Financial Liberalization, Market Discipline and Bank Risk

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Abstract

In the literature on systemic banking crises, two common themes are: (1) Risky lending often follows bank liberalization. (2) Lack of market discipline encourages risky lending. That not all liberalizations are followed by financial crisis and that financial systems without market discipline sometimes operate without incident invites examination of these themes. In a test of six countries, we find that our measure of bank risk increases significantly in the wake of financial liberalizations, but only where depositors fail to discipline banks. Our measures of market discipline and bank risk, however, are persistently inversely related.

The bank crisis empirical literature remains undecided over some of the connections of incentives for bank risk with bank crises. Even though a systemic shift in bank risk is the fulcrum over which these incentives may leverage into crisis, tests for systemic shifts towards risk-taking are rare in the literature. Instead, factors that make risky lending more attractive are typically examined directly in their relation to crises or, separately, to each other.

While these approaches have enriched the literature, testing the connection of risk incentives to crises may obscure the elucidation of systemic risk itself. Some financial crises, for example, are creatures of bad macroeconomic or fiscal outcomes whose links to risky lending in the traditional sense are tenuous – even though the lending turned out to be risky ex post owing to a force majeure.[1] Examining the connection of incentives for risk to the events triggered by such outcomes is instructive but may complicate our understanding of what caused the actual risk-taking. We simplify the examination by directly testing for shifts in systemic bank risk and for their connections to factors that make risk more attractive. With respect to who engages in risky lending and when it occurs, our results suggest that financial liberalization without depositor discipline is too powerful an intoxicant for many bankers to resist.

Even though we have distinguished between the economic literature on connections between incentives for bank risk and bank crises from the literature on links between one incentive and another, these two literatures speak to each other. Martinez Peria and Schmukler

[1] To clarify this distinction, a comparison of Mexico's 1994-95 Tequila Crisis with Argentina's 2001-2002 crisis is useful. In the former, an acceleration of capital outflows and a subsequent exchange rate crash was preceded by rapid expansion in the commercial banks' nonperforming loan ratios despite economic growth. We offer evidence below to suggest that in Mexico a systemic shift towards risk was not preceded or attended by fiscal or macroeconomic crisis. In retrospect, the Tequila crisis was widely perceived as a bank-risk-led crisis (viz. Gruben, 1996 and Gruben and McComb (2003). In the case of 2001-2002 Argentina, however, the fiscal crisis led to the banking crisis. Argentina's banking crisis was preceded by a change in government regulations to allow banks to use government debt to fulfill liquidity requirements, thence by government-ordered freezes on private bank deposits (the *corralito* and the *corralón*) and finally by the default on government debt held (under duress) by the banks. For an analysis of the factors associated with this crisis in contrast with Argentina's bank problems during Mexico's Tequila crisis, see Burdisso, Saban and D'Amato (2002).

(2001) conclude that deposit insurance does not diminish the extent of depositor discipline. Using a very different analytical approach, Demirgüc-Kunt and Detriagache (2002) find that deposit insurance does affect bank crises. Taken together these results call to question the linkage between depositor discipline and bank crises.

Unresolved conflicts also characterize recent related literature on financial regulation and deregulation. Barth, Caprio and Levine's (2001) results indicate that regulatorily restricting bank activities increases the likelihood of financial crises. In Boyd, Chang and Smith (1998), restricting bank activities in the presence of generous deposit insurance reduces financial fragility. And while Barth, Caprio and Levine conclude that less restrictive bank regulations make financial crises less likely, an earlier literature maintains that liberalizations and related loan expansions often precede large increases in loan defaults or full-blown crises (de la Cuadra and Valdés, 1992; Gorton, 1992; deJuan, 1995; Honohan, 1999, Kaminsky and Reinhardt, 1999; McKinnon and Pill, 1996).

While debate attends the links between banking crises and subsidized deposit insurance, the expectation of bank bailouts and other commonly hypothesized influences on depositor discipline, it is clear that systemic banking crises are not continuous components of any nation's financial system. Even when their deposits enjoy explicit and subsidized insurance, most bankers go about their business most of the time without a crash.

Likewise, though much literature is concerned that financial liberalizations precede bubbles - which in turn precede busts - these associations are also inconstant. Some regulatory transitions are orderly.

We examine whether one reason why banking crises tend to be sporadic may involve the way in which the factors discussed above are linked The infrequency of connections between

market indiscipline and shifts to high risk lending suggests that – when the circuit is completed – some third factor might switch it on. We examine whether the third factor may be bank liberalization. The inconstant links between risky lending and bank liberalization suggest that they also may be conditional on a third factor. We test to see if the factor may be depositor discipline.

In our sample, the connection between bank liberalization and risky behavior completes a circuit where and when we would expect if the connection were indeed persistently conditional on the absence of market discipline. The set of tests that allow identification of what links risky behavior, financial liberalization and market discipline (or indiscipline) is one contribution of this paper. We begin by testing for depositor discipline in six economies – Argentina, Canada, Mexico, Norway, Singapore and Texas. We then test for shifts in bank risk during periods of financial liberalization or privatization for the same countries.

I. Depositor Discipline

If bankers really strategize their lending risk in accordance with their anticipations of depositor discipline, as is sometimes argued, we posit that they are likely to expect the discipline will occur (if it occurs) most strongly and painfully in periods of systemic bank stress. We assume that lenders' expectations are rational – so that the way we know what lenders anticipated is by seeing what in fact subsequently happened. We accordingly test for market discipline in periods of bank stress that occurred in the wake of financial liberalizations that we also examine.[2] In the depositor (or market) discipline tests, we use bank-by-bank data to

[2] In our tests, the period of bank stress for Argentina and Mexico is 1995, the Tequila Crisis. For Norway, we use 1987-1989, the nation's banking crisis. Although other Scandinavian countries also had crises at about this time, bank-by-bank data for them were unavailable to us. For Singapore the financial stress period was 1997-1998, the Asian financial crisis. For Texas we chose the period of the state's savings and loan crisis. No one refers to the

characterize depositor responses to changes in the nonperforming loan ratio, in bank capitalization, and in two other properties of banks' asset and liability portfolios.[3]

Table I presents the bank-by-bank cross-sectional results for models of the six countries. For each country we performed ordinary least squares regressions to gauge how inflation-adjusted deposit growth during systemic banking stress periods responded to changes in (a) bank i's past-due loans as a percentage of total assets (PDL_i/TA_i, to measure asset portfolio quality), (b) on bank i's equity capital as a percentage of its total assets (EQ_i/TA_i, to capture banks' capacities to remain solvent in the face of financial losses), (c) on the logarithm of the quotient of bank i's total assets divided by the sum of assets for all banks in the system (TA_i/TA, to account for too-big-to-fail perceptions) and (d) on bank i's deposits as a percentage of its total liabilities (DEP_i/L_i, as a control for the potential influence of liability composition on depositor behavior).

In countries where depositors disciplined bankers by pulling out of asset-impaired banks, the ratio of past-due loans to total assets ought to explain changes in deposits during a national period of banking stress. In Table 1, only Argentina and Singapore showed a significantly negative relationship between the percentage change in the inflation-adjusted deposit growth rate of banks and the past-due loans to total assets ratio. The six equations give our measure of capitalization, the value of bank i's equity capital as a percentage of its total assets (EQ_i/TA_i), a smaller vote. Only Argentina's coefficient was positive and significant. Norway's was even negative, although not significant.[4]

Canadian case of 1984-1986 as a crisis period but it includes the first bank closings since before the Great Depression of the 1930s.

[3] Our focus on deposit growth, asset quality and capitalization is consistent with Calomiris and Wilson (1998). According to their argument, as asset quality falls, capitalization must increase to maintain deposits constant. Their characterization may be appropriate for industrial countries with contract enforcement and reasonably well-organized and attentive financial regulation. Developing countries, as will be seen, seem to offer a different story. For this reason we will ultimately focus our attention on asset quality and finally pay less attention to capitalization.

[4] Perhaps these results simply mean depositors' views are consistent with theoretical and other technical literature, which provides conflicting predictions on whether capital requirements curtail or promote bank performance of

With respect to the too-big-to-fail variable (TA_i/TA), only Singapore's coefficient was positive and significant. Four of the six sample countries showed a negative (but not significant) sign. Finally, while the deposit configuration variable was positive and significant in Norway, Argentina and Singapore, the Texas S&L coefficient was both negative and significant.

Regardless of cause, the number of countries with depositor discipline in their banks turns out to be very limited.[5] Consider a summary statistic, the significance level for the F-statistic of each country's respective equation. Using the .05 level of significance as a benchmark, only Argentina, Singapore and Texas offered evidence of overall depositor discipline, and obviously asset quality was not a major contributor to the Texas model's explanatory power. More narrowly, if a significant depositor response (.05 level) to a decline in asset quality (see footnotes 3 and 4) is the correct measure, only Argentina and Singapore show depositor discipline. It is possible that the commitment technology built into Argentina's Convertibility Plan and into the particular policy details associated with Singapore's exchange rate targeting regime may have led depositors to believe that government bailouts would be unlikely when banks failed in those countries (viz. Fernandez and Schumacher, 1998).

II. Financial Liberalization and Bank Risk

Although we tested market discipline in our six countries during periods of bank stress, the periods for which we tested for shifts in bank risks instead included years around financial liberalizations or bank privatizations as well as years when such events did not occur.

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stability. It appears to be difficult for regulators to establish capital standards that mimic those that would be demanded by well-informed, undistorted private –market participants. Indeed Rochet (1992), Besanko and Kanatas (1996) and Blum (1999) note that actual capital requirements may increase risk-taking behavior.

[5] At least by the strong definition of depositor discipline – depositors flee the banks. Some analysts argue that the conditions for depositor discipline are satisfied when bankers with high nonperfoming loan ratios and poor capitalization simply have to pay higher deposit rates than other bankers.

It is important to recall what might make banks take bigger risks after a financial liberalization. Jumps in bank liabilities typically follow financial liberalization because it signifies greater opportunities to develop markets. Suddenly, banks are permitted to pay interest on liabilities at rates the market will bear instead of what the government permits, or are simply allowed to acquire types of liabilities that had been proscribed. A correspondingly rapid increase in assets follows (Gorton, 1992).

In a narrative that resonates particularly with privatization episodes, de Juan (1995) notes that when new owners take control of a bank, they generally increase lending relative to the value of equity capital or the deposit base. Whether or not liberalizations and related rapid loan expansions are followed by large increases in loan defaults – as they are in Gorton (1992), de Juan (1995), Kaminsky and Reinhart (1999), and McKinnon and Pill (1996) – a common adjunct to financial liberalization is markedly increased competition in the banking system (International Monetary Fund, 1993).

As liabilities expand and banks seek to match them with new assets, not only the quantity but the *quality* of assets changes. More assets typically mean larger shares of certain assets. After privatization, for example, Mexican banks became much more focused on consumer markets.

Asset quality also often changes in the sense of the other meaning of the term *quality*. Under this same paradigm of financial liberalization, after a repressed financial system is liberalized banks cannot supply intermediation services efficiently because they lack expertise and adequate technology (Kaufman, 1998). Banks cannot evaluate the riskiness of loans and of the higher real interest rates typical of a liberalized system**.** Lenders lack past distributions on which to base their assessments. Loan portfolios become accordingly riskier.

These depictions of post liberalization/privatization banking markets are consistent with a more general theoretical literature on strategic interaction among firms in growing markets where investment and growth of a firm are constrained by physical factors (including qualified personnel) or financial factors. Firms make pre-emptive investments in a struggle for market share. This struggle for a share of a new market environment can be seen as key to the sudden onset of high-risk bank behavior on which much of the current literature on financial and exchange rate crises is based.

These same depictions of post liberalization/privatization banking markets are also consistent with studies of consumer behavior in which, for example, a credit card holder typically develops a long-standing affinity for the first credit card he or she receives (*Wall Street Journal*, 1996). In sum, banks fighting for market share may engage in riskier strategies in newly open markets (for example consumer credit markets in Mexico in the early 1990s) than in a more mature market - for the simple reason that the expected long-term stream of rewards is correspondingly greater to survivors who practiced such pre-emptive behavior.

A. The Model

We use a model that identifies high-risk behavior in a banking system – as well as moves to high-risk behavior. Even though the model serves these functions, its original purpose was to assess banking system competitiveness within or across markets. We appropriated a model of competition to characterize bank risk because one of the model's various states of competitiveness – a state that Shaffer (1993) defined as *supercompetition* – is mathematically identical to the high-risk tactic of producing where marginal cost exceeds marginal revenue.

Our emphasis on breaks towards risky bank behavior connects our work with the literature (Kaminsky and Reinhart, 1999, for example) in which the trajectory of a banking system begins with financial liberalization, leads through subsequent high risk lending, proceeds into serious financial stress and may conclude with a financial and exchange rate crisis. Recall our allegation that such trajectories are conditional upon other factors – that sometimes a financial liberalization is just a financial liberalization and not an incipient financial crisis. For now we focus on the portion of this sometime trajectory that joins (or does not join) liberalization to systemically risky bank behavior.

It is useful to focus on breaks towards risky behavior as necessarily transitory. If we characterize the market share struggle behind these breaks as requiring marginal cost to exceed marginal revenue the struggle cannot persist indefinitely What motivates the struggle is that the present value of expected future return is positive despite temporary losses.[6] Finally because the high-risk behavior we are characterizing is a market share struggle, it may take place across much or all of the nation's banking system.

To characterize breaks into high-risk bank behavior, we present a simultaneous equation model that Shaffer (1993) introduced to the banking literature. The approach allows tests of commercial bank system competitiveness through estimation of an index of market power (λ) and then applying a dummy variable to identify breaks in competitiveness or market power.

The test revolves around the idea that profit-maximizing firms set marginal cost to what the literature calls their *perceived marginal revenue.* If the firm's perceived marginal revenue schedule and demand schedule are identical, then setting marginal cost equal to perceived

[6] A case in point is the discussion above of consumer behavior with credit cards. Suppose credit cards have been little used in a country until now and the first bank to present a consumer with a card will likely win the consumer for life. Some banks entering the suddenly new credit card market may be motivated to distribute credit cards as

marginal revenue is identical to setting marginal cost equal to demand price, yielding the classical conditions for a competitive equilibrium. Here, firms behave simply as price takers.

At the opposite end of the competitive spectrum – where firms act as a joint monopoly – a firm sets marginal cost equal to a perceived marginal revenue that corresponds to the industry's marginal revenue curve (Bresnahan, 1982). Because the firm only perceives the marginal revenue schedule and the demand schedule as identical under competitive equilibrium, the index we use to gauge the competitiveness of a commercial banking system simply expresses the deviation of the average bank's perceived marginal revenue curve from the industry demand schedule. If there is no deviation, we have pure competition.

Following Bresnahan (1982)) we write a demand function for commercial bank services:

$$Q = D(P, Y, \alpha) + \varepsilon, \qquad (1)$$

where Q is quantity, P is price, Y is a vector of exogenous variables, α is a vector of demand equation parameters to be estimated, ε is a random error term. Actual (as distinguished from perceived) marginal revenue is:

$$MR = P + h(Q, Y, \alpha), \qquad (2)$$

$$= P + Q/(\partial Q/\partial P)$$

The function h(Q, Y, α) is the semi-elasticity of demand, and $h(\cdot) \leq 0$. Firms' *perceived* marginal revenue is:

$$MR^p = P + \lambda h(Q, Y, \alpha), \qquad (2')$$

where λ is a new parameter to be estimated, $0 \leq \lambda \leq 1$. Here, λ measures the degree to which firms recognize the distinction between demand and marginal revenue functions. Let c(Q, W, ß) be the average firm's marginal cost function, where W is a vector of exogenous supply side

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rapidly as possible and with less thought than it might otherwise to borrower creditworthiness because it perceives that haste will yield a greater present value of expected future return than prudent hesitation would.

variables and ß is a vector of supply side parameters to be estimated. Maximizing firms will set *perceived* marginal revenue equal to marginal cost or, where η is a random error term,

$$P = c(Q, W, ß) – \lambda h(Q, Y, \alpha) + \eta \qquad (3)$$

Price taking firms perceive no difference between their marginal revenue functions and demand function. For them, $\lambda = 0$. Firms acting as joint monopolies clearly perceive a difference between their demand and marginal revenue functions. They set output where marginal cost equals marginal revenue such that $\lambda = 1$. Intermediate values of λ correspond to other oligopoly solution concepts. A Cournot equilibrium is suggested when $\lambda = 1/n$.

An instructive detail of this estimating procedure is that (Shaffer, 1993) $–\lambda$ is also a local estimate of the percentage deviation of aggregate output from the competitive equilibrium level of output. Since actual price deviates from the competitive price by $–\lambda Q/(\partial Q/\partial P)$, and actual quantity deviates from the competitive quantity by $\partial Q/\partial P$ times the deviation in price, actual quantity will deviate from the competitive quantity by $–\lambda Q$. Thus, the percentage deviation in quantity is $–\lambda Q/Q = -\lambda$. If $–\lambda<0$, then output is less than what would occur in competitive equilibrium, meaning that firms are behaving as if they perceived that they had market power.

Of particular importance for the purposes of this paper, if $–\lambda>0$, then actual output seems to exceed the competitive equilibrium output level, even though static allocative efficiency requires the marginal cost pricing outcome of $\lambda = 0$. This bank behavior outcome is referred to as *supercompetition*. It signifies that the typical bank in the market is operating at an output level where marginal cost exceeds marginal revenue.

To estimate λ, it is necessary to estimate simultaneously specifications of both (1) and (3), treating P and Q as endogenous variables. The demand function is specified as:

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 Y + \alpha_3 PZ + \alpha_4 Z + \alpha_5 PY + \alpha_6 YZ + \varepsilon \qquad (2'')$$

where Q is output quantity, P is output price, Y is a measure of macroeconomic activity, assumed to be an exogenous variable, and Z is the price of a substitute for bank output, also assumed to be exogenous. The interaction terms, the products PZ, PY and YZ, are necessary to permit rotation of the demand curve as required to identify λ.[7]

Following Shaffer (1993), a translog cost function is used to estimate the average commercial bank's cost function as follows:

$$\begin{aligned} \ln C = \quad & \gamma_0 + \gamma_1 \ln Q + \gamma_2 (\ln Q)^2 + \gamma_3 \ln W_1 + \\ & \gamma_4 \ln W_2 + \gamma_5 \ln (W_1)^2 /2 + \gamma_6 \ln (W_2)^2 /2 + \\ & \gamma_7 \ln W_1 \ln W_2 + \gamma_8 \ln Q \ln W_1 + \gamma_9 \ln Q \ln W_2, \end{aligned} \tag{4}$$

where C is total cost, W_1 and W_2 are exogenous input prices, as explained below. Equation (4) gives rise to following marginal cost function, c(Q, W, ß),

$$MC = (C/Q)(ß_1 + ß_2 \ln Q + ß_3 \ln W_1 + ß_4 \ln W_2) + \eta \tag{5}$$

Therefore, equation (3) is specified as follows:

$$\begin{aligned} P = & -\lambda Q/(\alpha_1 + \alpha_3 Z + \alpha_5 Y) + (C/Q)(ß_1 + ß_2 \ln Q + ß_3 \ln W_1 \\ & + ß_4 \ln W_2) + \xi . \end{aligned} \tag{3'}$$

However, equation (3') is not configured to facilitate analysis of breaks in bank behavior. To allow for breaks, we rely on the following specification of (3):

$$\begin{aligned} P = & -\lambda Q/(\alpha_1 + \alpha_3 Z + \alpha_5 Y) + (C/Q)(ß_1 + ß_2 \ln Q + ß_3 \ln W_1 + ß_4 \ln W_2) \\ & - ß_5 DQ/(\alpha_1 + \alpha_3 Z + \alpha_5 Y) + \xi , \end{aligned} \tag{3''}$$

where D is a dummy variable to be more fully explained below and ξ is a random error term. The system of equations represented by (2") and (3") is then estimated simultaneously.

[7] As Shaffer (1993) explains, a necessary and sufficient condition to identify λ is that the demand equation not be separable in at least one exogenous variable that is included in the demand function, but excluded from the marginal cost function. This condition is satisfied if α_3 and α_5 do not both equal zero. This specification of the demand

In considering the key expressions in the model, it is useful to review the contradictions inherent in λ versus $ß_5$. It is easily possible for λ, the measure of competitiveness for an entire examination period, to take on values of zero or greater even though $ß_5$ takes on a negative sign. This combination of values would suggest that the typical bank in the country under consideration operated at output levels consistent with perfect competition ($\lambda = 0$) or less than competitive ($\lambda > 0$) on average during the examination period overall but that during the subperiod characterized by a dummy variable the bank ran at supercompetitive levels ($ß_5 < 0$). Applying the dummy variable for subperiods during or just following financial liberalization in fact turns out to result in episodes where $ß_5 < 0$ in several interesting cases, even though no entire examination periods in our model of the six countries ever yield a supercompetitive λ.

Research on the banking systems of the countries we consider here often disaggregates banks by their market scope. Banks are sometimes characterized as large national, small national, multiregional, or regional. Out of appreciation for this bank-by-bank heterogeneity of market scope, we emphasize that the technique applied here does not rely on any particular definition of bank markets. As long as the data sample spans at least one complete market, then estimates of λ are unbiased. Where the industry comprises multiple markets, λ signifies the average degree of market power over separate markets. Note that λ reflects the behavior of the average firm in the sample.

Although this model assumes banks are input price takers, violating the assumption does not damage the results in a way that would bother many analysts. If banks have market power over deposits, in violation of the assumption, it can be shown that the specification of λ overstates the overall degree of market power by misattributing any deposit power to the asset

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function, apart from the interaction terms, represents a first-order (linearized) approximation of the true demand function (Shaffer 1993). Our results lead to the conclusion that α_3 and α_5 are not zero. Therefore λ is identified.

side.[8] In this case a finding of perfect competition or supercompetition would be even more striking than if the input price-taking assumption were not violated.

B. Some Intuitions on Competitive Breaks

Before considering the tests to identify breaks into supercompetition, we offer figures to develop an intuitive appreciation of the changing relation between bank costs and revenues during financial liberalizations or privatizations. The six boxes in Figure 1 depict such changing relations, but the indicators that appear there are much less refined than the measures of competition expressed by λ (total period competition) and β_5 (break, or not, during liberalization/privatization). Each of the six boxes in Figure 1 depicts fluctuations in bank asset interest rates, bank deposit interest rates and the difference between them for one of our six sample countries. The sample periods differ for each country, but each period includes a subperiod during and following a financial liberalization/privatization.

A consideration of some contrasts may be in order. Argentina's overall period is December 1991 through March 1997. During the subperiod 1995.IV-1997.I, private owners took control of most of most of Argentina's publicly owned banks. Over this subperiod, which followed the Tequila Crisis of 1995, the spread between asset interest rates and deposit interest rates rose, although not to the levels typical of the first half of the 1990s. In any case, this subperiod does not show the decline in revenues relative to costs – or rise in costs relative to revenues – that might be consistent with a move towards substantively more competitive behavior. In contrast, Canada (overall sample period, 1965-1989, with annual data) began major bank liberalizations in 1980 and pursued further liberalizations in subsequent years. Around the

[8] For a proof, see Shaffer (1994), 8-9.

beginning of the liberalization subperiod, deposit rates in Figure 1 converge towards the value of asset rates, diverging again in 1982 and 1983.

Note also the reduction of Mexico's asset interest rates relative to deposit interest rates – as expressed through the falling difference between the two – during the privatization subperiod of June 1991- July 1992. During this period all of the Mexican banks (after consolidation) that had been nationalized in 1982 were sold to the private sector in a series of auctions.

Norway's chief liberalizations included the removal of interest rate controls in the fourth quarter 1985, the removal of reserve requirements in 1987, and the removal of exchange controls in 1989. During this period the change in spreads between asset interest rates and deposit interest rates was even more extreme than Mexico's during its period of privatization. A very similar pattern of movement materializes in Texas thrift institutions in the early 1980s when, suddenly, a system largely restricted to lending for home mortgages was permitted to configure its asset portfolio any way it wanted – to the point of holding no home mortgages. During the early and middle-1980s many Texas thrift institutions expanded their liabilities and assets by 100 percent per year.

By contrast, despite steady financial liberalization during the 1990s, the relation between asset rates and liability rates in Singapore shows little variation at all – a pattern consistent with what takes place in Argentina during its 1995-1997 period of privatizations but by and large inconsistent with what takes place during liberalization/privatization subperiods in the other four countries of our sample.

C. Data

So as to maximize degrees of freedom, we used the most often-reported data available for the applicable period for each country. Accordingly, the number of observations per year differs

among the six country models. Recall that the periods differ as well, inasmuch as we focus on including subperiods that include bank liberalizations or privatizations and these events take place at different times in different countries. The overall periods for each country are delineated in Table I under the heading "Data Period." The number of observations per year appear under the heading "Frequency."

What may be seen as liberalization/privatization subperiods, outlined in the section above, are denoted as "Dummy Period." However, we identified these subperiods by testing for structural breaks in the overall periods that would allow us to determine where the β_5 dummy ought to begin and end.

It is important to note that these subperiods are not perfectly consistent with the actual periods of liberalization or privatization. The Mexican privatization period, for example, began in June 1991 and continued through July 1992. However, the subperiod where the break in λ was large enough to motivate a dummy variable to account for it ran from December 1992 through December 1993. This disparity should not be surprising, considering that time typically elapses between the purchase of a bank and when the new owners take control sufficient to run it differently than management had before.

Other subperiods include 1995.IV-1997.I for Argentina, during which most bank privatizations took place, and a nine-year Canadian period (1981-89) following Canada's Bank Act of 1980.[9] Norway's principal liberalizations took place starting with the removal of interest rate controls in the second half of 1985, but the statistically defined liberalization subperiod only begins in the first half of 1986. The Texas savings and loan liberalization subperiod runs from 1984.I-1990.II while Singapore's is 1997.I-1999.IV. It should be noted that despite Singapore's

liberalizations of the 1990s, no subperiod offered strong evidence of a break from previous levels of competitive behavior.

The procedure applied here uses the intermediation model of a bank. This approach (see Klein, 1971; Sealey and Lindley, 1977; Shaffer, 1993) treats the bank as using labor to acquire deposits and additional labor plus deposits to generate assets. The measure of output (Q) is total assets. The price of the output (P) is total interest income divided by total assets, i.e. average rate earned on assets. This average rate of return will be affected not only by market lending rates but by changes in the past-due loan ratio. The model requires not only output prices (P), but input prices for deposits (W_1 = the average interest rate paid on deposits, i.e. total financial costs/total liabilities) and for labor (W_2 total personnel expenditures/total personnel).

In principal, a particularly appropriate substitute for banking services would be the commercial paper rate in each country. Unfortunately, during the periods under study in each country, data on such instruments were not available for most countries. Accordingly, in the case of Mexico, we used the interest rate on 28-data *cetes*, or Mexican treasury bills. We applied rates on three-month Canadian government paper for Canada, three-month Norwegian treasury certificates for Norway and three-month Singapore Government Securities (referred to as SGS) for Singapore. To make our approach to Texas as consistent as possible with other countries we used the U.S. three-month treasury bill. In the Argentine case, due to a lack of a series even for Argentine government paper rates for the period, three-month U.S. treasury bill rates were used because of their close correlation with LIBOR rates. Use of this series in the Argentine model provided the expected signs and hoped-for levels of significance in most cases.

As a measure of national output, an index of industrial production was used for Argentina and

[9] We also tested as Argentina's privatization period 1995.I-1997.I, so as to pick up twelve of the fifteen privatizations instead (as with 1995.IV-1997.I) of eleven. The results were not substantively different from

Mexico since less-than-annual observations for GDP were not always available. We used GNP for Canada, GDP for Norway and Singapore, and gross state product for Texas. For Argentina, Canada, Mexico, and Singapore all nominal variables were deflated using the consumer price index. For Norway we used the GDP deflator and for Texas we used the gross state product deflator.

D. Estimation and Results

Table II presents estimation results for the risk-shift models of each of the six countries. Our *a priori* expectations of the parameter estimates (a_i for α_i, b_i for $ß_i$) were mostly confirmed by the results, but with exceptions, particularly the case of $a_2 < 0$ (four wrong signs Argentina, Mexico, Norway and Texas out of six cases) and of $a_4 > 0$ in the cases of Mexico, Norway and Singapore (although Singapore was not statistically significantly different from zero.). Since the demand curve is assumed to be downward sloping, the estimate of $\partial Q/\partial P = a_1 + a_3 Z < 0$ must hold, as it did in all cases. As earlier noted, either a_3 or a_5 must be different from zero in order to identify λ, a condition that was always satisfied in some form, although Canada , Norway and Singapore were not statistically different from zero in their a_3 values and Singapore was not with respect to a_5 . Our estimate of the parameter vector ß met with *a priori* expectations in the sense that unexpected signs never were significant, although we held no *a priori* expectation on b_5.

The systems of equations were estimated by the method of Full Information Maximum Likelihood. This method assumes normally distributed errors. Initial parameter values for the FIML estimation were supplied by first estimating the system by non-linear Three-Stage Least Squares. The interaction variable YZ had to be omitted in the estimation because it was nearly perfectly linearly correlated with the variable Z for Argentina, Mexico, Norway , Singapore,

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characterizing the regime shift period as 1995.IV-1997.I.

Texas This was due to the small variation in industrial production that occurred over the period of the sample. Therefore, in the reported results, there are no estimates for a_6 for those two countries although there are estimates for Canada, where GNP was used for Y.

Problems with multicollinearity remain in this sample. In particular, ln W_1 is highly correlated with Z, causing difficulty in estimating and making inferences on the parameter vector ß. Nevertheless, convergence of the estimates was fairly rapid in all cases. The estimates also appear to be robust relative to initial values of the parameter estimates.

For the purposes of this discussion, the most important results involve the coefficients of λ, the variable that measures level of competitiveness, and of b_5, the λ-related dummy variable coefficient for the liberalization or privatization period for each of the six countries. Recall that the value of $-\lambda$ represents a typical bank's percentage deviation of output from competitive levels. A $-\lambda<0$ signifies output below the competitive level while $-\lambda>0$ suggests that output for some reason exceeds the competitive level.

With the exception of Texas, none of the banking systems' λ values were significantly different from zero. Texas registered a $-\lambda < 0$ (i.e. $\lambda > 0$) and significant, evidence of less than competitive output, signaling uncompetitive or collusive behavior for the overall measurement period. As will be discussed below, however, Texas' turns out to have a negative and significant b_5 coefficient for its liberalization subperiod.

That the null hypothesis that $\lambda = 0$ could not be rejected at a reasonable level of significance for the other five economies signifies that the average bank in each of them behaves consistently with the competitive paradigm. That is, in none of the five remaining cases did the average bank operate where marginal cost exceeded marginal revenue for its total observation period. We tested the robustness of the results for other specifications, especially for log first

differences. The results are qualitatively unchanged if iterations converge.

The question remains, however, as to whether any of the six economies posted high-risk, supercompetitive levels during their post-liberalization or privatization periods. Recall that in examining the results for the post-liberalization or privatization period, the sign and value of b_5, the dummy variable coefficient, deserve particular attention. For such periods, instead of equaling λ, the index of market power approximates $\lambda + b_5$ and b_5 is the difference of levels of competitiveness between two periods. If b_5 is negative and significant, the period for which the dummy applies demonstrates a significant increase in the riskiness of bank behavior. Where λ is not significantly different from zero, a negative and significant b_5 suggests that supercompetition characterized the liberalization/privatization subperiod

In sum, b_5 signals whether or not a break into supercompetitiveness took place during the liberalization/privatization subperiod. The signs of the b_5 coefficients in Table II show that in these sub-periods, the average bank in low depositor discipline countries as defined by the coefficient on the past-due-loan-to-assets ratio in the six equations in Table I (Canada, Mexico, Norway, Texas) may have pursued riskier behavior than outside these periods. However, only the Canada, Mexico and Texas risk shifts were significantly different from zero.

III. A Connection Between Depositor Discipline and Breaks to Riskiness

Figure 2 graphically links depositor discipline with breaks to riskiness for the six economies tested. To characterize the degree of depositor discipline, the horizontal axis presents the t-statistic of the coefficient of the past-due-loans-to-total-assets ratio for the six economies for which an equation appears in Table I, multiplied by minus unity. Because the values are multiplied by minus one, the most significantly negative relation between the past due

loan ratio and deposit growth would be the farthest to the right on the figure, while the least negative and significant relation between these variables would be the farthest to the left on the figure. This configuration means that Argentina has the greatest degree of depositor discipline, followed by Singapore. Mexico has the least depositor discipline, followed by Canada.

To characterize the structural break in the direction of supercompetitiveness, the vertical axis presents the value of the b_5 coefficient that appears in Table II. Recall that the more negative an economy's b_5 is, the stronger its break to supercompetitiveness is. Conversely, the more positive an economy's b_5, the less of a break towards supercompetition. By this measure, with a value between –0.3 and –0.4, Mexico makes the largest break towards supercompetitiveness during its privatization period while, with values of zero, Singapore and Argentina do not make breaks toward supercompetitiveness at all. Recall that neither the λ values of Mexico, Singapore nor Argentina are significantly different from zero, signaling that Mexico did enter a supercompetitiveness episode while neither Singapore nor Argentina did.

The most important aspect of Figure 2 is the overall conclusion it allows – that by these measures the less depositor discipline a country has (i.e. the farthest to the left the country is on the figure) the more profound (i.e. farther below zero) is its liberalization/privatization period break towards supercompetition.

Figure 3 reaffirms this relationship with t-statistics on both the x and y axis. As before, the x-axis delineates t-values (again multiplied by minus unity) for the coefficients of the depositor discipline variable PDL/TA for each of the six countries. In contrast to Figure 2, Figure 3's y-axis presents t-statistics for the b_5 coefficient of each country. Here, the more negative the t-value of the b_5 the more significant the break towards supercompetition. By this

pair of measures as well, banking systems with less depositor discipline are clearly more prone towards breaks into supercompetition, where marginal cost exceeds marginal revenue.

IV. Conclusion

We have tested the links between depositor discipline and the predisposition of banks to break towards risky behavior in periods associated with bank liberalization or privatization. The distinctions between what we test and what others test is important. We focus on depositor discipline rather than the presence or not of deposit insurance because it is conceivably possible to have depositor discipline with or without deposit insurance or other bank or depositor rescue programs. Moreover, the presence of *de facto* depositor insurance is hard to identify. Some countries (Korea in the 1990s, for example) did not in fact have deposit insurance *de juris* but turned out to have it *de facto* or *ex post facto.* Our concern was not whether bankers had deposit insurance but whether depositors were willing to punish them when their asset quality went bad.

More important, and more unusually, we tested to see if or when banks took risky positions under some circumstances during liberalization or privatizations. From a policy perspective, we considered this behavior by banks more important than whether or not they fell into crises. Crises, after all, could be caused by a host of factors – some of which had nothing to do with banks' predispositions toward risk-taking. Therefore our examination – focusing on depositor discipline rather than ex ante insurance, and on bank risk rather than bank crisis - is much narrower in many senses than what is typical in similar work.

Our question was: Were banks without much depositor discipline more likely to take risks than banks with depositor discipline. Certainly by the standards of Figure 2, the answer is

that they do. This finding is important because risk is something banks can take on their own, regardless of what is going on in the economy.

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TABLE I
Deposit Growth and Asset Quality
In Six Nations

	Argentina	Canada	Mexico	Norway	Singapore	Texas S&L
Constant	-82.979***	5.041	-33.040	-16.217	1470.73**	
	(4.21)	(0.04)	(1.21)	(0.69)	(2.82)	*0.205***
						(0.083)
PDL_i/TA_i	-1.120***	-0.800	-0.280	-4.805	-3.957***	*-0.617*
	(3.72)	(0.213)	(0.07)	(1.25)	(3.39)	
						(0.822)
EQ_i/TA_i	0.942**	-5.850	0.429	-6.614	0.750	*0.262*
	(2.29)	(1.54)	(0.12)	(1.24)	(0.64)	
						(0.228)
TA_i/TA	0.018	-0.563	-0.813	-0.808	1.709***	*-2.694*
	(0.02)	(1.13)	(0.83)	(0.82)	(2.98)	
						(4.026)
DEP_i/L_i	1.128***	0.399	0.516	2.057**	15.208**	*-1.625***
	(4.49)	(0.33)	(0.88)	(2.40)	(2.86)	
						(0.469)
R^2	0.764	0.331	0.196	0.223	0.547	*0.0134*
Prob(F-Stat)	0.0001	0.232	0.627	0.089	0.0134	*0.0055*
# of Observations	20	18	16	36	20	*1085*
Period	1995	1984-86	1995	1987-89	1997-99	*1984-1990*

Note: the dependent variable is the percentage change in the inflation-adjusted deposit growth rate of bank i. PDL_i/TA_i is bank i's past-due loan as a percentage of total assets. EQ_i/TA_i is bank i's equity capital as a percentage of total assets. TA_i/TA is the bank i's total assets over the sum of total assets of the banks examined. DEP_i/L_I is bank i's deposit as a percentage of total liability. *t*-statistics in parentheses, based on approximate standard errors (***: significant at 0.01 level, **: significant at 0.05 level, *: significant at 0.1 level)

TABLE II
Estimation of Equation (2'') and (3')

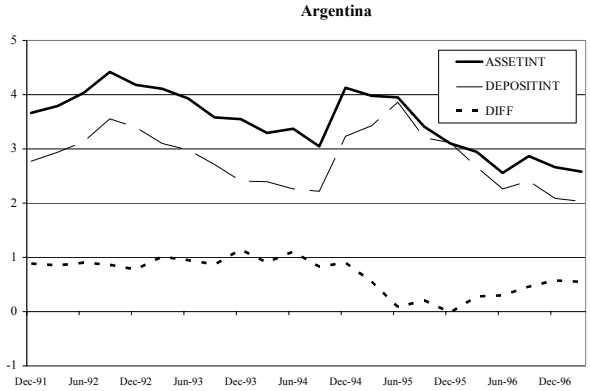
	Argentina	Canada	Mexico
α_0	750979***	-12211	425690
	(3.86)	(0.11)	(0.74)
α_1	-23857842***	-3020770***	-38456010*
	(4.55)	(5.25)	(1.89)
α_2	-7342***	0.56925	-156
	(3.89)	(1.27)	(0.03)
α_3	-3373371***	61863	1828469***
	(5.33)	(0.72)	(4.19)
α_4	133609***	9874	-186328***
	(5.38)	(0.76)	(5.36)
α_5	243664***	13.869***	460617**
	(4.73)	(4.48)	(2.37)
α_6		-0.07015	
		(1.69)	
$\equiv\beta_1$	6.89405***	0.71310	6.71503***
	(4.16)	(0.95)	(2.91)
$\equiv \beta_2$	-0.36894***	0.01034	-0.35608**
	(4.09)	(0.26)	(2.63)
$\equiv \beta_3$	0.01051	-0.06658**	-0.00144
	(0.17)	(2.54)	(0.02)
$\equiv \beta_4$	0.39261**	-0.00272	0.37083*
	(2.23)	(0.03)	(1.83)
$\equiv \beta_5$	0.00620	-0.03563*	-0.32464**
	(1.25)	(1.95)	(2.57)
λ	-0.00053	-0.00183	0.45874
	(0.24)	(1.08)	(1.63)
Adj R^2 (2")	0.770	0.971	0.700
Adj R^2 (3")	0.959	0.995	0.969
# of Observations	22	25	81
Data Period	91:q4 - 97:q1	65 – 89	87:Apr - 93:Dec
Dummy Period	95:q1 - 97:q1	81 – 89	92:Dec - 93:Dec
Frequency	Quarterly	Annual	Monthly

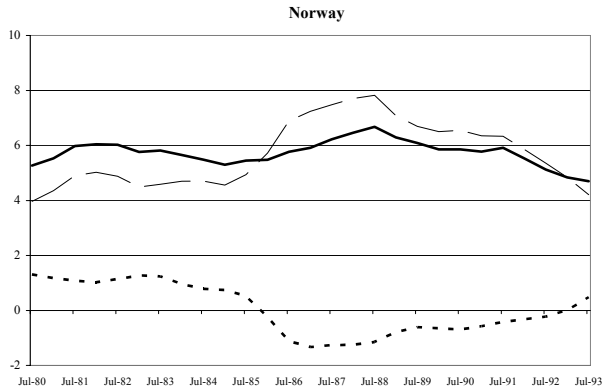
	Norway	Singapore	Texas S & L
α_0	460321***	-78307***	613928***
	(3.97)	(4.22)	(4.37)
α_1	-4381748***	-224519	-5237226***
	(5.25)	(1.46)	(2.78)
α_2	-5071***	3387***	-7959***
	(4.08)	(16.30)	(5.64)
α_3	44693	2636	-583752***
	(1.66)	(1.33)	(8.25)
α_4	-5973*	-720	46589***
	(1.88)	(0.71)	(9.20)
α_5	53617***	6765*	90157***
	(4.48)	(1.68)	(4.66)
$\equiv\beta_1$	5.45968**	0.02532	6.97687***
	(2.51)	(0.01)	(6.20)
$\equiv\beta_2$	-0.15084	0.16889	-0.32122***
	(1.65)	(0.62)	(4.45)
$\equiv\beta_3$	-0.04003	0.59932***	0.04685
	(0.38)	(15.13)	(0.42)
$\equiv\beta_4$	0.36654**	0.03666	0.30577**
	(2.58)	(0.19)	(2.60)
$\equiv\beta_5$	-0.06319	-0.00225	-0.15098***
	(1.46)	(0.91)	(3.28)
λ	-0.00085	-0.07679	0.15479***
	(0.06)	(1.62)	(3.21)
Adj R^2 (2")	0.876	0.956	0.763
Adj R^2 (3")	0.862	0.932	0.487
# of Observations	27	42	60
Data Period	80:II - 93:II	91:q1 - 01:q3	84:q1 - 98:q4
Dummy Period	86:I - 90:II	97:q1 - 99:q4	84:q1 - 90:q2
Frequency	Semi-Annual	Quarterly	Quarterly

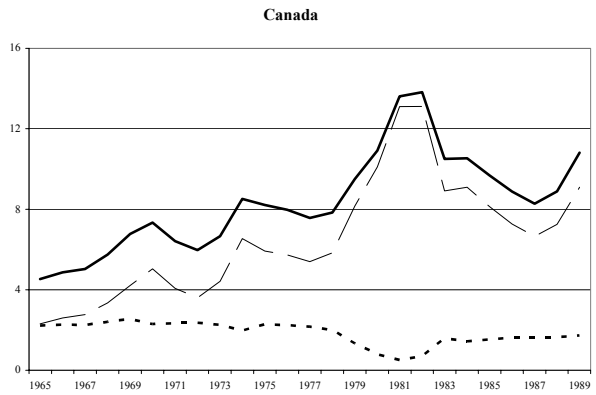
Note: *t*-statistics in parentheses, based on approximate standard errors (***: significant at 0.01 level, **: significant at 0.05 level, *: significant at 0.1 level).

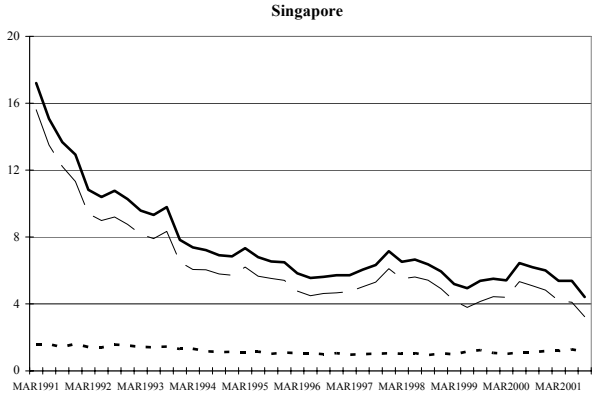
Footnote:
We tried to test the robustness of the results for other specifications, especially for log first differences. The results are qualitatively unchanged if iterations converge.

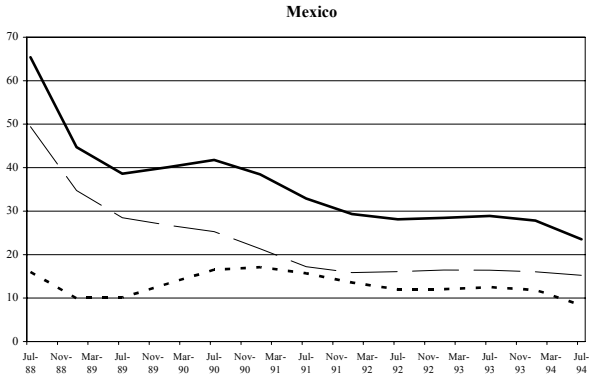
Figure 1. Asset Interest Rates and Deposit Interest Rates











*Asset interest rate was calculated using only loans considering the significant portion of asset included government securities in Mexico.

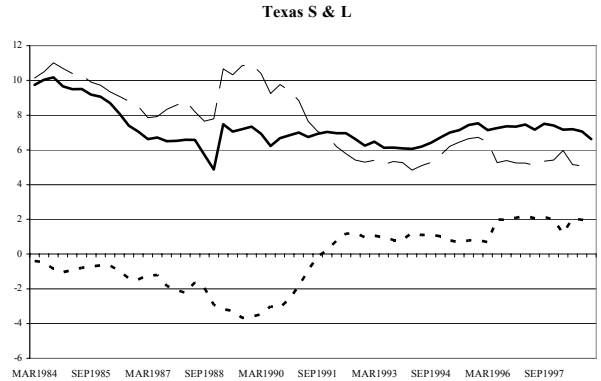
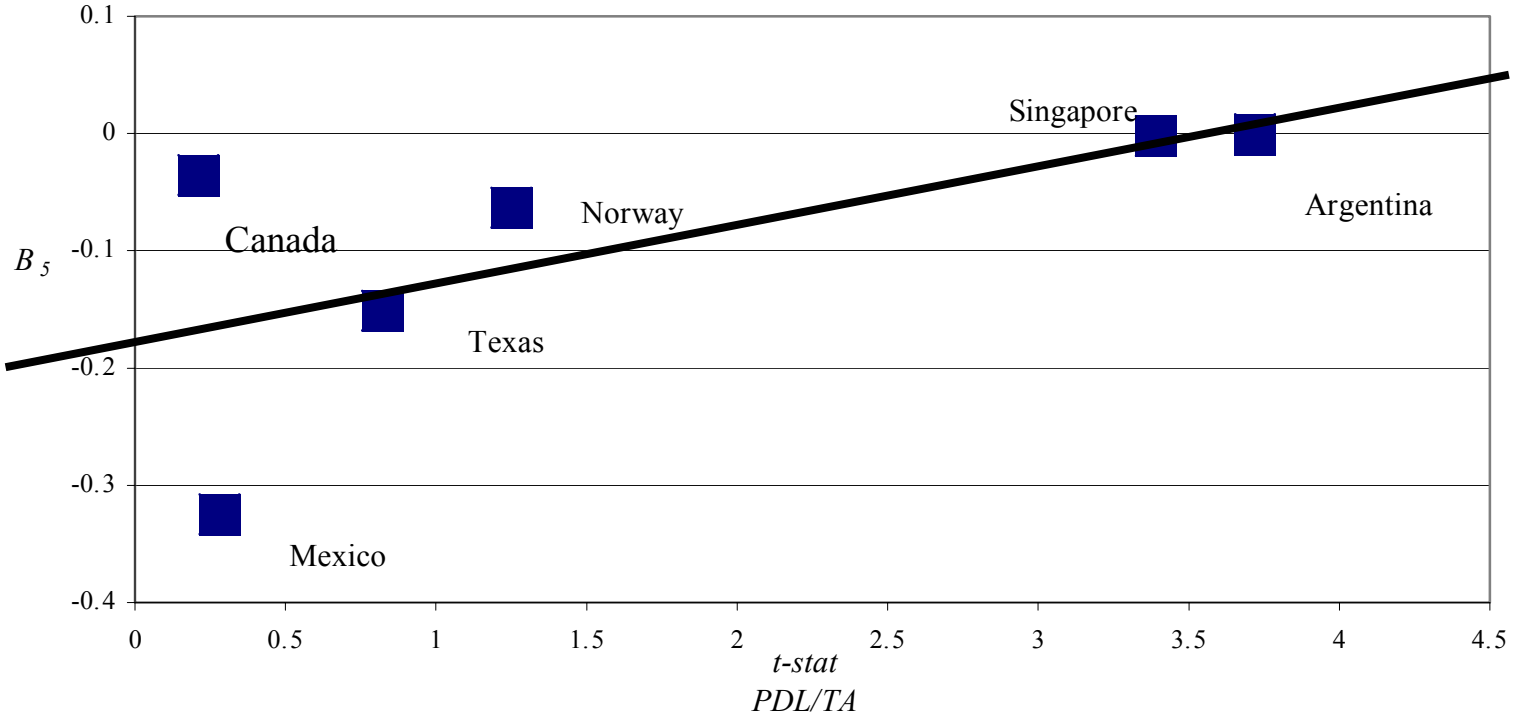
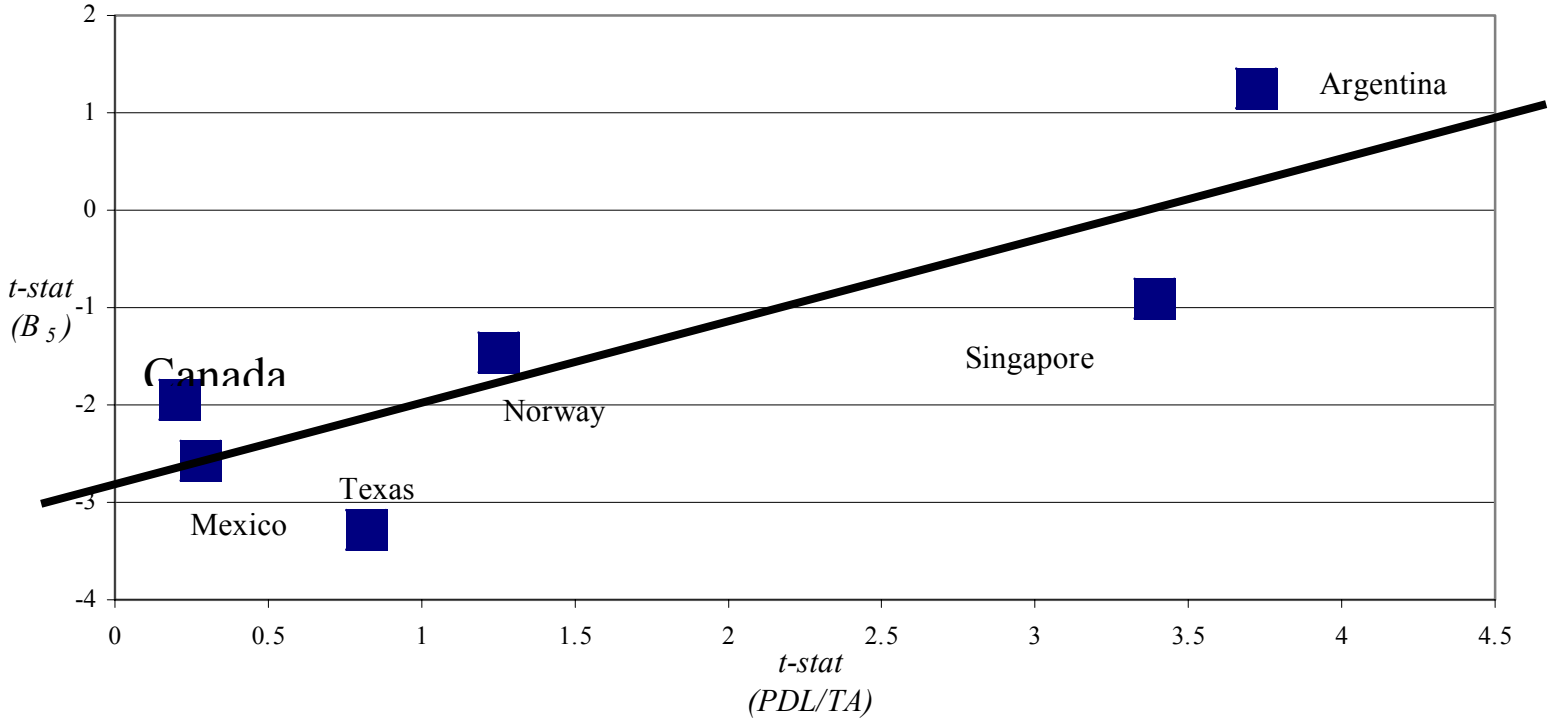


Figure 2: Depositor Discipline and Shift Towards High Risk Behavior I



Note: The proxy of depositor's discipline is the t-statisitcs of the coefficients of PDL/TA in table 1 and the change of competitiveness of the banks is measured by the coefficient B_5 in table 2.

Figure 3: Depositor Discipline and Shift Towards High Risk Behavior II



Note: The proxy of depositor's discipline is the t-statisitcs of the coefficients of PDL/TA in table 1 and the change of competitiveness of the banks is measured by the t-statistics of the coefficient B_5 in table 2.