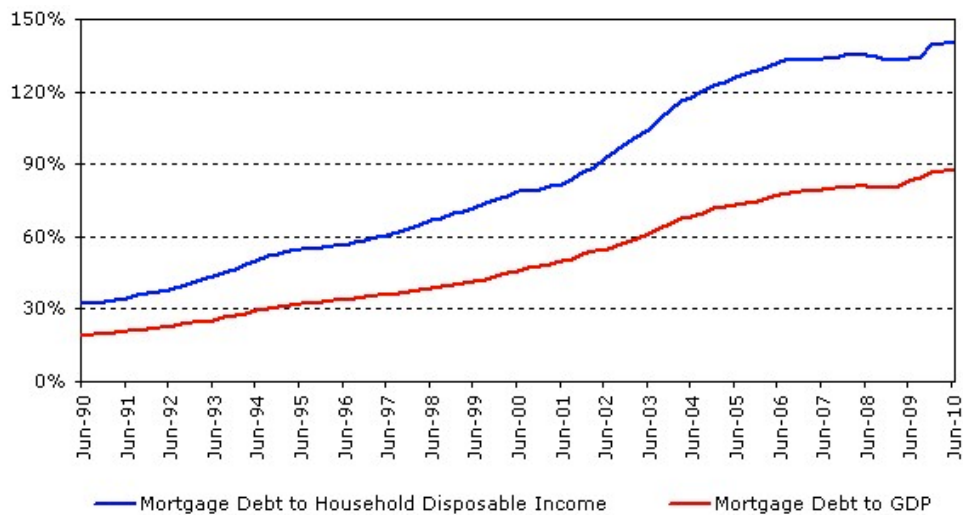
**Figure 15: Australian House Prices versus Rents (March 1987=100)**



Source: ABS Cat 6416 & 6401

73

**Figure 16: Australian Mortgage Debt to Household Disposable Income and GDP**



Sources: RBA Statistical Tables, ABS

74

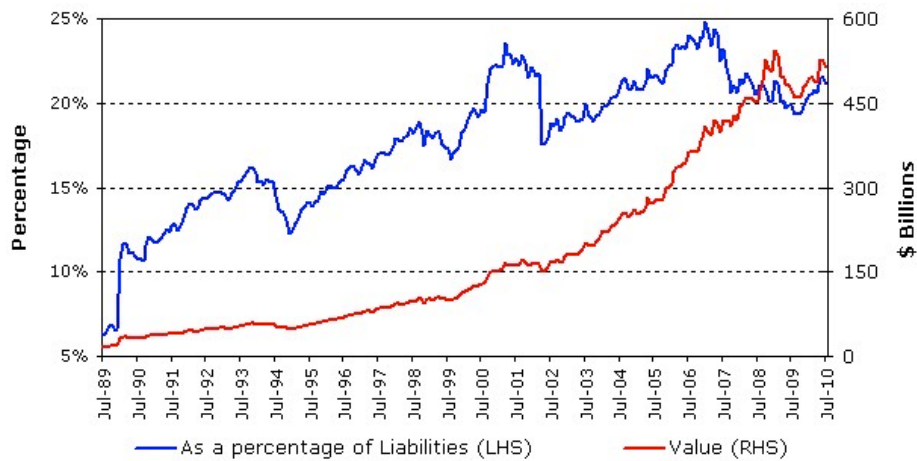
<sup>72</sup> See The Economist (2010, Apr. 15) and Holzer (2010, May 28).

<sup>73</sup> Figure 15 Source: Van Onselen (2010, Sept. 27).

<sup>74</sup> Figure 16 Source: Ibid.

Perhaps the most significant vulnerability in the Australian economy comes from the high percentage of bank offshore borrowing that has been used to fuel the housing market (Figure 17). The percentage of bank liabilities offshore has increased from 10 percent in 2000 to 22 percent after the crisis.

**Figure 17: Australian Banks' Offshore Funding**



Source: RBA Statistical Table B3

75

Similarly to Canada, lending increased in the mortgage market and became the largest asset-class exposure among Australian Banks, increasing from 35 percent of assets in 1990 to 57 percent in 2010.<sup>76</sup> If access to this foreign borrowing were to dry up as a result of a prolonged freezing in global credit markets (rather than the brief setback in 2008 that was quickly insured by the liability guarantee programs discussed above), housing prices might decline dramatically if institutions are unable to fuel the market with further lending.<sup>77</sup>

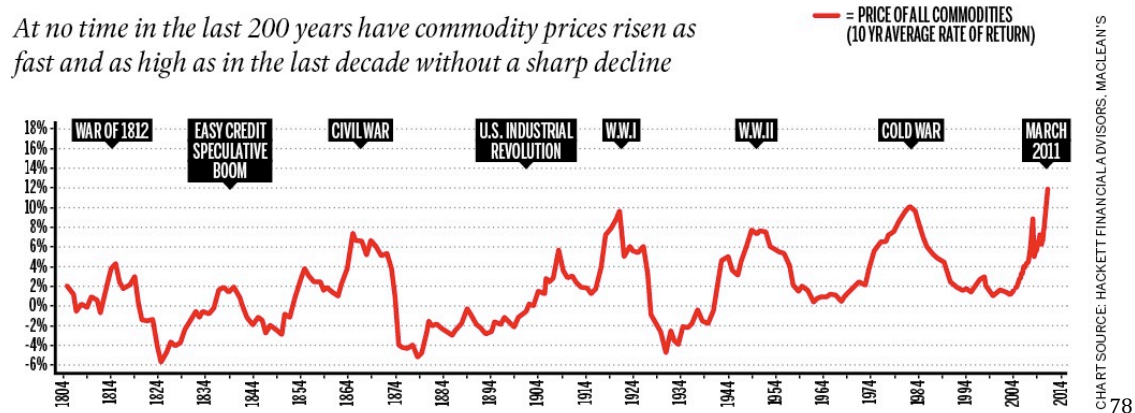
<sup>75</sup> Figure 17 Source: Ibid.

<sup>76</sup> 65% of total assets at CBA and Westpac, 55% at ANZ and 50% at NAB. See Van Onselen (2011, May 30).

<sup>77</sup> In fact, there is evidence to suggest that a housing correction is already taking place. The house price index for the weighted average of the eight Australian state

Further, as commodity export-based economies, both Canada and Australia have been supported by the decade long global commodities boom that preceded the crisis and continues in its aftermath (Figure 18).

**Figure 18: Commodity Prices**



As explained by Kirby and Alini (2011), rising commodity prices have helped Canada weather the storm by keeping unemployment and inflation low and increasing disposable income. Foreigners invested \$116 billion in Canadian investments in 2010 and an additional \$11.8 billion in January 2011. The resource-based S&P/TSX total return index has risen 120 percent in the past decade. However, given past trends visible clearly in Figure 18, it seems possible that a correction in commodity prices may occur in the short to medium term, which would impact the Canadian economic climate considerably. The same, of course, is true of Australia. In addition, Canada and Australia have developed significant

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capitals decreased 1.9 percent between June quarter 2010 and June quarter 2011 (Australian Bureau of Statistics, 2011).

<sup>78</sup> Figure 18 Source: Kirby (2011).



exposures to the Chinese Economy.<sup>79</sup> A slowdown in China would result in lower prices for Canadian and Australian exports and a lower demand for their real estate.

### **4.3 Summary**

The analysis of the U.S. experience contained in section 4.1 demonstrated that the subprime crisis was primarily caused by severe regulatory failures that enabled banks to aggressively grow their business and fuel a credit boom with reckless lending. The analysis of the Canadian and Australian experiences contained in section 4.2 then demonstrated that these systems were relatively resilient for reasons other than market structure and that their models have not yet been thoroughly tested. In these circumstances, it is premature to suggest that an oligopoly model will necessarily contribute to financial stability if adapted by systems elsewhere. In this connection, it is interesting to note two instances where banks demonstrated significant instability in an oligopoly market structure: (i) the U.K. system in the recent crisis and (ii) Australia's Westpac Banking Corporation in the 1980s and early 1990s. For a discussion, see Box 1 below.

#### **Box 1. The Cases of the U.K. System and Westpac Banking Corporation**

##### *(i) The U.K. in the crisis*

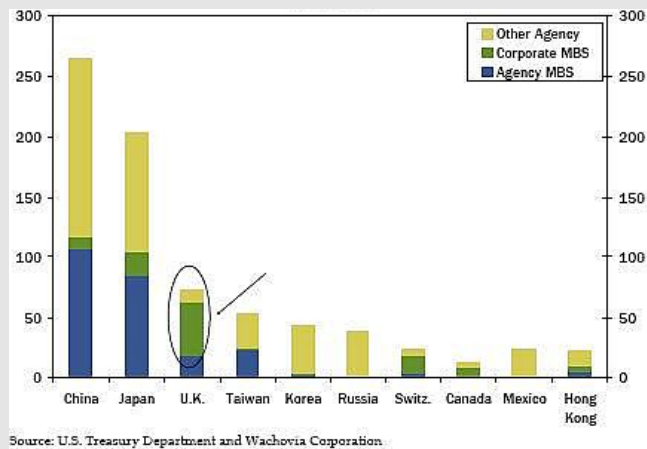
The banking system in the U.K. is highly concentrated and dominated by four large banks: HSBC, Royal Bank of Scotland (RBS), Lloyds Banking Group (LBG), and

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<sup>79</sup> Australia is perhaps most vulnerable to a correction in commodity prices due to its significant exposure to the Chinese economy. China accounts for 60 percent of iron ore consumption and 52 percent of coal consumption worldwide. These raw materials are Australia's largest two exports. See Van Onselen (2011, Jun. 6).

Barclays. Including the fifth largest bank, Standard Chartered, these institutions were responsible for 63 percent of total domestic deposit taking and lending before the crisis; a total that was projected to increase to 74 percent after a number of post-crisis mergers were finalized, including the acquisition of HBOS by LBG (Bank of England, 2008). Despite the similarities in market structure to the Canadian and Australian systems, the U.K. experience in the recent crisis was much more closely aligned with that of the U.S.

Figure 19: Exposures to U.S. Mortgage Market (\$Billions)



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Net dependence on wholesale funding among U.K. banks rose from zero in 2001 to £738 billion in 2008 (Davis, 2009). The big banks in the U.K. grew their businesses and boosted profits by making use of structured products and off-balance-sheet vehicles to increase leverage in much the same way as the large U.S. banks (see section 4.1). Northern Rock famously fell victim to a bank run as a result of liquidity and funding pressure and was eventually nationalized. HBOS was acquired by Lloyds after experiencing similar funding difficulties. U.K. banks also

<sup>80</sup> Figure 19 Source: Wall Street Journal (2007, Aug. 15).

made large write-downs from direct exposures to U.S. subprime MBSs (Figure 19). RBS and LBG needed to be bailed out by the U.K. government in October 2008 and more than 80 percent of RBS and 40 percent of LBG remain in state ownership (Independent Commission on Banking, 2011).

(ii) *Westpac in the 1980s and 1990s*

In 1982, Australia's oldest and largest bank, Bank of New South Wales, merged with Commercial Bank of Australia to form Westpac Banking Corporation. Although the bank was one of the most sound and resilient during the recent crisis, it was, in the early 1990s, one of the world's weakest.

As described by Carew (1997)<sup>81</sup>, "The fall of this commercial giant (was) a tragedy of errors: the story of a bank that wanted to be bigger and better. In the attempt, it all but crippled itself" (p. 3). Over a two-year period in the late 1980s, the bank's assets grew by more than 50 percent and the business expanded significantly overseas. Westpac's central focus was to become 'Australia's World Bank' but inevitably, this expansion involved a significant deterioration of the business. When the booming housing market eventually collapsed, it was revealed that Westpac and its subsidiaries were "over-exposed to a moribund property sector" (p.5). By the time this story was bestowed upon the U.S. and European banks in the early 21<sup>st</sup> century, perhaps Westpac had learned its lesson.

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<sup>81</sup> All information on Westpac presented in Box 1 is borrowed from Carew (1997).

## **5. Efficiency Implications of the Competition-Stability Debate**

It is submitted that policy reform should not compromise the traditional efficiencies associated with competitive market economies unless it is necessary and appropriate to do so. As Beck (2008) explains, “Even if there were a trade-off between competition and stability, it is ex-ante not clear whether stability should have a higher priority than efficiency, which has clearly been shown to be linked to higher degrees of competition” (p. 19).

In this connection, this paper argues that stability and efficiency goals can be addressed simultaneously with policy that, among other things, limits the market crippling TBTF problem. It is clear that “LCFIs were the primary, private sector catalysts for the financial crisis...” (Wilmarth, 2010, p. 709). Addressing the severe moral hazard posed by implicit guarantees through appropriate regulation of LCFIs will make banking systems more stable by limiting contagion and forcing institutions to internalize risk. It will also make them more efficient by mitigating the competitive distortions associated with implicit government subsidies. Although it has been widely argued that universal banking results in efficiency gains through economies of scope and scale, the literature suggests that these gains are likely exhausted at an asset level near \$100 billion.<sup>82</sup>

### **5.1 Distortions Arising From the TBTF Problem**

In the aftermath of the crisis, restoring functionality and stability to the financial system was the main priority of governments and central banks. It is

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<sup>82</sup> See Wilmarth (2009) and Berger, Demsetz, and Strahan (1999).

generally accepted that the bailouts that ensued were necessary ex-post to prevent a complete collapse of financial systems in the U.S. and Europe.<sup>83</sup> What was revealed by the crisis, however, is that institutions had been operating under a blanket of implicit government subsidies that created a number of regulatory and competitive market distortions.<sup>84</sup>

First, implicit guarantees provide powerful incentives for risk taking. Larger and more interconnected institutions are more likely to be rescued in the case of failure, providing banks with incentives to expand their balance sheets by using government guarantees as low-cost funding for risky capital market activity (Wilmarth, 2010). Subsidies effectively “shielded institutions from normal market forces” (Avgouleas, 2010) and led to drastic misuse of financial innovation.<sup>85</sup>

Second, government guarantees distort fundamental principles of free markets. With the understanding that they will not be allowed to fail, institutions obtain less costly access to capital and receive higher ratings on their bonds. As a result, they are able to dominate the market and drive out competitors who lack access to guarantees by offering customers artificially lower borrowing costs and higher rates on deposits (Avgouleas, 2010).

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<sup>83</sup> Institutions in the U.S. and Europe received \$9 trillion in support from governments and central banks (Wilmarth, 2010).

<sup>84</sup> For detailed discussions, see Avgouleas (2010) and Wilmarth (2010).

<sup>85</sup> Refer to section 4.1.

## 5.2 Reform of the TBTF Problem

Several approaches have been suggested to limit the distortions associated with TBTF subsidies. Certainly, a combination of these and other methods will be required to fully address the TBTF problem in the future.

### 5.2.1 *Banking Separation Models*

A number of proposals have attempted to design a framework that will reinstate separation between the traditional commercial business of banking and capital market activities that existed prior to deregulation. Some, including Bank of England Governor Mervyn King and Federal Reserve of Kansas City chief executive Thomas Heonig, have campaigned for a strict break-up of the mega-bank model.<sup>86</sup> Others believe that the costs of doing so would be needlessly high and argue that benefits of universal banking should be sustainable as long as a strong regulatory framework (i) prevents banks from engaging in risky business that overly intertwines retail and capital market activities and (ii) allows the various parts of the bank to be resolved individually in the case of failure.

John Kay (2009) proposes an extreme model of 'narrow banking' in which deposits are backed entirely by risk free, mostly short-term government bonds and lending activity is undertaken by separate subsidiaries. Avgouleas (2010) proposes a three-tiered separation model for the licensing of banks based on the size and riskiness of activities. Wilmarth (2010) suggests a similar two-tiered system. The Independent Commission on Banking (2011) in the UK, chaired by Sir John Vickers, recommends a form of 'ring-fencing' whereby retail operations would become a

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<sup>86</sup> See Hoenig (2011).

separate subsidiary of the universal bank. The banks would be required to maintain capital ratios and loss-absorbing debt for the retail business and for the bank as a whole. The 'Volcker Rule', designed by former Federal Reserve Chairman Paul Volcker and endorsed by President Obama, prevents deposit-taking institutions from engaging in proprietary trading for its own profit, restricts involvement with hedge funds and private equity funds, and limits the size of banks.<sup>87</sup> An adaptation of the Volcker Rule is included as part of the Dodd-Frank Wall Street Reform and Consumer Protection Act passed by Congress in July 2010.<sup>88</sup>

### *5.2.2 Improving Loss Absorbency*

In order to truly shield the taxpayer and the greater economy from distress resulting from the failure of LCFIs, institutions must be better able to absorb losses through the business cycle. Proposed reforms include (i) new capital and liquidity requirements, (ii) bail-in debt, and (iii) LCFI insurance funds.

There is general consensus among authorities that LCFIs require more stringent capital requirements than those that existed before the crisis. The Basel III Accord, designed by the Basel Committee on Banking Supervision in response to the deficiencies revealed by the crisis, introduces new requirements on bank capital, liquidity, and leverage. As opposed to the 2 percent common equity and 4 percent Tier 1 capital of risk-weighted assets required by its predecessor, Basel III requires banks to hold 4.5 percent and 6 percent respectively, as well as a capital

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<sup>87</sup> See The White House (2010). For a discussion on the merits and drawbacks associated with these proposals, see Avgouleas (2010).

<sup>88</sup> See One Hundred Eleventh Congress of the United States of America, Second Session (2010).

conservation buffer of 2.5 percent by the 2019 full implementation deadline (Basel Committee, 2010). The accord also introduces a minimum leverage ratio of 3 percent, a Liquidity Coverage Ratio that requires banks to hold sufficiently liquid assets to cover cash flows over a 30-day period, and a Net Stable Funding Ratio requiring the amount of available stable funding to exceed the amount that would be required by a one-year period of distress.<sup>89</sup>

Others, however, have proposed that more than just capital requirement adjustments are needed to ensure that failing institutions are better able to absorb losses. One such proposal is that banks be required to issue contingent capital (so-called 'CoCos'), whereby a decrease in capital below a predetermined threshold would trigger an automatic conversion of debt to common stock. This would increase equity during times of crisis and encourage greater monitoring by debt holders (Wilmarth, 2010). A similar proposal, referred to as bail-in debt, forces creditors to absorb losses while the bank is still operating. Rather than conversion based on automatic triggers, the bail-in method allows regulators to decide at what point the conversion occurs before a collapse. The goal is to prevent a 'Lehman moment' by forcing creditors to absorb losses while the bank is still solvent.<sup>90</sup> Andrew Haldane, Executive Director of Financial Stability at the Bank of England, discussed the merits of CoCos and bail-in debt as forms of micro-prudential regulation in a February 2011 speech to the Institute of International European Affairs:

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<sup>89</sup> Scott (2011).

<sup>90</sup> See Tett (2010) and Independent Commission on Banking (2011).



“It lines up incentives. The pay-off profile of these CoCos is such that, in the good times, you get paid, and in the bad times, your claim gets diluted so you bear the downside risk of your actions. That will make both shareholders in banks and staff in banks much more risk-sensitive, much less likely to bet the ranch next time around” (Haldane, 2011).

However, Admati, DeMarzo, Hellwig, and Pfleiderer (2010) are skeptical of the prevailing view that equity is relatively expensive and, as a result, do not support the notion that hybrid securities are socially preferable to simply having banks hold more equity. Further, a reliance on automatic triggers allows for potential manipulation by investors, managers, and regulators as conversion times approach. The terms on which this debt is issued to investors would also be costly to banks and might not be easily agreed upon.

Wilmarth (2010) recommends the establishment of a pre-funded Systemic Risk Insurance Fund to be administered by the FDIC, requiring those institutions designated TBTF to pay insurance premiums that adjust based on the systemic risk posed by the bank. The fund would be used to support LCFIs in the case of crisis.

It has also been suggested that LCFIs should be required to have working plans that lay out, well in advance, how they will be effectively resolved or dismantled in the case failure. As explained by Andrew Haldane in the same 2011 speech:

“We need the good bits (of the bank) to be preserved, and the bad bits to be wound down. That calls for a plan for how you pull apart a bank in the event of the worst happening.... They’re living wills. They’re explaining what will be done if death comes to a big interconnected bank such as not to blow the world up in a way that Lehman (Brothers) did” (Haldane, 2011).

These so-called living wills, as described by Wilmarth (2010), should resemble the outcome of a Chapter 11 bankruptcy proceeding.

### **5.3 Summary**

In summary, the TBTF problem posed by inadequate management of the universal banking model makes banking markets less stable and distorts competition. Working to eliminate the implicit government subsidies under which banks operate will thus appease both stability and competition policy advocates.<sup>91</sup>

## **6. Conclusion**

This paper has demonstrated that there is not adequate support for the position that oligopoly banking models, if adapted by other countries, would necessarily contribute to financial stability. Further academic research would be constructive, especially as it pertains to the competition-stability nexus under different forms of regulation. It is important, however, that the traditional market efficiencies attributed to competition not be compromised unless there is a strong indication that doing so is necessary and appropriate. Based on an analysis of the recent crisis experience in the U.S., Canada, and Australia, the evidence, at this point, is not convincing. In the meantime, policy makers should continue to focus on reforming the existing faulty regulatory frameworks. These efforts must account for the competitive landscapes in the respective financial systems.

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<sup>91</sup> It is important to understand that TBTF regulation will not, in itself, ensure financial stability or robust competition in banking markets. Additional policy will be needed to address anti-competitive deficiencies in banking. These include switching costs, the stability of branch banking, and other barriers to entry. Addressing these concerns, however, is more complex because of our inadequate understanding of the competition-stability relationship.

## Appendix 1

The following model of bank competition, presented originally by Allen and Gale (2000), is shown here as adapted by Boyd and De Nicoló (2005) and Carletti (2007). The model demonstrates that a higher level of competition in the market for deposits leads to lower bank profits, greater risk taking, and a decrease in stability.

In a two-period economy, dates 0 and 1, there are two classes of risk-neutral agents: banks and depositors. There are  $N$  banks competing in the deposit market with access to a set of constant-returns-to-scale technologies indexed by  $S$ . Given a level of input  $y$ , the risky technology yields  $Sy$  with probability  $p(S)$  and 0 with probability  $1 - p(S)$ , where  $p(S)$  satisfies  $p(0)=1$ ,  $p(S)=0$ ,  $p' < 0$  and  $p'' \leq 0$  for all  $S \in [0, \bar{S}]$ . i.e.  $p(S)S$  is a strictly concave function of  $S$  and reaches a maximum  $S^*$  when  $p'(S^*)S^* + p(S^*) = 0$ . A higher level of  $S$  means a higher probability of failure. A higher  $S$  yields a higher expected output to the left of  $S^*$  and a lower expected output to the right of  $S^*$ . The bank chooses  $S$  at date 0 and is unobservable to other agents. At date 1, agents can observe at no cost whether the investment outcome has yielded positive or zero output.

For depositors, the total supply of deposits is represented by an upward sloping inverse supply curve  $r_D(\cdot)$ , which satisfies  $r(0) \geq 0$ ,  $r' > 0$ ,  $r'' \geq 0$ . Total deposits of each bank  $i$ , which are all insured at a cost to banks of  $\alpha$ , are denoted  $D_i$  and thus total deposits are given by  $\sum_{i=1}^N D_i$ . Banks compete for deposits à la Cournot and the interest rate is a function of total deposits. In equilibrium, bank  $i$  chooses the pair  $(S_i, D_i)$  to maximize profits, which is given by:

$$p(S_i)[S_i D_i - r_D(\sum_{i=1}^N D_i)D_i - \alpha D_i]. \quad (1)$$

Conditions for an interior Nash equilibrium (NE) are:

$$p'(S_i)[S_i - r_D(\sum_{i=1}^N D_i) - \alpha]D_i + p(S_i)D_i = 0, \quad (2)$$

$$p(S_i)[S_i - r_D(\sum_{i=1}^N D_i) - r'_D(\sum_{i=1}^N D_i)D_i - \alpha] = 0. \quad (3)$$

In a symmetric NE, conditions (2) and (3) reduce to:

$$p'(S)[S - r_D(ND) - \alpha] + p(S) = 0, \quad (4)$$

$$S - r_D(ND) - r'_D(ND)D - \alpha = 0. \quad (5)$$

These conditions characterize a symmetric equilibrium where each bank chooses a portfolio  $(S^*, D^*)$ .

As  $N \rightarrow \infty$ ,  $D \rightarrow 0$ . This implies  $r_D(\sum_{i=1}^N D_i)D_i \rightarrow 0$ , and thus  $S - r_D(\sum_{i=1}^N D_i) \rightarrow 0$

and  $p(S) = 0$ . As a result, as  $N \rightarrow \infty$ ,  $S \rightarrow \bar{S}$ , meaning higher levels of competition induce banks to take greater risks.

## Appendix 2

Boyd and De Nicoló (2005) extend the Allen and Gale (2000) model of bank competition by introducing a loan market where entrepreneurs choose the riskiness of their investments. The authors show that lower interest rates prevalent in more competitive loan markets decrease the costs to entrepreneurs, providing them with greater profits and a lower incentive to make risky investments with bank loans.

In the same two-date economy described in Appendix 1, many entrepreneurs have access to projects of a fixed size (normalized to 1). The entrepreneurs borrow from the banks, which cannot observe their choice of risk  $S$  but take into account the best response of entrepreneurs given their loan rate  $r_L$ . Total amount of loans is denoted by  $L$ . Entrepreneurs choose  $S \in [0, \bar{S}]$  to maximize:

$$p(S)(S - r_L). \quad (1)$$

By strict concavity of the objective function, an interior solution to the maximization problem is given by:

$$h(S) \equiv S + \frac{p(S)}{p'(S)} = r_L. \quad (2)$$

By (2), a higher interest rate on loans causes entrepreneurs to choose riskier investments through an increase in  $S$ .

The inverse demand for loans satisfies:  $r_L(0) > 0$ ,  $r'_L < 0$ ,  $r''_L \leq 0$  and  $r_L(0) > r_D(0)$ . Consistent with the interest rate in the deposit market, the interest rate on loans is a function of total loans  $L$ . Since banks have no equity in the model,  $L =$

$\sum_{i=1}^N D_i$ . In a NE, each bank chooses deposits to maximize profits, taking into account

the entrepreneurs' choice of risk. Thus, bank  $i$  chooses  $D_i$  to maximize

$$p(S)[r_L(\sum_{i=1}^N D_i)D_i - r_D(\sum_{i=1}^N D_i)D_i - \alpha D_i], \quad (3)$$

s.t.

$$h(S) \equiv S + \frac{p(S)}{p'(S)} = r_L(\sum_{i=1}^N D_i), \quad (4)$$

where condition (4) reflects the equality of total loans with total deposits and that

borrowers will choose an optimal  $S$ . Letting  $S(\sum_{i=1}^N D_i)$  denote the function implicitly

defined by (4), bank  $i$  chooses  $D_i$  to maximize

$$p[S(\sum_{i=1}^N D_i)][r_L(\sum_{i=1}^N D_i)D_i - r_D(\sum_{i=1}^N D_i)D_i - \alpha D_i] \quad (5)$$

s.t.

$$0 \leq S(\sum_{i=1}^N D_i) \leq \bar{S}. \quad (6)$$

In a symmetric interior NE, different from Allen and Gale (2000), the level of risk  $S$  is strictly decreasing in the number of banks  $N$  and, as  $N \rightarrow \infty$ , the NE converges to the competitive outcome; i.e.,  $r_L(D) - r_D(D) - \alpha = 0$ . This occurs because banks are aware that entrepreneurs will respond to their higher loan rates by increasing the riskiness of their investments. Banks are then able to take this response into account when setting loan rates.

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