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Abstract

The authors examine the degree of contestability in the Canadian banking system using the *H*-statistic proposed by Panzar and Rosse (1987) and modified by Bikker, Spierdijk, and Finnie (2006). A modification is necessary because the standard approach of controlling for size using total assets leads to an upward bias in the *H*-statistic. The authors propose a variety of model specifications and test for contestability using detailed quarterly balance-sheet data from 2000 to 2006. Contrary to Bikker, Spierdijk, and Finnie (2006), the authors find that the Canadian banking sector is in equilibrium and characterized by monopolistic competition. This result is in line with earlier studies of the Canadian banking sector (Nathan and Neave 1989) as well as cross-country studies that use cruder measures of Canadian banking inputs (Claessens and Laeven 2005). As in Bikker, Spierdijk, and Finnie (2006), the authors show that projecting revenue on total assets leads to an upward bias regarding the level of competition.

JEL classification: G21, L11
Bank classification: Financial institutions

Résumé

À l'aide de l'indice H créé par Panzar et Rosse (1987) et modifié par Bikker, Spierdijk et Finnie (2006), les auteurs examinent le degré de contestabilité au sein du système bancaire canadien. L'indice doit être modifié parce que l'approche habituelle, qui consiste à tenir compte de la taille de la banque en incluant l'actif total parmi les variables explicatives, induit un biais à la hausse dans l'indice de Panzar et Rosse. Pour mesurer le degré de contestabilité, les auteurs estiment un éventail de modèles au moyen de données détaillées provenant des bilans trimestriels des banques et couvrant la période allant de 2000 à 2006. Contrairement à Bikker, Spierdijk et Finnie (2006), ils constatent que le secteur bancaire canadien se caractérise par un équilibre de concurrence monopolistique. Ce résultat est conforme à ceux des travaux précédemment consacrés au secteur (Nathan et Neave, 1989) et à ceux d'études multipays qui reposent sur des mesures moins fines de la production des banques canadiennes (Claessens et Laeven, 2005). À l'instar de Bikker, Spierdijk et Finnie (2006), les auteurs montrent que le fait d'employer pour variable dépendante le ratio du revenu à l'actif total entraîne une surestimation du niveau de concurrence.

Classification JEL : G21, L11
Classification de la Banque : Institutions financières

1 Introduction

Banks play an important role in the intermediation of savings into investment in the economy. As a result, their behaviour has implications for capital allocation, firm growth, industrial expansion, and economic development. In light of the global trend of consolidation in the financial industry, the degree of competition in the banking system has received heightened interest among researchers and policy-makers. Most of the debate has focused on the implications of a competitive banking system for economic efficiency and financial stability. Traditionally it is perceived that a more concentrated industry is less competitive and thus may compromise economic efficiency. However, empirical research yields mixed results on the relationship between concentration and competition. For example, using a data set of almost 4,000 banks from 50 countries, Claessens and Laeven (2005) find that their measure of competition is not negatively related to traditional measures of concentration. In contrast, an earlier study by Bikker and Haaf (2002) on banks in 23 European countries finds support for the conventional view that concentration impairs competitiveness.

Another common perception is that some amount of market power is necessary for stability in the banking system (see, for example, references cited in Carletti and Hartmann 2003). Larger banks with market power have typically been viewed as having incentives to minimize risk-taking behaviour and improve their screening behaviour. A review of the literature by Northcott (2004), however, shows it is not clear that such a trade-off between size and stability exists. Franklin and Gale (2004) have shown, for example, via the manipulation of various models, that perfect competition and financial stability can coexist. Based on a monetary general-equilibrium economy, Boyd, Nicolo, and Smith (2004) find that the probability of a costly banking crisis is always higher under competition than under monopoly. Based on a study of 38 countries during the period 1980–2003, on the other hand, Schaeck, Čihák, and Wolfe (2006) find that more competitive banking systems are less prone to banking crises.

This paper focuses on the first issue: whether market concentration compromises competition in Canada. Canada has a highly concentrated banking market. The "Big Six" banks account for more than 90 per cent of the assets in the banking system.[1] Also, Herfindahl-Hirschman measures are typically in the medium to high range, pointing to a high degree of market concentration. It is of interest, therefore, to assess the impact of such

1. These banks are Royal Bank Financial Group, Bank of Montreal, Canadian Imperial Bank of Commerce, TD Bank Financial Group, National Bank, and Bank of Nova Scotia.

a concentrated industry structure on the competitive behaviour of the country's banking system. In addition to recent cross-country studies, two studies have paid particular attention to the competitive behaviour in Canadian banks. In the first study, Nathan and Neave (1989) estimate separate Panzar-Rosse statistics for the banking industry, trust industry, and mortgage companies for 1982, 1983, and 1984. Their findings indicate that none of the three industries exhibits monopolistic behaviour. In the second study, Shaffer (1993) examines Canadian banks from 1965 to 1989 and rejects joint monopoly among Canadian banks; he concludes that the industry is generally consistent with perfect competition.

The goal of this paper is to measure the degree of contestability in the Canadian banking industry based on the Panzar-Rosse H-statistic. A market is contestable if there are no barriers to entry and exit is costless. Panzar and Rosse (1987) derive three testable hypotheses using a reduced-form revenue equation: monopoly, monopolistic competition, and perfect competition. The test involves measuring the effect on revenue of an increase in factor costs. A monopolist will increase its price if marginal cost increases, and, given that demand is elastic, revenue will fall. A perfectly competitive bank operates at the minimum of the average cost curve; therefore, an increase in cost by, say, 1 per cent will lead the bank to increase its price by 1 per cent and revenue will increase by the same amount. A monopolistic competitor's reaction is somewhere in between.

The two previous studies of Canadian banks (Nathan and Neave 1989; Shaffer 1993) also estimate a contestability statistic (or its variation) for the banking industry using data up to the late 1980s. They adopt either time-series regressions with annual observations of industry (aggregate) banking data spanning two decades (Shaffer 1993), or cross-sectional estimations for each year and for each of the banking industry, trust industry, and mortgage companies (Nathan and Neave 1989). We use a novel database that consists of quarterly bank-level balance-sheet and income-statement variables. The quarterly frequency and our adoption of panel techniques allow us to focus on a relatively short and relevant time period: 2000Q2 to 2006Q1. An important assumption of the Panzar-Rosse statistic is that the market is in equilibrium, with no entry and exit. Given the rapid consolidation and the amount of foreign bank entry that occurred in the 1980s and early 1990s, our sample period reflects a period of relative equilibrium. Furthermore, by using only data booked in Canada, ours is the first empirical study to focus on the domestic market. We therefore remove potential complications due to different market and regulatory conditions faced by financial institutions overseas. This is particularly important given that around a third of

the assets in the Canadian banking sector are booked overseas.

Based on H-statistic estimates, we mostly reject the assumptions of monopoly power and perfect competition. This suggests that the Canadian banking market is best described as monopolistic competition. It is interesting that our study – which focuses on the latest time period using never-before-seen detailed data as well as model specifications – produces H-statistics that are qualitatively similar to those using earlier sample periods and less sophisticated data. In the past 20 years, the Canadian banking sector has experienced important consolidation, which includes the acquisition by banks of mortgage and loans companies, trust companies, and other financial service providers, as well as new entries by foreign banks and their subsidiaries. This finding suggests that, regardless of the substantial structural changes that took place in the past 20 years, Canadian banks have behaved more or less in a monopolistically competitive fashion.

This paper is organized as follows. Section 2 provides an overview of the Canadian banking industry, including a discussion of the evolution of the regulatory environment for banks, and the resulting changes that have taken place in the industry. Section 3 describes the model that we use to measure the contestability in the Canadian banking industry, and discusses results. Section 4 offers some conclusions.

2 Canadian Banking Industry

Historically, the structure of the Canadian banking industry has been relatively stable. For instance, from 1920 to 1980, Canada consistently had 11 banks (Bordo 1995). However, after several regulatory changes removing the sharp limits on the entry of foreign banks, by May 2006 there were over 60 banks operating in Canada: 19 domestic banks, 23 foreign bank subsidiaries, and 21 foreign bank branches. Nevertheless, banking itself is relatively concentrated: the six largest banks hold close to 90 per cent of total bank assets.

Prior to 1980, the financial services industry had been segmented (by legislation, regulation, and practice) into distinct "pillars": commercial banking, trust business and residential lending, insurance underwriting and brokerage, and securities underwriting and dealing. As well, there were sharp limits on the entry of foreign banks into the Canadian market. However, in the past 25 years, with changes in both market practice and a series of revisions in the governing financial legislation, there have been substantial changes in the Canadian banking industry. Key characteristics have been the entry of foreign banks and the expansion of banks into the range of financial services, including the trust business,

insurance underwriting and sales (although not through bank branches), and securities underwriting and dealing. For discussions of these and related developments in Canada, see Daniel, Freedman, and Goodlet (1993), Freedman (1998), and Engert et al. (1999).

Canadian banks are federally incorporated and regulated primarily under the federal Bank Act, which defines their range of activities. Unlike their U.S. counterparts, Canadian banks have never been prohibited from conducting nationwide branching and banking. As a result, a few Canadian banks have grown to be large national banks. The Bank Act also requires a periodic review of the legislation that governs Canadian financial services. This formal review process led to important financial legislation amendments in 1980, 1987, 1992, 1997, and 2002, which have contributed to more diversified business lines and more market-oriented activities in Canadian banks. In addition, important changes to the legislation regarding the activities of foreign banks were made in 1981 and 1999, which have resulted in more foreign entry and competitive forces in the domestic banking market.

The 1980 Bank Act revisions are important because they allowed banks to establish subsidiaries in markets such as insurance, venture capital, and mortgage lending. This allowed banks to compete more effectively in these markets by allowing them to do as trust companies and raise deposits that were not subject to reserve requirements. As well, foreign banks were allowed to establish subsidiaries in Canada. Prior to the 1980 revisions, foreign bank entry had been curtailed by amendments to the 1967 Bank Act. Between 1967 and 1980, foreign banks operated in Canada through non-bank affiliates. Following the 1980 revisions these affiliates were incorporated as subsidiaries, subject to the provisions of the Bank Act, and able to conduct the full range of banking activities. This legislative change led to many foreign banks entering the Canadian market. Foreign bank subsidiaries, like any regular domestic bank, are currently supervised by the Office of the Superintendent of Financial Institutions (OSFI).

In 1987, Canadian banks (both domestic and foreign) were permitted to invest in corporate securities dealers, as well as distribute government bonds. All major banks subsequently made substantial investments in the securities business and purchased control of most of the existing large investment dealers. The 1987 amendments also allowed financial intermediaries to conduct brokerage activities.

In 1992, Canadian banks were given the right to enter the trust business through the establishment, or acquisition, of trust companies. Most trust companies were subsequently purchased by Canada's largest banks. The financial difficulties that many trust companies

experienced following the collapse of the speculative real estate boom in the late 1980s contributed to the ability of banks to acquire them.

In 1997, new legislation included various changes to update and revise the amendments made in 1992. In 1999, foreign banks were allowed to set up foreign bank branches in Canada, without having to establish a subsidiary. Given the difficulties related to deposit insurance and supervision that would arise under a regime of unrestricted branch entry, foreign bank branches were allowed to take only wholesale deposits of 150,000 dollars or more. The 2002 legislative changes widened the scope within which Canadian banks conduct business. For example, they were allowed to own finance companies.

While there has been consolidation among various financial services firms accompanying the regulatory developments, there have been no mergers among major Canadian banks for years. The latest major consolidation in the financial sector was the acquisition of Canada Trust by TD Bank, which was completed in 2000Q1. As well, the entry of the foreign banks has not resulted in a significant loss of market share of the major banks or domestic banks, in general. Nevertheless, foreign banks have brought innovation and competitive pressure that may have influenced the way Canadian banks conduct business.[2]

3 *H*-statistic

The method developed by Panzar and Rosse (1987) (hereafter denoted PR) allows us to estimate the competitive behaviour of banks on the basis of the comparative static properties of reduced-form revenue equations based on cross-section data. It also allows us to investigate the extent to which a change in factor input prices is reflected in (equilibrium) revenues earned by a specific bank. Specifically, the PR H-statistic is calculated using reduced-form bank revenue equations; it measures the sum of the elasticities of the total revenue of the bank with respect to the bank's input prices.

PR show that, if their method is to yield plausible results, banks need to have operated in a long-term equilibrium, while their performance needs to be influenced by the actions of other market participants. Furthermore, the model assumes a price elasticity of demand, η_D, greater than unity, and a homogeneous cost structure. To obtain the equilibrium output

2. In addition, credit unions have a long history in Canada of offering a banking option outside of the large banks, and in some provinces are substantial market players. Credit unions are provincially regulated and we do not have access to the same type of data that are available for banks that report to OSFI. Ignoring credit unions can therefore underestimate the level of contestability.

and the equilibrium number of banks, profits are maximized at the bank as well as at the industry level when marginal revenue equals marginal cost. Let w_i be a vector of K input prices (for K inputs). In equilibrium, the zero-profit constraint holds at the market level:

$$\pi^* = p^*Y - w'(Y)X^* = ((MS_i)(-1/\eta_D)(1+\lambda))p^*Y = 0, \tag{1}$$

aggregated over all firms i. Variables marked with an asterisk represent equilibrium values. We assume that the average market share of firm i (MS_i) and conjectural variation (λ) are strict functions of exogenous variables. Market power is then measured by the extent to which a change in factor input prices ($w_{k,i}$) is reflected in the equilibrium revenues (R_i^*) earned by bank i.[3] Panzar and Rosse (1987) define a measure of competition, the H-statistic, as the sum of the elasticities of the reduced-form revenues with respect to the K input prices[4]:

$$H = \sum_{k=1}^{K} \frac{\partial p^*Y}{\partial \omega_k} \frac{\omega_k}{p^*Y}. \tag{2}$$

The estimated value of the H-statistic ranges between $-\infty$ and 1. H is smaller than zero if the underlying market is a monopoly; H ranges between zero and unity for other types of competition, such as an oligopoly; an H of one indicates perfect competition. Shaffer (1983) demonstrates formal linkages between the Panzar-Rosse H-statistic, the conjectural variation elasticity, and the Lerner index.

A number of papers have applied the PR methodology to the issue of competition in the financial sector, although mostly to the banking system specifically. Shaffer (1983) is one of the first to apply the PR model to banks. He estimates the H-statistic using a group of New York banks with 1979 data, and finds monopolistic competition. Shaffer (1993) later applies a variation of the H-statistic to a set of Canadian banks and strongly rejects the hypothesis that the Canadian banking sector is monopolistic. Nathan and Neave (1989) also apply the methodology to Canadian banks, finding perfect competition for the year 1982 and monopolistic competition for 1983 and 1984 for each of the following three sectors: banks, trust companies, and mortgage companies. Other studies have applied the methodology to non-North American countries. For example, Molyneux, Altunbas, and Gardener (1996) find evidence of a monopoly in the Japanese banking sector in 1986–1988. Using a sample from 1987 to 1994, Rime (1999) finds monopolistic competition for the

3. In the empirical literature, the equilibrium price (∂p_i^*) is often used instead.
4. See Panzar and Rosse (1987) or Vesala (1995) for details of the formal derivation of the H-statistic.

Swiss banking system. Examples of cross-country studies include Bikker and Groeneveld (2000) and Claessens and Laeven (2005). Empirical studies generally reject both perfect monopoly and perfect competition, finding mostly evidence of monopolistic competition.

Bikker, Spierdijk, and Finnie (2006), however, have recently raised questions regarding previous estimates of contestability. They suggest that most empirical studies that use the H-statistic to measure the degree of contestability in the banking industry severely overestimate the level of banking competition. This is because the PR equation is naturally a revenue equation, whereas most empirical research uses a price equation. That is, when income as a fraction of assets is used as the dependent variable, rather than just income, the estimated price elasticities naturally sum to one (for details, see Bikker, Spierdijk, and Finnie 2006). This implies a bias in the H-statistic towards one; i.e., towards perfect competition and away from the null hypothesis of monopoly or monopolistic competition. Bikker, Spierdijk, and Finnie (2006) also point out that the standard practice of controlling for bank size by including total assets as an explanatory variable will lead to a similar bias. Given that the results in Bikker, Spierdijk, and Finnie (2006) are for a specific set of models and not general, we compare estimates for both formulations. As in Bikker, Spierdijk, and Finnie (2006), we find a larger H-statistic when income scaled by assets is the dependent variable than when income is the dependent variable.

Some cross-country studies also use the H-statistic as a (linear) measure of competition in banking, and then investigate the factors that contribute to the degree of competition in those countries. For example, using a sample of 23 countries, Bikker and Haaf (2002) study the relationship between the H-statistic and bank-specific and country-specific factors, including measures of market concentration. The authors find that a more concentrated market leads to a lower H-statistic and thus less competition. On the other hand, using a similar framework, Claessens and Laeven (2004) find from their sample of 50 countries that a higher degree of contestability is related to greater foreign bank entry and fewer entry and activity restrictions, but not banking system concentration. Two other studies have linked competition, again measured by the H-statistic, with economic growth and financial stability, respectively. Claessens and Laeven (2005) estimate the H-statistic for 16 countries and then relate it to measures of industry growth. The authors find that greater competition in a country's banking system allows financially dependent industries to grow faster. Schaeck, Čihák, and Wolfe (2006) adopt the H-statistic used in Claessens and Laeven (2004) to study its relationship with measures such as the likelihood of a financial crisis, whose identification is taken from Demirgüç-Kunt and Detragiache (2005). They find

that banking systems with a higher H-statistic (more competition) are less likely to have a financial crisis and that the time to crisis is longer in a competitive environment.

While these cross-country studies yield interesting results, they should be interpreted with caution. First, the H-statistic relies on the assumption that markets are in equilibrium. By comparing the H-statistic across countries, the studies implicitly assume that the banking systems in these countries are consistently in equilibrium during the sample period. Second, the literature has not agreed on a robust mapping of the H-statistic into the Bresnahan-Lau conduct parameter. For example, Shaffer (1983) has shown that, for a fixed number of firms in short-run equilibrium, H is an increasing function of the Bresnahan-Lau conduct parameter, and, consequently, a decreasing function of competitive conduct. As a result, linear interpretations of the H-statistic may be problematic. For robustness, Shaffer (2004) suggests a dichotomous dependent variable that indexes whether each observation has a point estimate of H that is positive or negative. Interestingly, Canada belongs to the set of countries in all four studies. Table 1 reports the H-statistics for Canadian banks from other studies. With the exception of Bikker, Spierdijk, and Finnie (2006), these studies tend to suggest that the Canadian banking system ranks among the most contestable.[5]

3.1 Specification and estimation

To calculate the H-statistic and test its range for Canadian banks, we apply the following regression to a panel data set of Canadian banks described in section 3.2:

$$R = \alpha + \beta\ lcost + \gamma\ kcost + \delta\ dcost + \sum_{i=1}^{J} f_i + \epsilon. \tag{3}$$

Banks are assumed to produce one composite output, which consists of different types of loans, security investments, and any interest-bearing assets. This is the definition of "banking output" most commonly used in this literature, and it is consistent with the underlying notion inherent in the PR model, that financial intermediation is the core business of most banks. The dependent variable, R, is revenue from the core business, although it has taken on a number of definitions in empirical research. Total interest income (int) and total interest income relative to all interest-bearing assets (int_ta) are typically used to proxy revenue. However, as noted by Allen and Liu (2007), in the past

5. Bikker, Spierdijk, and Finnie (2006) find that the Canadian system can be characterized as a monopoly, but they dismiss this result, because the industry is estimated to be out of equilibrium, which makes their statistical test meaningless in this case.

decade Canadian banks (primarily the Big Six) have been generating a larger share of their income from non-interest-bearing activities.[6] In the past five years, the income generated from non-interest-bearing activities has surpassed that generated from traditional banking activities. To take account of the importance of such activities, we allow R to be defined as either total revenue (rev) or total revenue as a ratio of total assets (rev_ta). The former is used as the dependent variable in Nathan and Neave (1989). According to Bikker, Spierdijk, and Finnie (2006), normalizing the dependent variable by assets produces an artificially high estimate of contestability – a consideration we investigate.

Equation (3) also includes the total expense on salaries, pensions, and employee benefits as a ratio of total assets, which is a proxy for the unit price of labour ($lcost$). Ideally, we would have liked to obtain the total labour expense per employee, but the number of employees is not available for all of the banks considered in this study. We follow the common practice in the literature of dividing employee expenses by total assets. $kcost$ is a measure of capital cost; it is defined as the expense on premises, computers, and equipment divided by the total stock of premises and fixed assets on the bank's balance sheet. $dcost$ is the price of deposits, measured by the interest expense on deposits divided by deposits. f is a vector of bank-specific factors, which can be categorized as follows: general, risk, business diversification, and operational efficiency.

In addition to cost factors, a number of risk factors are included in equation (3). The riskiness of banks is an important consideration that may affect the pricing of its output. One such measure is the equity-to-asset ratio ($equi_ta$) (a bank is more risky if it has a low equity-to-asset ratio). A second measure of riskiness is interbank exposure, measured as deposits from other banks as a percentage of total deposits ($inter1$), and deposits at other banks as a percentage of total assets ($inter2$). The third measure of riskiness is holding of corporate shares as a percentage of a bank's balance sheet ($corp_ta$) (the more corporate shares a bank holds, the more risky is the bank). The fourth measure is a bank's issuance of subordinated debt as a percentage of a bank's total liabilities ($subdebt_lia$). Also included is the ratio of total loans to total assets ($loans$) and the percentage of securities investment as a percentage of total assets ($secu_ta$).

As noted earlier, Canadian banks (especially the large ones) derive a large part of their revenue from non-traditional activities. The degree to which banks diversify their business should have important implications on the way they price their products. For example, a

6. Non-traditional banking activities include depositor services, underwriting, foreign exchange trading, and wealth management.

bank may be willing to pay a higher interest rate on deposit accounts, in order to attract customers to their other products, such as wealth management and insurance. We consider the following variables to proxy bank business diversification: non-interest income relative to total revenue (*nonin_rev*), deposit services fees as a percentage of total deposits (*dep_d*), credit and debit card fees as a percentage of total interest income (*card_int*), and insurance-related net income as a percentage of net operating revenue (*ins_ta*).

Since banks are profit-maximizing firms, a more operationally efficient bank can lower the price of its products and maintain a reasonable profit margin. We proxy operational efficiency using several measures. We first use an expense ratio – the ratio of non-interest expense to net operating revenue (*expense*). Investment expenses on employee training, and on computers and related equipment, may also have a long-term effect on the bank's cost efficiency. Allen, Engert, and Liu (2006) find that both variables are significant in explaining the cost efficiency of the six largest Canadian banks. Expenses on employee training as a ratio of total assets are denoted *train_ta*, and the ratio of expenses on computers and equipment as a percentage of a bank's total stock of physical assets is denoted *it_z*2.

Prior to estimating (3) and calculating H-statistics, we test for industry equilibrium. This is done by using as a dependent variable in (3) either return on equity (ROE) or return on assets (ROA), estimating the price elasticities, and testing the hypothesis that they sum to zero against the alternative that they are less than zero. We conduct this test because, in the long run, rates of return on assets (or equity) are equalized across banks and must be uncorrelated with input prices.

3.2 Data

The data are quarterly observations of 10 domestic and 15 foreign banks operating in Canada from 2000Q2 to 2006Q1. The number of banks is limited by data availability. The 10 domestic banks are: Royal Bank Financial Group, Bank of Montreal, Canadian Imperial Bank of Commerce, TD Bank Financial Group, Bank of Nova Scotia, National Bank, Canadian Western Bank, Laurentian Bank, Citizens Bank of Canada, and ManuLife Bank. The 15 foreign banks are: Bank of Tokyo-Mitsubishi, Mizuho Corporate Bank, Sumitomo Mitsui Banking Corporation, HSBC Bank of Canada, JPMorgan Bank, ING Bank, Bank of China, Bank of East Asia, BCP Bank Canada, BNP Paribas, CTC Bank of Canada, International Communication Bank of Cathay, MBNA Canada, National Bank of Greece, and ABN Amro Bank. Our sample starts at 2000Q2, so that the acquisition of Canada

Trust by TD Bank is fully reflected in the TD Bank data. The assets of the banks in our sample account for 97.8 per cent of the total Canadian dollar assets of the banking sector.

The data set is taken from the chartered banks' consolidated monthly balance sheet and quarterly consolidated statement of income, collected by OSFI. The consolidated monthly balance-sheet data at the aggregate level are published in Tables C1 and C2 in the *Bank of Canada Banking and Financial Statistics*. Large categories of the consolidated statement of income at the aggregate level are available in Table K2 in the same publication at an annual frequency. Disaggregated data are confidential. All balance-sheet data are monthly average values and are converted to quarterly series by taking the quarterly average of the monthly observations. We focus on the domestic market by limiting our choice of variables to those booked in Canada. All data are deflated by the GDP deflator (1997 = 100). Detailed definitions of all variables used in this study are presented in Table 2.

3.3 Results

We estimate equation (3) on the sample of 25 banks over the period 2000Q2 to 2006Q1. We first note that the null hypothesis that the banking industry is in equilibrium is not rejected. We can therefore interpret our estimates of H as estimates of market contestability.

The H-statistics for the different specifications as well as p-values for different null hypotheses are presented in Table 3. We consider four dependent variables and four sets of explanatory variables, providing us with 16 estimates of contestability. The first model ($M1$) consists of the three prices and a regulatory dummy variable which captures changes to the Bank Act in 2002. Model $M2$ includes the risk factors, $M3$ adds the business diversification variables, and $M4$ adds the operational efficiency indicators. In each model, we control for size using the categorical variable, *category*. At each point in time, we sort banks into four categories based on total assets. We do not control for size using total assets as the explanatory variable, because that would lead to an upward bias in H (Bikker, Spierdijk, and Finnie 2006).

The first observation is that the H-statistics for the dependent variables normalized by total assets (price equations) are larger than for those that are not normalized (revenue equations), as discussed in Bikker, Spierdijk, and Finnie (2006). We therefore focus on the revenue equations. For the two simplest models, we cannot reject the null hypothesis of monopoly power in the Canadian banking sector in three out of four cases. This result is similar to what Bikker, Spierdijk, and Finnie (2006) find for Canada over the period 1987

to 2004.[7] For the more complete models (i.e., those with more control variables and greater explanatory power), the H-statistic estimates suggest monopolistic competition. The range is 0.18 to 0.35. The model fit is also good; $M4$, for example, has a within R^2 of approximately 0.6.

Although our estimates of contestability are quantitatively smaller than what is found in previous studies (due to methodological differences), the conclusions are similar to those in Claessens and Laeven (2004) for the years 1994–2001, Claessens and Laeven (2005) for 1987–1996, and Nathan and Neave (1989) for 1983 and 1984; each of those studies concludes that Canada's banking system is characterized by monopolistic competition. However, our results differ substantially from Nathan and Neave (1989) for 1982. The latter result indicates that the Canadian banking industry was perfectly competitive in 1982.

Several caveats should be noted. First, the PR test assumes equilibrium conditions in the market with zero entry and exit. While we focus on a period (2000–06) with relatively little consolidation, there is still some entry and exit. In addition, equilibrium conditions may differ between our sample period and those of the other studies we cite. As a result, direct comparison of the H-statistics may not be reliable. Second, while we look at alternative definitions of banking output and price with an aim to take into account the diversified business mix of Canadian banks, the PR framework allows for only one single (composite) output. It is quite likely that the cost structure and pricing strategy differ substantially between traditional loan business and non-traditional activities, such as security underwriting. A more reliable H-statistic should be obtained for each business line. This would require detailed input data for each business line, which, unfortunately, do not exist.

4 Conclusion

This paper reports our analysis of competition in the Canadian banking sector from 2000 to 2006. We use the methodology developed in Panzar and Rosse (1987) to compute H-statistics for a variety of model specifications. In almost every instance we strongly reject both the null hypothesis of monopoly power and perfect competition, irrespective of which variables we use to define output and prices. Given the superior measurement of our data set relative to previous studies, it is interesting that our results are not much different from those in the previous studies (Nathan and Neave 1989; Claessens and Laeven 2004). Possible explanations are that the H-statistic tends to be robust to the measurement error

7. The authors point out, however, that they reject the hypothesis that the Canadian banking industry is in equilibrium, and therefore the H-statistic does not have a meaningful interpretation.

of marginal cost or demand (Genesove and Mullin 1998), and that, given the wide range of estimates that imply monopolistic competition, rejecting this conclusion is difficult.

The question of market power in the Canadian banking industry cannot be completely answered, therefore, by using comparative statics as we have done in this paper. If the necessary bank-level data were available, we could in fact estimate market power based on the conduct of the banks. Necessary information includes not only input prices and output levels but also output prices and demand shifters. The behaviour of the banks could then be estimated based on a theoretical model, and explicit hypotheses regarding market power could be tested. Structural approaches of modelling bank behaviour are currently an active field of research, which will in the next few years hopefully contribute to our measurement of market power in the banking industry.

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Table 1
Results from Other Studies: *H*-statistics of Canadian Banks

Studies	H-statistics	Period	Notes	Conclusion
Nathan and Neave (1989)	1.06	1982	All banks	Perfect competition
Nathan and Neave (1989)	0.68	1983	All banks	Monopolistic competition
Nathan and Neave (1989)	0.73	1984	All banks	Monopolistic competition
Bikker and Haaf (2002)	0.60	1991	All banks	Monopolistic competition
Bikker and Haaf (2002)	0.62	1997	All banks	Monopolistic competition
Bikker and Haaf (2002)	0.74	1991	Small banks	Monopolistic competition
Bikker and Haaf (2002)	0.63	1991	Mid-scale banks	Monopolistic competition
Bikker and Haaf (2002)	0.56	1991	Large banks	Monopolistic competition
Bikker and Haaf (2002)	0.60	1997	Large banks	Monopolistic competition
Claessens and Laeven (2004)	0.67	1994-2001	All banks	Monopolistic competition
Claessens and Laeven (2005)	0.67	1987-1991	All banks	Monopolistic competition
Claessens and Laeven (2005)	0.62	1992-1996	All banks	Monopolistic competition
Bikker, Spierdijk, and Finnie (2006)	-0.001†	1987-2004	All banks	Monopoly

† Bikker, Spierdijk, and Finnie (2006) conclude that the Canadian banking system is not in equilibrium for their sample period, and dismiss this result as meaningless.

Table 2
Data Description

Variable definitions	
Dependent variables	
int	Interest income
int_ta	Interest income as a ratio of total interest-bearing assets
rev_ta	Total revenue as a ratio of total assets
rev	Total revenue
Input costs	
lcost	Salaries, pensions, and other staff benefits as ratio of total assets
kcost	Rental expense on real estate and depreciation on premises, furniture, fixtures, computers, and equipment divided by total stock of land, buildings, and equipment, less accumulated depreciation
dcost	Total interest expense on deposits divided by the total dollar amount of deposits
Bank-specific factors	
size	Total assets
equi_ta	Equity as a ratio of total assets
*intbank*1	Deposits from other banks
*intbank*2	Deposits at other banks
corporate	Holding of corporate shares as a percentage of total assets
subdebt	Issuance of subordinated debt as a ratio of total assets
loans	Ratio of total loans to total assets
nonin_rev	Non-interest income as a ratio of total revenue
dep_d	Deposit services fees as a percentage of total deposits
card_int	Credit and debit card fees as a percentage of total interest income
ins_ta	Insurance-related net income as a percentage of net operating revenue
foreign	The ratio of assets booked overseas to total-currency assets
expense	The ratio of non-interest expense to net operating revenue
train_ta	Expenses on employee training as a ratio of total assets
*it_z*2	Ratio of expenses on computers and equipment as a percentage of a bank's total stock of physical assets

Note: All variables are in their natural logs. Unless specified otherwise, all balance sheet data are those booked in Canada and all income statement data are those reported in Canadian dollars.

Table 3
***H*-statistics of 25 Canadian Banks, 2000Q2 – 2006Q1**

$M1 = \{dcost\ ccost\ lcost\ rul\ category\}$					
Dependent variables	H	Pr: $H = 0$	Pr: $H = 1$	Pr: $H \leq 0$	R^2_{within}
int	0.006	0.923	0.000	0.461	0.431
rev	-0.04	0.516	0.000	0.742	0.402
int_ta	0.55	0.000	0.000	0.000	0.730
rev_ta	0.49	0.000	0.000	0.000	0.583
$M2 = \{M1\ risk\}$					
Dependent variables	H	Pr: $H = 0$	Pr: $H = 1$	Pr: $H \leq 0$	R^2_{within}
int	0.16	0.008	0.000	0.004	0.538
rev	0.07	0.258	0.000	0.129	0.485
int_ta	0.61	0.000	0.000	0.000	0.758
rev_ta	0.51	0.000	0.000	0.000	0.617
$M3 = \{M2\ diverse\}$					
Dependent variables	H	Pr: $H = 0$	Pr: $H = 1$	Pr: $H \leq 0$	R^2_{within}
int	0.29	0.000	0.000	0.000	0.588
rev	0.18	0.000	0.000	0.000	0.523
int_ta	0.63	0.000	0.000	0.000	0.770
rev_ta	0.52	0.000	0.000	0.000	0.659
$M4 = \{M3\ operational\}$					
Dependent variables	H	Pr: $H = 0$	Pr: $H = 1$	Pr: $H \leq 0$	R^2_{within}
int	0.35	0.000	0.000	0.000	0.620
rev	0.30	0.000	0.000	0.000	0.596
int_ta	0.67	0.000	0.002	0.000	0.796
rev_ta	0.63	0.000	0.008	0.000	0.754

Note: In all cases, the null hypothesis that the industry is in equilibrium is not rejected. int_ta and rev_{ta} are the traditional left-hand-side variables in the PR methodology – interest income by total assets and revenue by total assets, respectively. *int* and *rev* are simply interest income and revenue, respectively.