Review of Economics & Finance
Submitted on 06/08/2015
Article ID: 1923-7529-2016-02-57-18 Christian Calmès, and Raymond Théoret

The Asymmetric Impact of Portfolio Mix on Bank Performance over the Business Cycle: U.S. and Canadian Evidence

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Abstract: We analyze the dynamic linkage between fee-based income and bank performance linkage in the aftermath of the crisis. Surprisingly, our time series approach suggests that the share of fee-based income keeps contributing substantially to bank return on assets (*ROA*) and risk-adjusted *ROA* after the crisis. More precisely, our multivariate GARCH framework suggests that the co-movements between *ROA* and fee-based income return are asymmetric—i.e., crucially depend on the phase of the business cycle.

Keywords: Bank, Diversification, Business cycles, Multivariate GARCH, GMM

JEL Classifications: C32, G20, G21

1. Introduction

It is now widely admitted that the activities most related to market-based banking are riskier than those associated with traditional banking (e.g., Stiroh, 2004; Stiroh and Rumble, 2006; De Jonghe, 2009; Calmès and Théoret, 2010, 2012, 2013a, 2013b, 2014a, 2014b). However, the share of non-interest income in bank net operating revenue (*snonin*) has decreased substantially in the aftermath of the crisis (Figures 1 and 2). Likewise, the demand for bank services also contracted strongly during the last crisis (Bernanke, 1989, 1995). In this context, it is interesting to investigate how exactly this crisis has affected the interplay between bank performance and fee-based income.

The main contribution of this paper is to show that the *dynamics* of the link between bank performance and *snonin* crucially depends on banks' portfolio-mix, which in turn channels the interactions between credit-related versus market-related banking activities, and in turn impacts banks' risk-return trade-offs in a specific way. Most studies on this link are based on panel analyses, or simply simulate the effects of changes in portfolio-mix on the bank risk-return trade-off (Stiroh, 2004; Stiroh and Rumble, 2006; Laeven and Levine, 2007; Schmid and Walter, 2009). Intuitively, this kind of approach—generally relying on cross-section analysis—is not necessarily appropriate to monitor the dynamics of the bank risk-return trade-off. Instead, we rely on a time series approach, and we also analyze the link between *ROA* and *snonin* for two banking systems which display very contrasting portfolio-mixes, in order to illustrate how portfolio-mix impacts bank performance over the business cycle.

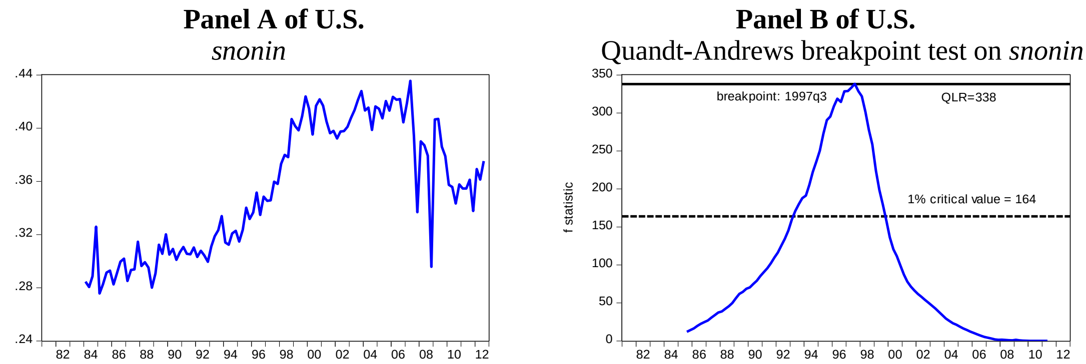


Figure 1. Quandt-Andrews unknown breakpoint test on U.S. banks' *snonin*
(Source of Figure 1: FDIC)

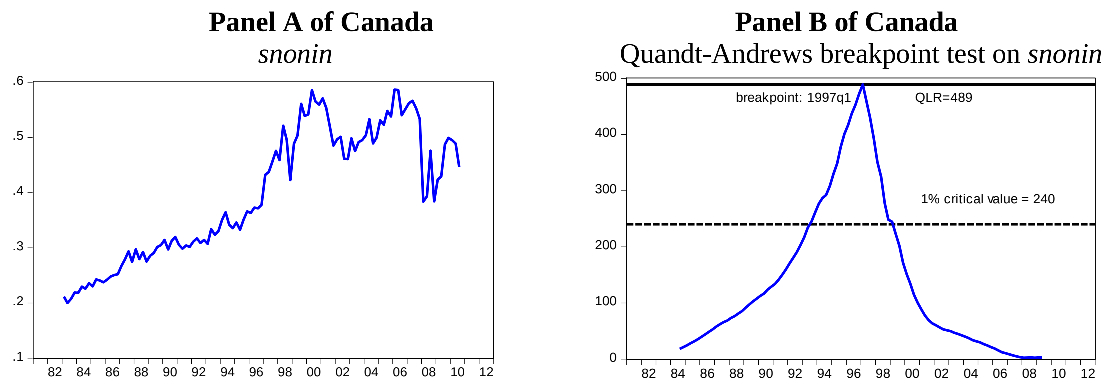


Figure 2. Quandt-Andrews unknown breakpoint test on Canadian banks' *snonin*
(Sources of Figure 2: Canadian Bankers Association; Bank of Canada)

We consider U.S. and Canadian banks in the longest time frame possible—i.e., from the first quarter of 1984 to the last quarter of 2010—and then over the subperiod 1997-2010 because of the structural break in the *snonin* time series found around 1997 for both banking systems. Consistent with the stylized facts we document in the next section, our main hypothesis (*H1*)—the responsiveness hypothesis—is that *ROA* should be more responsive to *snonin* with the U.S. banks' portfolio-mix. Indeed, we find that *snonin* contributes positively to U.S. banks' *ROA*, *even* in the aftermath of the crisis, although the link has obviously weakened during the 1997-2010 period. We attribute this first set of results to a more credit-based portfolio-mix, where fee-based activities—i.e., banking activities more related to traditional banking lines—play a dominant role.

In order to analyze the fluctuations in the co-movements between *ROA* and the components of net operating income—i.e., net interest income and fee-based income—over the business cycle, we introduce a new methodology based on a multivariate GARCH procedure and consider three additional hypotheses. We assume a complementary "dynamic" counterpart to hypothesis *H1*. According to this hypothesis (*H2*)—the persistency hypothesis—, since the contribution of *snonin* to bank performance is greater in the U.S., and since fees associated with traditional activities weight more in U.S. banks' non-interest income, the co-movements between bank performance and its components should be more persistent for U.S. banks. In Canada, *mutatis mutandis*, we might expect more volatile co-movements.

Two last hypotheses are analyzed with our MGARCH framework:

(i) Hypothesis (*H3*)—the risk hypothesis—regards how the co-movements between bank performance and key banking activities relate to the level of risk in the banking system. Our estimations suggest that the co-movements between *ROA* and *snonin* are co-linear to the level of risk in the banking system.

(ii) Relatedly, the last hypothesis (*H4*)—the asymmetry hypothesis—postulates that bank behaviour should be asymmetric according to the phase of the business cycle—i.e., crises (or recessions) might be characterized by more pronounced co-movements between bank performance and its components (Dewachter and Wouters, 2014). Our results suggest important asymmetries between expansion and contraction periods, the extreme movements between *ROA* and *snonin* being concentrated in the latter, mostly because of the magnitude and the celerity of the deleveraging process observed in recessions[1] (Calmès and Théoret, 2013a, 2014a).

This article is organised as follows. Section 2 presents a brief literature review; Section 3 provides our data and the stylized facts contrasting the U.S. and Canadian banking systems. In Section 4, we introduce a model specifically designed to analyse the relative performance of the two banking systems and we discuss the estimation methods used in this paper—i.e., GMM and multivariate GARCH. Section 5 and 6 provide the empirical results—i.e, the testing of our four hypotheses, while Section 7 concludes.

2. Brief Literature Review

The literature that documents the relationship between product-mix and bank performance is rather sparse, and rarely concerned with the way this link might be influenced by the business cycle. More precisely, most studies only focus on a few components of bank fee-based activities and do so in a rather static setting (e.g., Lown et al., 2000; Stiroh and Rumble, 2006 ; De Jonghe, 2009).

Previous studies confirm that the retail-based share of non-interest income contributes the most to *ROA* and risk-adjusted *ROA* (e.g., Vander Vennet et al., 2004; Busch and Kick, 2009). Net servicing fees associated with retail activities display a high variance in the U.S., but compensated by a higher risk premium. However, the effect of trading activities on bank performance is unclear in the literature. For instance, Estrella (2001) and Stiroh and Rumble (2006) find that these activities decrease bank risk-adjusted returns. Others show that trading might reduce risk for small banks, and Schmid and Walter (2009) show that it could increase the value of a bank's franchise. Furthermore, most empirical studies also identify insurance as providing substantial diversification benefits (Boyd and Graham, 1988; Kwan and Laderman, 1999; Lown et al., 2000; Estrella, 2001; Vander Vennet *et al.*, 2004; De Jonghe, 2009; Schmid and Walter, 2009). In our experiments, we confirm that insurance fees indeed deliver important diversification benefits, as they are weakly or negatively correlated with the other components of non-interest income (Calmès and Théoret, 2014b). Furthermore, securitization fees seem also to be an important driver of bank return (Calmès and Théoret, 2014b). According to the literature, the combination of commercial and investment banking may increase the performance of financial conglomerates (Vander Vennet et al., 2004; De Jonghe, 2009; Schmid and Walter, 2009). However, the diversification benefits associated with the other components of fee-based income are not always clear. Finally, Stiroh and Rumble (2006) find that fiduciary fees contribute positively to bank risk-adjusted returns over the period 1997-2002.

[1] Deleveraging gives raise to fire sales and other important negative externalities (e.g., Shleifer and Vishny, 2010; Gennaioli et al., 2011). Vishny, 2010; Gennaioli et al., 2011).

3. Data and Descriptive Statistics

3.1 Data sources

Bank studies are often performed on yearly data but this kind of data is not really appropriate to study the business cycle properties of time series, so we use quarterly data instead. We rely on aggregate quarterly data retrieved from the whole U.S. and Canadian banking universes. The U.S. sample comprises all U.S. banks and runs from the first quarter of 1984 to the third quarter of 2012. Data are drawn from the Federal Deposit Insurance Corporation (FDIC) database. The Canadian sample runs from the first fiscal quarter of 1984 to the third fiscal quarter of 2010. In total, we consider eight banks and quarterly data for about twenty-seven years, so that, aggregating, we are dealing with more than one-hundred observations. Data come from the Canadian Bankers Association, the Office of the Superintendent of Financial Institutions (OSFI), the Bank of Canada and CANSIM, a database managed by Statistics Canada.

Table 1. U.S. and Canadian banks' non-interest income mix

Fees \ Periods		2001Q1-2010Q4					2007Q2-2009Q2				
		mean	**median**	**s.d.**	**max**	**min**	**mean**	**median**	**s.d.**	**max**	**min**
Traditional fees											
Deposit fees	U.S.	0.16	0.16	0.02	0.25	0.13	0.18	0.17	0.04	0.25	0.14
	Canada	0.12	0.11	0.02	0.19	0.08	0.14	0.14	0.03	0.19	0.10
Fiduciary fees	U.S.	0.18	0.18	0.03	0.25	0.11	0.20	0.18	0.03	0.25	0.15
	Canada	0.18	0.17	0.05	0.36	0.11	0.25	0.21	0.07	0.36	0.25
Total traditional fees	U.S.	0.34	0.34	0.03	0.45	0.28	0.38	0.38	0.04	0.44	0.31
	Canada	0.29	0.28	0.08	0.56	0.18	0.39	0.36	0.10	0.56	0.27
Market-based fees											
capital market fees	U.S.	0.05	0.05	0.01	0.07	0.04	0.06	0.06	0.01	0.07	0.04
	Canada	0.35	0.35	0.07	0.56	0.21	0.40	0.36	0.11	0.55	0.21
trading income	U.S.	0.06	0.07	0.07	0.14	-0.23	0.01	0.04	0.14	0.14	-0.23
	Canada	0.09	0.15	0.18	0.26	-0.53	-0.14	-0.05	0.26	0.17	-0.53
Securitization fees	U.S.	0.08	0.1	0.04	0.12	-0.01	0.07	0.07	0.03	0.11	-0.02
	Canada	0.05	0.04	0.03	0.16	0.03	0.08	0.08	0.04	0.16	0.03
Total market-based fees	U.S.	0.18	0.21	0.07	0.25	-0.09	0.12	0.18	0.12	0.22	-0.09
	Canada	0.49	0.52	0.12	0.66	0.07	0.33	0.38	0.16	0.53	0.07
Other fees											
Insurance fees	U.S.	0.02	0.02	0.01	0.03	0.01	0.02	0.02	0.01	0.03	0.01
	Canada	0.06	0.06	0.03	0.12	0.02	0.09	0.08	0.02	0.12	0.06
All other fees	U.S.	0.45	0.44	0.05	0.67	0.40	0.47	0.45	0.09	0.67	0.41
	Canada	0.16	0.15	0.03	0.25	0.11	0.18	0.19	0.05	0.25	0.11

***Notes*:** This table provides the shares of each component of non-interest income for U.S. and Canadian banks over the period for which a detailed decomposition of fee-income is available—i.e, from 2001Q1 to 2010Q4. It also provides the shares for the subprime crisis—i.e., from 2007Q2 to 2009Q2. Traditional fees are associated with bank traditional activities—i.e., loans. They embed a lot of credit risk. Market-based fees are related to bank activities on financial markets.

***Data Sources*:** FDIC; Bank of Canada.

3.2 Stylized facts

3.2.1 What differences does portfolio-mix make?

Table 1 above provides the relative portfolio-mix of the U.S. and Canadian banking systems. Fees related to traditional activities include deposit fees and fiduciary fees. These fees weight more in U.S. bank non-interest income. For instance, over the period 2000-2010, this share amounts to 34% for U.S. banks compared to 29% for Canadian banks. The fact they are generally more profitable than the other ones may partly explain why the ratio of non-interest income to assets is higher for U.S. banks (Hertle and Stiroh, 2006; Calmès and Théoret, 2013b, 2014b). Note that during the subprime crisis, the share of traditional fees in non-interest income increases in both countries, and especially in Canada, which suggests that this kind of fees might be less cyclical than the others.

Market-based fees comprise the capital market fees, trading income and securitization fees. The share of these fees is much more important for Canadian banks than for the U.S. ones. For instance, over the period 2000-2010, this share amounts to 49% for Canadian banks and to only 18% for U.S. banks. The share of market-based fees clearly decreases during the subprime crisis, which suggests that this business line is very exposed to financial shocks.

Within the category of market-based fees, capital market fees are the component differentiating the most the two banking systems. Over the period 2000-2010, the average share of capital market fees amounts to 35% for Canadian banks and to only 5% for U.S. banks. Trading income also weights more in Canadian banks' non-interest income. This share is very unstable and quite exposed to financial shocks, its mean value being 0% for U.S. banks and -14% for Canadian banks during the subprime crisis.

Importantly, Canadian banks are less involved in securitization fees than the U.S. ones, the mean shares being respectively 5% and 8% over the 2000-2010 period. Note that this share registers wide fluctuations over the subprime crisis for both banking systems. Indeed, securitization tends to sustain mortgage credit at the beginning of the crisis, but to recede thereafter.

The last category of non-interest income—i.e., other fees—comprises the insurance fees and all remaining fees. The share of insurance fees is higher for Canadian banks than for U.S. banks. Note that this share is quite stable in the U.S., while it increases significantly in Canada during the subprime crisis. This pattern supports the results of many studies about the positive contribution of insurance to bank performance, especially in terms of diversification benefits (Boyd and Graham, 1988; Kwan and Laderman, 1999; Lown et al., 2000; Estrella, 2001; Vander Vennet et al., 2004; De Jonghe, 2009; Schmid and Walter, 2009; Calmès and Théoret, 2014b).

3.2.2 snonin trends and cycles

Table 2 provides the descriptive statistics for U.S. and Canadian banks over the sample—i.e., from the first quarter of 1984 to the last quarter of 2010—but also over the subperiod ranging from the first quarter of 1997 to the last quarter of 2010. We highlight this particular subperiod because of the structural break observed in the behaviour of the share of non-interest income in net operating income (*snonin*) in both countries around this year. Indeed, the Quandt-Andrews unknown breakpoint test reveals that a breakpoint is depicted for the U.S. *snonin* series around the third quarter of 1997, and around the first quarter of 1997 for the Canadian banks' corresponding series (Figures 1 and 2). Correspondingly, the relationship between the return on assets (*ROA*) and *snonin* also displays a change of regime around 1997 (Calmès and Théoret, 2010).

Turning to the descriptive statistics, first note that non-interest income growth is higher for Canadian banks (Table 2). For instance, over the 1997-2010 period, the mean rate of growth of non-interest income amounts to 8.87% for Canadian banks and 6% for the U.S. ones. More importantly however, non-interest income growth is much more volatile for Canadian banks than for U.S. banks, the respective standard deviations being 23.37% and 10.08% respectively. This divergence is due to the relative portfolio-mix of Canadian and U.S. banks (Calmès and Théoret, 2013b, 2014b) and in particular the fact that the Canadian banking system is more market-oriented—i.e., displays banking activities more related to non-traditional banking.

Table 2. U.S. and Canadian banks' descriptive statistics

Items \ Periods		1997-2010					1984-2010				
		mean	**median**	**s.d.**	**max**	**min**	**mean**	**median**	**s.d.**	**max**	**min**
Asset growth											
	U.S.	6.35	7.22	3.41	10.95	-5.60	5.13	6.18	3.77	10.95	-5.60
	Canada	8.11	7.96	6.47	21.90	-8.74	7.72	7.78	5.16	21.90	-8.74
Net interest income growth											
	U.S.	5.67	5.31	2.64	13.38	0.83	6.08	5.32	4.02	23.80	-3.13
	Canada	5.55	3.57	7.71	26.78	-9.37	6.18	5.17	6.79	26.78	-9.37
Non-interest income growth											
	U.S.	6.00	7.22	10.08	41.13	-17.39	7.11	7.68	8.37	41.13	-17.39
	Canada	8.87	10.49	23.37	50.64	-63.48	10.88	13.05	17.48	50.64	-63.48
Net operating income growth											
	U.S.	5.85	5.98	3.37	16.32	-1.34	6.45	6.16	3.92	20.36	-1.34
	Canada	6.97	7.03	10.93	29.63	-25.28	7.95	8.52	8.75	29.63	-25.28
lta											
	U.S.	0.60	0.60	0.02	0.63	0.55	0.60	0.60	0.02	0.63	0.55
	Canada	0.55	0.55	0.04	0.64	0.48	0.62	0.63	0.07	0.72	0.48
snonin											
	U.S.	0.39	0.40	0.03	0.43	0.29	0.35	0.34	0.05	0.44	0.28
	Canada	0.50	0.50	0.05	0.58	0.38	0.40	0.38	0.11	0.58	0.21
ROA											
	U.S.	0.96	1.19	0.53	1.37	-1.09	0.78	1.01	0.53	1.37	-1.09
	Canada	0.68	0.71	0.19	1.22	0.22	0.60	0.66	0.38	1.22	-2.56
RA_ROA											
	U.S.	20.91	15.50	30.22	177.83	-1.25	14.54	9.02	23.79	177.83	-1.25
	Canada	10.78	5.53	10.23	40.00	1.82	10.44	5.63	10.23	40.00	1.07
ROE											
	U.S.	10.43	12.76	5.86	15.71	-11.71	9.46	12.01	6.20	15.71	-20.30
	Canada	14.78	15.20	4.17	26.17	4.74	12.84	13.81	8.43	26.17	-57.68
Leverage											
	U.S.	10.55	10.76	1.01	11.97	8.81	13.09	11.94	3.31	19.35	8.81
	Canada	21.59	21.41	1.32	23.96	18.05	21.34	21.20	1.93	27.16	17.98
net interest income/assets											
	U.S.	3.17	3.19	0.21	3.53	2.77	3.17	3.17	0.31	3.82	2.47
	Canada	1.74	1.75	0.17	2.10	1.40	2.21	2.00	0.52	3.21	1.41
non-interest income / assets											
	U.S.	2.07	2.14	0.24	2.43	1.17	1.76	1.81	0.42	2.43	0.98
	Canada	1.78	1.83	0.34	2.47	0.90	1.48	1.40	0.42	2.47	0.71

Notes: This table provides some descriptive statistics for the U.S. and Canadian banking systems over the whole sample period—i.e., from 1984 to 2010—and over the subperiod stretching from 1997 to 2010. The growth statistics are reported at annual rates. Leverage is the ratio of assets to equity. The symbols used in this table are the following. *lta* is the loans to assets ratio. *snonin* is the share of non-interest income in net operating income. *ROA* is bank return on assets. *RA_ROA* is risk-adjusted *ROA*, defined as the ratio of *ROA* to the GARCH (conditional) standard deviation of *ROA*. *ROE* is bank return on equity.

Data Sources: FDIC; Bank of Canada; Canadian Bankers Association.

To summarize, the key variable in this study, *snonin*, is higher in Canada than in the U.S. For instance, over the period 1997-2010, the mean values of *snonin* are equal to 50% and 39% respectively. Table 2 shows that the spread between the Canadian and U.S. *snonin* series has been increased since 1984.

3.2.3 Banks' performance

Turning to the indicators of financial performance, note that U.S. banks are significantly more profitable than Canadian banks in terms of *ROA*, the mean values of *ROA* being 0.96 and 0.68 over the 1997-2010 period respectively. The positive spread between the U.S. and Canadian *ROA* series has also increased since 1984. This relationship is even stronger for the risk-adjusted *ROA*. Consequently, the first hypothesis we want to test in this paper reads as follows:

H1*: The sensitivity of ROA to snonin is greater for U.S. banks than for Canadian banks.*

The intuition is that *snonin* contributes greatly to U.S. bank performance, despite the fact that they have a lower *snonin* than Canadian banks. In fact, U.S. banks have a higher ratio of non-interest income to assets than Canadian banks. This ratio averages 2.07 for U.S. banks, and 1.78 for Canadian banks over the 1997-2010 period. Furthermore, the greater sensitivity of U.S. banks is attributable to a larger off-balance-sheet leverage (Calmès and Théoret, 2013b). U.S. banks are also more involved in the most profitable *snonin* activities, and this in turn makes the bank co-movement between fee-based activities and performance more persistent (Calmès and Théoret, 2013b, 2014b).

Accordingly we also test the dynamic counterpart of *H1*:

> ***H2:*** *Since the contribution of snonin to bank performance is greater in the U.S. and since fees related to traditional activities weight more heavily in U.S. banks' non-interest income, we expect co-movements between ROA (risk-adjusted ROA) and its components to be more persistent for U.S. banks, in line with their specific portfolio-mix. In Canada, mutatis mutandis, we expect more volatile (cyclical) co-movements.*

Indeed, market-based activities weight heavily in the fees generated by Canadian banks. This should result in more volatile co-movements between bank performance and its components. Conversely, the fees generated by U.S. banks are more associated with traditional activities. Since these fees are more stable than the market-based ones, co-movements are more persistent in the U.S.

3.3 The impact of portfolio-mix on net operating income growth

In line with Stiroh (2004) and Calmès and Liu (2009) we compute the decomposition of the variance of net operating income growth considering two aggregates of portfolio mix: non-interest income versus net interest income. During the whole sample period, the variance of U.S. banks' non-interest income growth is moderate (13.61), but the contribution of non-interest income to the variance of net operating income growth is higher than the contribution of net interest income: 9.87 versus 2.11 (Table 3). Over the period 1997-2010, the contribution of net interest income barely changes, whereas the one of non-interest income rises to 18.03. As a matter of fact, the room for more diversification benefits associated with non-interest income activities seems rather moderate in the U.S., as the two income streams are actually positively correlated.

The variance of Canadian bank net operating growth is also moderate (16.73) during the whole period (1984-2010, Table 4). The contribution of non-interest income is again higher than the contribution of net interest income: 13.00 versus 5.63. More importantly, from 1997 to 2006, and especially from 1997 to 2010 (a sample including the subprime crisis), the role played by non-interest income increases sharply. As a matter of fact, since 1997, the rise in the variance of net operating income growth is mainly due to the volatility of non-interest income (Table 4). In contrast, the variance of net interest income remains close to its average level during the recent subperiod. Note that for Canada, the covariance between net interest income and non-interest income remains *negative*, which suggests some additional diversification benefits. For instance, during the subperiod 1997-2006, these benefits still represent 26% of the standard deviation of net operating income.

Table 3. Decomposition of the variance of net operating income growth: U.S. banks

	1997-2006			1997-2010			1984-2010		
	Average share	**Variance**	**Contribution to variance**	**Average share**	**Variance**	**Contribution to variance**	**Average share**	**Variance**	**Contribution to variance**
Net operating revenue		5.57			21.20			13.61	
Net interest income	0.60	2.29	**0.82**	0.61	3.39	**1.26**	0.65	5.00	**2.11**
Noninterest income	0.40	22.37	**3.58**	0.39	118.54	**18.03**	0.35	80.54	**9.87**
Covariance		2.44	**1.17**		4.02	**1.91**		3.59	**1.63**
Diversification effect			**-0.44**			**-0.76**			**-0.91**
in % of net operating revenue s.d.			**-19%**			**-17%**			**-25%**

Table 4. Decomposition of the variance of net operating income growth: Canadian banks

	1997-2006			1997-2010			1984-2010		
	Average share	**Variance**	**Contribution to variance**	**Average share**	**Variance**	**Contribution to variance**	**Average share**	**Variance**	**Contribution to variance**
Net operating revenue		41.48			61.41			16.73	
Net interest income	0.49	16.42	**3.94**	0.50	16.23	**4.05**	0.60	15.65	**5.63**
Noninterest income	0.51	145.36	**37.81**	0.50	235.16	**58.79**	0.40	81.19	**13.00**
Covariance		-0.54	**-0.26**		-2.86	**-1.43**		-3.93	**-1.89**
Diversification effect			**-1.69**			**-1.85**			**-1.89**
in % of net operating revenue s.d.			**-26%**			**-24%**			**-46%**

Notes to Tables 3 and 4: For variance decomposition, see Stiroh and Rumble (2006). The diversification effect is the difference between the standard deviation (s.d.) of net operating income growth and the weighted sum of the s.d. of the components.

Data sources*:* Table 3 from FDIC; Table 4 from Canadian Bankers Association and Bank of Canada.

4. Empirical Framework

4.1 The model

We analyze the dynamics of the link between the share of non-interest income and bank performance over the business cycle using a framework first developed by Stiroh (2004) for the U.S., and followed by Calmès and Liu (2009) and Calmès and Théoret (2010, 2012) for Canada. The general form of this model is:

$$ROA_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 snonin_t + \mathbf{X_t}\boldsymbol{\alpha} + \varepsilon_t \qquad (1)$$

where ROA_t is the return on assets; y_{t-1} is the dependent variable lagged one period; $snonin_t$ is the share of non-interest income in net operating revenue; $\mathbf{X_t}$ is a vector of control variables, and ε_t is the innovation or error term.

Following Stiroh (2004) and Calmès and Théoret (2010, 2012), Equation (1) is also estimated on a risk-adjusted basis. To scale up *ROA*, we deflate it by its conditional volatility as measured by a GARCH (1,1) model (Calmès and Théoret, 2010).

4.2 Estimation procedures

4.2.1 Asymmetry and endogeneity issues

To estimate our model we first rely on OLS, the benchmark procedure generally used in the literature. However, in order to control for the non-linearities and asymmetries embedded in the equations' innovations, we also introduce an EGARCH estimation procedure (Nelson, 1991; Calmès and Théoret, 2014a). Indeed, bank return distributions are non-Gaussian and characterized by asymmetries and excess kurtosis (fat-tail risk). In such case, the OLS remains the best linear unbiased estimator (BLUE), but it is possible to find a nonlinear estimator asymptotically more efficient with the maximum likelihood estimator (MLE) (Judge et al. 1985, pp. 441 and following). The MLE iterations lead to efficiency gains as the coefficients of the whole model change until convergence is achieved.

There is also an obvious *endogeneity* issue stemming from the interaction between the banking variables. Indeed, the decision to diversify in market-based fees activities is obviously endogenous (Campa and Kedia, 2002; Baele et al., 2007; Laeven and Levine, 2007; De Jonghe, 2009; Calmès and Théoret, 2012). As argued by Campa and Kedia (2002), the firm's choice to diversify is likely to be a reaction to exogenous forces which impact firm's value. Hence, bank return on assets (*ROA*) may well be a function of the share of non-interest income (*snonin*), but alternatively *snonin* is also a function of *ROA* (Demsetz and Strahan, 1995; Goddard et al., 2008; Busch and Kick, 2009). In other words, market-based fees activities could generate diversification benefits, which tends to increase *ROA*, and in this case the relation between *ROA* and *snonin* should be positive; but at the same time however, a decrease in performance might also induce banks to take more risk by increasing their involvement in market-based fees activities (Boyd and Gertler, 1994; Gollier et al., 1996; Estrella, 2001; Vander Vennet et al., 2004), and then the relation between *ROA* and *snonin* would be negative. In brief, *ROA* and *snonin* are two interactive bank decision variables, and if we rely on OLS, the associated endogeneity can possibly bias the estimation of the sensitivity of *ROA* to *snonin* (Stiroh, 2004; Stiroh and Rumble, 2006; Calmès and Théoret, 2012).

To deal with this issue, we introduce a GMM estimation—an instrumental variable iterative procedure which also tackles the heteroskedasticity and autocorrelation problems present in the estimations (Hansen, 1982). We run these estimations with robust instruments based on the higher moments of the explanatory variables (Fuller, 1987; Lewbel, 1997; Racicot and Théoret, 2008, 2012 and 2014; Meng et al., 2011).

4.2.2 The multivariate GARCH

After having analyzed the static aspects of the bank risk-return trade-off, we turn to its dynamic dimensions with a multivariate GARCH model (MGARCH) (Bollerslev et al., 1988; Engle and Kroner, 1995). In order to account for our model dynamics, we introduce a MGARCH model. As far as we know, this is a novelty in the banking literature. At first, the autoregressive conditional heteroskedasticity model (ARCH(q)) may be written as:

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

where h_t is the conditional variance, α_0 is the constant, and ε_t is the innovation of the regression (Engle, 1982). According to this model, the conditional variance is related to the lagged squared innovations through the α_i coefficients. Second, if we allow the conditional variance to follow an ARMA (p,q) process, the GARCH(p,q) model obtains (Bollerslev, 1986):

$$\sigma_t^2 = h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \gamma_j h_{t-j} \qquad (3)$$

In addition to the lagged squared innovations, the conditional variance at time *t* depends on the lagged conditional variances (h_{t-j}) in the GARCH(*p*,*q*) model. However, this formulation neglects the conditional covariances between the innovations. The MGARCH model palliates this limitation. In our empirical framework, assuming a GARCH(1,1) process, each element (h_{ijt}) of the conditional variance-covariance matrix may be written as:

$$h_{ijt} = c_{ij} + a_{ij}\varepsilon_{it-1}\varepsilon_{jt-1} + b_{ij}h_{ijt-1} \qquad (4)$$

5. Main Results Regarding H1 and H2 Hypotheses

5.1 H1 hypothesis

The share of non-interest income (*snonin*) impacts significantly U.S. bank *ROA* over the 1984-2012 period, its estimated coefficient being equal to 2.87 with OLS and 3.65 with GMM (Table 5). The *snonin* variable also contributes significantly to risk-adjusted *ROA*, the estimated coefficients being 27.95 and 40.62, respectively. As expected, the discrepancy between these two coefficients signals that endogeneity indeed biases downward the coefficient associated with *snonin* in the OLS estimation (Calmès and Théoret, 2012). After the 1997 breakpoint, the estimated coefficients of *snonin* are similar to those obtained over the 1984-2012 period. However, in the risk-adjusted *ROA* regression, the estimated coefficients are somewhat lower, and only significant in the GMM estimation, which might suggest that the beneficial impact of *snonin* on U.S. bank performance has likely receded in the last decades.

Table 5. Estimation of *ROA* and risk-adjusted *ROA*: U.S. banks

	1997-2012						1984-2012					
	ROA			RA_ROA			ROA			RA_ROA		
	OLS	EGARCH	GMM	OLS	EGARCH	GMM	OLS	EGARCH	GMM	OLS	EGARCH	GMM
c	0.22	0.18	-0.31	-2.12	-0.51	-7.49	-0.12	0.01	-0.35	-4.06	-2.88	8.01
	0.76	*1.06*	*-0.62*	*-0.43*	*-0.05*	*-1.22*	*-0.71*	*0.19*	*-2.08*	*-2.98*	*-1.95*	*-6.41*
snonin	2.51	1.77	4.09	23.96	23.47	37.42	2.87	2.12	3.65	27.95	23.54	40.62
	3.65	*3.53*	*3.41*	*1.70*	*1.17*	*2.18*	*4.93*	*6.61*	*6.17*	*5.66*	*4.60*	*9.20*
llp	-0.41	-0.29	-0.31	-4.12	-5.07	-3.80	-0.56	-0.45	-0.58	-3.84	-3.07	-3.95
	-4.11	*-3.16*	*-2.86*	*-4.61*	*-2.91*	*-5.27*	*-7.42*	*-7.47*	*-8.84*	*-6.03*	*-4.31*	*-7.00*
y_{t-1}	0.11	0.36	0.26	0.40	0.29	0.40	0.34	0.44	0.30	0.42	0.41	0.35
	1.07	*0.35*	*1.82*	*3.40*	*2.72*	*3.43*	*4.32*	*5.97*	*4.33*	*4.92*	*4.41*	*4.72*
dum_crisis	-0.42	-0.35	-0.67	-	-	-	-	-	-	-	-	-
	-3.96	*-4.66*	*-5.52*	-	-	-	-	-	-	-	-	-
Adjusted-R^2	0.90	0.89	0.89	0.73	0.73	0.72	0.86	0.86	0.86	0.77	0.76	0.75
D.W.	1.60	2.11	2.15	1.84	1.66	1.86	1.40	1.71	1.30	1.87	1.72	1.75

Notes: This table provides the estimation of Equation (1) for U.S. banks. *ROA*, return on assets ; *RA_ROA*: risk-adjusted *ROA*—i.e., the ratio of *ROA* to its conditional volatility; *snonin*, share of non-interest income in net operating revenue; *llp*, ratio of loan loss provisions over total assets; y_{t-1}: the dependent variable lagged one period; *dum_crisis*: a dummy variable taking the value of 1 from the third quarter of 2007 to the second quarter of 2009 and 0 otherwise. The *t* statistics are reported in italics.

In contrast to the U.S. results, the OLS estimation of Equation (1) suggests *no* significant contribution of *snonin* to Canadian bank *ROA* over the whole sample (Table 6). When estimated with the EGARCH method, the coefficient of *snonin* is significant but low (0.19). The GMM method does not pin down any significant contribution of *snonin* to bank returns. Actually, the impact of *snonin* on risk-adjusted *ROA* turns negative with all three estimation procedures, albeit not significant.

However, after 1997, the coefficient of *snonin* becomes significant at the 1% level with the three estimation methods, and actually turns positive, in the range of 2. It is also positive and significant at the 1% level for risk-adjusted *ROA* but, once again, the range of estimated coefficients is lower than in the U.S. As expected, because it does not properly control for endogeneity, the OLS estimation procedure understates the impact of *snonin*, the estimated coefficient being equal to 13.84 with OLS versus 18.68 with GMM (Calmès and Théoret, 2012).

Summarizing, data seem to support our main hypothesis, that U.S. banks' *ROA* and risk-adjusted *ROA* are more responsive to *snonin* than the Canadian banks' counterparts.

Table 6. Estimation of *ROA* and risk-adjusted *ROA*: Canadian banks

	1997-2010						1984-2010					
	ROA			RA_ROA			ROA			RA_ROA		
	OLS	EGARCH	GMM	OLS	EGARCH	GMM	OLS	EGARCH	GMM	OLS	EGARCH	GMM
c	-0.19	-0.20	-0.27	-3.62	-3.36	-1.58	0.62	0.62	0.73	4.58	4.26	4.48
	-1.02	*-1.62*	*-1.51*	*-1.47*	*-1.55*	*-0.55*	*8.09*	*19.93*	*9.36*	*4.48*	*4.11*	*5.33*
snonin	1.94	1.82	2.22	13.84	14.02	18.68	0.07	0.19	0.18	-1.85	-1.28	-1.86
	4.95	*6.40*	*6.42*	*2.81*	*3.25*	*3.52*	*0.43*	*5.00*	*1.14*	*-0.97*	*-0.74*	*-1.08*
llp	-0.50	-0.43	-0.58	-1.99	-3.55	-8.38	-0.32	-0.28	-0.37	-2.82	-2.59	-3.22
	-4.02	*-3.35*	*-7.50*	*-1.19*	*-2.01*	*-5.84*	*-5.89*	*-11.99*	*-7.08*	*-6.00*	*-4.56*	*-6.13*
y_{t-1}	0.03	0.09	0.24	0.49	0.51	0.64	0.18	0.11	0.36	0.51	0.56	0.59
	0.39	*1.02*	*2.50*	*5.55*	*5.09*	*6.90*	*2.32*	*4.95*	*4.14*	*6.85*	*7.76*	*10.40*
Adjusted-R^2	0.49	0.49	0.50	0.40	0.38	0.41	0.41	0.38	0.44	0.44	0.43	0.43
D.W.	1.74	1.84	2.08	1.56	1.50	1.72	1.77	1.60	2.08	1.51	1.57	1.57

Notes: This table provides the estimation of Equation (1) for Canadian banks. *ROA*, return on assets ; *RA_ROA*: risk-adjusted *ROA*—i.e., the ratio of *ROA* to its conditional volatility; *snonin*, share of non-interest income in net operating revenue; *llp*, ratio of loan loss provisions over total assets; y_{t-1}: the dependent variable lagged one period. The *t* statistics are reported in italics.

5.2 H2 hypothesis

Figure 3 provides the co-movements between U.S. banks' *ROA* and its two return components—the net interest margin and the share of non-interest income in total assets—using our MGARCH approach, while Figure 4 reports the corresponding plots for risk-adjusted *ROA*. For both components of *ROA*, the respective co-movements with *ROA* (risk-adjusted *ROA*) are quite persistent. This pattern is mainly related to the portfolio-mix of U.S. banks, non-interest income weighting more fees related to traditional activities—i.e., business lines more dependent on the relationship between the bank and its clients than on the business cycle itself.

Figure 5 and 6 are the corresponding plots of the co-movements of *ROA* and risk-adjusted *ROA* with their return components for Canadian banks. Given the Canadian banks' market-oriented portfolio-mix, the behaviour of the co-movement between *ROA* (risk adjusted *ROA*) and the ratio of non-interest income contrasts with the one of U.S. banks with respect to persistence. As expected, the co-movement between *ROA* (risk-adjusted *ROA*) and the ratio of non-interest income is less persistent, and more cyclical than in the U.S. Moreover, the variance of the ratio of non-interest income shows a clear tendency to increase after 1997 and to become more sensitive to economic slowdowns and financial crises. The conditional variance of non-interest income is thus more cyclical in Canada than in the U.S, mainly because of the Canadian banks' portfolio mix particularly tilted towards market-based banking, an evidence supporting *H2*.

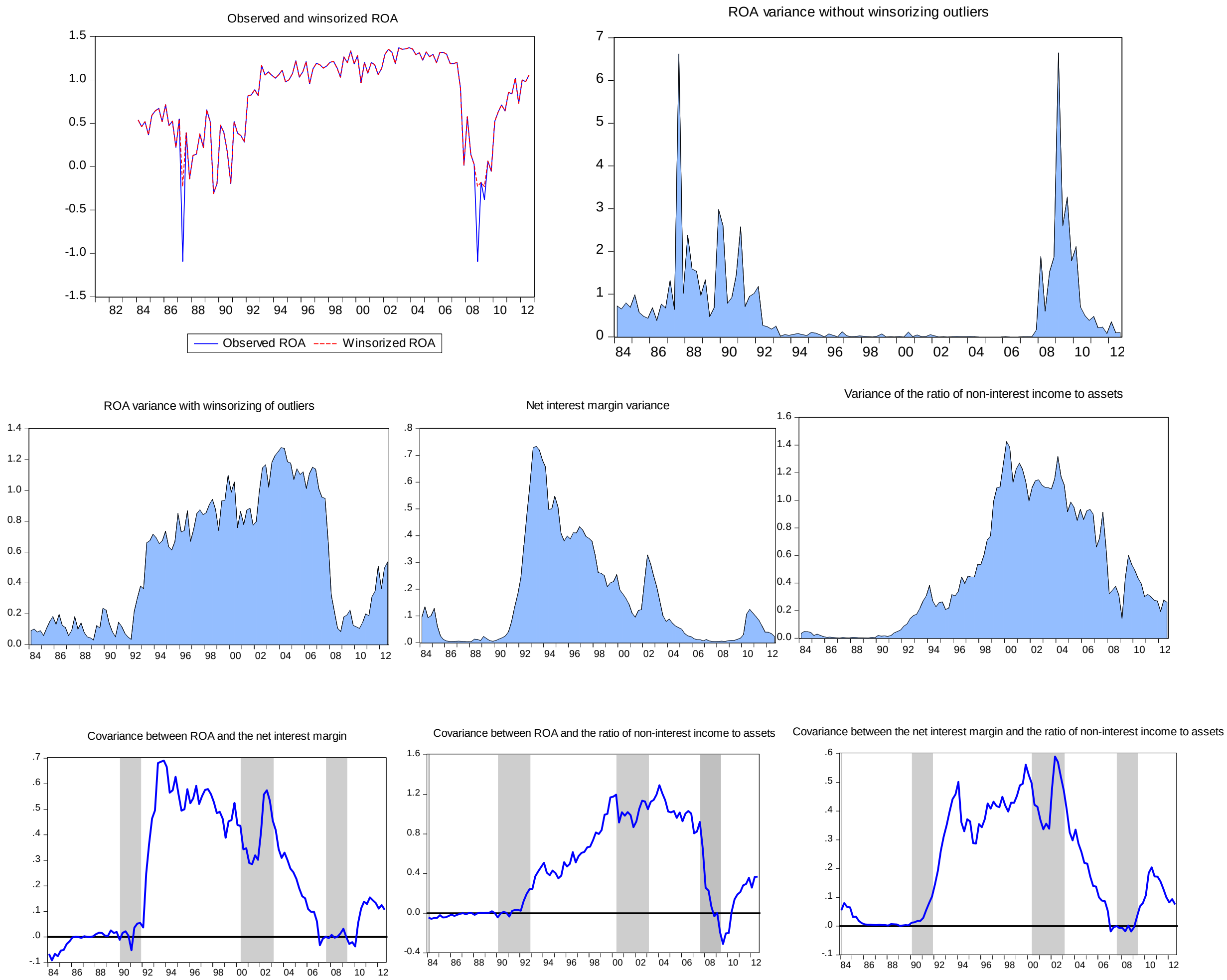


Figure 3. Conditional covariance between U.S. bank *ROA* and the components of net operating income

Notes: *ROA* is winzorized using a 95% confidence interval. The conditional variances and covariances are computed using a multivariate GARCH process based on the BEKK procedure. Shaded areas correspond to periods of recession or financial crises.

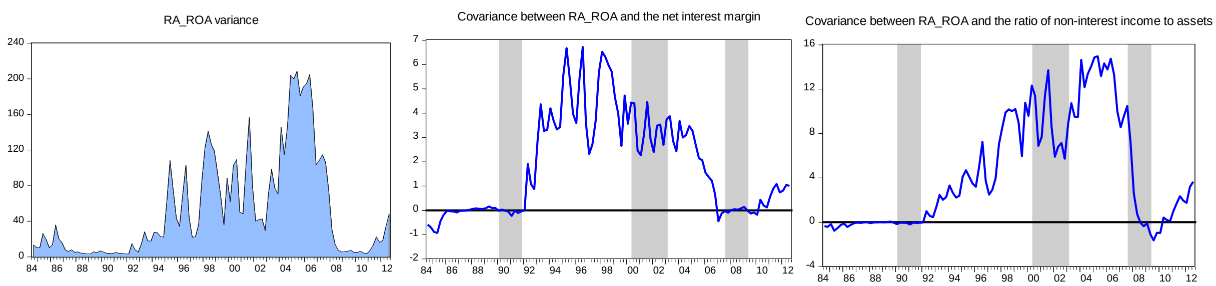
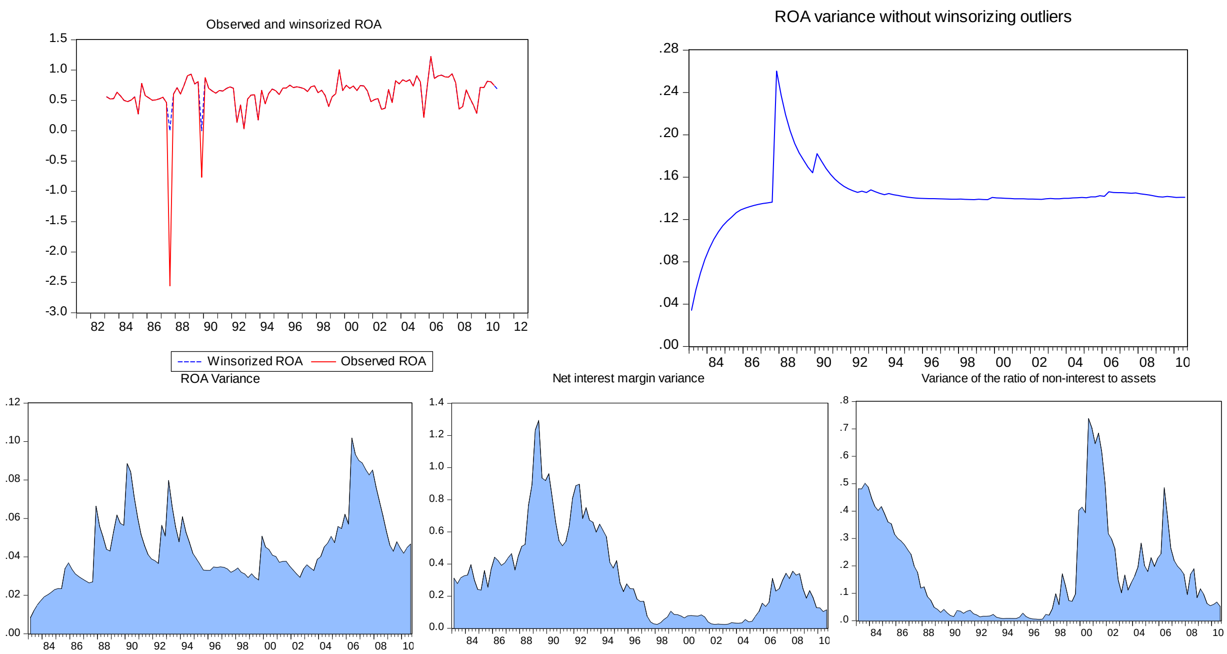


Figure 4. Conditional covariance between U.S. bank risk-adjusted *ROA* and the components of net operating income (the above three panels)

Notes: *RA_ROA* is computed as the ratio of *ROA* to its conditional variance. The variance and covariances are computed using a MGARCH process based on the BEKK procedure. Shaded areas correspond to periods of recession or financial crises.



Note: Variance is computed after winsorizing *ROA* series.

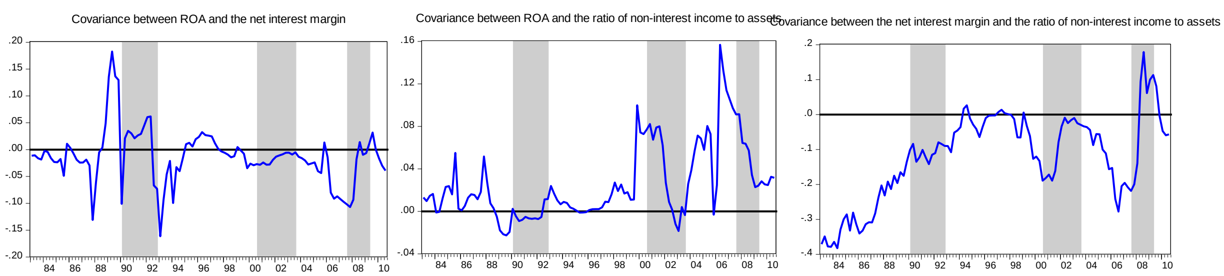


Figure 5. Conditional covariance between Canadian bank *ROA* and the components of net operating income

Notes: *ROA* is winzorized using a 95% confidence interval. The conditional variances and covariances are computed using an MGARCH process based on the BEKK procedure. Shaded areas correspond to periods of recession or financial crises.

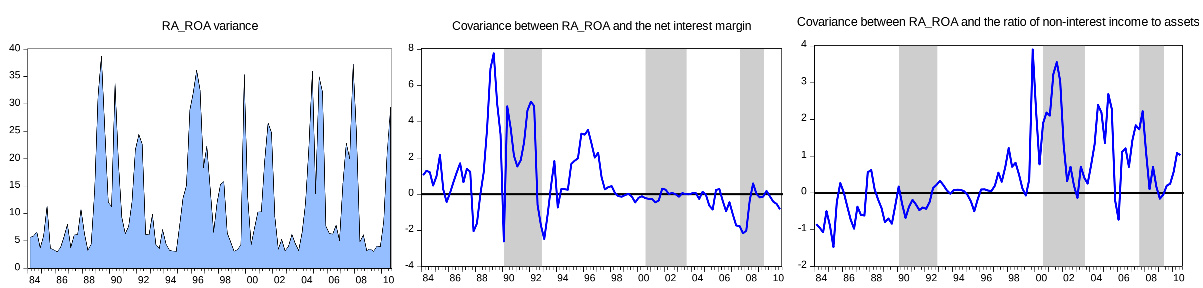


Figure 6. Conditional covariance between Canadian bank risk-adjusted *ROA* and the components of net operating income (the above three panels)

Notes: *RA_ROA* is computed as the ratio of *ROA* to its conditional variance. The variance and covariances are computed using a MGARCH process based on the BEKK procedure. Shaded areas correspond to periods of recession or financial crises.

6. Asymmetric Co-movements and the Dynamics of Risk

In this section we complement the study by showing how the measures of bank performance "cycle" with respect to net interest and non-interest income. In light of the empirical evidence we have documented so far, we formulate the two following hypotheses:

***H3**: The co-movements between bank performance and key banking activities should be related to the level of risk in the banking system (Calmès and Théoret, 2010, 2014a; 2014b)*[2].

***H4:** Crises (or recessions) might be characterized by more pronounced co-movements between bank performance and its components. Normal times should be associated with weaker co-movements. In other words, bank behaviour should be asymmetric according to the phase of the business cycle.*

6.1 The U.S. case

6.1.1 U.S. banks' risk

Before looking at co-movements between U.S. banks' *ROA* and its components, we first track the evolution of bank risk over the sample period in order to relate the co-movements to the level of risk. Three crises show up when *ROA* data are not winsorized: the financial crisis of the late 1980s, the recession of the 1990s and the subprime crisis (Figure 3). First note that the *ROA* conditional variance observed during the subprime crisis has a similar amplitude to the one observed at the end of the 1980s, when defaults of emerging countries greatly impaired banks' profits. More importantly, however, when winsorizing the outliers, the conditional variance of *ROA* is quite low from 1984 to 1992 and in the aftermath of the crisis, but there is an obvious change in regime from 1992 to 2008. Indeed, the conditional variance of *ROA* jumps after the recession of 1992, and it tends to rise thereafter until 2008.

The rising conditional variance of *ROA* from 1992 to 2008 stands as a symptom of the increase in risk within the banking system[3]. A look at the variances of the net interest margin and the ratio of non-interest income to assets helps explain this change in average risk. In line with the conditional variance of *ROA*, the variance of the net interest margin—as measured by the ratio of net interest income to assets—jumps in 1992 but decreases slowly thereafter. After the subprime crisis, its variance is as low as it was before 1992. By contrast, the evolution of the conditional variance of the ratio of non-interest income is quite similar to the one of the variance of *ROA*, so that it actually drives the variance of *ROA*—i.e., the evolution of risk in the U.S. banking system. These patterns are in line with our *H3* hypothesis.

6.1.2 U.S. banks' performance

The same applies for the co-movement between *ROA* and the ratio of non-interest income. Its behaviour mimics the one of the conditional variance of the ratio of non-interest income. It increases from 1992 to 2002, and then tends to stabilize until the crisis, before a sudden collapse. The rising risk in the U.S. banking system from 1992 to 2008 tends to be associated with a strong positive co-movement between *ROA* and the ratio of non-interest income, which supports our hypothesis of a positive link between the level of bank risk and the degree of the co-movement between *ROA* and *snonin* (*H3*). Moreover, consistent with our *H4* hypothesis, this pattern also reveals an

[2] See also Veronesi (2010, chap 18.) for a model linking the price of risk to co-movements between macroeconomic and financial variables, like returns.

[3] According to the classical financial theory, return variance is a good indicator of the risk of well-diversified portfolios. Banks' portfolios defined at the aggregate level as ours are obviously well-diversified.

obvious asymmetry in the behaviour of the co-movement according to the phase of the business cycle.

We obtain similar results when we examine the co-movements of risk-adjusted *ROA* instead of plain *ROA* (Figure 4). First note that the positive co-movement between U.S. bank risk-adjusted *ROA* and the ratio of non-interest income observed over the whole sample (excepting the subprime crisis) is in line with the estimation of our risk-adjusted *ROA* model (Table 5). Consistent with the *H3* hypothesis, this co-movement is strongly related to the conditional variance of risk-adjusted *ROA*. For instance, between 2002 and 2007, the variance of risk-adjusted *ROA* is very high in comparison with the other sample periods, as is the co-movement. Similar to the variance of risk-adjusted *ROA*, the co-movement collapses after 2007.

This dynamics can be easily explained. In the long-run, the co-movement between risk-adjusted *ROA* and the ratio of non-interest income should revert to a mean level accounting for the risk premium associated with bank risk—i.e., the long-term price of bank risk. However, in periods associated with high leveraging, as from 2002 to 2008, the risk premia increase, hence the positive co-movement. Similarly, when a shock occurs, there is a deleveraging process which loosens the co-movement between risk-adjusted *ROA* and the ratio of non-interest income.

Summarizing, the co-movements between *ROA* and its two return components are positively related to the risk prevalent in the banking system *(H3)*. However, they are not immune to important shocks like the one related to the subprime crisis (*H4*).

6.2 Canada

6.2.1 Canadian banks' risk

When winsorizing the outliers, the impact of the subprime crisis on *ROA* variance is more apparent. Looking at the return components of this variance, as in the U.S., we find that the variance of the net interest margin has decreased substantially since the beginning of the 1990s. Note also that the conditional variance of the ratio of non-interest income is lower in Canada than in the U.S., which partly explains why U.S. banks' *ROA* is more sensitive to *snonin* in the estimation of our *ROA* model (Tables 5 and 6).

6.2.2 Canadian banks' performance

As in the U.S., the co-movements between *ROA* and its return components are related to the corresponding return conditional variance (*H3*). However, the co-movement between Canadian banks' *ROA* and their net interest margin is very different from the U.S. one. The plot of this co-movement reveals that net interest margin has usually a relatively small contribution to the variations of *ROA*, except in financial crises, when it tends to mitigate the drop in *ROA*.

The co-movement between Canadian bank *ROA* and the ratio of non-interest income increases greatly after 1997, and it also becomes much more cyclical. In line with the variance of this ratio, the co-movement increases in times of expansions, but tends to collapse in times of recession or shocks (*H4*)[4]. Interestingly, the Canadian bank co-movement between *ROA* and the ratio of non-interest income stands as a good *leading* indicator of bank risk—i.e., it increases in expansion and starts to decrease before an economic downturn, and to resume its upward trend before the ensuing expansion.

Finally, note that after the breaking point of 1997, the co-movement between risk-adjusted *ROA* and net interest margin is close to 0 in Canada, except before the subprime crisis when it turns negative, a situation corrected during the crisis (Figure 5). By contrast, the traditional activities perform much better in the U.S. in terms of risk-adjusted *ROA*. Consistent with our previous estima-

[4] Like the Enron's shock in 2005 which led to a drop in this co-movement.

tions, we also find that the co-movement between Canadian risk-adjusted *ROA* and the ratio of non-interest income is negative or near 0 before 1997, which might be associated with a learning process period (Calmès and Théoret, 2010). After 1997, as in the U.S., the co-movement is usually positive, but it is much more volatile than in the U.S. This larger asymmetry in the Canadian banking system relates to its more market-based portfolio-mix.

7. Conclusion

The main contribution of this paper is to show that the link between bank performance and its components fluctuates over the business cycle. Compared to previous studies, which often adopt a static framework, our analysis provides a comprehensive description of the cyclical properties of the bank risk-return trade-off. We find that non-interest income tends to contribute positively to bank performance regardless of the portfolio-mix involved. More importantly, we show that this positive contribution is associated with a progressive building-up of risk in expansion, whereas the co-movement between risk and performance tends to collapse in period of turmoil. In other words, we find that the cyclical co-movements between bank performance and its components—especially non-interest income—are asymmetrically related to the level of risk at play in the banking system.

The nature of the portfolio-mix likely plays a decisive role in explaining this dynamics. For example, being more involved in the retail business, our findings support the view that U.S. banks tend to benefit more from fee-based activities than their Canadian counterparts (Hirtle and Stiroh, 2006; Calmès and Théoret, 2014b). By contrast, due to a portfolio-mix focusing more on market-based banking, the co-movements between banks' performance measures and the ratio of non-interest income are more volatile and less persistent in Canada.

To summarize, depending on their portfolio-mix, banks react differently to unexpected shocks. Ultimately, the co-movements between bank performance and its components are endogenous to the banking system. Based on our experiments, we might thus argue that the regulatory authorities should consider carefully the bank portfolio-mix specific to the country zone they examine to formulate effective regulation of market-based banking.

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