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The change in banks' product mix, diversification and performance: An application of multivariate GARCH to Canadian data

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Abstract

Data suggest a change in banks' performance attributable to a greater involvement in non-traditional activities. Market-oriented banking increases banks' accounting returns at the cost of a higher volatility in financial results. The motivation of this paper is to study how bank product mix impacts diversification and performance. Thanks to a rich dataset and a new methodology we are able to shed light on the apparently contradictory results found in the literature regarding the benefits to diversify in market-based banking. Some key conditional volatilities reveal that these benefits may in fact vary over business cycles and through time. Introducing a framework based on a multivariate GARCH procedure and a modified Hausman test, our main findings suggest that most components of non-interest income actually provide non-negligible diversification benefits with respect to traditional banks' business lines. In normal times, diversification even works for the components most related to market-oriented banking, i.e., trading income and capital markets fees. Not so surprisingly however, during crisis episodes these diversification benefits might vanish for most of the components, except for insurance and securitization, which act as buffers. Despite the evolution of the banking business model, fees related to banks' traditional activities – deposit, credit card and loan fees – seem to remain the most stable and profitable sources of income.

JEL classification: C32; G20; G21.
Keywords: Market-oriented banking; Product mix; Diversification; Multivariate GARCH; Endogeneity.

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Changement dans la composition des produits bancaires, diversification et performance: Une application du GARCH multivarié aux données canadiennes

Les données suggèrent un changement dans la performance des banques attribuable à leur plus grande implication dans des activités non traditionnelles. Le *banking* orienté vers les marchés financiers accroît les rendements comptables des banques au coût cependant d'une plus grande volatilité de leurs résultats financiers. Le but de ce papier est d'étudier comment la composition des produits bancaires impacte la diversification et la performance. À l'aide d'une base de données étoffée et d'une nouvelle méthodologie, nous sommes en mesure d'éclairer les résultats en apparence contradictoires de la littérature ayant trait aux bénéfices de diversification reliés au *banking* orienté vers les marchés financiers. Certaines volatilités conditionnelles clés révèlent que ces bénéfices peuvent varier selon les cycles économiques et à travers le temps. Fort d'un cadre d'analyse basé sur la procédure du GARCH multivarié et sur une modification du test d'Hausman, nos principaux résultats suggèrent que la plupart des composantes des revenus autres que d'intérêt procurent des bénéfices de diversification non négligeables en regard des activités traditionnelles des banques. En temps normaux, la diversification joue même pour les composantes les plus reliées au *banking* orienté vers les marchés financiers, c'est-à-dire les revenus et commissions tirés des marchés des capitaux. Cependant, sans beaucoup de surprise, ces bénéfices de diversification tendent à disparaître en temps de crise pour la plupart des composantes des revenus autres que d'intérêt, à l'exception toutefois des primes d'assurance et des commissions de titrisation, qui agissent à titre de paravents contre le risque. Malgré l'évolution du patron bancaire, les commissions reliées aux activités traditionnelles – telles que les frais de service sur dépôts, prêts et cartes de crédit – semblent demeurer les sources de revenus les plus stables et les plus rentables.

Classification JEL: C32; G20; G21.
Mots-clefs: Banking orienté vers les marchés financiers; Composition des produits bancaires; Diversification; GARCH multivarié; Endogénéité.

1. Introduction

Canadian bank returns measured by the return on assets (*ROA*) and the return on equity (*ROE*) share a very close relationship[1], both trending upward since the beginning of the 1990s[2] (Figure 1). This pattern can be explained by the risk premium associated with bank non-traditional activities (Stiroh 2006, Calmès and Théoret, 2010). By 2000, non-interest income accounts for 57% of net operating revenue, up from only 25% in 1988 (Figure 2). As the new banking business lines mature this ratio stabilizes, but the fluctuations of the share of non-interest income in bank operating income (*snonin*) become increasingly sensitive to financial markets after 1997 (Calmès and Liu 2009). For example, the fees stemming from bank capital markets activities represent only 7% of non-interest income in 1994 but then jump to 33% in 1997; the share of the fees related to bank wealth management, including mutual funds, rises from 4% to 11%[3] during this time frame. Similarly, the percentage of corporate securities in bank assets also increases, from 2% in 1994 to 8% in 2007, with a corresponding decrease in short-term corporate loans (Figure 3)[4]. A marked increase in the share of bank market funding, from 11% in 1995 to 21% in 2010 also follows the decline in the growth of bank personal deposits (Figure 4). Not surprisingly then, the rising share of market-oriented banking increases the sensitivity of bank financial results to the fluctuations in capital markets.

- Insert Figures 1, 2 and 3 here –

[1] Given the high correlation between *ROE* and *ROA* we only report *ROA* results.
[2] A similar trend is observed in U.S. banking.
[3] The corresponding shares for trading, the activity which contributes the most to the volatility of bank financial results, are not available before 1997.
[4] This jump in the relative share of corporate securities to the detriment of business loans in bank assets may be explained by the downward trend of interest rates over the sample period. It is also related to the fact that business loans are penalized by the Basel I and Basel II risk-weight ratios used to compute regulatory capital. This leads to a new type of banking strategy aiming at transferring bank risk off-balance-sheet to decrease credit risk (Brunnermeier 2009).

In this context, the motivation of this paper is to examine the impact of market-based banking on the risk-return trade-off, and particularly the incidence of the change in banks' product mix on diversification dynamics and banks' performance. We resort to a model of banks' accounting returns which takes into account the endogeneity of banks' decision to invest in non-traditional activities, and we rely on a multivariate GARCH procedure to compute some key conditional correlations and covariances. To our knowledge, this study is also one of the first to analyze the impact of the change in bank product mix with an exhaustive decomposition of banks' income sources. The results of most studies are generally based on the decomposition of a subset of fees, restricted to two or three categories, and only consider the impact of one particular component on bank performance. The literature first shows that the fees related to retail activities – deposit, credit card and loan fees – are the ones which improve the most the risk-return trade-off (Gallo *et al.* 1996, Vander Vennet *et al.* 2004, Busch and Kick 2009). The literature also suggests that these fees are also the most stable sources of income over time, and certainly help banks to palliate the structural decline in net interest margins (Busch and Kick 2009). Second, the studies focusing on financial mergers generally conclude that a combination of commercial and investment banking may increase the performance of financial conglomerates (Krozner and Rajan 1994, Vander Vennet *et al.* 2004, DeJonghe 2009, Schmid and Walter 2009)[5]. Third, some authors find that fiduciary income may increase bank risk-adjusted return, and that insurance may provide a good diversification strategy (Boyd and Graham 1988, Kwan and Laderman 1999, Estrella 2001, Vander Vennet *et al.* 2004, Stiroh and Rumble 2006, DeJonghe 2009, Schmid and Walter 2009, Slijkerman *et al.* 2012). However, the impact of market-oriented activities such as trading is less clear.

[5] Laeven and Levine (2007) differ on that matter.

For example, some authors find that trading reduces banks' risk adjusted returns (Stiroh 2004), while others argue the opposite (Krozner and Rajan 1994, Schmid and Walter 2009). The main contribution of our study is to show that these apparently contradictory results are in fact partly attributable to the time-varying and *conditional* nature of banks' income components (De Jonghe 2009, 2010).

-Insert Figure 4 here-

Compared to the previous studies, we analyze the diversification benefits related to banks' non-traditional activities with a much more detailed decomposition of non-interest income, and, more importantly, we resort to a multivariate GARCH (mGARCH) procedure which helps track how diversification evolves, over business cycles and through time. This methodology unveils a new set of results regarding the impact of the change in banks' product mix on risk-adjusted accounting returns. We can first confirm that, consistent with the literature, the income streams most related to net interest income – i.e., retail and wealth management fees – contribute the most to risk-adjusted returns. However, we also find that the impact of trading income and capital market fees is positive and significant at the usual thresholds. In other words, the components of non-interest income most related to market-oriented banking may actually provide non-negligible diversification benefits during normal times. In this framework we can also show that the comovements between the indicators of bank performance and the components of non-interest income vary over business cycles and through time. In particular, these diversification benefits seem to vanish in times of crisis, especially for the trading, capital markets and to a lesser extent for the wealth management components. By con-

trast, securitization fees and insurance premiums might still act as buffers in these periods.

This paper is organized as follows. Section 2 presents the data and our methodology, a mGARCH-based procedure and a modified Hausman test treating the increase in diversification endogeneity. Section 3 exposes some key stylized facts associated with the change in bank product mix, while section 4 details our model and empirical results. The last section concludes with some macroprudential policy observations.

2. Data and methodology

2.1 Data

A unique feature of the Canadian dataset is that it provides a wealth of information regarding banks' non-traditional activities, enabling a much detailed breakdown of *snonin* components than those usually found in the literature. Our sample runs from the first fiscal quarter of 1988 to the third fiscal quarter of 2010. Given its length, this sample is particularly well-suited to examine how diversification in market-based activities impacts bank performance through time. In total we consider eight banks and quarterly data for about twenty three years, so that aggregating we have around ninety observations, a reasonable number to perform standard time series regressions. We use aggregate data on the whole Canadian banking system, data on broad bank aggregates coming from the Canadian Bankers Association and data on the components of non-interest income from the Bank of Canada[6] and the Office of the Superintendent of Financial Institutions. The other data are drawn from CANSIM, a Statistics Canada database. The sample comprises

[6] We thank economists Étienne Bordeleau and Céline Gauthier for providing these statistics.

the major domestic banks which, taken together, account for 90 percent of the banking industry. All of them are chartered banks, i.e., commercial banks regulated by the Bank Act, running all kinds of financial services under the same roof, from loan business to investment banking, fiduciary services, financial advice, mutual funds, insurance and securitization.

Compared to the U.S. or the European banking sectors, the Canadian banking sector might appear quite small to draw any meaningful inference about the impact of the new banking environment. However, our methodological choice, based on aggregate time series, a comprehensive dataset and very parsimonious models, is more than enough to derive robust results on diversification dynamics and the impact of product mix on bank performance.

2.2 The mGARCH framework and the modified Hausman test

To cast our analysis on banks' performance in a dynamic setting we rely on a multivariate GARCH process (mGARCH) to compute the conditional covariances and correlations of key variables. The original autoregressive conditional heteroskedasticity model (ARCH(q)) due to Engle (1982) may be written as:

$$\sigma_t^2 = h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2$$

where h_t is the conditional variance and ε_t, the innovation of the regression. Bollerslev (1986) generalizes Engle's model by allowing the conditional variance to follow an ARMA (p,q) process. The GARCH(p,q) model obtains:

$$\sigma_t^2 = h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \gamma_j h_{t-j}$$

One problem with these formulations is that they neglect the conditional covariances between the innovations. The mGARCH model palliates this limitation. In this framework, assuming a GARCH(1,1) process, each element of the conditional variance-covariance matrix may be written as:

$$h_{ijt} = c_{ij} + a_{ij}\varepsilon_{it-1}\varepsilon_{jt-1} + b_{ij}h_{ijt-1}$$

Generalizing to a GARCH (*p*,*q*) process, we obtain the Bollerslev *et al.* (1988) vectorized (VEC) model:

$$vec(\mathbf{H_t}) = vec(\mathbf{C}) + \mathbf{A}vec\left(e_t e_{t-1}^{'}\right) + \mathbf{B}vec\left(\mathbf{H_{t-1}}\right)$$

where **C** is an $N \times N$ matrix and **A** and **B** are $N^2 \times N^2$ matrices.

The VEC mGARCH model thus requires the estimation of a number of coefficients which may be quite large. Hence we adopt the BEKK (Engle and Kroner 1995) procedure, a more parsimonious approach in terms of the number of parameters to estimate. It reads:

$$\mathbf{H_t} = \mathbf{C} + \mathbf{A}\left(\varepsilon_t \varepsilon_{t-1}^{'}\right)\mathbf{A'} + \mathbf{B}\mathbf{H_{t-1}}\mathbf{B'}$$

where **C**, **A**, and **B** are $N \times N$ matrices.

In other respects, to account for the increasing endogeneity stemming from the interaction between *ROA* and the share of non-interest income in operating income (*snonin*), we rely on a modified Hausman procedure developed in Calmès and Théoret (2012b). This procedure introduces an artificial variable in the regressions associated with the endogenous variables. The resulting regressions are equivalent to TSLS estimations, but directly embedding an endogeneity test. The instruments used to compute the

artificial variables are derived from the cumulants of the explanatory variables, treating the non-linearities which drive the innovations[7].

3. The change in product mix and diversification

3.1 The change in bank product mix

Since the volatility of *snonin* increasingly contributes to the volatility of operating income we should expect a related change in bank net operating income volatility. Data actually suggest the presence of a structural break around 1997[8]. Of course, the financial turmoil in the Asian markets and the high-tech bubble can be partly accountable for such fluctuations. The adoption in 1997 of the Value-at-Risk (VaR) as the standard bank risk measure might also contribute to the increased income growth volatility because of the tendency of the VaR to underestimate the negative impact of the tails of the return distributions[9]. But the increasing share of non-interest income is surely another important factor to understand the change in bank net operating income (Stiroh, 2004; Lepetit *et al*., 2008). During the 1988-1996 period, data show that net interest income contributes the most to the variance of net operating income, but that after 1997 the rise in the variance of bank net operating income is indeed due for the most part to the increased volatility of non-interest income (Table 1).

- Insert Table 1 here -

To describe where the change in banks' business model is coming from, we follow Stiroh (2004) and Calmès and Liu (2009) and first provide the descriptive statistics

[7] The higher-moment instruments are presented in Calmès and Théoret (2012b) and Racicot and Théoret (2012).
[8] We run Chow and CUSUM tests confirming this structural break. See also Calmès and Théoret (2009). A discussion of additional tests follows.
[9] Fat tail risks, which are related to the kurtosis of the return distributions, are generally much higher than the risks associated with the variance (DeJonghe, 2009, 2010).

of the components of bank non-interest income over the period 1997-2010[10] (Table 2). These components are ordered according to their relative importance at the end of 2010. Two components are particularly important on this list: the fees stemming from capital markets and the income generated by bank trading activities. The average share of these two components is almost 50% over the period 1997-2010. In fact, these two components seem to drive the fluctuations of the moving average variance of non-interest income (Figure 5). Note that while these variances are relatively moderate in normal times, they sharply increase during contraction episodes, and that for a total variance of 2626.6, the absolute contribution of the trading income component is as high as 2550.3, which represents a relative contribution of 97% to the total variance, although the average relative share of trading income in non-interest income only amounts to 11% (Table 3). Even when excluding the last crisis, the contribution of this component to the variance is over 85%, and the remaining variance is mainly explained by the capital markets component. In other words, the fluctuations of non-interest income growth seem to be mainly explained by the two components most related to bank market-oriented activities.

-Insert Figure 5 here and Tables 2 and 3 here-

3.2 Non-traditional activities and diversification

The high volatility of capital markets fees and trading income would be problematic if the conditional correlation between the trading and capital markets components were high. Fortunately, data suggest otherwise. Based on our mGARCH procedure, the conditional correlation between the two components most related to capital markets, albeit positive, is relatively low (under 0.25 at the beginning of the sample period) and is actually trending downward over the period (Figure 6). Consequently, even if banks'

[10] Statistics on most components of non-interest income are not available before 1997.

non-traditional activities are mainly market-oriented (in terms of volatility), the low correlation between the trading and capital markets components actually seems *a priori* to provide some diversification benefits.

The next two most important components of non-interest income are the wealth management and retail components. The wealth management component includes the fees stemming from the fiduciary and mutual fund business lines, and the retail component regroups the deposit, loan and credit card fees. Table 2 shows that the share of the retail component – the component most related to traditional banking – is quite stable over the sample period. It increases from 13% to 15% from 1997 to 2010, while the wealth management share is increasing from 14% to 19%. Importantly, note that the wealth management share is more volatile than the retail one as it includes a market-component, i.e., fees related to mutual funds. The specific share of mutual funds is equal to 17% at the beginning of the crisis, only declines to 11% in 2009 and gets back to 13% in 2011. However, at 0.8, the conditional correlation between retail and wealth management fees is relatively high and stable through time. By comparison, the correlation between retail and trading shares remains around -0.75, and trading income and mutual funds fees are not much related. The conditional correlation between trading income and mutual fund fees is actually negative during the subprime crisis. Overall, given these relatively low conditional correlations between market-oriented business lines, data tend *a priori* to suggest that there might be some diversification benefits associated with the change in banks' product mix.

To further investigate this aspect it is instructive to look at insurance and securitization, two non-traditional banking business lines. Since the 1992 Amendment to the

Bank Act (which allows banks to be involved in insurance and fiduciary activities), the share of insurance in non-interest income has climbed from 5% in 1997 to 19% in 2010. While securitization is less developed in Canada than in the U.S. (especially because of the earlier presence of government-backed conduits in the U.S.), it takes off in 1997 with the launch of a secondary market for mortgage loans. This timing is partly related to an innovation of the Canadian Mortgage and Housing Corporation (CMHC). Securitization actually begins in 1987 with the National Housing Act – Mortgage-Backed Securities (NHA MBS), but, after 1997, it literally explodes[11]. Just before the last financial crisis, about 30% of bank mortgage loans were securitized compared to 18% for personal loans and 10% for corporate loans. Interestingly, compared to securitized personal and commercial loans, the crisis does not really impact securitized mortgage loans. Like the insurance business line, securitization proves quite resilient to crises. In fact, in terms of diversification benefits, *ceteris paribus*, insurance and securitization revenues seem to offer the best strategy. Insurance is often mentioned in the literature as an activity providing substantial diversification benefits to banks (Boyd and Graham, 1988; Kwan and Laderman, 1999; Estrella, 2001; Vander Vennet *et al.*, 2004; DeJonghe, 2009; Schmid and Walter, 2009, Slijkerman *et al.* 2012), but, to the best of our knowledge, securitization is rarely viewed as providing similar diversification benefits.

Finally, note that the share of the *snonin* components most related to bank retail activities – like deposit, credit card and loan fees – are quite stable over the sample period (Table 2). The most important of these components, deposit fees, is especially stable. Even if its level stalls during the subprime crisis, its share in non-interest income fluctu-

[11] This non-traditional activity is often cited as a perfect illustration of the new type of banking business lines emerging concomitantly to the regulatory changes to the Bank Act (Calmès 2004).

ates around 12% over the sample period. By comparison, the share of mutual fund and underwriting fees is more sensitive to the stock market cycles, fluctuating between 25% and 50%, and declining from 50% to 27% during the financial crisis.

- Insert Table 4 and Figure 6 here –

3.3 Diversification dynamics

To fully appreciate the diversification benefits provided by the components of non-interest income, it is instructive to describe how they behave through time. Figure 7 shows that just before the crisis, i.e., on the second quarter of 2007, the capital markets component dominates clearly the other ones, followed by the wealth management and trading components at almost equal par. Insurance and retail contributions are also relatively close while securitization is clearly smaller. However, during the second quarter of 2009, the capital markets component, and especially the trading component collapse, while all the other components of non-interest income remain quite stable in value. This particular pattern well reflects the higher sensitivity of the market-oriented components to business conditions, but it is also a manifestation of the banks' tendency to refocus on their core business and the activities most related to traditional banking during downturns (Calmès and Théoret 2012a).

- Insert Figure 7 here –

3.4 Net interest income versus non-interest income

The comovements between net interest income and non-interest income components provide additional information on the diversification benefits related to banks' product mix. The contrast between the comovements of net interest and non-interest incomes expressed in terms of assets is highlighted in Figure 8**.** In 1988, the conditional

covariance between the two ratios is close to -0.8 but it progressively increases thereafter until 1997. Subsequently, the covariance, which remains usually negative, stabilizes near zero, suggesting a better integration of bank traditional and non-traditional business lines after 1997. Note also that the benefits from diversification tend to vanish in bad times. Indeed, the conditional correlation between the two ratios remains close to -1 until 1997, and then oscillates around -0.75, but it is close to 1 during the subprime crisis.

- Insert Figure 8 here –

Looking at the correlations between the ratios of net interest income to assets (net interest margin), non-interest income to assets and *snonin*, on the one hand, and the components of non-interest income on the other hand, the interest margin does not appear to be correlated with the capital markets and trading shares during normal times (Table 4). However these correlations become positive and significant if we include the subprime crisis, which supports the idea that the diversification benefits associated with market-oriented banking might be lower in bad times. Furthermore, net interest margin is quite related to the retail component of non-interest income and its correlation increases further during crises. There is also a close link between net interest margin and the deposit fees expressed in terms of assets (Figure 9), as well as with other components of the retail fees, like the loan and credit card fees. In other respects, net interest margin tends to be negatively correlated to the wealth management and insurance components[12], and this negative comovement even increases during crises, corroborating the diversification ben-

[12] Note that the negative correlation between net interest margin and wealth management fees may surprise given the close connection between net interest margin and retail fees, on the one hand, and retail and wealth management fees on the other hand. However, like for trading, the negative correlation between net interest margin and wealth management might be due to the presence of the mutual fund fees in the wealth management share, a component which comoves with the stock market.

efits associated with these business lines. During the last crisis we also observe a negative comovement between the net interest margin and securitization[13].

Finally note that during the crisis the comovements of the capital and trading components with both net interest margin and non-interest income increase, a pattern shared by the retail component. By comparison, the wealth management, securitization and especially insurance components comove less with net interest margin and non-interest income.

- Insert Figure 9 here –

4. Product mix and risk-adjusted performance

4.1 The change in bank performance

The standard deviation of the ratio of non-interest income to assets seems to be the main driver of the standard deviation of *ROA* since 1997 (Figure 10). After 1997 the volatility of *snonin* increases in conjunction with the stock market index (S&P/TSX) and with the fluctuations of bank stock trading portfolio, and if the conditional covariance between the TSX and *snonin* is relatively moderate until 1997, it certainly increases during the 2002-2007 period (Figure 11). Consistent with the stylized facts we documented earlier, note that this covariance decreases substantially in times of recessions, banks reducing *snonin* before reversals. Not surprisingly, note also that the comovement between the conditional covariance of *snonin* and the output gap increases after 1997. Similarly to what obtains with the TSX, the comovement between *snonin* and the output gap drops in downturns. Since the TSX is leading the cycle (Figure 12), this pattern might relate to the

[13] Diversification benefits *between* the components of *snonin* seem to increase during the crisis (Table 3). However, this seems to be due to the increasing shares of the activities which contribute the least to the covariance between the components, like insurance and securitization (Figure 7).

growing influence of financial markets fluctuations on *snonin*. The relationships between *ROA*, the output gap and the TSX are less clear however. *ROA* is still found procyclical, except in contraction episodes. More importantly, the covariance between *ROA* and the output gap (or TSX) is more volatile in the 2000s (Figure 11). This supports the idea of a change in banks' risk-return trade-off and a greater sensitivity of financial results to securities markets.

- Insert Figures 10, 11 and 12 here –

4.2 The model

To analyze the change in bank risk-return trade-off we resort to the following benchmark model for *ROA*:

$$ROA_t = \gamma_1 + \gamma_2 snonin_t + \gamma_3 LLP_t + \gamma_4 y_{t-1} + \zeta_t$$

where *ROA* is the return on assets, *LLP* are loan loss provisions (expressed in terms of assets), y_{t-1} is the lagged dependent variable and ζ_t is the innovation. We also estimate this equation by substituting the components of *snonin* to *snonin* itself, and an equation for the standard deviation of *ROA* based on the same explanatory variables:

$$sd(ROA) = \theta_1 + \theta_2 sd(snonin) + \theta_3 sd(LLP) + \theta_4 y_{t-1} + \zeta_t$$

where *sd(.)* stands for the standard deviation of the variable appearing in parentheses. The standard deviation is computed using a rolling window of four quarters. This equation is also estimated with the components of *snonin*. Finally, for robustness sake, we also estimate equations directly based on a risk-adjusted measure of *ROA*:

$$RA\_ROA_t = \phi_1 + \phi_2 snonin_t + \phi_3 LLP_t + \phi_4 RA\_ROA_{t-1} + \zeta_t$$

where $RA\_ROA_t = \frac{\bar{ROA}}{sd(ROA)}$, $\bar{ROA}$ being the moving average of *ROA* computed over four quarters.

4.3 The change in bank product mix

The fit of the model seems quite reasonable over the 1988-1996 and 1997-2010 subperiods, the adjusted R^2 being about 0.70 over both subperiods and lower for the whole sample (because of the change in bank product mix, Table 5). Consistent with the idea that loan loss provisions ought to lower profits, the coefficient of the ratio of loan loss provisions to total assets, at -0.29, is significantly negative.

- Insert Table 5 here -

As the literature suggests, Table 5 confirms that the risk-return trade-off improves throughout the sample period. During the first subperiod, the coefficient of *snonin* is negative, at -1.94, but actually turns significantly positive in the second period (at 2.31). Since we are interested in the changes of the *snonin-ROA* relationship, it is also instructive to run a recursive regression over the whole sample period[14]. Figure 13 confirms the regime change in the sensitivity of *ROA* to *snonin* around 1997. After 1997 the confidence interval of the coefficient of *snonin* is usually above 0, signalling a significant positive contribution of *snonin* to *ROA*. Hence, this finding supports the emergence of some diversification benefits in market-oriented banking.

- Insert Figure 13 here -

However, to get a more rigorous assessment of this change, we must properly account for the evolution of the endogenous link between *snonin* and *ROA*. In fact, the en-

[14] This regression is run on a rolling window of 15 observations.

dogeneity significantly biases the coefficient of *snonin*. Over the period 1997-2010, the coefficient of *snonin* is equal to 2.31 when estimated with the usual OLS method, but to 2.71 with our modified Hausman procedure (Table 6). The coefficient of *snonin* thus appears globally underestimated when the endogeneity bias is ignored. Indeed, being significantly negative (-1.90), the w_{snonin} indicator confirms that the impact of *snonin* is significantly understated in the OLS run. The fact that non-traditional activities positively impact returns when controlling for endogeneity has been often reported in the literature (Campa and Kedia 2002, Busch and Kick 2009, Schmid and Walter 2009), regardless of the way endogeneity is accounted for. However, our Hausman procedure shows that this positive influence actually increases after 1997.

- Insert Tables 6 and 7 here -

Consistent with this finding, the estimation of the standard deviation of *ROA* reveals that the standard deviation of *snonin* has the most significant and largest coefficient, especially in the second subperiod (Table 7). Incidentally, the coefficient of *sd(snonin)* is not significant before 1997 while it is significant at the 99% confidence level thereafter. This result is almost unaffected by the introduction of an alternative measure of returns adjusted for risk. Over the 1997-2010 subperiod the coefficient of *snonin*, significant at the 5% threshold, is equal to 40.72 when estimated with OLS, but to 60.94, significant at the 1% threshold when estimated with our Hausman procedure (Tables 8 and 9). The coefficient of w_{snonin}, significant at the 1% threshold, is also high, at -37.62, which confirms the underestimation of the *snonin* coefficient. We thus find robust evidence that bank risk-adjusted returns improve through time (Demsetz and Strahan 1995, Stiroh 2006, Altunbas *et al.* 2007).

- Insert Tables 8 and 9 here -

To our knowledge, the modified Hausman procedure we introduce is the first attempt to analyze bank diversification in a dynamic setting. Some authors (e.g., Stiroh and Rumble 2006, Laeven and Levine 2007) compare their results before and after the correction for the endogeneity and generally find their results robust to endogeneity. The studies of DeYoung and Rice (2004), Goddard *et al.* (2008) and Busch and Kick (2009) use standard instruments to tackle the simultaneity bias between *ROA* and *snonin*, but they do not measure the extent of the endogeneity biases and account for endogeneity upfront. Yet, the seminal study of Campa and Kedia (2002) on the diversification discount in industrial conglomerates shows the importance of performing Hausman tests. In their study, when accounting for endogeneity with this kind of procedure, the diversification discount disappears and even turns into a premium in some cases. The new set of results we derive from this kind of procedure is in the same spirit. The increase in endogeneity actually appears symptomatic of a tighter link between non-interest income and banks' risk-adjusted returns, i.e., a change in banks' business model.

4.4 Non-interest income components and bank performance

To regress *ROA* on the shares of the components of non-interest income we resort to two estimation methods: OLS and the Generalized Method of Moments (GMM), a robust IV estimation procedure[15].

- Insert Table 10 here -

[15] To implement the GMM procedure we rely on the robust instruments presented in Calmès and Théoret (2012b) and Racicot and Théoret (2012).

Consistent with the stylized facts previously discussed the share of retail income seems to contribute the most to *ROA* (Table 10)[16]. When estimated with OLS its coefficient is equal to 9.42 and significant at the 1% threshold, and 11.20 with GMM, also significant at the 1% threshold. The insurance share is the second component that impacts the most *ROA*. In spite of their volatility, the capital markets and trading shares have quite comparable patterns, with GMM estimated coefficients respectively equal to 3.39 and 3.13. As expected, the components most related to market-oriented banking display the highest *t* statistics. The wealth management share has a significant positive contribution to *ROA* in the OLS run but its influence, albeit positive, is not significant in the GMM estimation. Finally, if not adjusting returns for risk, securitization seems to exert a negligible impact on banks' performance.

The picture is somewhat different when we turn to the estimations of risk-adjusted *ROA*. The two components most related to market-oriented banking continue to have a very significant positive impact on risk-adjusted *ROA*. The wealth management share coefficient becomes more significant and close to the one of the retail share. In the GMM estimation these coefficients are respectively equal to 140.78 and 174.73. More importantly, the securitization share now displays the most important contribution while the insurance share impact weakens.

Consistent with the literature (e.g. Gallo *et al.* 1996, Vander Vennet *et al.* 2004, Busch and Kick 2009) we find that the retail component, the activity most related to traditional banking, is the activity which seems to improve the most the risk-return trade-off. An activity quite related to retail, wealth management, is also a good performer in the

[16] Note that this result is in line with the sectorial *ROA* published by Canadian banks in their annual reports. Indeed, the retail segment proves the most profitable. However, this result is not adjusted for risk. See: Price Waterhouse Coopers, Canadian Banks 2006 and 2010.

risk-adjusted *ROA* estimations. Similar to our results, Stiroh and Rumble (2006) also find that fiduciary fees increase banks' risk-adjusted returns. Mutual funds, which are included in the wealth management component, seem also to be a profitable activity, especially considering that they are less exposed to stock market conditions compared to trading (Gallo et al. 1996).

More importantly, the contribution of the capital markets share is found both high and significant, regardless of the estimation method. This result is consistent with the idea that a combination of commercial and investment banking may increase the performance of financial conglomerates (Krozner and Rajan 1994, Vander Vennet *et al.* 2004, De Jonghe 2009, 2010, Schmid and Walter 2009). However, the literature is less clear regarding the effect of trading activities on bank performance. For example, Estrella (2001) and Stiroh and Rumble (2006) find that these activities decrease banks' risk-adjusted returns, while Lepetit *et al.* (2008) show that trading might reduce risk for small banks, and Krozner and Rajan (1994) and Schmid and Walter (2009) show that it could increase value. Our results, based on comprehensive data and a detailed breakdown of *snonin* components, actually suggest that despite its high volatility, trading contributes positively and significantly to *ROA* and risk-adjusted *ROA* in normal times (Table 10). In line with Busch and Kick (2009), we also find that fees activities rise banks' risk-adjusted returns. Additionally however, we can argue that the diversification benefits associated with specific components of non-interest income are likely time-varying. The empirical results previously reported in the literature may also be sensitive to the sample period considered, especially if the period is a short one (DeJonghe 2009, 2010).

4.5 Discussion

When looking at the relationship between the logarithm of the standard deviation of *ROA* and the logarithms of the standard deviations of the components of *snonin*[17], we can first confirm that the trading share greatly impacts the standard deviation of *ROA*, with an elasticity equal to 0.5, significant at the 1% threshold (Table 11). Given this large impact in relative terms, the capital market share does not seem to impact significantly the standard deviation of *ROA*. Consistent with the stylized facts documented earlier, the securitization share negatively impacts the standard deviation of *ROA*. However, this impact seems to decrease during crises. Insurance has no significant impact on the standard deviation of *ROA* during the period 1997-2006, but a negative one over the whole sample period. In other words, insurance seems to provide diversification benefits even in downturns. Finally, consistent with our previous findings, wealth management has a negative influence on the standard deviation of *ROA*, and retail has a positive impact, suggesting some diversification benefits stemming from the wealth management business lines.

- Insert Table 11 here –

These results show that the diversification patterns may actually be time-varying and conditioned by the sample period, so it is interesting to study the interactions between traditional and non-traditional activities, regressing net interest income on the *snonin* components and two control variables – the three-month prime corporate rate and the yield on the TSX stock market index. In this case, insurance and wealth management again appear to be the business lines contributing the most to diversification, their respective coefficients being respectively -0.93 and -0.27 (Table 12). With an estimated coeffi-

[17] We formulate this regression in terms of logarithms for the regression coefficients to be directly comparable.

cient of 2.07, significant at the 1% threshold retail contributes less to diversification since, by its nature, it is mainly associated with traditional banking.

More importantly, note that during the period 1997-2006, diversification works very well for the two components most related to market-oriented banking, and especially for trading for which the correlation with net interest income is actually negative most of the time and often close to -0.75 (Figure 14). However, during the last financial crisis, the pattern is quite different. Except for insurance and securitization, the conditional correlations jump towards one. In other words, the benefits of diversification in market-based banking tend to disappear when they are needed the most for stabilizing bank income[18]. In line with these results, Vander Vennet *et al.* (2004) find that European diversified banks did not perform better than specialized banks during the 2000-2003 downturn[19]. This phenomenon is related to the fat-tail risk associated with non-interest income, a risk not accounted for in the standard deviation but detected with our mGARCH procedure[20].

- Insert Table 12 and Figure 14 here –

5. Conclusion

The last decades innovations in financial intermediation have greatly changed the way banks do business. Their accounting returns are now greater than before but their financial results are also more volatile. These higher returns are likely due to the market risk premia charged on banking activities (Calmès and Théoret 2010) and to the cost efficiency with which banks manage their fees business[21]. For decision makers, the policy

[18] For the wealth management fees a simple correlation coefficient seems to suggest diversification benefits during the last financial crisis. However, with the partial conditional correlation coefficients, i.e., the mGARCH procedure, the picture is somewhat different.
[19] They do not qualify their findings with a non-interest income decomposition however.
[20] Indeed, a GARCH procedure accounts for the kurtosis of a distribution, a higher moment which is related to rare events like crises. For an alternate approach and further details, see DeJonghe (2009, 2010).
[21] This argument is developed in Smith (1999) who asserts that the greater returns of Canadian banks may be due to cost efficiency. Note however that banks' fees business displays a greater operating leverage than traditional activities (DeYoung and Roland, 2001).

implications we can derive from our analysis are quite straightforward. Despite the improvement in banks risk-return trade-off, our study confirms that banking has become a riskier business, as the volatility of bank revenues has greatly increased. However, it is important to realize that the contribution to risk differs greatly from one component of non-interest income to the next. For example, the main drivers of risk are the components most-related to market-oriented banking, but this risk is actually quite low during normal times, and only intensifies during crisis episodes. In this respect, cyclical capital buffers like those proposed by Basel III may in principle help control the risk stemming from non-interest income. Moreover, except for capital markets fees and trading income, most components of non-interest income do not seem to be particularly worrying, even in downturns. For instance, the fees stemming from mutual funds, even if they are sensitive to stock market returns, do not seem to display any sign of disruption during the last crisis. Our results also indicate that banks tend to refocus on their core business during bad times, i.e., on the activities most related to traditional banking (Calmès and Théoret 2012a). This pattern tends to contain losses. More preoccupying however is the overshooting we find in the reaction of some non-interest income components to financial shocks, like trading income and capital markets fees.

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Tables

Table 1
Decomposition of the variance of net operating income growth

	1988-1996			1997-2010			1988-2010		
	Average share	Variance	Contribution to variance	Average share	Variance	Contribution to variance	Average share	Variance	Contribution to variance
Net operating revenue		11.0			66.3			33.3	
Net interest income	0.67	13.6	**6.1**	0.49	17.0	**4.1**	0.57	15.2	**4.9**
Noninterest income	0.33	27.7	**3.0**	0.51	243.7	**63.4**	0.43	153.4	**28.4**
Covariance		4.3	**1.9**		-2.2	**-1.1**		0.05	**0.0**
Diversification effect			**-0.89**			**-1.83**			**-1.77**
Correlation			**0.22**			**-0.03**			**0.01**

	1997-2006			2007-2010		
	Average share	Variance	Contribution to variance	Average share	Variance	Contribution to variance
Net operating revenue		41.2			104.6	
Net interest income	0.49	16.5	**4.0**	0.53	13.6	**3.8**
Noninterest income	0.51	141.1	**36.7**	0.47	468.8	**103.6**
Covariance		1.0	**0.5**		-5.5	**-2.8**
Diversification effect			**-1.62**			**-1.87**
Correlation			**0.02**			**-0.07**

Notes: The variance decomposition is obtained by using the simple portfolio variance formula, which is $Variance = \mathbf{w}^T \mathbf{\Omega} \mathbf{w}$, where $\mathbf{w}$ is the vector of the respective shares of net interest income and non-interest income in bank net operating revenue, and $\mathbf{\Omega}$ is the variance-covariance matrix of net interest income growth and non-interest income growth. Diversification effects are computed as the difference between the standard deviation of net operating income growth and the weighted sum of the standard deviations of its components.
Data source: Canadian Bankers Association and Bank of Canada.

Table 2

Components of non-interest income, 1997-2010

	noninterest income	capital markets	wealth mgt.	retail	insurance	trading	securitization	other
Level (end-of-period, thousand $)	10472325	2513622	2039389	1522159	2017461	130621	723671	1525402
Mean (thousand $)	8503278	2692371	1345518	1039965	975060	939987	403025	1107352
Median (thousand $)	8188799	2647529	1297605	1021984	988188.6	1293237	334615	1053265
Std. Dev. (thousand $)	1911782	556968	430527	275342	545112	1191256	220719	179172
Share (start-of-period)		0.37	0.14	0.13	0.05	0.14	0.01	0.16
Share (end-of-period)		0.24	0.19	0.15	0.19	0.01	0.08	0.15
Average share		0.32	0.16	0.12	0.11	0.10	0.05	0.13
Skewness	0.06	0.76	0.10	0.15	0.54	-1.84	2.18	1.17
Kurtosis	2.55	4.52	1.75	2.08	2.47	6.24	9.11	3.69

Some subcomponents of non-interest income	**Mutual fund and underwriting fees**	**Deposit fees**	**Investment mgt. Fees**	**Credit card fees**	**Loan fees**
Level (end-of-period, thousand $)	2996517	1258234	902279	683544	459509
Mean (thousand $)	2547130	898114	656102	484546	372121
Median (thousand $)	2625775	885743	634029	468218	358553
Std. Dev. (thousand $)	585965	238886	203289	132580	62518
Share (start-of-period)	0.37	0.11	0.08	0.07	0.05
Share (end-of-period)	0.27	0.12	0.09	0.07	0.04
Average share	0.35	0.11	0.08	0.06	0.05
Skewness	0.71	1.56	2.20	1.46	0.61
Kurtosis	4.85	5.60	8.24	5.23	3.17

Notes: Capital markets comprises the global wholesale banking business providing corporate, public sector and institutional clients with a wide range of products and services. *Income wealth management* designates a full range of investment, trust and other wealth management, and asset management products (e.g., mutual funds) and services provided to high net worth clients. *Retail* income includes personal and business retail banking operations, especially deposit, loan and credit card fees. *Insurance* comprises life and health, home, auto and travel insurance products. *Trading* comprises trading and distribution operations largely related to fixed income, foreign exchange, equities and derivative products. *Securitization* refers to the securitization process of credit card receivables and residential mortgages primarily used to diversify bank funding sources and enhance liquidity positions. Components shares are expressed in terms of total noninterest income.
Data source: Bank of Canada and the Office of the Superintendant of financial institutions (OSFI).

Table 3

Decomposition of the variance of non-interest income growth, 1997-2010

	Average share		Variance		Contribution to variance		Covariance		Contribution to covariance		Total	
	1997-2006	1997-2010	1997-2006	1997-2010	1997-2006	1997-2010	1997-2006	1997-2010	1997-2006	1997-2010	1997-2006	1997-2010
Components												
capital market income	0.33	0.32	261.13	342.68	**28.69**	**36.13**	44.66	127.17	**14.23**	**44.51**	**42.93**	**80.64**
income wealth-mgt income	0.14	0.16	51.98	44.28	**1.04**	**1.11**	-4.44	22.75	**-0.69**	**3.61**	**0.35**	**4.72**
retail income	0.12	0.12	84.59	98.92	**1.13**	**1.51**	-2.19	61.92	**-0.25**	**7.65**	**0.88**	**9.16**
insurance income	0.09	0.11	391.67	399.42	**2.88**	**4.80**	-101.02	-56.72	**-8.59**	**-6.22**	**-5.71**	**-1.42**
trading income	0.16	0.10	10860.60	238111.95	**262.36**	**2506.74**	135.27	424.34	**9.95**	**43.54**	**272.31**	**2550.28**
securitization income	0.04	0.05	428.38	522.92	**0.62**	**1.15**	-16.84	-460.44	**-0.60**	**-21.58**	**0.02**	**-20.43**
other income	0.13	0.13	20.71	18.94	**0.36**	**0.34**	19.00	24.41	**2.53**	**3.27**	**2.89**	**3.62**
Total					**297.10**	**2551.79**			**16.58**	**74.78**	**313.67**	**2626.56**
Diversification effect											-26.7	-62.2

Notes: The variance decomposition is obtained by using the simple portfolio variance formula, which is $Variance = \mathbf{w}^T \mathbf{\Omega} \mathbf{w}$, where $\mathbf{w}$ is the vector of the respective shares of the components of non-interest income, and $\mathbf{\Omega}$ is the variance-covariance matrix of the components expressed in growth rates. The contribution of component *i* to the total variance and covariance is computed with the following derivative: $\frac{\partial \text{var}iance}{d\mathbf{w}} = 2\mathbf{\Omega}\mathbf{w}$, where the relative contribution of component *i* is equal to $2\mathbf{\Omega}_i\mathbf{w}$, with $\mathbf{\Omega}_i$ the i^{th} line of the $\mathbf{\Omega}$ matrix. Diversification effects are computed as the difference between the standard deviation of non-interest income growth and the weighted sum of the standard deviations of its components.

Table 4

Correlation between net interest income, non-interest income and *snonin*, and the non-interest income components

	net interest / assets		**non interest / assets**		***snonin***	
	1997-2006	**1997-2010**	**1997-2006**	**1997-2010**	**1997-2006**	**1997-2010**
capital markets	0.04	0.30	0.79	0.79	0.55	0.61
	0.77	*0.03*	*0.00*	*0.00*	*0.00*	*0.00*
trading	-0.24	0.33	0.88	0.87	0.81	0.81
	0.15	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*
wealth management	-0.17	-0.35	0.06	-0.05	0.25	0.22
	0.31	*0.01*	*0.72*	*0.75*	*0.14*	*0.12*
retail	0.28	0.47	-0.13	0.25	-0.16	0.05
	0.10	*0.00*	*0.45*	*0.08*	*0.35*	*0.75*
insurance	-0.31	-0.42	-0.05	-0.30	0.14	-0.05
	0.07	*0.00*	*0.79*	*0.03*	*0.42*	*0.72*
securitization	0.01	-0.16	0.29	-0.16	0.22	-0.16
	0.98	*0.25*	*0.09*	*0.27*	*0.20*	*0.26*
other	0.43	0.71	0.27	0.55	0.06	0.24
	0.01	*0.00*	*0.11*	*0.00*	*0.74*	*0.10*

Notes: Since bank interest margin is defined as a percentage of assets, the time series composing non-interest income are also expressed on this basis. The *p*-values of the correlations are reported in italics.

Table 5

OLS estimation of *ROA*

Variables	1988-1996	1997-2010	1988-2010
c	1.47	-0.33	0.66
	5.87	*-1.89*	*6.29*
snonin	-1.94	2.31	-0.02
	-2.50	*6.93*	*0.12*
LLP	-0.38	-0.54	-0.29
	-5.19	*-4.44*	*-5.74*
ROA_{t-1}	0.36	0.19	0.18
	2.52	*1.43*	*2.24*
Adjusted R^2	0.77	0.70	0.41
DW *stat.*	2.08	2.15	1.68

Notes: *ROA*, return on assets ; *snonin*, share of non-interest income in net operating revenue; *LLP*, ratio of loan loss provisions over total assets. The *t* statistics are reported in italics.

Table 6

Hausman regression of *ROA*

Variables	1988-1996	1997-2010	1988-2010
c	1.45	-0.55	0.67
	5.43	*-2.86*	*6.16*
snonin	-1.89	2.71	-0.05
	-2.36	*7.67*	*-0.22*
LLP	-0.38	-0.50	-0.33
	-5.18	*-3.33*	*-5.81*
ROA_{t-1}	0.38	0.78	0.21
	2.48	*4.06*	*2.45*
w_{snonin}	97.53	-1.90	0.91
	0.40	*-1.74*	*0.03*
Adjusted R^2	0.73	0.73	0.42
DW stat.	2.12	2.22	1.69

Notes: The explanatory variables are: *snonin*, share of non-interest income in net operating revenue; *LLP*, ratio of loan loss provisions over total assets. The *w* variable is the residuals obtained with a regression of *snonin* on cumulant instruments (Calmès and Théoret 2012b, Racicot and Théoret 2012). The *t* statistics are reported in italics.

Table 7

Standard deviation of *ROA*

Variables	1988-1996	1997-2010	1988-2010
c	0.02	0.01	0.01
	0.89	*0.58*	*0.14*
sd(snonin)	2.26	2.73	2.62
	0.14	*6.42*	*1.90*
sd(LLP)	0.56	0.28	0.56
	4.00	*1.27*	*7.03*
$sd(ROA)_{t-1}$	0.65	0.63	0.65
	6.75	*5.71*	*11.92*
Adjusted R^2	0.66	0.69	0.72
DW *stat.*	2.15	1.60	2.13

Notes: The dependent variable is the standard deviation of *ROA* computed on a rolling window of four quarters. The same procedure is followed to compute the standard deviation (*sd*) of the explanatory variables.

Table 8

OLS estimation of the risk-adjusted *ROA*

Variables	1988-1996	1997-2010	1988-2010
c	-6-71	-14.69	4.65
	-0.47	*-1.65*	*1.03*
snonin	39.82	40.72	2.00
	1.01	*2.14*	*0.26*
LLP	-5.80	-8.55	-5.13
	-2.12	*-2.34*	*-1.70*
RA_ROA_{t-1}	0.80	0.64	0.67
	1.01	*10.20*	*6.64*
Adjusted R^2	0.67	0.49	0.52
DW stat.	2.01	1.67	1.60

Notes: The dependent variable is a moving average of *ROA* scaled by a rolling *ROA* standard deviation of four quarters. The explanatory variables are: *snonin*, share of non-interest income in net operating revenue; *LLP*, ratio of loan loss provisions over total assets, and RA_ROA_{t-1}, risk-adjusted *ROA* lagged one period. The *t* statistics are reported in italics.

Table 9

Hausman regression of the risk-adjusted *ROA*

Variables	1988-1996	1997-2010	1988-2010
c	-4.89	-23.36	5.23
	-0.33	*10.89*	*1.28*
snonin	38.11	60.94	2.17
	0.80	*11.71*	*0.21*
LLP	-6.51	-9.51	-5.75
	-2.82	*-4.23*	*-3.61*
RA_ROA_{t-1}	0.72	0.59	0.66
	5.00	*15.93*	*13.09*
w_{snonin}	379.01	-37.62	10.96
	2.47	*-3.75*	*1.32*
Adjusted R^2	0.69	0.47	0.53
DW stat.	1.97	1.55	1.65

Notes: The dependent variable (*RA_ROA*) is a moving average of *ROA* scaled by a rolling *ROA* standard deviation of four quarters. The explanatory variables are: *snonin*, share of non-interest income in net operating revenue; *LLP*, ratio of loan loss provisions over total assets, and RA_ROA_{t-1}, risk-adjusted *ROA* lagged one period. The *w* variable is the residuals obtained with a regression of *snonin* on cumulant instruments (Calmès and Théoret 2012b, Racicot and Théoret 2012). The *t* statistics are reported in italics.

Table 10

Regression of *ROA* and risk-adjusted *ROA* on the components of *snonin*

	ROA		***RA_ROA***	
Variables	**OLS**	**GMM**	**OLS**	**GMM**
C	-0.63	-0.87	-26.30	-44.87
	-2.06	*-4.90*	*-5.61*	*-4.16*
capital markets share	3.08	3.39	46.41	73.36
	4.77	*8.20*	*3.42*	*2.60*
trading share	2.83	3.13	51.17	90.24
	9.03	*15.15*	*7.25*	*7.03*
wealth manag.share	3.08	1.03	82.85	140.78
	4.77	*1.20*	*2.23*	*3.29*
retail share	9.42	11.20	121.48	174.73
	2.98	*5.49*	*2.45*	*1.74*
insurance share	3.77	3.52	-11.35	33.19
	3.85	*5.04*	*-0.53*	*0.70*
securitization share	-1.08	0.06	175.62	304.93
	-0.60	*0.05*	*7.42*	*5.34*
Llp	-0.53	-0.52	-0.88	-4.05
	-6.60	*-8.70*	*-0.95*	*-1.39*
y_{t-1}	-0.11	-0.10	0.73	0.61
	-1.56	*-3.70*	*15.86*	*10.36*
Adjusted R^2	0.81	0.81	0.44	0.50
DW stat.	2.24	2.32	1.51	1.50

Notes: RA_ROA is risk-adjusted *ROA*, i.e., a four-quarter moving average of *ROA* scaled by a rolling *ROA* standard deviation of four quarters. Consistent with *snonin*, the components of non-interest income are expressed as ratios of net operating income, the sum of net interest income and non-interest income. y_{t-1} is the dependent variable lagged one period. The *t* statistics are reported in italics. Note that the estimation period runs from 1997 to 2010 since most of the components of non-interest income are not available before 1997.

Table 11

Equation of the logarithm of the standard deviation of *ROA*

	1997-2006	**1997-2010**
log(sd_markets)	-0.59	-0.05
	-0.95	*-0.09*
log(sd_trading)	0.50	0.51
	9.20	*7.46*
log(sd_wm)	0.01	-0.07
	0.25	*-1.03*
log(sd_retail)	0.13	0.16
	1.29	*1.46*
log(sd_insur)	0.06	-0.07
	0.79	*-1.81*
log(sd_secur)	-0.49	-0.27
	-7.42	*-3.15*
Adjusted R^2	0.50	0.55
DW stat.	1.50	1.61

Notes: The standard deviations are computed on a rolling window of four quarters. They are expressed in logarithms to make the estimated coefficients comparable.

Table 12

GMM regression of net interest income on the components of non-interest income (as % assets)

Variables	GMM
C	0.70
	5.68
capital markets	0.02
	0.61
trading	0.04
	1.82
wealth manag.	-0.27
	-1.74
retail	2.07
	8.07
insurance	-0.93
	-7.57
securitization	0.01
	0.04
r_{corp}	-0.03
	-4.50
r_{TSX}	-0.01
	-1.39
net interest income$_{t-1}$	0.51
	11.82
Adjusted R^2	0.83
DW stat.	2.05

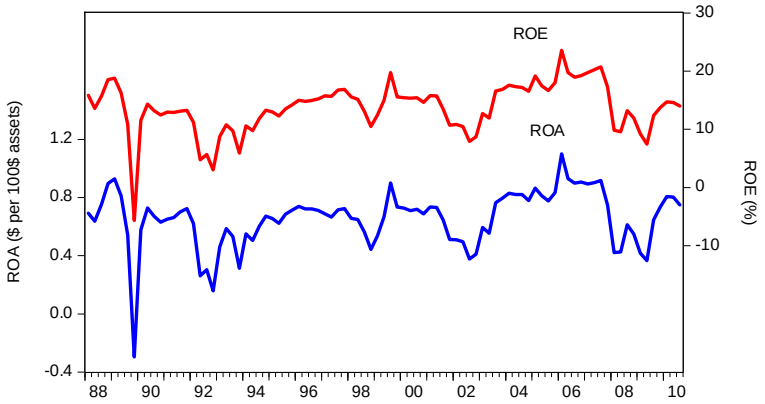
Notes: The time series are expressed in percent of bank assets. r_{corp} is the 3-month prime corporate paper rate, an indicator of monetary conditions, and r_{TSX} is the quarterly yield on the TSX stock market index. The *t* statistics are reported in italics. To implement the GMM regression we resort to robust instruments (Calmès and Théoret 2012b, Racicot and Théoret 2012).

Figures

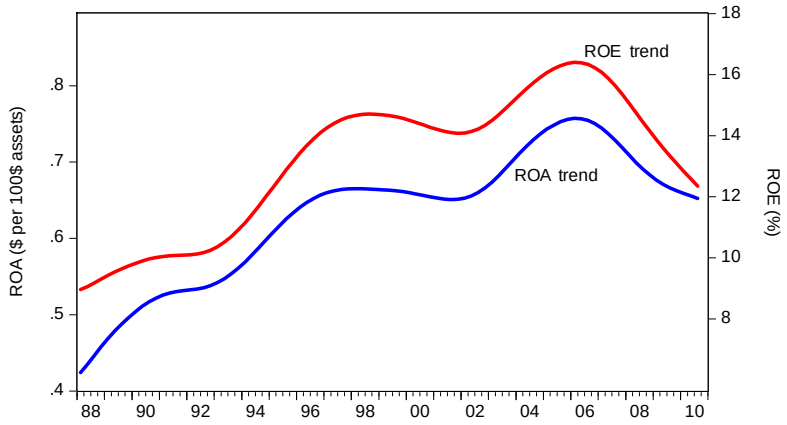
Figure 1

ROA and *ROE* levels and trends

Levels



Hodrick Prescott trends



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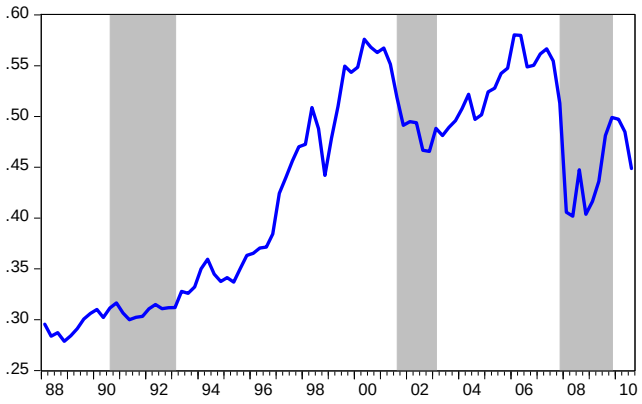
Source: Canadian Bankers Association.

Figure 2

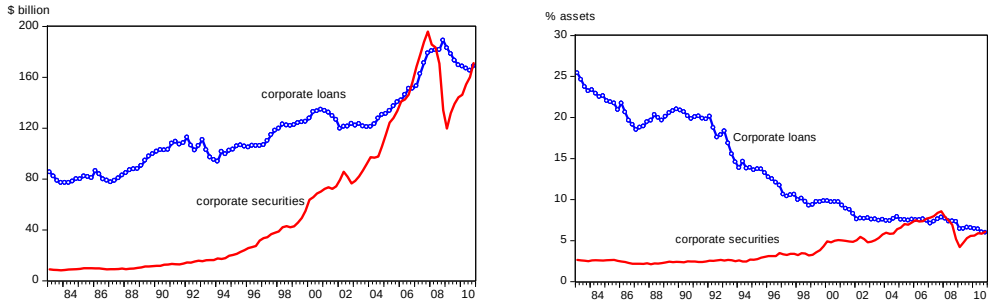
Share of non-interest income, 1988-2010



Note: Shaded areas correspond to periods of contractions or marked economic slowdown.
Source: Canadian Bankers Association.

Figure 3

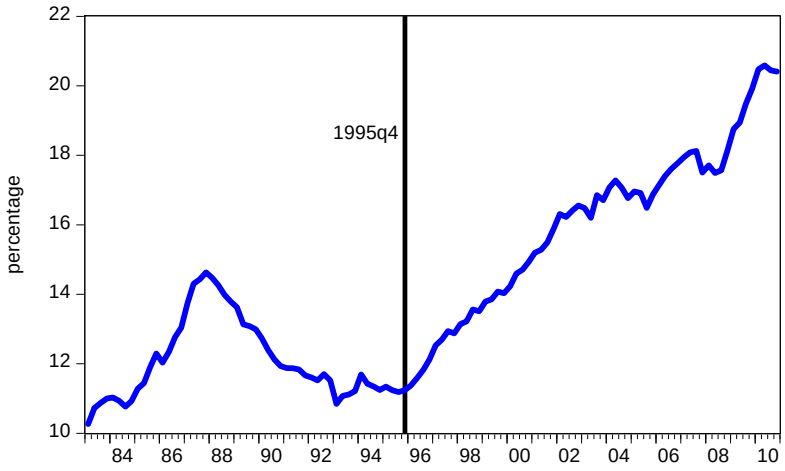
Short-term corporate loans and corporate securities held by Canadian banks (in levels and as % of banks' assets)



Source: Statistics Canada, CANSIM

Figure 4

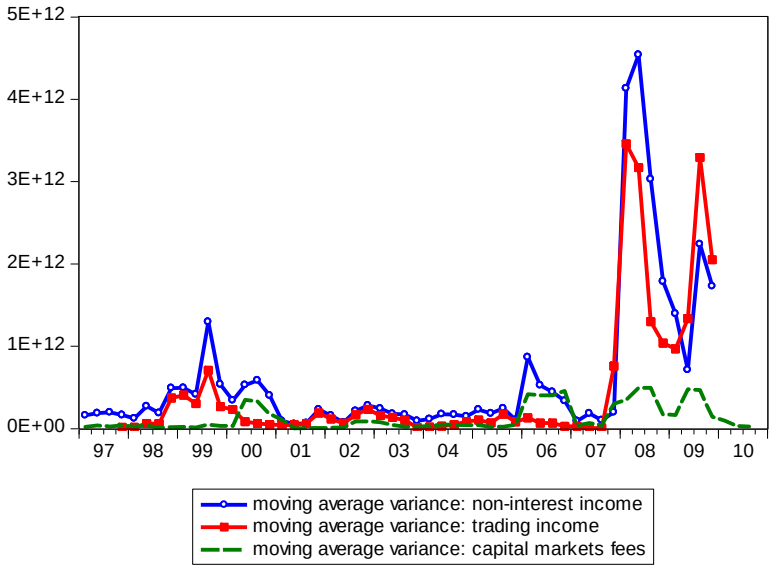
Market funding in total Canadian banks' global funding in $CAN



Notes: Global funding includes total deposits, equity and debentures. Market funding are deposits bought on financial markets.
Source: Statistics Canada, CANSIM.

Figure 5

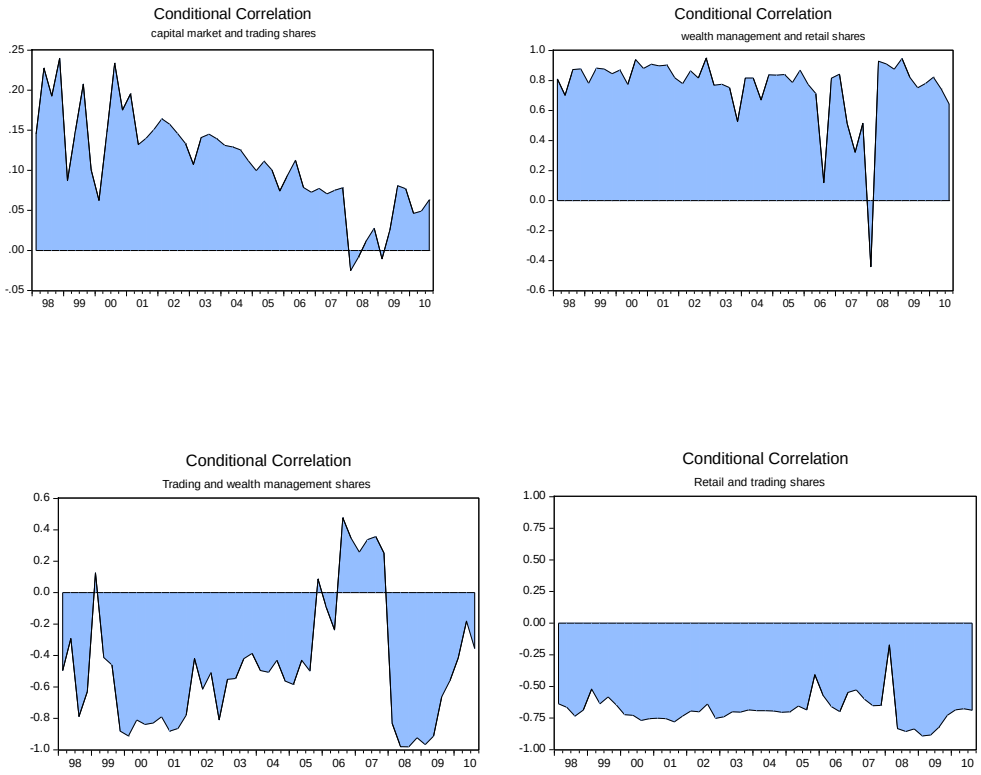
Variance of non-interest income and of its two most volatile components, trading income and capital markets fees, 1997-2010



Note: The variance is a rolling variance computed over four quarters.
Source: Bank of Canada.

Figure 6

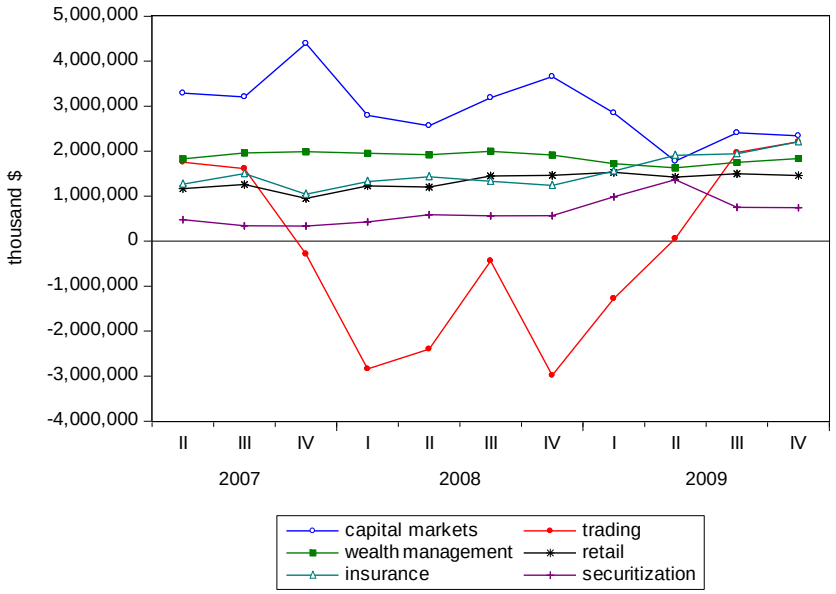
Conditional correlations between key components of non-interest income



Note: The conditional correlations are computed with a mGARCH model using the BEKK procedure (Engle and Kroner 1995).

Figure 7

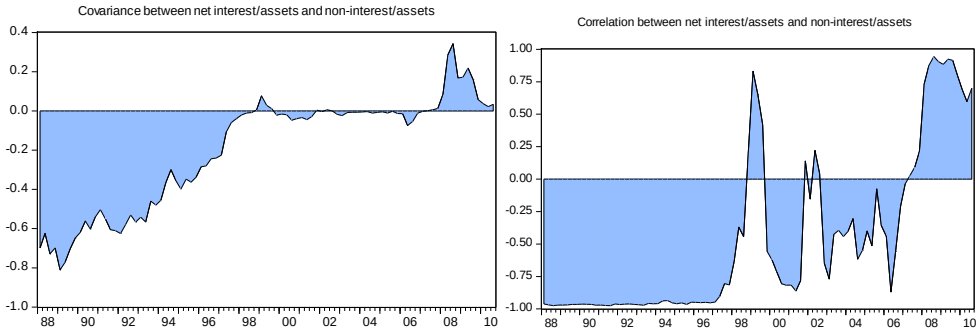
Behaviour of non-interest income components during the crisis



Source: Bank of Canada.

Figure 8

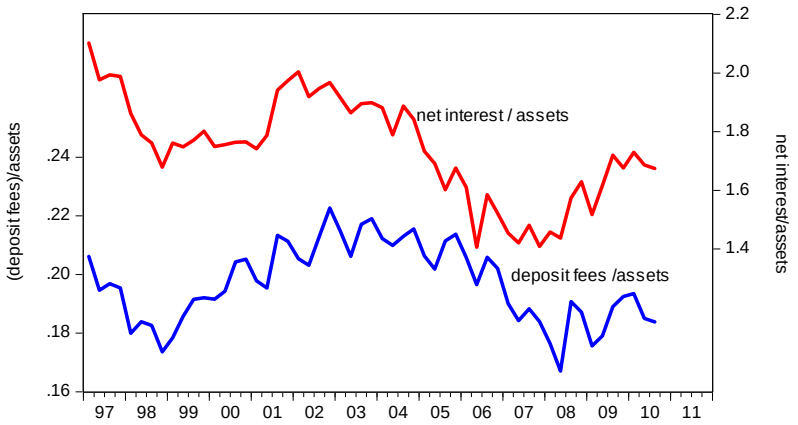
Conditional covariance and correlation between net interest/assets and non-interest/assets



Note: These conditional covariance and correlation are computed with a mGARCH model using the BEKK procedure (Engle and Kroner 1995).

Figure 9

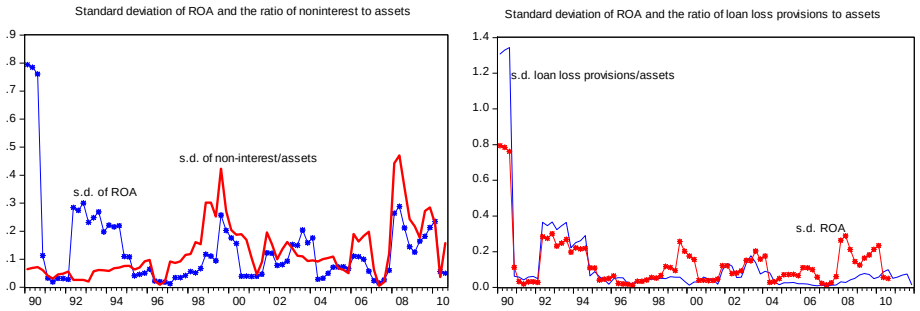
Net interest/assets and (deposit fees)/assets



Source: Bank of Canada and OSFI.

Figure 10

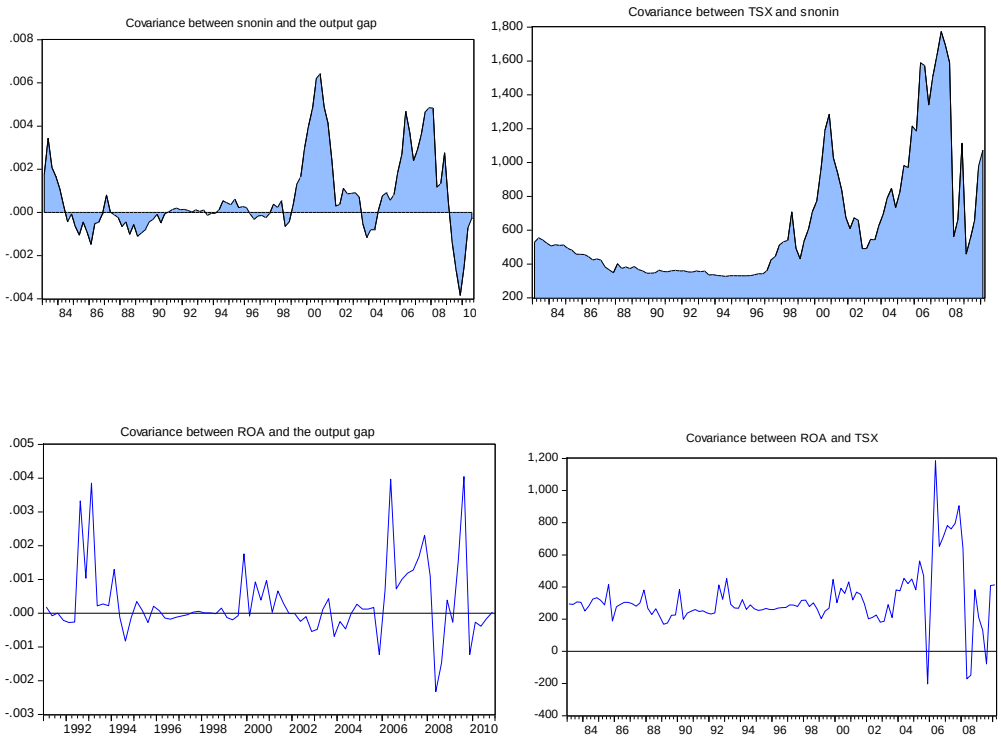
Standard deviation of *ROA* v/s standard deviation of non-interest/assets and loan loss provisions/assets



Note: The standard deviations are computed on a rolling window of four quarters.

Figure 11

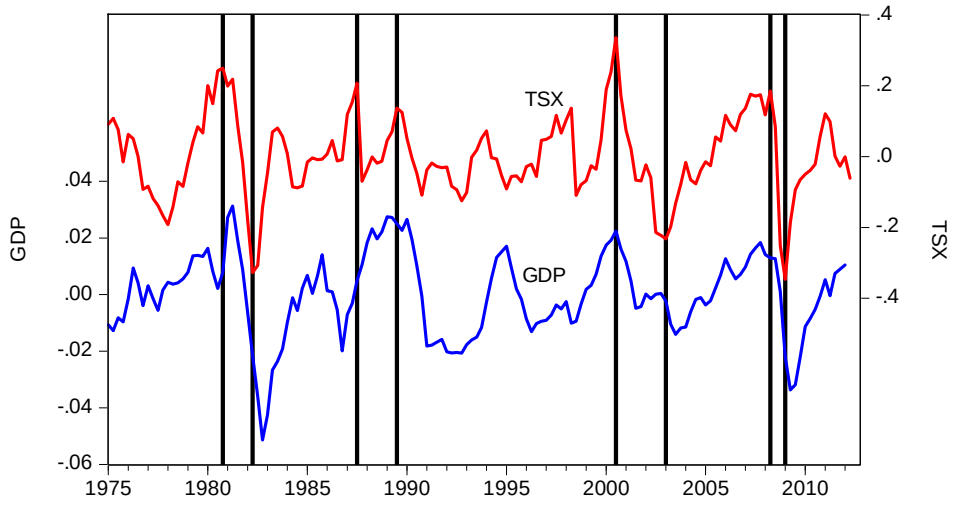
Snonin and *ROA* covariances between *TSX* and the output gap



Note: These conditional covariances are computed with a mGARCH model using the BEKK procedure **(**Engle and Kroner 1995).

Figure 12

TSX and GDP cycles, 1975-2010

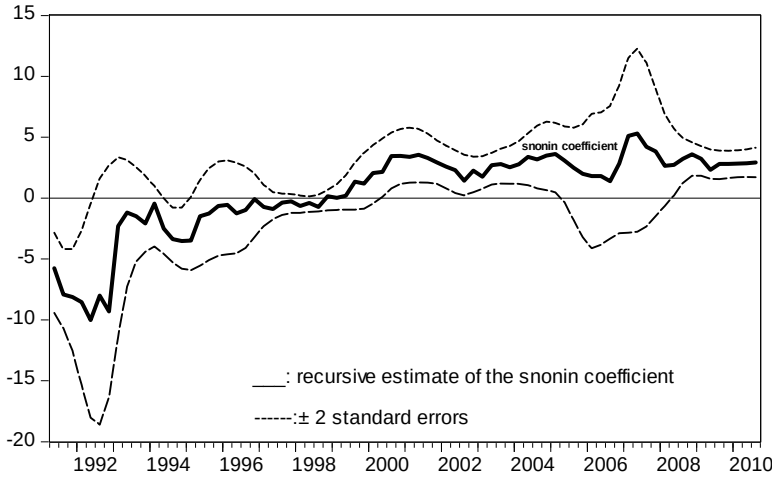


Notes: The variables cycles are computed with the Hodrick-Prescott filter. The vertical lines indicate the highs and lows of the TSX.

Source: Statistics Canada, CANSIM.

Figure 13

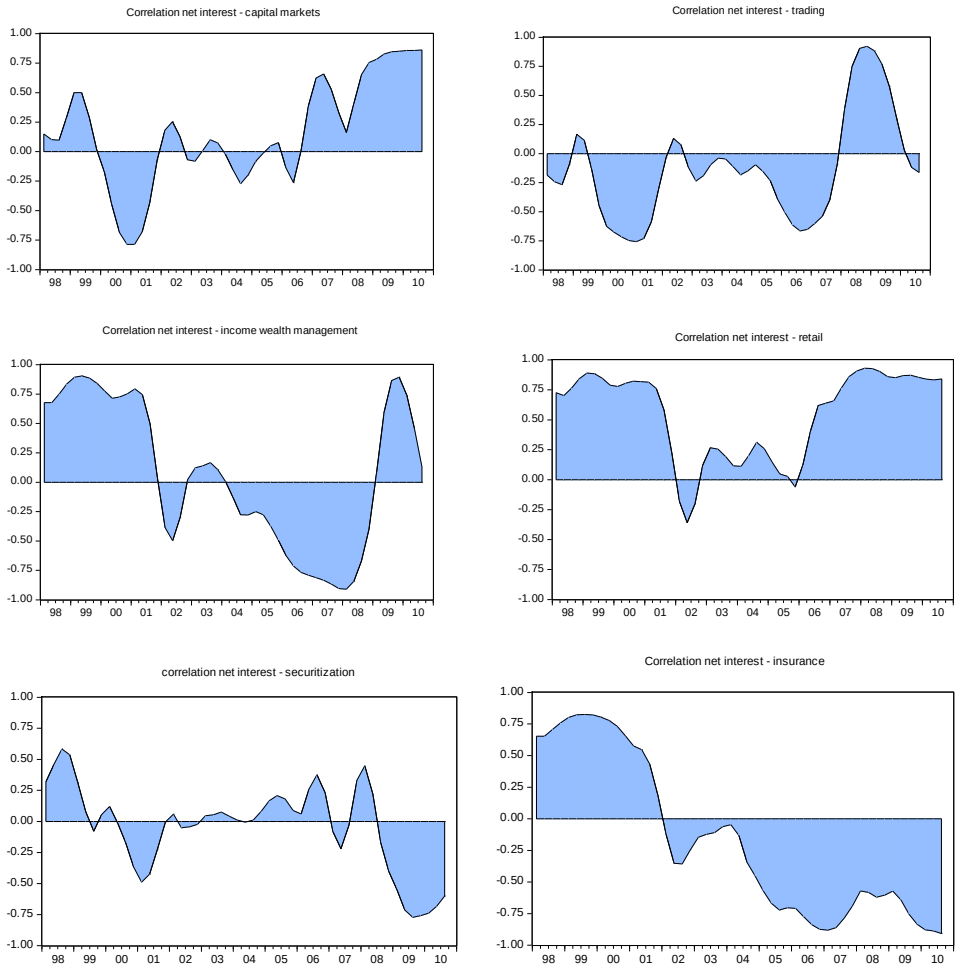
Recursive estimate of the *snonin* coefficient in the *ROA* model



Note: The *snonin* coefficient is computed recursively using a rolling window of 15 observations.

Figure 14

Conditional correlations between net interest income
and the components of non-interest income (as % assets)



Note: The conditional correlations are computed with a multivariate GARCH system based on the BEKK procedure (Engle and Kroner 1995).