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The views expressed in this paper are those of the authors.
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Abstract

Our contribution in this paper is threefold. First, we survey the empirical literature on consumption smoothing mechanisms of regional economic shocks. Second, building on the work of Asdrubali et al. (1996), we present evidence on the role played by various smoothing mechanisms for specific economic shocks affecting Canadian provinces. Third, we assess whether smoothing mechanisms play a role at the North American level in facilitating the adjustment to shocks affecting Canada and the United States specifically. Our main conclusion is that there appears to be substantially more smoothing of specific provincial shocks across Canadian provinces than there is smoothing of specific shocks affecting the two countries. From this perspective, and in the absence of major structural changes, a Canada–U.S. monetary union would pose several challenges. We also conclude that the "quantity anomaly," i.e., the empirical finding that consumption tends to be less correlated than output across countries and across U.S. states, is not present in Canadian provincial data.

JEL classifications: F33, F36, G15
Bank of Canada classifications: Exchange rates, Exchange rate regimes

Résumé

L'étude apporte une contribution à trois égards. Les auteurs commencent par passer en revue les études empiriques traitant des mécanismes qui permettent d'atténuer l'incidence des chocs économiques régionaux sur la consommation. S'inspirant des travaux d'Asdrubali et coll., ils présentent ensuite certains résultats concernant le rôle joué par divers mécanismes de lissage de la consommation en présence de chocs économiques spécifiques aux provinces canadiennes. Les auteurs se demandent enfin si ces mécanismes facilitent l'ajustement de l'économie nord-américaine aux chocs frappant à la fois le Canada et les États-Unis. Leur principale conclusion est que les chocs spécifiques aux provinces canadiennes semblent mieux amortis d'une province à l'autre que les chocs communs aux deux pays. De ce point de vue et en l'absence de changements structurels majeurs, une union monétaire entre le Canada et les États-Unis poserait plusieurs problèmes. Les auteurs constatent également que l'« anomalie quantitative », soit le résultat empirique selon lequel la consommation est moins corrélée que la production d'un pays à l'autre et d'un État américain à l'autre, ne se vérifie pas dans le cas des provinces canadiennes.

JEL: F33, F36, G15
Classifications de la banque : Taux de change, Régimes de taux de change

Introduction

Recent developments, notably European monetary union, have stimulated economic research on the costs and benefits of monetary unions. Researchers have taken various approaches.[1] On the theoretical side, two main approaches can be distinguished by the frictions generating the monetary non-neutralities that make the exchange rate regime relevant.[2] Price and wage rigidities are at the heart of contributions by Bayoumi (1994), Ricci (1997), and Beine and Docquier (1998). These authors provide general-equilibrium models formalizing the original insights on optimum currency areas provided by, most notably, Mundell (1961), McKinnon (1963), and Kenen (1969). In this literature, the key advantages of a common currency are that it reduces transaction costs and uncertainties inherent to a fluctuating nominal exchange rate. The main cost a common currency imposes is the loss of nominal exchange rate variations as an adjustment mechanism in the event of a specific shock in one region of the monetary union. As a consequence, one might expect greater volatility in that region's output and employment. However, alternative mechanisms such as labour mobility and transfers from a central government or other sources could compensate for the absence of nominal exchange rate movement.

Taking a different tack, Helpman and Razin (1982) and Neumeyer (1998) emphasize the implications of insurance markets' incompleteness for the choice of an exchange rate regime. They conclude that exchange rate variability can be beneficial because real payoffs of nominal assets denominated in different currencies will differ, which increases the opportunities to insure against real economic shocks. In these models, the desirability of a monetary union increases with the degree of completeness of insurance markets, because market completeness makes diversification in various currencies less critical.

Most of the empirical literature tries to assess the costs and benefits of monetary unions in the spirit of the models focussing on price and wage rigidities. For instance, there have been numerous studies of the degree of shock or business-cycle asymmetry across regions of existing monetary unions or regions seen as monetary union candidates (e.g., Bayoumi and Eichengreen 1994, or Dupasquier et al. 1996). Also, many studies have focused on adjustment mechanisms such as labour mobility and transfer mechanisms. For example, Eichengreen (1993) and Blanchard and Katz (1992) study labour mobility, while Sachs and Sala-i-Martin (1992), von Hagen (1992), and Bayoumi and Masson (1995) discuss government transfers. Recently,

1. Lafrance and St-Amant (1999) survey the recent literature. Fenton and Murray (1993) is a useful survey of the earlier literature.
2. Helpman (1981) and Lucas (1982) developed welfare-equivalence theorems for alternative exchange rate regimes in environments where asset markets are complete and money is neutral. While this is a useful benchmark, it has little to do with the real world.

Asdrubali et al. (1996), Sorensen and Yosha (1998), and others have developed techniques to estimate jointly the role of various market and government mechanisms in smoothing region-specific shocks. In this paper, we build on the Asdrubali et al. and Sorensen and Yosha papers by estimating the relative importance of alternative smoothing mechanisms within Canada and between Canada and the United States.

Our contribution is threefold. First, we briefly survey the empirical literature on federal and market-smoothing mechanisms. Second, we present evidence on consumption smoothing and the role played by various mechanisms in smoothing specific economic shocks affecting Canadian provinces. This includes evidence on the contribution of different fiscal mechanisms (such as direct taxes and unemployment insurance) and evidence on how the importance of the various mechanisms has evolved through time. Third, we assess whether smoothing mechanisms help facilitate the adjustment to specific shocks between Canada and the United States.

Nominal rigidities and an incomplete insurance market both justify looking at smoothing mechanisms. For instance, in the presence of nominal rigidities, federal and market income-smoothing mechanisms can help stabilize output by stimulating aggregate demand in a region affected by a specific negative demand shock.[3] The amount of smoothing also indicates to what extent insurance mechanisms are complete in a certain geographical area. It thus provides a measure of how close that area is to being an optimum currency area from the point of view of the literature that focusses on asset markets' completeness.

Our study is of interest because the degree of consumption smoothing across regions or countries affects the costs and benefits of fixing the exchange rate. Finding a similar degree of smoothing across Canadian provinces and between Canada and the United States would imply that, from the point of view of the mechanisms that could be used in a monetary union to compensate for asymmetric shocks, a common currency would not be very challenging. Conversely, finding much more smoothing across Canadian provinces than between Canada and the United States would suggest that a monetary union could be problematic. Finding that there is little smoothing between Canada and the United States would not be that problematic if there were a high degree of economic-shock symmetry between the two countries. However, assymetry of shocks and, to a lesser extent, of business cycles has been found in empirical studies.[4]

In section 1 of this paper, we briefly survey the empirical literature on international and intranational smoothing mechanisms. In section 2, we present our methodology and the data we

3. Note however that the role of *public* transfers as a smoothing mechanism has been questioned by some economists, including Courchene (1993) and Obstfeld and Peri (1998), who conclude that they are too persistent and may in fact impede economic adjustment instead of facilitating it.
4. See, for instance, Bayoumi and Eichengreen (1994) and Dupasquier et al. (1996).

use. Section 3 discusses results for both the intra-Canada smoothing of regional shocks and the smoothing of shocks affecting Canada and the United States. We conclude in section 4.

Our main conclusion is that there is substantially more smoothing of specific provincial shocks among Canadian provinces than there is smoothing of country-specific shocks in North America. In the case of intra-Canada smoothing, we find that in recent years capital markets have become the most important smoothing mechanism. We estimate that the unemployment insurance system is the most important channel of federal-transfers smoothing. As well, we find that the "quantity anomaly,"—the empirical finding that consumption series are less correlated than are output series across countries and across U.S. states—is not present in Canada. In fact, we find that consumption series are much more correlated than are output series across provinces. This in itself is consistent with substantial consumption smoothing in Canada.

1. The literature on international and intranational smoothing

This literature has evolved from studies focussing on fiscal federalism mechanisms to studies taking into account market-based smoothing mechanisms.

1.1 Fiscal federalism

In many countries, a region experiencing an adverse shock can count on net transfers from other regions through the central-government budget. While the tax obligations of the afflicted region fall, it benefits from higher subsidies and higher social expenditures from the centre. However, these compensatory mechanisms usually do not exist between countries.[5]

Many studies have tried to estimate how much stabilization regions get in practice via net transfers from the central government after specific regional shocks. Mélitz and Zumer (1998) discuss the relevant literature contrasting various approaches that have been used. Most researchers have focussed on the United States and obtained estimates of around 20 per cent, i.e., a region-specific shock lowering income by one dollar gives rise to transfers of 20 cents. An exception is Sachs and Sala-i-Martin (1992), who find a 40 per cent attenuation of regional shocks by the central government's budget. However, because Bayoumi and Masson (1995) argue that the Sachs and Sala-i-Martin estimation method uses series in levels averaged over time, it cannot distinguish between stabilization and the long-run income-redistribution effects of fiscal policy. The latter relates more to equity considerations than to the efficiency of economic adjustment in a monetary union. Other studies' results are more related to economic stabilization. Results for Canada tend to show a similar amount of stabilization but more redistribution than occurs in the

5. An exception is Europe, where there are transfer mechanisms through common institutions. However, this is still very limited.

United States (e.g., Bayoumi and Masson 1995, Mélitz and Zumer 1997, Kneebone and McKenzie 1998, and Obstfeld and Peri 1998).

1.2 Adding in the role of market mechanisms

Market mechanisms can also aid consumption smoothing, facilitating the participation of a region in a monetary union. For instance, members of a monetary union can smooth consumption via cross-ownership of productive assets. Also, they may smooth consumption by lending and borrowing on credit markets. If markets were complete, there could be perfect risk sharing through these mechanisms.

However, there is evidence that financial markets are not complete in practice. For instance, Backus et al. (1992) find that cross-country output series correlations exceed consumption series correlations. The opposite would be expected in the presence of consumption smoothing. This finding is the quantity anomaly. Hess and Shin (1997) and Sorensen and Yosha (1998) report similar results at the intranational level for the United States. However, there might be a measurement problem with the U.S. results because data on retail sales are used in the absence of data on regional consumption. Also, Stockman and Tesar (1995) show that introducing taste shocks in a model with complete markets may reconcile the theory with the empirical findings. There could be substantial consumption smoothing across countries or regions, even in the presence of the quantity anomaly. Sorensen and Yosha (1998) present correlations of income series and find that they are indeed higher than those of output series, which they interpret as evidence of income smoothing across U.S. states.

Capital market studies, such as French and Poterba (1991) and Tesar and Werner (1995) for the United States and Japan, find that foreign assets form a very small portion of investors' portfolios—around 5 to 10 per cent. This is also consistent with very little international risk sharing.

Several authors have tried to estimate how much income or consumption smoothing occurs in practice. Atkeson and Bayoumi (1993) and Bayoumi et al. (1999) develop simple empirical models, which they estimate with data for states of the United States, regions of the U.K., and a group of European countries. They find much more smoothing of labour and capital income across regions of the United States and the U.K. than across OECD countries or in Europe. Bayoumi and Klein (1995) propose a method based on the idea that individuals in a financially integrated geographical area smooth consumption with respect to movements in aggregate income in that area. Thus, regional consumption follows regional income if individuals use only regional capital markets, but it follows national income or global income if individuals use national or world capital markets. They conclude that the provinces of Canada are a financially integrated area but that they are only partially integrated with the rest of the world.

One possible limitation of this approach is that the results might depend on some simplifying assumption, such as the one that the world is made of different types of representative consumers having differing access to borrowing and lending and who are unable to borrow or lend to each other. Moreover, it fails to analyze the channels by which smoothing occurs.

In contrast, Asdrubali et al. (1996) use an approach allowing them to identify various mechanisms through which risk sharing can occur in the United States. They emphasize three mechanisms. First, the members of the federation can share risk via cross-ownership of productive assets, facilitated by a developed capital market. Second, income smoothing can be provided by the tax-transfer system of the central government. Third, the members of the federation may smooth their consumption through lending and borrowing in credit markets. They call these capital-market, federal-government, and credit-market smoothing mechanisms. They also propose a framework for quantifying the amount of interstate risk sharing achieved through each of these smoothing mechanisms. Moreover, they decompose these mechanisms into more disaggregated subcomponents.

Their method uses panel data and is based on an identity decomposing the cross-sectional variance in per-capita gross U.S. state product into several components (this is discussed in section 3). In their base-case estimation, using a sample of annual data from 1963 to 1990, Asdrubali et al. find that 62 per cent of shocks to the per-capita gross product of individual states are smoothed through transactions in financial markets (39 per cent through the capital market and 23 per cent through the credit market), 13 per cent are smoothed by the federal tax-transfer system, and 25 per cent are not smoothed. Therefore, although perfect insurance is not achieved, there is considerable risk sharing among U.S. states and most of that risk sharing comes through decentralized market mechanisms.

Sorensen and Yosha (1998) explore income and consumption smoothing patterns among European Union (EU) countries and Organisation for Economic Co-operation and Development (OECD) countries using a methodology similar to that of Asdrubali et al. Not surprisingly, they find that public transfers contribute more to consumption smoothing in the United States than in either the OECD or the EU. The total amount that is not smoothed among OECD nations, and especially the EU nations, is considerably larger than the amount not smoothed among U.S. states. These results suggest that capital and credit markets are more integrated among U.S. states than among EU or OECD countries.

Four recent papers build on the work by Asdrubali et al. and Sorensen and Yosha. Mélitz and Zumer (1999) consider various countries and groups of countries using an approach slightly different than that used by Asdrubali et al., but find similar results for the United States. For Canada, they find that smoothing through credit and capital markets amounts to 54 per cent, while smoothing through government transfers is about 9 per cent. Some 37 per cent of provincial

output shocks are left unsmoothed. However, Mélitz and Zumer do not show much detail for Canada. For instance, they do not present disaggregated results for the various federal fiscal instruments and they do not study whether the role of the various mechanisms has changed over time.

We also see problems with Mélitz and Zumer's analysis. For instance, even though provincial price series are available, they deflate provincial output, income, and consumption data with aggregate Canadian price series. Another problem is that their measure of federal transfers excludes transfers to provincial governments, which implies that they underestimate the role of federal transfers as a smoothing mechanism. Finally, Mélitz and Zumer do not correct for autocorrelation and heteroscedasticity in their estimations.

Del Negro (1998) and Crucini (1999) take into account the intertemporal aspects by using measures of permanent income instead of current income. Del Negro finds that there is very little smoothing of specific country shocks across Europe. Crucini reports estimates consistent with a substantially higher degree of consumption smoothing across U.S. states and Canadian provinces than across the G-7 countries. However, he does not identify smoothing channels.

Athanasoulis and van Wincoop (1998) propose an approach using measures of relative growth uncertainty for American states based on the residuals from VAR models. They find that 71 per cent of potential welfare gains from risk sharing have already been achieved in the U.S. economy; 60 per cent through financial markets and 11 per cent through federal fiscal policy.

A limitation common to Del Negro, Crucini, and Athanasoulis and van Wincoop is that their results are not as disaggregated as Asdrubali et al. (1996) or Sorensen and Yosha (1998). In particular, they do not identify disaggregated fiscal smoothing channels and do not identify separate smoothing through credit and capital markets. Another limitation is the use of generated variables in the regressions, such as measures of permanent income or estimates with VAR models of output shocks, that could lead to large measurement errors and biased estimates.

We draw three main conclusions from this literature. First, there appears to be a significant amount of consumption smoothing in the presence of regional specific shocks achieved at the subnational level. Second, although fiscal mechanisms play a significant role, market mechanisms appear to be more important. Third, there appears to be little smoothing at the international level. The results suggest that there is a substantial degree of risk sharing among Canadian provinces, principally through market mechanisms. We see a need, however, for a detailed study of the mechanisms through which this occurs. We also see a need, in the context of the debate on a Canada–United States monetary union, for results on the amount of risk sharing between Canada and the United States. We are not aware of any research on the latter question. What results are available are for larger groups of countries.

2. Methodology and data

We begin with a comparison of output, income, and consumption correlations for Canadian provinces. Finding higher correlations of consumption and income series than for output series across Canadian provinces would be evidence of consumption and income smoothing of shocks to provincial output.

However, correlations do not provide estimates of the fraction of shocks to provincial GDP absorbed through various smoothing channels. There are several channels through which risk sharing can occur in a federal regime. Our methodology for identifying these various mechanisms follows closely that of Asdrubali et al. (1996). These authors' approach is consistent with a dynamic general-equilibrium model in which provincial output is affected by specific exogenous shocks. With full risk sharing, consumption in each province does not fluctuate in the presence of specific regional output shocks.[6]

The method involves the use of panel data and is based on the following identity decomposing the cross-sectional variance in provincial per-capita gross domestic product:

$$gdp^i = \frac{gdp^i}{pi^i} \cdot \frac{pi^i}{dpi^i} \cdot \frac{dpi^i}{c^i} \cdot c^i , \qquad (1)$$

where *pi*, *dpi*, and *c* denote, respectively, per-capita provincial income, per-capita disposable provincial income, and per-capita provincial consumption, and where *i* is an index of provinces. Note that *c* includes both private and government consumption. The time index is suppressed for the moment to simplify the presentation.

If full risk sharing after capital market smoothing is achieved, pi should not co-move with gdp. If full risk sharing is not achieved, there is scope for further income smoothing by the federal tax-transfer system. If full risk sharing is achieved at this level, dpi should not co-move with gdp. Otherwise, there is scope for further consumption smoothing in credit markets. If full risk sharing is achieved after all the channels of smoothing, c will not vary with gdp.[7]

6. See Sorensen and Yosha (1998) for a detailed discussion of the underlying model.
7. Labour mobility is yet another mechanism through which consumption smoothing can occur. However, Asdrubali et al. estimate that it plays a very small role in the United States, at least in the short run, since it tends to be slow. Blanchard and Katz (1992) also show significant but slow adjustment through mobility. The role of labour mobility in smoothing consumption is likely to be even smaller in Canada, where labour is usually seen as less mobile than in the United States (Obstfeld and Peri 1998).

We take logs and differences in (1), multiply both sides by $\Delta\log gdp^i$, and take expectations to get the following decomposition of the cross-sectional variance in gdp^i:

$$var\{\Delta\log gdp^i\} = cov\{\Delta\log gdp^i, \Delta\log gdp^i - \Delta\log pi^i\}$$
$$+ cov\{\Delta\log gdp^i, \Delta\log pi^i - \Delta\log dpi^i\}$$
$$+ cov\{\Delta\log gdp^i, \Delta\log dpi^i - \Delta\log c^i\}$$
$$+ cov\{\Delta\log gdp^i, \Delta\log c^i\} .$$

We then divide by the variance of $\Delta\log gdp^i$ and obtain the following:

$$1 = \beta_K + \beta_F + \beta_C + \beta_U,$$

where the β are the ordinary least squares estimates of the slopes in the following regressions:

$$\Delta\log gdp_t^i - \Delta\log pi_t^i = v_{K,t} + \beta_K \Delta\log gdp_t^i + u_{K,t}^i , \quad (2)$$

$$\Delta\log pi_t^i - \Delta\log dpi_t^i = v_{F,t} + \beta_F \Delta\log gdp_t^i + u_{F,t}^i ,$$

$$\Delta\log dpi_t^i - \Delta\log c_t^i = v_{C,t} + \beta_C \Delta\log gdp_t^i + u_{C,t}^i ,$$

$$\Delta\log c_t^i = v_{U,t} + \beta_U \Delta\log gdp_t^i + u_{U,t}^i .$$

β_K, β_F, and β_C are interpreted as the incremental percentage amount of smoothing achieved via, respectively, capital markets, federal transfers, and credit markets and β_U is interpreted as the amount not smoothed. Note that provincial governments' net borrowing on credit markets is included in credit markets' smoothing. If $\beta_U = 0$, full risk sharing is achieved and $\beta_K + \beta_F + \beta_C = 1$. If full risk sharing is not achieved, then consumption in province i varies positively with idiosyncratic shocks to province i's output, and $\beta_U > 0$. Hence, $\beta_K + \beta_F + \beta_C < 1$. The $v_{X,t}$ are fixed-time effects capturing year-specific impacts on growth rates, most notably the impact of the growth in aggregate Canadian real gross domestic product. The β coefficients will then be weighted averages of the year-by-year cross-sectional regressions.[8] These coefficients are not constrained in any manner.

As noted by Sorensen and Yosha (1998), the cross-sectional variance decomposition presented in (2) is not affected by the possible presence of the idiosyncratic taste shocks mentioned by Stockman and Tesar (1995). Since it is the left-hand-side variable that could be subject to such shocks, the regression coefficients β_C or β_U are not biased.

To take into account autocorrelation in the residuals, we assume that the error terms in each equation and in each province follow AR(1) processes. We also allow for specific provincial

8. See Asdrubali et al. (1996), footnote 5, for an explicit formula.

heteroscedasticity. In practice, we estimate the system in (2) by a two-step generalized least squares procedure. Estimations are performed with STATA.

We further decompose the amount of income smoothing by the federal government. To do this we proceed as follows. Consider, for instance, federal direct taxes. We first measure the sensitivity of $\Delta \log pi$ to $\Delta \log gdp$ using the method described above. Then we measure the sensitivity of $\Delta \log(pi$ + federal direct taxes) to $\Delta \log gdp$. The difference between the two regression coefficients is the amount of smoothing achieved by federal direct taxes.

We describe the sources of our data in detail in Appendix 1. Note that we use provincial consumer price index (CPI) data to deflate provincial series.[9] As mentioned previously, Mélitz and Zumer used aggregate Canadian CPI series for Canada, which may have biased their results. We do not use provincial deflators because the series available are either too short or of poor quality.

Our approach for estimating the amount of risk sharing between Canada and the United States is similar. As in the Canadian case, we first compare correlations between Canadian and U.S. consumption, income, and output series. The interpretation is the same, i.e., larger consumption and income correlations than output correlation would indicate the presence of risk-sharing mechanisms.

Following Sorensen and Yosha (1998), we then present estimates based on the following decomposition:

$$gdp^i = \frac{gdp^i}{gnp^i} \cdot \frac{gnp^i}{ni^i} \cdot \frac{ni^i}{dni^i} \cdot \frac{dni^i}{c^i} \cdot c^i , \qquad (3)$$

where *gdp*, *gnp*, *ni*, *pi*, *dpi*, and *c* denote, respectively, per-capita gross domestic product, per-capita gross national product, per-capita national income, per-capita national disposable income, and per-capita consumption (public and private), and where *i* is an index of countries. The national identities are related in the following way: GNP = GDP + net factor income, NI = GNP – capital depreciation, DNI = NI + international transfers, C = DNI – net saving. A richer decomposition is made possible at the international level by the larger available data set. For instance, GNP provincial data is not available. A difference to note is that, while transfers include only federal transfers in the Canadian case, individual transfers are also included in this instance. The data we use for the Canada–United States study is also described in Appendix 1.

9. Long and reliable deflator series are not available for Canadian provinces.

After manipulation, (3) leads to the following estimated equations:

$$\Delta\log gdp_t^i - \Delta\log gnp_t^i = v_{f,t} + \beta_f \Delta\log gdp_t^i + u_{f,t}^i \,, \tag{4}$$

$$\Delta\log gnp_t^i - \Delta\log ni_t^i = v_{d,t} + \beta_d \Delta\log gdp_t^i + u_{d,t}^i \,,$$

$$\Delta\log ni_t^i - \Delta\log dni_t^i = v_{v,t} + \beta_v \Delta\log gdp_t^i + u_{v,t}^i \,,$$

$$\Delta\log dni_t^i - \Delta\log c_t^i = v_{s,t} + \beta_s \Delta\log gdp_t^i + u_{s,t}^i \,,$$

$$\Delta\log c_t^i = v_{u,t} + \beta_u \Delta\log gdp_t^i + u_{u,t}^i \,.$$

We follow Sorensen and Yosha in interpreting β_u as the fraction of shocks to GDP that is not smoothed. The coefficients $\beta_f, \beta_d, \beta_v$, and β_s are interpreted as the fraction of shocks to GDP absorbed through factor income flows, depreciation, international transfers, and saving (the credit market), respectively. Note that governments can contribute to smoothing through saving.

Sorensen and Yosha provide the following explanation for the inclusion of depreciation. In the National Accounts data, depreciation is responsible for the difference between GNP and NI. Depreciation is calculated according to fixed accounting rules. Therefore, since the capital–output ratio is typically countercyclical, the officially calculated depreciation will constitute a larger fraction of output in recessions and a smaller fraction in booms, resulting in cross-sectional dissmoothing.

3. Results

3.1 Risk sharing in Canada

In Table 1, we compare average provincial correlations of output, income, and consumption series (all in per-capita terms) for Canadian provinces. These correlations are calculated from the logarithm of each series, differenced at the 1-year frequency (left panel) or Hodrick-Prescott filtered (right panel). As mentioned in our literature survey, most studies have found that consumption correlations are lower than output correlations—the quantity anomaly. We find no such anomaly in the Canadian data. Instead, we find that consumption correlations are higher than income correlations, which are themselves higher than output correlations. To the best of our knowledge, these results have not been presented elswhere. They are consistent with a substantial amount of consumption smoothing of regional provincial economic shocks in Canada.

Table 1: Average interprovincial correlations of real output, provincial income, disposable provincial income, and consumption, 1962–1995

	First differences	HP-filtered series
Gross domestic product	.49	.50
Personal provincial income	.52	.63
Disposable personal provincial income	.50	.66
Consumption (private and public)	.67	.77

Table 2 reports the results from estimating the equations in (4). We find that only 14 per cent of shocks to provincial gross state product are not smoothed. In their base-case estimation, Asdrubali et al. find 25 per cent for the United States. Mélitz and Zumer (1998) find 37 per cent for Canada, but their methodology is different from ours and is likely to suffer from some serious shortcomings (see the discussion in section 2). The *p* values indicate that all the results are highly significant.[10]

Table 2: Generalized least squares estimates of income and consumption smoothing, per cent, across Canadian provinces, 1962–1995[a]

Capital markets (β_K)	37 (.00)
Federal transfers (β_F)	27 (.00)
Credit markets (β_C)	27 (.00)
Unsmoothed (β_U)	14 (.00)

a. The *p* values of the estimates are in parentheses.

10. As mentioned in the methodology section, we follow Asdrubali et al. (1996) and most of this literature in assuming that specific provincial shocks are exogenous. If this were not the case, there could be an endogeneity bias. As a robustness test, we estimated the same model by two-stage least squares using various instruments. Our main result, concerning the size of the unsmoothed part, was found to be very robust, with the estimate varying between 12 and 14 per cent. However, the use of instruments tended to increase the role of capital markets and federal transfers, but to decrease that of the credit market. The size of the changes was found to vary with the instruments. Given the general difficulty finding good instruments, we decided not to emphasize these results.

Our breakdown shows that a considerable part of the shocks to gross provincial product, 37 per cent, is absorbed by capital market smoothing. This reflects the fact that the Canadian capital market is highly integrated. Credit market smoothing is also estimated at 27 per cent, which means that the total amount of smoothing through market mechanisms in Canada is 64 per cent. We estimate that the amount of smoothing accomplished via the federal tax-transfer system is 27 per cent, which is slightly more than what is found in the literature for Canada (around 20 per cent).

These results and those obtained by Asdrubali et al. (1996) indicate that smoothing via federal transfers and credit markets is higher in Canada than in the United States (see section 2). This is consistent with the fact that the Canadian federal government is generally seen as playing a larger role than its U.S. counterpart in stabilization and redistribution. Also, historically, the banking system is more integrated in Canada than in the United States, which allows for greater credit market smoothing.[11]

We further decompose income smoothing by the federal government in Table 3. Our results indicate that the major part of income smoothing by the federal government occurs through the unemployment insurance system (around 13 per cent for the total of contributions and benefits) and through federal government transfers to provincial and local governments (around 6 per cent). These transfers include money for health, education, and the Canada Assistance Plan. The important role played by unemployment insurance in consumption smoothing reflects the fact that contributions and benefits vary with the state of the economy. When unemployment is high, employers and employees as a whole contribute less and more people receive benefits.

11. It can be argued that only the unpredictable part of fluctuations in regional output should be included in the regressions because this is what economic agents want to insure against. As a robustness test of our results, we follow Asdrubali et al. (1996) and estimate autogressive models of real output with two lags. We then re-estimate equations in (4) using the innovations of the autoregressive models as the regressors instead of $\Delta \log gdp$, finding that the estimated coefficients are very similar to the ones of the original model. This is shown in Table A1 of Appendix 1. The main change is a decline to 18 per cent of federal-transfers smoothing. A disadvantage of this alternative approach is that it uses generated regressors.

Table 3: Generalized least squares estimates of components of smoothing by the federal government, per cent, 1962–1991[a]

Income taxes	–0.17
Other direct personal taxes	0.23
Direct taxes from business	3.39
Indirect taxes	2.74
Other indirect taxes	–0.87
Unemployment insurance contributions	6.25
Unemployment insurance benefits	7.28
Old age assistance	–0.35
Federal transfers to provincial and local governments	6.64
Other federal transfers	3.39
Total federal smoothing[b]	27.0

a. The sample stops in 1991 due to data limitations.
b. The coefficients of the marginal smoothing have been rescaled to add up to 27 for the sake of consistency.

The regression results for *k*-differenced data (adjacent observations are *k* years apart) are shown in Table 4. This is intended to show how income and consumption smoothing are affected by the frequency of the data. We find that the amount of capital market smoothing is little affected by the differing frequency. By contrast, while credit market smoothing declines with the differing frequency, federal government smoothing tends to increase. This is similar to the results obtained by Asdrubali et al. (1996) for the United States. They argue that the pattern for credit may reflect the fact that lenders actually pull out loans from states (or provinces) that have been unlucky for several years in a row. This is offset by federal transfers, whose importance increases with the size of *k*. At a 10-year frequency, smoothing through federal transfers becomes as important as capital markets smoothing. Asdrubali et al. found that, in the United States, k=10 was 18 per cent. The amount left unsmoothed is larger in the United States at all frequencies, reaching 53 per cent at k=10.

Table 4: Generalized least squares estimates of income and consumption smoothing across Canadian provinces,[a] for different frequencies of the data, per cent, 1962–1995

	1 year	2 years	3 years	5 years	10 years
Capital markets (β_K)	37 (.00)	39 (.00)	44 (.00)	35 (.00)	40 (.00)
Federal transfers (β_F)	27 (.00)	24 (.00)	33 (.00)	38 (.00)	40 (.00)
Credit markets (β_C)	27 (.00)	23 (.00)	18 (.00)	17 (.00)	15 (.00)
Unsmoothed (β_U)	14 (.00)	.20 (.00)	24 (.00)	27 (.00)	24 (.00)

a. The *p* values of the estimates are in brackets.

To discern trends in the respective roles played by the various smoothing mechanisms, we split our sample into two subperiods (see Table 5)

.

Table 5: Generalized least squares estimates of income and consumption smoothing,[a] per cent, 1962–1995

	1962–95	1962–78	1979–95
Capital markets (β_K)	37 (.00)	17 (.00)	52 (.00)
Federal transfers (β_F)	27 (.00)	27 (.00)	24 (.00)
Credit markets (β_C)	27 (.00)	44 (.00)	14 (.00)
Unsmoothed (β_U)	14 (.00)	.12 (.00)	15 (.00)

a. *p* values of the estimates are in parentheses.

Our results strongly suggest that the role of capital market smoothing has become more important. Asdrubali et al. (1996) conclude the same for the United States. This probably reflects financial innovations and better access to securities markets in recent years. Conversely, credit markets smoothing appears to have decreased through time in Canada; Asdrubali et al. found the

same result for the United States. The unsmoothed component and federal transfers show little change.

3.2 Canada–U.S. risk sharing

We compare average correlations of output, income, and consumption for Canada and the United States in Table 6. A striking difference with the Canadian results is that consumption and income series are less correlated than the output series of the two countries. Consumption in first differences is in fact the least correlated, which is consistent with the quantity anomaly found at the international and United-States-interstate level. As mentioned in section 2, this might reflect national consumers' preference shocks and may be compatible with significant consumption smoothing. Still, this is a major difference with what was found in the case of intranational correlations in Canada.

Table 6: Average Canada–U.S. correlations of gross domestic product, gross national product, national income, disposable national income, and consumption, 1969–1995

	First difference	HP-filtered series
Gross domestic product	.75	.75
Gross national income	.74	.76
National income	.74	.71
Disposable national income	.74	.71
Consumption (private and public)	.56	.74

Table 7 presents our estimates, based on equation (4) in section 2, of the contribution of various smoothing channels across the two countries. Compared with Sorensen and Yosha's 1998 results for Europe (for the sample 1981–90), there is more consumption smoothing across Canada and the United States (52 per cent versus 24 per cent for Europe). This is reflected in a higher degree of smoothing through savings between Canada and the United States than among European countries (62 per cent versus 24 per cent). Depreciation plays a similar role in both cases. While international transfers are found to play a small (5 per cent) but statistically significant role in Europe, not surprisingly it is completely absent between Canada and the United States. Smoothing through factor income is insignificant in all cases.

Table 7: Generalized least squares estimates of income and consumption smoothing, per cent, across Canada and the United States,[a] 1969–1995

Factor income flows (β_f)	0 (0.46)
Depreciation (β_d)	–12 (0.00)
International transfers (β_v)	0 (0.84)
Savings (β_s)	62 (0.00)
Unsmoothed (β_u)	48 (0.00)

a. The *p* values of the estimates are in parentheses.

Sorensen and Yosha (1998) decompose international smoothing through savings into smoothing via, respectively, domestic net investment and net exports. They measure the fraction of shocks smoothed via domestic net investment by estimating the coefficient in the regression of $\Delta\log gdp_t^i - \Delta\log(gdp_t^i - I_t^i)$ on $\Delta\log gdp_t^i$, where I_t^i is net physical investment. Similarly, the coefficient in the regression of $\Delta\log gdp_t^i - \Delta\log(gdp_t^i - (X_t^i - M_t^i))$ on $\Delta\log gdp_t^i$ measures the fraction of shocks that is smoothed through fluctuations in net exports.

We perform the same regressions for Canada the United States; the results are shown in Table 8. They show that the bulk of consumption smoothing is achieved via domestic investment, not international trade. Sorensen and Yosha report similar results for the OECD. This is consistent with the stylized fact, documented by, among others, Backus et al. (1992) and Blanchard and Fisher (1989), that the current account is counter-cyclical but that domestic net investment is pro-cyclical.

Table 8: Generalized least squares estimates of domestic net physical investment and net exports smoothing among Canada and the United States, per cent, 1969–1995[a]

Net Investment	66 (.00)
Net Exports	–17 (.00)

a. The *p* values of the estimates are in parentheses.

A caveat to the analysis presented in this subsection is that, due to the small number of degrees of freedom available in the Canada–United States case, we could not correct for autocorrelations and heteroscedasticity. However, we verified that, in the case of Canadian provinces, these corrections have little impact on the results. This gives us confidence that our results for the United States are sound—at least qualitatively.

4. Conclusions

In this study we analyzed the channels of consumption smoothing within Canada and between Canada and the United States. At the interprovincial level, our empirical results show that the non-smoothed part of provincial specific shocks is around 14 per cent, which is lower than the 37 per cent found by Mélitz and Zumer for Canada and the 25 per cent found by Asdrubali et al. for the United States. We find that capital markets, credit markets, and federal net transfers account, respectively, for 37 per cent, 27 per cent, and 27 per cent of the smoothing. We also find that the role of capital market smoothing appears to have increased over time. Finally, we find that there is a more important role for federal transfers in Canada than was found by Asdrubali et al. for the United States, and that this smoothing mainly comes through the unemployment insurance system.

With respect to consumption smoothing between Canada and the United States, we do not find evidence of a significant role played by capital markets or international transfers. This is consistent with the international evidence presented by Sorensen and Yosha (1998). However, we do find more consumption smoothing between Canada and the United States than is found by Sorensen and Yosha across the OECD or Europe.

In sum, we find more intranational consumption smoothing within Canada than between Canada and the United States. The absence of public transfer mechanisms between the two countries partly accounts for this. Our results also suggest less smoothing through market mechanisms between Canada and the United States than across Canadian provinces. In the

context of the theoretical literature emphasizing nominal rigidities that was discussed in the introduction, these results imply that the Canadian monetary union has effective mechanisms that can facilitate adjustment to specific regional shocks. Fewer mechanisms apparently exist to facilitate adjustment to specific country shocks in North America.

From the point of view of the literature emphasizing insurance market incompleteness (also discussed in the introduction), these results suggest that there is a large degree of insurance against specific provincial shocks inside Canada. The fact that the effect of these shocks cannot be attenuated through diversification in different currencies inside Canada is thus not much of a problem. Losing the possibility of using currency diversification at the North American level would be more consequential, since there appears to be less insurance completeness at that level.

In sum, our findings suggest that, from the point of view of consumption smoothing mechanisms in the presence of specific country shocks, and in the absence of deep structural reforms, a Canada–U.S. monetary union would encounter more difficulties than would the existing Canadian monetary union.

An interesting finding is that the quantity anomaly is absent in Canada. In fact, we find that consumption series are much more correlated than output across provinces. This is in itself consistent with the presence of substantial consumption smoothing in Canada. However, we find that the quantity anomaly is present between Canada and the United States.

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Appendix 1: The data

Gross provincial product

Gross domestic product per person is taken from CANSIM Selected Economic Indicators (matrices 6968–6977, line 15). This figure was then divided by the CPI of each province to arrive at real GDP per person.

Canadian real GDP is defined as the sum of the 10 provinces' GDP (line 14), divided by Canadian CPI. The real GDP is then divided by the sum of the 10 provinces' populations.

Provincial income

Personal income (matrices 6968–6977, line 15)
– Federal transfers to persons (matrices 6757–6766, line 9)
– Federal transfers to provinces and local governments (matrices 6757–6766, line 13 + line 14)
= Provincial income

Provincial income is then divided by CPI and then by population to give real provincial income per person.

Canadian income is the sum of the nominal provincial incomes of each province. This is divided by Canadian CPI, and again by the populations of the 10 provinces to get real Canadian income per person.

Disposable provincial income

Personal income (matrices 6968–6977, line 15)
– Direct taxes from persons to federal government (matrices 6757–6766, line 1)
– Direct taxes from corporations to federal government (matrices 6757–6766, line 2)
– Indirect taxes (matrices 6757–6766, line 4)
+ Other current transfers from persons (matrices 6757–6766, line 5)
= Disposable provincial income

Canadian disposable income is calculated in a similar way as Canadian income.

Consumption

Personal expenditure on consumer goods and services (matrices 2623–2631, 6950 line 1)
+ Government current expenditure on goods and services (line 6)
= Total consumption

Total consumption, divided by provincial CPI yields real consumption, which in turn is divided by population to give consumption per person.
Canadian consumption is calculated in a similar way as Canadian income and disposable income.

Decomposition of federal transfers and taxes

Unemployment benefits (matrices 5067–5076 and 6961 line 4)
Old age security payments (line 6)
Other transfers include:

- family and youth allowances
- war pensions
- war veterans' allowances
- pensions to government employees
- scholarship and research grants
- adult occupational training payments
- Prairie Farms Assistance Act payments
- Local Initiatives Program payments

Income taxes (matrices 5027–5053 and 6953 line 1)
Unemployment insurance contributions by employers and employees (line 4)
Other direct taxes include:

- succession duties and estate taxes
- employer and employee contributions to unemployment insurance

Direct taxes from business (matrices 6769–6788, line 2)
Indirect taxes (line 3)
Other current transfers from persons to the federal government (line 4)

Aggregate data

U.S. aggregate GDP, GNP, NI, DNI, and total consumption have been divided by the GDP deflator (all series are from OECD National Accounts, main aggregates, Volume 1, 1998) and then by U.S. population (from the International Monetary Fund's IFS International Financial Statistics database). Canadian aggregated data is calculated in the same way.

Gross domestic product
+ *net factor income from the rest of the world*
= Gross national product
– *consumption of fixed capital*
= National income
+ *net current transfers from the rest of the world*
= National disposable income
– *savings*
= Final consumption

Appendix 2

Generalized least squares estimates of income and consumption smoothing, base case and estimates with the unpredicted part of gross provincial product,[a] per cent, 1962–1995

	Base case	Unpredicted part
Capital markets (β_K)	37 (.00)	36 (.00)
Federal transfers (β_F)	27 (.00)	18 (.00)
Credit markets (β_C)	27 (.00)	22 (.00)
Unsmoothed (β_U)	14 (.00)	10 (.00)

a. The *p* values of the estimates are in parentheses.

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