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**Employment Adjustments in
High-Trade-Exposed
Manufacturing in Canada**

by

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Abstract

The study presents a model and estimates the dynamic response of employment in high-trade-exposed manufacturing to the Canadian dollar's appreciation. The evolution of employment shares of high-trade-exposed manufacturing for the 10 provinces from 1987 to 2006 is captured using a general error correction model. This model is estimated using state-of-the-art time-series–cross-sectional (TSCS) data econometrics.

The main finding of the study is that a substantial part of the adjustment to the Canadian dollar's appreciation since 2002 had already been completed in Canadian high-trade-exposed manufacturing industries by July 2007. However, simulation results suggest further employment losses in these industries if the value of the Canadian dollar remains around US\$0.95. The reason for these further losses is that employment share does not adjust immediately to movements in the exchange rate. Estimates from the models indicate that between 60 percent and 70 percent of the adjustment to exchange rate movements is completed after two years. Consequently, most of the adjustment that still needs to be done results from the appreciation of the Canadian dollar thus far in 2007.

The results also suggest that the effect of movements in the real exchange rate on employment in high-trade-exposed manufacturing is highly heterogeneous across provinces. Not surprisingly, the results suggest that the effect would be greater and particularly significant in Quebec and Ontario. If the dollar remains around US\$0.95, simulation results suggest that the proportion of the adjustment that still needs to be done (July 2007) is less in Quebec (between 18 percent and 26 percent) and Ontario (between 27 percent and 33 percent) than in Canada as a whole (between 30 percent and 36 percent). If the Canadian dollar remains at or around parity with the U.S. dollar, the proportion of the adjustment still remaining increases to the 31 percent and 37 percent range for Quebec, 39 percent and 43 percent range for Ontario, and 42 percent and 46 percent range for Canada as a whole.

There is a considerable amount of risk involved in simulation exercises of this type. The risks are related to uncertainty regarding the future evolution of two key variables of the models: the value of the Canadian dollar, and the evolution of the U.S. economy. Risk also results from model uncertainty.

Keywords: Exchange rate, labor market adjustments, Dutch disease, Kiviet adjustment, Canadian provinces

JEL classification: C5, F41, R1, R5

Résumé

On présente dans cette étude un modèle économétrique dynamique conçu pour mesurer l'incidence de l'appréciation du taux de change réel sur l'emploi dans l'industrie manufacturière exposée à la concurrence étrangère. Un modèle de correction d'erreurs est utilisé afin de rendre compte de l'évolution de la part de ce type d'emploi dans les dix provinces canadiennes de 1987 à 2006.

Le principal résultat fondé sur les dernières données utilisées dans l'étude, soit celles de juillet 2007, est que l'ajustement de l'emploi à l'appréciation du taux de change depuis 2002 a déjà été opéré en grande partie. Cependant, les résultats de simulations donnent à penser que d'autres pertes d'emploi dans les industries manufacturières exposées à la concurrence étrangère sont à prévoir si le dollar canadien se maintient autour de 0,95

É.-U. Ces pertes supplémentaires s'expliqueraient par le fait que l'emploi ne s'ajuste pas instantanément aux fluctuations du taux de change. Selon le modèle, 60 à 70 % de l'ajustement de l'emploi au taux de change est réalisé après 2 ans. Le gros de l'ajustement qui reste à faire découle de la forte appréciation du taux de change en 2007.

Les résultats portent également à croire que les effets des variations du taux de change réel sur la part de l'emploi dans le secteur manufacturier exposé à la concurrence étrangère varient considérablement d'une province à l'autre. Les effets apparaissent beaucoup plus importants au Québec et en Ontario. De plus, si le dollar se maintient autour de 0,95 É.-U., les résultats donnent à penser que la part de l'ajustement qui resterait à être opéré (en juillet 2007) est inférieure au Québec (entre 18 et 26 %) et en Ontario (entre 27 et 33 %) par rapport à l'ensemble du Canada (entre 30 et 36 %). Cependant, si le dollar se maintient autour de la parité, la part de l'ajustement qui reste à faire s'accroît et se situe dans une fourchette de 31 à 37 % pour le Québec, de 39 à 43 % pour l'Ontario, et de 42 à 46 % pour l'ensemble du Canada.

Le risque associé à des exercices de simulation de ce type est considérable en raison notamment de l'incertitude entachant les perspectives d'évolution du dollar canadien et de l'économie américaine, et de l'incertitude intrinsèque au modèle.

Mots clé: Taux de change, ajustements du marché du travail, malaise hollandaise, ajustement de Kiviet, provinces canadiennes

Classification JEL: C5, F41, R1, R5

1. Introduction

Since 2002, prices for energy and other raw commodities have been spurred on by the substantial increase in world economic activity and increased geopolitical uncertainties. For Canada, these developments translated into an improvement in its terms of trade and a 50-percent appreciation of the Canadian dollar to a 30-year record high of about US\$0.96 in recent weeks. Aggregate economic activity in Canada remained strong and the unemployment share by mid-2007 had fallen to levels not seen since 1974. However, the appreciation of the Canadian dollar and the resource boom have given rise to significant pressures across sectors and regions. The real gross domestic product (GDP) and employment grew faster in the natural resource and domestic-oriented sectors. But employment in the manufacturing sector fell by 275 400 or 11.9 percent between the last quarter of 2002 and the second quarter of 2007. The employment losses in that sector are concentrated in Quebec and Ontario and are largely in industries with a high degree of exposure to international trade, whose competitiveness has been hurt by the dollar appreciation.

Improvements in terms of trade in Canada have generated a substantial positive wealth effect and are obviously beneficial to the Canadian economy overall. From an economic point of view, the terms-of-trade shock signals that labour and capital have to be transferred from the trade-exposed manufacturing sector to the booming natural resource and domestic-oriented sectors. Geographically speaking, the adjustment implies that economic growth is switching from the industrial Quebec-Windsor core to the periphery and, more specifically but not uniquely, to Alberta's booming economy that has been fuelled by the rapid development of the oil sands industry.

The purpose of this paper is to provide estimates and to analyze the response and dynamics of employment in the high-trade-exposed manufacturing sector at the provincial level to the appreciation of the Canadian dollar.² Firms are facing adjustment

² A trade-exposed manufacturing industry is one with a higher degree of exposure to international trade than the average for the manufacturing sector as a whole. This concept is further explained in Section 4 and Appendix C.

costs and we should expect capital and labour to adjust only gradually to important shocks such as the Canadian dollar's appreciation. Consequently, we believe it important to better understand the adjustment of employment in high-trade-exposed manufacturing in Canada to the movements in the value of the Canadian dollar and to know if further adjustments should be expected.

The results of this study suggest that the effect of movements in the real exchange rate on employment in high-trade-exposed manufacturing is highly heterogeneous across provinces. Not surprisingly, the results suggest that the effect would be greater and particularly significant in Quebec and Ontario. We also find that the estimated speed of adjustment varies across the various procedures at hand for estimating fixed-effects dynamic models. This specific result should not be surprising since the fixed-effects dynamic models are known to provide biased estimates of the adjustment speed when small samples are used. For this reason, most of the empirical analysis reported in this study deals with the sensitivity of the estimated speed of adjustment in various econometric specifications.

The study also reports in-sample and out-of-sample dynamic simulations of the benchmark parsimonious model. The in-sample simulations, covering the period from 2003 to 2006, are used to evaluate the possible bias from the various estimation techniques. The out-of-sample simulations cover the period from 2007 to 2010. The purpose of this exercise is to evaluate the extent of the adjustment still to be completed in employment in high-trade-exposed manufacturing across provinces with the appreciation of the Canadian dollar thus far in 2007.³

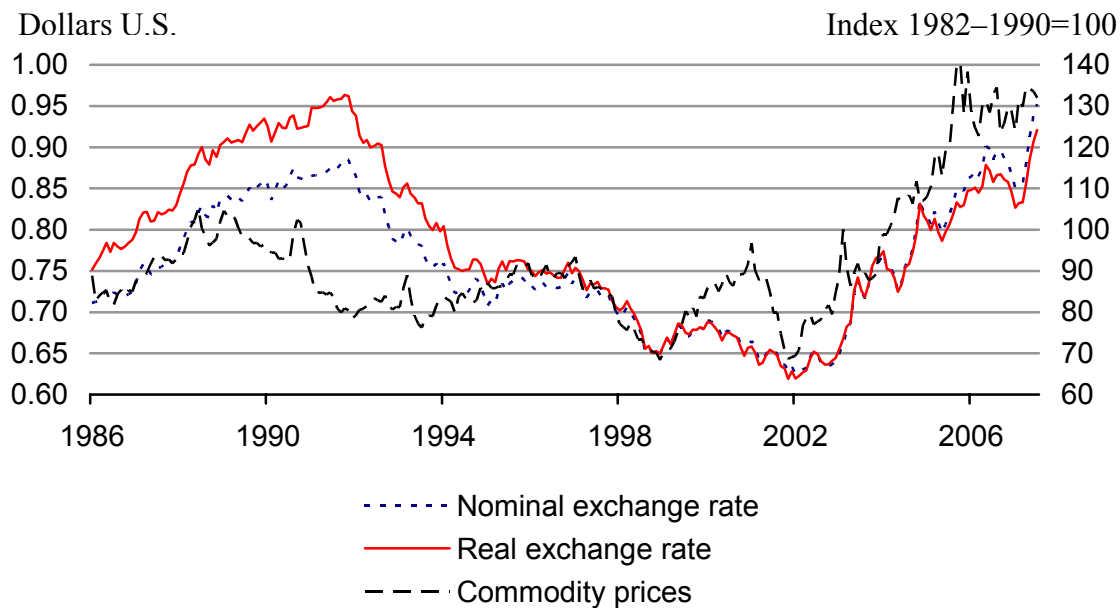
In Section 2, we synthesize the recent trends in Canadian manufacturing employment by the degree of exposure to international trade. The theoretical framework is developed in Section 3. Data and estimation methods are described in Sections 4 and 5 and the estimation results, in-sample and out-of-sample simulations are presented in Section 6. The main findings are summarized in Section 7.

³ In July 2007, the Canadian dollar reached a 30-year record high of US\$0.9521, a gain of 10 percent from December 2006.

2. Recent trends in manufacturing employment in Canada

In this decade, rapidly expanding world economies, particularly those of China and India, have led to higher demand for the natural resources — such as oil, copper, nickel and aluminum — of which Canada is an important producer. The increase in world natural resource prices, as illustrated by the Bank of Canada total commodity price index, has often been mentioned by economists as an important factor that contributed to the appreciation of the Canadian dollar (Figure 1).

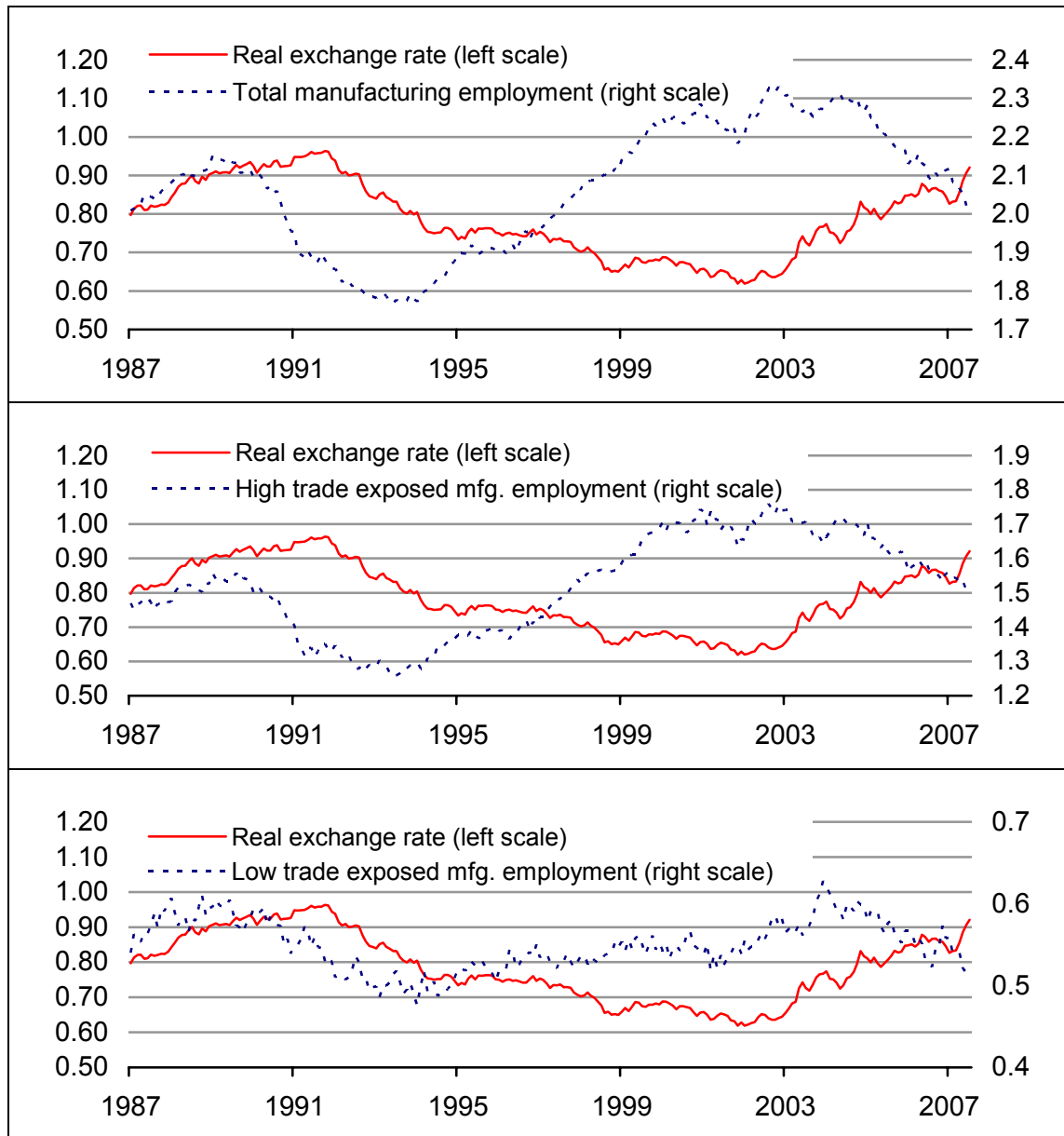
Figure 1. Canada exchange rate and the Bank of Canada's commodity price index



The appreciation of the Canadian dollar since 2002 has been accompanied by an adjustment in the labour market in the manufacturing sector. In this sector, employment decreased by 275 400 (or 11.9 percent) from the fourth quarter of 2002 to the second quarter of 2007 (Figure 2, top chart). And the employment losses were mostly in industries with a high degree of exposure to international trade (Figure 2, middle chart). Eighty percent of the decline in total manufacturing employment, the equivalent of 220 000 jobs, was in these industries and concentrated in Quebec and Ontario. In contrast,

employment in manufacturing industries with a low degree of exposure to international trade fell by 55 000 during the same period (Figure 2, bottom chart).

Figure 2. Canada real exchange rate and manufacturing employment by degree of exposure to international trade



Given the observed change in the Canadian exchange rate in the past years and the increasing importance of international trade for the Canadian economy, it is useful to model, estimate and analyze the response of manufacturing employment across the country to movements in the Canadian exchange rate. In the next section, a simple dynamic model of employment in high-trade-exposed manufacturing industries is described.

3. Theoretical framework

The general structure of our empirical model is the dynamic time-series and cross-sectional (TSCS) version of the error correction model (ECM):⁴

$$\Delta EM_{i,t} = -\beta(EM_{i,t-1} - \frac{\gamma_{1,i}}{\beta} X_{i,t-1}) + \gamma_{1,i} \Delta X_{i,t} + \eta_{i,t}. \quad (\text{ECM})$$

Here, $\Delta EM_{i,t}$, the dependent variable, is the first difference of high-trade-exposed manufacturing employment share in province $i = 1, \dots, 10$, and year $t = 1987$ to 2006. $X_{i,t}$ is a vector of K control variables; $\eta_{i,t}$, the error term, will be modelled with a fixed-effects component. In this dynamic set-up, the adjustment of the trade-exposed manufacturing employment share to a once-and-for-all shock to the exchange rate is proportional to the difference between the actual and the new equilibrium levels (the terms between brackets in the ECM equation).⁵ When the adjustment is completed, the full effect of a shock to variable X_i^* is

$$\frac{dEM_i^*}{dX_i^*} = \frac{\gamma_{1,i}}{\beta}.$$

A necessary condition for convergence of the adjustment process is that $0 < \beta < 1$. In this set-up, β is the adjustment speed.

⁴ The microfoundations for such an ECM might be derived from a labour-demand framework with adjustment costs. See, for example, Leung and Yuen (2005).

⁵ If the exchange rate is continually adjusting, the employment share adjusts continually toward a changing equilibrium level.

In our empirical investigation, the $\eta_{i,t}$ were modelled with a provincial fixed-effects component c_i and the idiosyncratic errors $\varepsilon_{i,t}$. It was impossible to use fixed-time effects since one of our main variables of interest, the real exchange rate, has only a time-series dimension. We estimate the dynamic fixed-effects models in this paper by adding $EM_{i,t-1}$ to both sides of the ECM equation and by merging the $\gamma_{1,i}\Delta X_{i,t}$ with $-\gamma_{1,i}X_{i,t-1}$. Being more specific with the list of controls yields the following TSCS regression model:

$$EM_{i,t} = (1 - \beta)EM_{i,t-1} + \gamma_{1,i} \log(REM_t) + \varphi_{1,i} \log(1 + TW_{i,t}) + \varphi_2 Z_{i,t} + \varphi_3 Z_t + c_i + \varepsilon_{i,t}. \quad (M1)$$

Our main variable of interest is REM_t , the Canadian real exchange rate. $TW_{i,t}$ is the trade-weighted tariff of province i at time t taken from Beine and Coulombe (2007). The $Z_{i,t}$ are the other controls that might account for the changes in trade-exposed manufacturing employment shares. Some of these variables, such as the provincial business cycles, have a time-series and cross-sectional dimension. Others, such as the U.S. business cycles, are constant across the i .

4. Data

To estimate the response and analyze the dynamics of high-trade-exposed manufacturing employment shares at the provincial level to the appreciation of the Canadian dollar, a balanced panel of annual data was constructed. The database includes both province-specific and aggregate data. All sources and definitions are reported in the data appendix (Appendix D).

The set of potential controls has not been restricted and we have included in various stages of our empirical modelling such variables as energy prices, a measure of China's import penetration into the Canadian and U.S. markets, provincial terms of trade and various measures of Canadian business cycles. In the final model, we retain in the set of controls only those variables that were significant and robust. These variables are the real

effective exchange rate, the provincial trade-weighted tariffs taken from Beine and Coulombe (2007), and Canadian provincial and U.S. business cycles.

This paper uses primarily the Labour Force Survey (LFS) database released by Statistics Canada. LFS provides data on employment for all the Canadian industries under the NAICS (North American Industrial Classification System) classification. (See Appendix C for list of industries by degree of exposure.) The paper focuses on manufacturing industries with a high degree of exposure to international trade by province. The data are annual and at the industry three-digit level. The variables we use in the empirical section come from this database. They are the high-trade-exposed manufacturing employment share $EM_{i,t}$ for $I = 1, \dots, 10$ and $T = 1, \dots, 20$. For a given province, the employment share of high-trade-exposed manufacturing is computed as the employment in manufacturing industries with a high degree of exposure to international trade, divided by the total labour force. The other province-specific data used in this paper are the real provincial final demand's business cycle and the provincial trade-weighted tariffs.

This study uses Dion's (1999) methodology to classify the industries into a high and low degree of trade exposure, based on their ratio of exposure to international trade. As in Dion's study, the ratio of exposure to international trade is computed as exports as a share of production less imported inputs as a share of production plus competing imports as a share of the domestic market. The ratios for all manufacturing industries were computed internally with input-output tables for the year 2000. Industries with a ratio of trade exposure above the average for the manufacturing sector are classified as having a high degree of trade exposure. Industries with a ratio below the manufacturing sector average are classified in the group with a low degree of trade exposure.

The other data used in this paper include the real U.S. business cycle and the real effective exchange rate. The real effective exchange rate is the CERI effective exchange rate deflated by the consumer price index (CPI). One should recall that an increase in the real effective exchange rate corresponds to an appreciation of the Canadian dollar vis-à-vis other currencies.

More details are given on data sources in the data appendix (Appendix D).

5. Estimation methods

Before discussing results, a few econometrics issues need to be addressed. It is well known in the literature that the data-generating process for many economic variables is characterized by stochastic trends that could result in spurious inference if the time-series properties are not carefully investigated. However, Phillips and Moon (1999) have shown that panel-data regression estimates with non-stationary data provide consistent estimators of the true value of the parameter. This is because the panel estimator averages across units and the information contained in independent cross-sectional data of the panel leads to a stronger overall signal than in pure time-series cases. Furthermore, the heterogeneity of Canadian provinces' industrial structure increases the information contained in the cross-sectional dimension of the data.

As mentioned in Section 3, our point of departure for estimating manufacturing employment with a high degree of exposure to international trade in the Canadian provinces is the general error correction model applied to a TSCS data structure in the provincial (cross-section) and year (time) dimensions. In this framework, after an exogenous shock such as an appreciation of the real exchange rate, provincial employment responds by partially adjusting to its new equilibrium level. The challenge for our empirical analysis will be obtaining unbiased estimates of the long-run elasticity and the speed of adjustment. For this purpose, we use state-of-the-art estimation techniques that have been especially designed to tackle the most important problems in estimating dynamic TSCS models in a finite sample.

The straightforward approach to estimating equation M1 is to use the least-squares dummy variable estimator (LSDV), through which the unobserved heterogeneity across the provinces is modelled with fixed effects. However, Nickell (1981) has shown that the LSDV is biased for a finite T in autoregressive TSCS models, but this bias becomes less significant as T increases. Most importantly for our analysis, Nickell (1981) shows that

LSDV estimators tend to overestimate the speed of adjustment, which is precisely our main variable of interest.

A number of consistent instrumental variables (IV) and generalized method of moments (GMM) estimators have also been proposed in the econometrics literature as alternatives to LSDV. Anderson and Hsiao (1982) suggest two simple IV estimators that, upon transforming the model in first differences to eliminate the unobserved individual heterogeneity, use the second lags of the dependent variable, either differenced or in levels, as an instrument for the differenced one-time lagged dependent variable. Arellano and Bond (1991) propose a GMM estimator for the first-differenced model that relies on both correlation structure of the disturbance and a greater number of internal instruments and that has been shown to be more efficient than the AH estimator. Blundell and Bond (1998) observed that, with highly persistent data, first-differenced IV or GMM estimators might suffer from a severe small-sample bias due to weak instruments. To solve this, they suggest a system GMM estimator with first-differenced instruments for the equation in level and instruments in level for the first-differenced equation.

A weakness of IV and GMM estimators is that their properties hold for large N , so they can be severely biased and imprecise in panel data with a small number of cross-sectional units, as it is often the case in our regional datasets. On the other hand, earlier Monte Carlo studies (Arellano and Bond [1991], Kiviet [1995] and Judson and Owen [1999]) demonstrate that LSDV, although inconsistent, has a relatively small variance compared with IV and GMM estimators. Another weakness of the GMM estimators is the underlying assumptions of stationarity of the dependent variables in the Blundell-Bond case. In fact, the validity of this procedure rests on the assumptions of the stationarity of the dependent variable, which is often not the case in macroeconomic data. Although the non-stationarity of the dependent variable may also lead to problems with the Arellano-Bond estimator because non-stationary lagged levels may not be an appropriate instrument, Bun and Kiviet (2001) have shown that, in a small-sample case, the additional bias due to non-stationarity is small.

An alternative approach based on the bias correction of LSDV has recently become popular in the econometric literature. Nickell (1981) derives an expression for the inconsistency of LSDV as N goes to infinity, while Kiviet (1995) uses higher-order asymptotic expansion techniques to approximate the small-sample bias of the LSDV estimator, which he finds can be predicted with a good precision. Because the approximation terms are evaluated, they are of no direct use for estimation. To make them operational, Kiviet suggests replacing the true parameters by estimates from some consistent estimators. Monte Carlo evidence showed that the resulting bias-corrected least-squares dummy variables estimator (LSDV) often outperforms the IV and GMM estimators in terms of bias and root mean squared error (RMSE). Other evidence from the Monte Carlo experiments — by Judson and Owen (1999) in a case of stationary dependent variables and Bun and Kiviet (2001) in a case of non-stationary dependent variables — strongly supports LSDV when N is small, which is the case in most macroeconomics panels. However, Kiviet’s approach does not address the potential endogeneity of other regressors, which GMM does.

6. Estimation results

6.1 Empirical findings

The results of our TSCS estimations of dynamic equation M1 are presented in Table 1. Interestingly, the three estimation techniques, LSDV, GMM and Kiviet, produce consistent results. In most cases, the point estimates of the various exogenous variables do not vary much across techniques and have the expected sign. However, the key adjustment parameter — 1 minus the parameter of the lagged-dependent variable being the annual speed of adjustment to the new equilibrium — varies slightly across the three techniques. The speed is higher for the GMM estimate (0.46) and the lowest for Kiviet (0.36). The adjustment speed for the LSDV estimate falls between at 0.44. These results are not surprising since, as mentioned in Section 5, Kiviet estimations are designed to correct for the tendency of LSDV models to overestimate the adjustment speed in a dynamic model. The results suggest, however, that the Nickell and GMM biases due to

small sample are not large but might matter for the purpose of analyzing the response of employment to exchange rate changes in the medium run.

Table 1. Estimation results (dependent variable is high-trade-exposed manufacturing employment share $EM_{i,t}$)

		LSDV		GMM		Kiviet	
$EM_{i,t-1}$		0.560	(0.050) ^a	0.541	(0.052) ^a	0.644	(0.043) ^a
U.S. cycle		10.229	(2.821) ^a	10.363	(2.906) ^a	10.981	(2.965) ^a
Provincial cycle		2.941	(1.347) ^b	2.912	(1.478) ^b	1.954	(1.238)
Real exchange rate	Newfoundland	-0.006	(0.004)	-0.006	(0.008)	-0.007	(0.008)
	PEI	0.009	(0.007)	0.010	(0.008)	0.010	(0.008)
	Nova Scotia	-0.020	(0.007) ^a	-0.020	(0.008) ^b	-0.020	(0.007) ^a
	New Brunswick	-0.015	(0.009)	-0.014	(0.008) ^c	-0.013	(0.008) ^c
	Quebec	-0.047	(0.005) ^a	-0.051	(0.008) ^a	-0.045	(0.009) ^a
	Ontario	-0.052	(0.005) ^a	-0.053	(0.008) ^a	-0.049	(0.008) ^a
	Manitoba	-0.021	(0.007) ^a	-0.020	(0.008) ^b	-0.020	(0.008) ^b
	Saskatchewan	-0.000	(0.006)	-0.003	(0.009)	-0.0001	(0.008)
	Alberta	-0.016	(0.005) ^a	-0.018	(0.008) ^b	-0.014	(0.008) ^c
	British Columbia	-0.017	(0.006) ^a	-0.018	(0.009) ^b	-0.015	(0.008) ^c
Provincial trade weighted tariffs	Newfoundland	25.168	(11.353) ^b	37.692	(37.547)	25.823	(30.485)
	PEI	-78.454	(21.464) ^a	-97.508	(24.191) ^a	-68.688	(17.235) ^a
	Nova Scotia	58.116	(20.101) ^a	70.005	(37.933) ^c	55.125	(26.234) ^b
	New Brunswick	14.199	(14.815)	14.595	(21.455)	12.113	(17.002)
	Quebec	80.127	(11.089)	84.660	(17.430) ^a	75.666	(16.299) ^a
	Ontario	136.584	(18.573) ^a	143.469	(38.267) ^a	120.158	(35.193) ^a
	Manitoba	-1.276	(15.723) ^a	5.873	(23.408)	2.260	(17.415)
	Saskatchewan	-34.140	(22.812)	-23.178	(45.920)	-25.467	(36.766)
	Alberta	-29.312	(19.455)	-0.327	(45.556)	-23.326	(32.203)
	British Columbia	60.580	(19.861) ^a	74.103	(40.939) ^c	52.791	(22.910) ^b

Notes: ^a, ^b and ^c indicate significance at the 1-, 5- and 10-percent levels. Bootstrapped standard errors (Kiviet) and robust standard errors (fixed-effects and GMM) are in parentheses. Sample period is 1987–2006. 200 panel observations in all regressions. $R^2 = .401$ for LSDV regression.

The effect of the exchange rate on the employment share of high-trade-exposed manufacturing is negative and significant at least at the 5-percent level in the three provinces with the largest manufacturing bases: Ontario, Quebec and Manitoba. This effect is also negative and significant at least at the 10-percent level in Alberta, British Columbia and Nova Scotia.

It is important to understand that parameters $\gamma_{1,i}$ cannot be interpreted as provincial (short-run) elasticities of employment share with respect to the real exchange rate ($\eta_{EM,REM}^{i,t}$). In fact, $\gamma_{1,i} = \eta_{EM,REM}^{i,t} \times EM_{i,t}$.⁶ Hence, even though this elasticity was constant across provinces, the estimated $\gamma_{1,i}$ will differ across provinces as long as the employment share in the manufacturing sector varies across provinces.

It is possible to compute the $\eta_{EM,REM}^{i,t}$ for each province using observed employment rates in 2007 and estimated coefficients. If the Kiviet estimator is used, the provinces can be divided into three groups. For Quebec and Ontario, $\eta_{EM,REM}^{i,t}$ is around -0.46. At the other extreme, Saskatchewan and Prince Edward Island have nil or positive (and non-significant) elasticities while the $\eta_{EM,REM}^{i,t}$ for the remaining provinces range from -0.22 to -0.35. Results for fixed-effects regression and GMM are very similar. As suggested by those results, high-trade-exposed manufacturing industries in Quebec and Ontario are more sensitive to changes in real exchange rate than such industries in other provinces.

The effect of the trade-weighted tariffs is positive and highly significant for Quebec and Ontario in all estimations. These results concur with Trefler (2004). The decrease in the Canada–U.S. tariffs following the FTA had a negative effect on trade-exposed manufacturing employment in the two largest manufacturing provinces in Canada. The

⁶ This point is easily established using Equation M1. Taking partial derivative of employment with respect to exchange rate yields to $\frac{\partial EM}{\partial REM} = \frac{\gamma_{1,i}}{REM_{i,t}}$. Substituting this result in the formula for employment rate elasticity with respect to exchange rate, $\eta_{EM,REM}^{i,t} = \frac{\partial EM}{\partial REM} \frac{REM_{i,t}}{EM_{i,t}}$, and isolating $\gamma_{1,i}$ leads to the result.

same effect, significant at least at the 10-percent level, is also observed for British Columbia and Nova Scotia. Interestingly, the effect of the trade-weighted tariffs is reversed and highly significant in Prince Edward Island. In the other five provinces (Newfoundland, New Brunswick and the Prairie Provinces), the effect of the tariff variable is not significant.

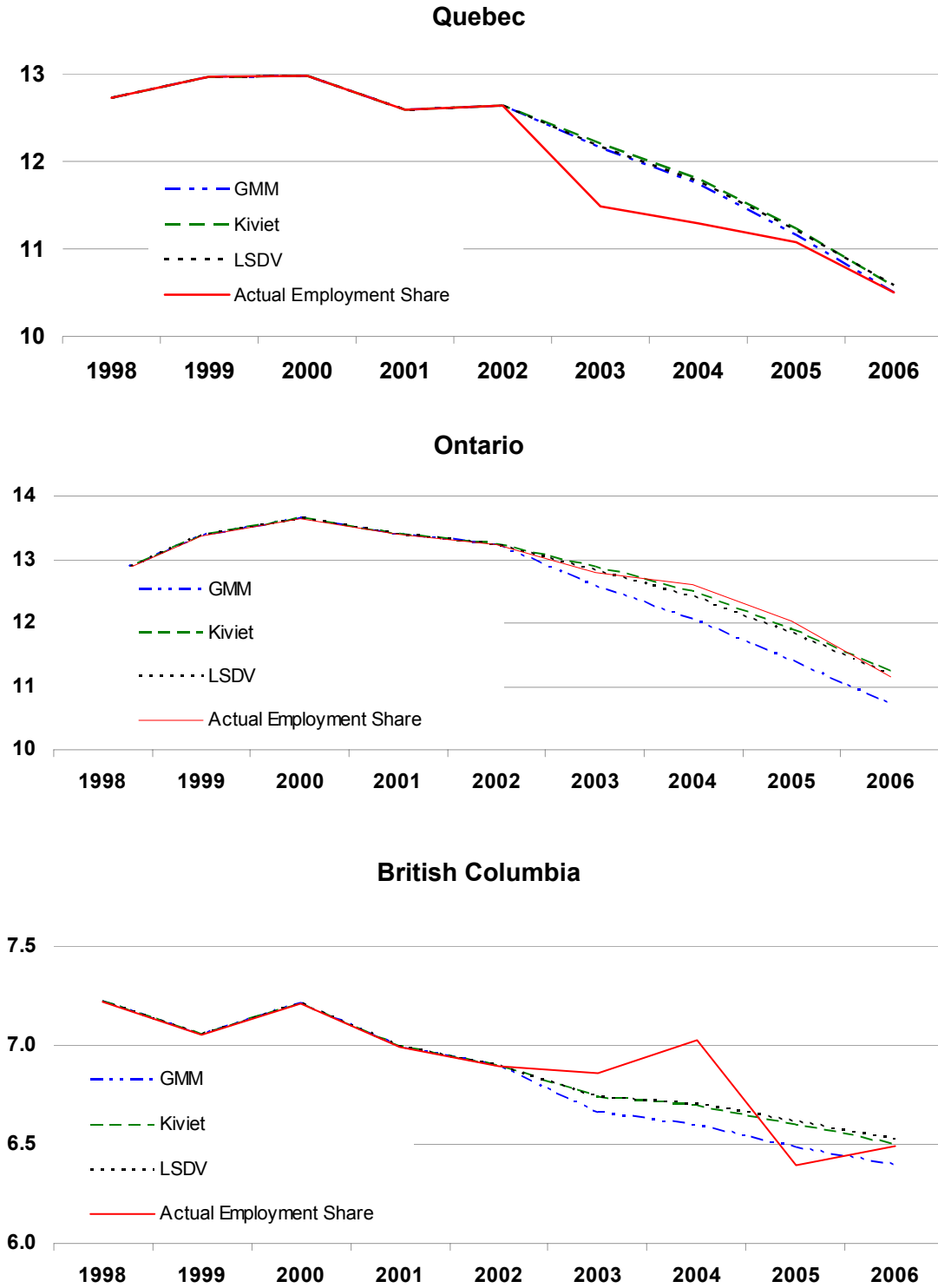
6.2 In-sample simulations

We carried out a variety of in-sample simulations for different subsamples and the 10 provinces. In all cases, we used the point estimates of the dynamic model presented in Table 1 to construct three simulation models (LSDV, GMM and Kiviet) based on data from the 1987–2006 sample. All simulations use the forecasted values of the lagged dependent variable to solve the model in the simulation period. Consequently, the simulation exercise is a dynamic simulation and a predicted series can diverge significantly from the actual series for recursive errors, especially if the forecast period is long.

Results for Quebec, Ontario and British Columbia for the period 2003–2006 are shown in Figure 3. For Ontario and British Columbia, the LSDV and Kiviet models provide excellent in-sample forecasts from 2003 to 2006 and clearly outperform the GMM model. In the case of Quebec, the three models track the evolution very well of the employment share of high-trade-exposed manufacturing from 2003 and 2006.⁷

⁷ (Non-reported) results for simulations performed over the 1990–2006 period also show clearly that, overall, the fixed-effects and Kiviet models outperformed the GMM model.

Figure 3. In-sample simulations of trade-exposed-manufacturing employment share model for selected provinces



The results from the in-sample dynamics are very useful for two reasons. First, they show that our dynamic model is able to track and explain well the adjustment in employment in high-trade-exposed manufacturing in Quebec, Ontario and British Columbia following the sharp appreciation of the Canadian dollar, and thus the adjustment in Canada when the parameters of the simulation model are based from either LSDV or Kiviet estimations. Second, they show that it is better, for the sake of brevity, to base our out-of-sample projections only on LSDV or Kiviet estimations.

To further investigate the performance of the dynamic models, a rolling one-step-ahead forecast for the LSDV model was performed. The results are shown for Ontario and Quebec in Appendix B and confirm the robustness and stability of the model employed.

6.3 Out-of-sample simulations

The results of the three out-of-sample simulations are shown in Table 2 below. The first simulation is the forecast up to July 2007.⁸ Since the model has been estimated with data up to 2006, the forecast for 2007 is an out-of-sample forecast. This forecast is carried out with a real exchange rate corresponding to US\$0.95, the nominal exchange rate observed in July 2007. For simulations covering the period 2007–2010, we present results for two scenarios regarding the exchange rate. In the first scenario, the real exchange rate from 2007–2010 is forecast to remain constant at the level corresponding to the value of the nominal exchange rate observed in July 2007 (US\$0.95). Given the evolution of the Canadian dollar toward parity and above up to October 2007, we also present the results of simulation with the Canadian dollar at parity with the U.S. dollar.

The out-of-sample simulations are illustrated for all provinces in Appendix A. Because nearly 75 percent of all employment in high-trade-exposed manufacturing industries is concentrated in Quebec and Ontario, Table 2 focuses only on these two provinces and Canada as a whole. The results for Canada as a whole are computed from the aggregation of the simulations from the 10 provinces. Furthermore, the level of U.S. real GDP is

⁸ The actual employment data were available up to July 2007 when the first complete version of this paper was circulated.

assumed to remain at potential during the simulation period. This implies that the U.S. business cycle variable has no influence on the projected evolution of the employment shares in the future.

Table 2. Performance of high-trade-exposed manufacturing employment share model for Quebec, Ontario and Canada as a whole

	Quebec		Ontario		Canada	
Actual change in the high-trade-exposed employment share between 2002 and 2006	-2.14		-2.07		-1.47	
Actual change in the high-trade-exposed employment share for the first seven months of 2007	-0.80		-0.61		-0.33	
	Kiviet	LSDV	Kiviet	LSDV	Kiviet	LSDV
Projected change in the high-trade-exposed employment share the first seven months of 2007*	-0.46	-0.41	-0.48	-0.46	-0.34	-0.32
Exchange rate at 0.95 US\$ / C\$						
Projected change from 2006 to 2010 with U.S. real GDP at potential	-1.83	-1.46	-1.92	-1.62	-1.36	-1.12
% of the adjustment in the employment share adjustment already completed by July 2007	74%	82%	67%	73%	64%	70%
Exchange rate at parity						
Projected change from 2006 to 2010 with U.S. real GDP at potential	-2.52	-2.09	-2.67	-2.32	-1.89	-1.62
% of the adjustment in the employment share adjustment already completed by July 2007	63%	69%	57%	61%	54%	58%

* Exchange rate used is US\$0.95/C\$. The impact for the seven first months of 2007 is simply 7/12 of the impact for 2007.

The first point that emerges from Table 2 is that the actual change in employment share of high-trade-exposed manufacturing in Canada in the first seven months of 2007 (-0.33) falls between the dynamic forecasts of Kiviet (-0.34) and LSDV (-0.32). These remarkable results, however, have been achieved by the virtue of aggregation that sometimes eliminated measurement errors. In our case, we can see that for both Quebec

and Ontario, the decline in the employment share in high-trade-exposed manufacturing has been much more severe in the first seven months of 2007 than forecasted by the models. In Quebec, the decrease in the actual employment share (-0.80) is almost twice the predictions from Kiviet (-0.46) and LSDV (-0.41). The same phenomenon, but to a lesser extent, is observed for Ontario with the actual employment share decline in the first seven months of 2007 (-0.61) larger than the predicted decreases (-0.48 and -0.46 for Kiviet and LSDV, respectively). Consequently, on average for all other eight provinces, the predictions for the first seven months of 2007 overestimate the actual change in the trade-exposed manufacturing employment shares.⁹

The most useful numbers to be found in Table 2 regarding the simulations up to 2010 are related to the percentage of the predicted adjustment that has been completed by July 2007. This number corresponds to

$$\left(\frac{EM_{7/07} - EM_{2002}}{EM_{2010} - EM_{2002}} \right) \times 100 .$$

In this framework, the $EM_{2010} - EM_{2002}$ can be divided into two parts: first, the actual data up to the end of 2006; and second, the simulated values over the 2007–2010 period.

For Canada, the percentage of the adjustment already completed for the US\$0.95 scenario is estimated to be 64 percent for Kiviet and 70 percent for LSDV. For the parity scenario, these percentages drop to 54 percent and 58 percent respectively for Kiviet and LSDV. One should remember that it is not surprising to find that this number is systematically smaller for simulations coming from Kiviet’s methodology since LSDV estimations tend to overestimate the adjustment speed. If the adjustment speed is overestimated, the economy is closer to its predicted equilibrium than it would be otherwise. Consequently, and again for Canada as a whole, the estimation techniques suggest that between 30 percent and 36 percent of the predicted adjustment to the exchange rate appreciation

⁹ As can be seen in Appendix A, in provinces such as Manitoba, Alberta and British Columbia — and contrary to what is predicted by our simulations — employment shares in the high-trade-exposed manufacturing have indeed increased in the first seven months of 2007.

needs to be done over the next three-and-a-half years for the US\$0.95 scenario. For the parity scenario, the predicted adjustment still to be done ranges between 42 percent and 46 percent.

Compared with Canada as a whole, the model suggests that a larger proportion of the adjustment to the shock appears to have been already completed in Quebec in the US\$0.95 scenario, between 74 percent for Kiviet and 82 percent for LSDV. The Quebec economy appears closer to its new equilibrium employment share in the high-trade-exposed manufacturing sector. In other words, the model suggests that between 18 percent and 26 percent of the predicted adjustment to the exchange rate appreciation needs to be completed for the US\$0.95 scenario. These numbers increase to 31 percent and 37 percent in the parity scenario. Ontario falls between Quebec and Canada as a whole regarding the extent of the adjustment completed by July 2007. According to Kiviet and LSDV out-of-sample simulations, between 67 percent (Kiviet) and 73 percent (LSDV) of the adjustment to the appreciation appears to have been already completed by July 2007 in the US\$0.95 scenario. These numbers fall to 57 percent and 61 percent with the parity scenario. The economies of Quebec and Ontario emerge as closer to their new equilibrium than the rest of Canada. This factor follows from the sharp decline in the employment share in trade-exposed manufacturing in these two provinces in the first seven months of 2007.

7. Conclusion and risk assessment

The main conclusion of this paper is that most of the adjustment to the Canadian dollar's appreciation since 2002 had already been completed in the Canadian high-trade-exposed manufacturing industries by July 2007. However, results from simulation of the models suggest further employment losses in these industries if the Canadian dollar remains around US\$0.95. The reason for these further losses is that the employment share does not adjust immediately to movements in the exchange rate. Estimates from the models indicate that between 60 percent and 70 percent of the adjustment to movements in the exchange rate is completed after two years. Consequently, most of the adjustment that

still needs to be done results from the appreciation of the Canadian dollar in 2007. Furthermore, estimates from the models suggest that the proportion of the adjustment still needing to be done is smaller in Quebec (between 18 percent and 26 percent) and Ontario (between 27 percent and 33 percent) than in Canada as a whole (between 30 percent and 36 percent). If the Canadian dollar remains around parity with the U.S. dollar, the proportion of the adjustment still to be done increases to between 31 percent and 37 percent in Quebec, between 39 percent and 43 percent in Ontario, and between 42 percent and 46 percent in Canada as a whole.

There is a considerable amount of risk involved in a simulation exercise of the dynamic employment models over the period from 2007 to 2010. The risk comes from two sources. First, the benchmark scenarios are based on the critical assumption that the value of the Canadian dollar up to 2010 will remain around US\$0.95 or around parity. This is a critical aspect of the simulations reported in the study since high-trade-exposed manufacturing industries, particularly in Ontario and Quebec, are very sensitive to movements in the exchange rate. A substantial portion of the additional adjustment results from the further appreciation of the Canadian dollar in the first seven months of 2007. Future increases (decreases) in the Canadian exchange rate should result in further decreases (increases) in the employment share in high-trade-exposed manufacturing industries. Along that line, the benchmark scenario is also based on the assumption that the U.S. economy will stay on its potential level up to 2010. Recent analysis from private sector economists suggest that this might not be the case since they see an increased risk of a more significant U.S. slowdown with the ongoing weakening of the U.S. housing sector and the global liquidity crunch. The effect of a U.S. slowdown cannot easily be measured since the Canadian exchange rate is likely to adjust in response to the resulting slowing in the demand for Canadian exports.

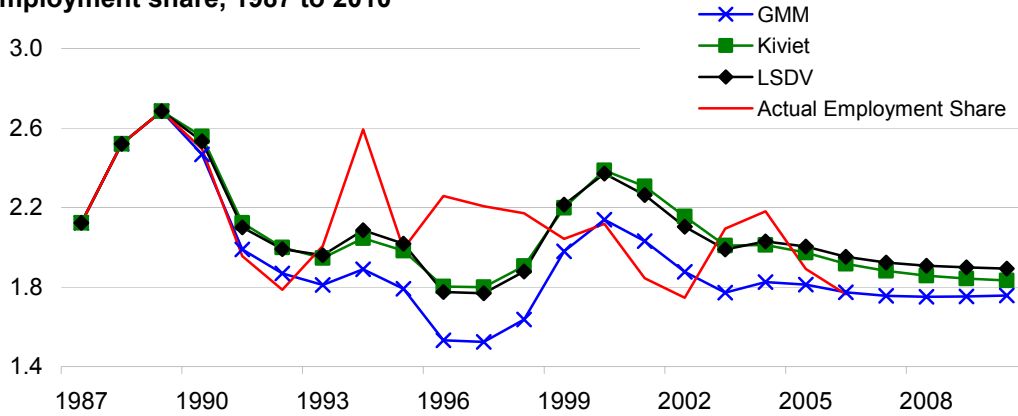
A second source of risk comes from model uncertainty. The dynamic simulations are based on the assumption that the Canadian economy will adjust in the future in the same way it has adjusted in the past. Most of the risk is the result of the projection into the future of the past speed of adjustment and the slope coefficients for the exchange rate effects. The Canadian economy might adjust in the next few years differently from how it

adjusted on average in the past 20 years. This might be due, for example, to the fact that the estimated effect of exchange rate movements since 2002 also captures the effect of increased import penetration from China. We have not been able to isolate a significant effect of the increased China import penetration since this variable is highly correlated with exchange rate movements. Given that exchange rate changes are substantial for the whole period of study, unlike China import penetration, the potential effect of a China variable is captured by the exchange rate variable. Consequently, the recent exchange rate appreciation might exert a different long-run effect on the Canadian high-trade-exposed manufacturing industries from past movements in the exchange rate. Unfortunately, we do not have enough years of data since 2002 to be able to estimate a structural break in the model that would have occurred so close to the end of the sample period.

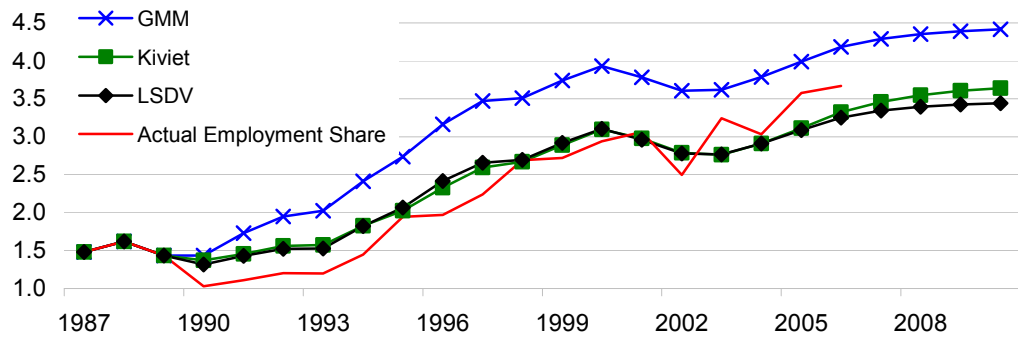
Another type of model uncertainty results from our modelling choice. Our strategy has been to estimate separate effects for the exchange rate across provinces and to provide a common estimate for the speed of adjustment. This choice was based on the desire to provide a relatively precise estimate of the speed of adjustment by making the best use of the cross-sectional variance. Still, the recent evolution of employment share in high-trade-exposed manufacturing industries indicates that Quebec and Ontario will continue to adjust to the appreciation contrary to the remaining provinces. Of course, the dynamic employment models used in the study are not designed to capture short-run movements. However, the modelling strategy might provide bias forecast at the provincial level if the regional composition of the change in employment shares observed in the first seven months of 2007 is an indication of any future trends.

Appendix A. Simulation performance of provincial dynamic employment models, 1987–2010

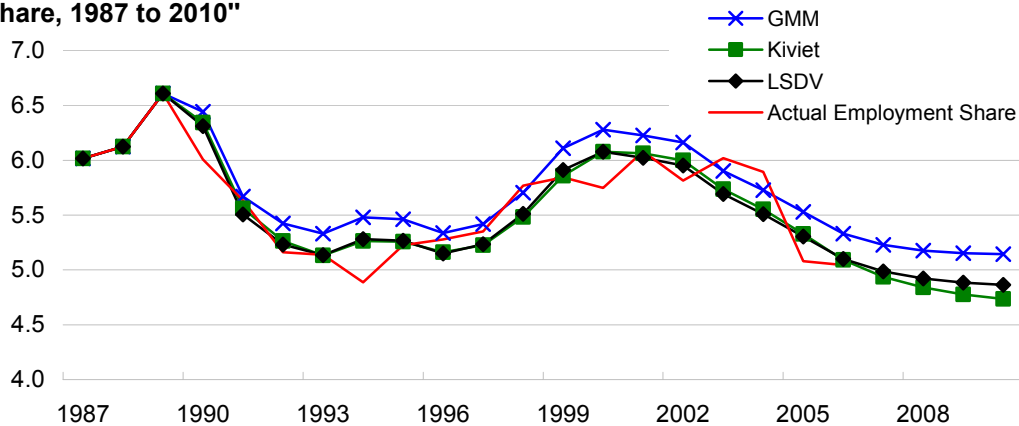
"Newfoundland and Labrador, high trade exposed manufacturing employment share, 1987 to 2010"



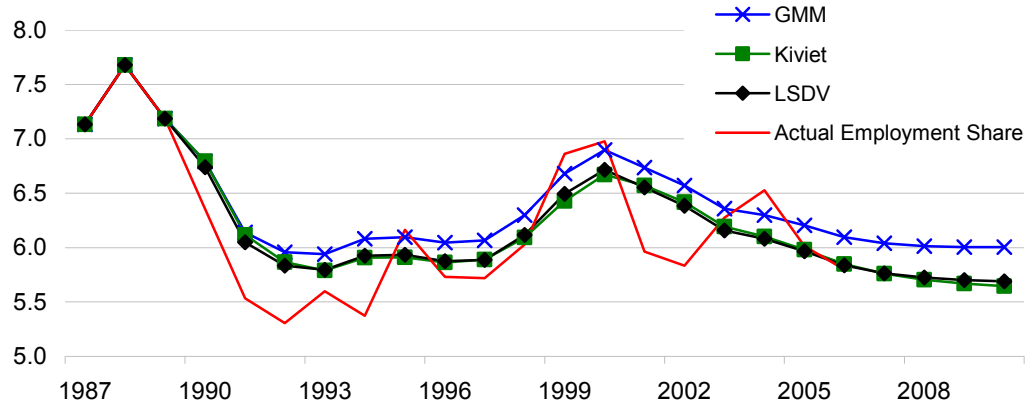
"Prince Edward Island, high trade exposed manufacturing employment share, 1987 to 2010"



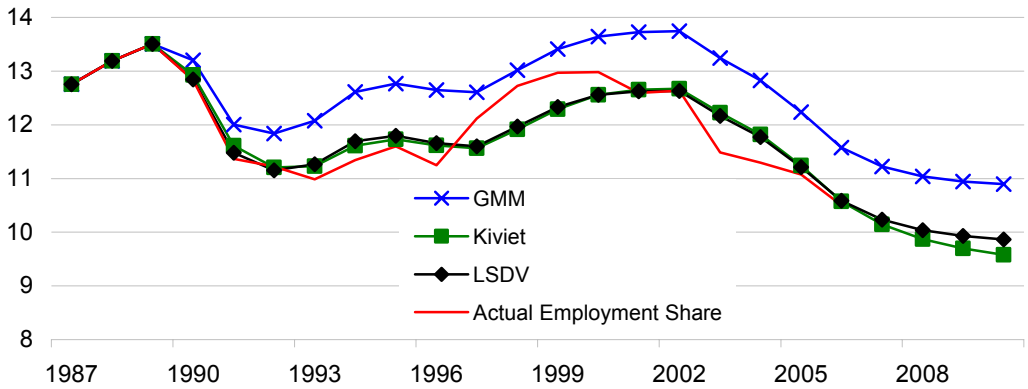
"Nova Scotia, high trade exposed manufacturing employment share, 1987 to 2010"



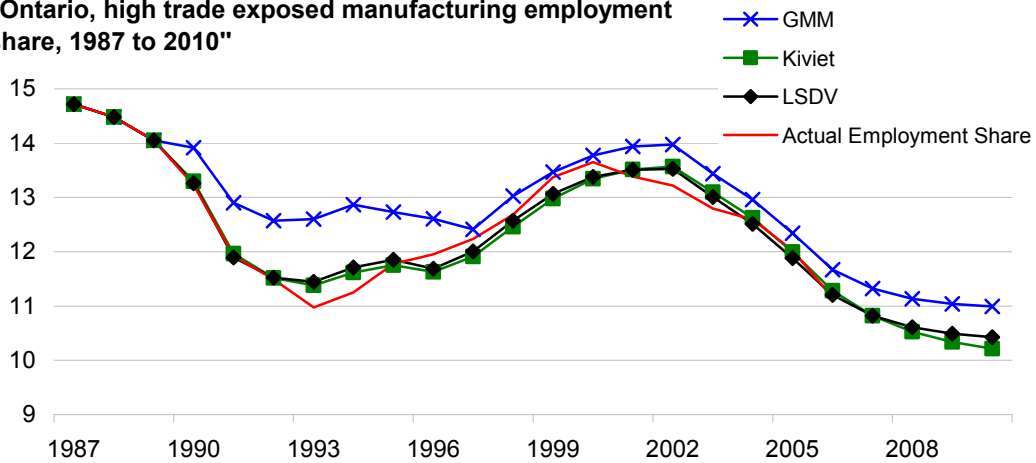
"New Brunswick, high trade exposed manufacturing employment share, 1987 to 2010"



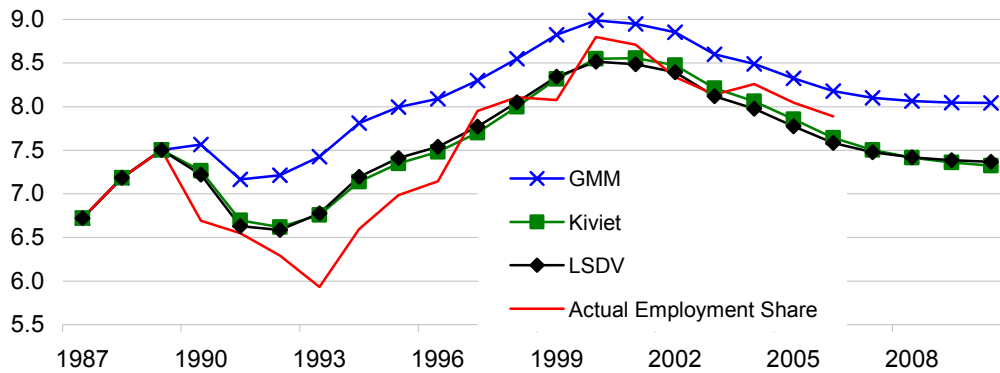
"Quebec, high trade exposed manufacturing employment share, 1987 to 2010"



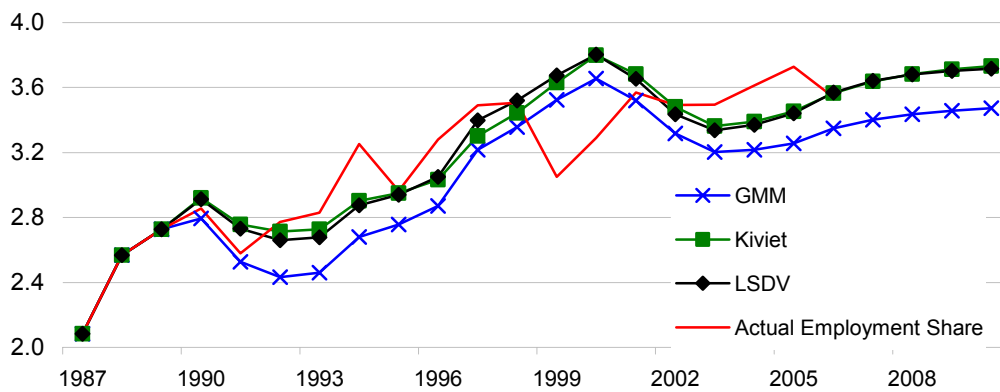
"Ontario, high trade exposed manufacturing employment share, 1987 to 2010"



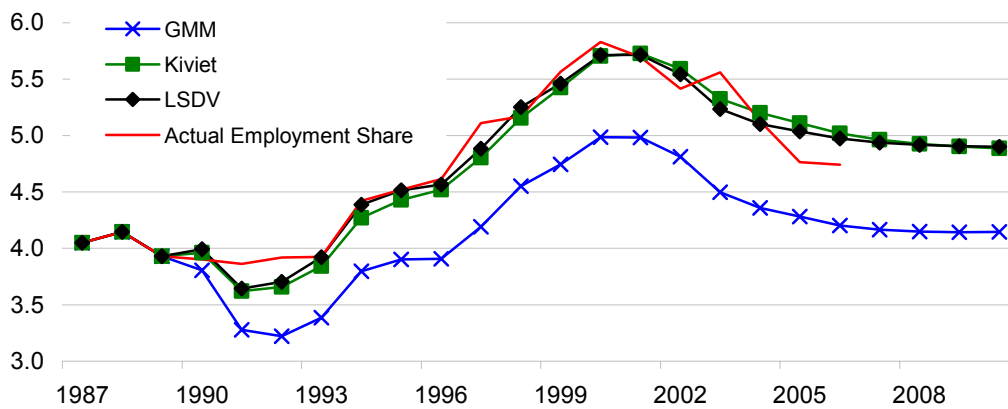
"Manitoba, high trade exposed manufacturing employment share, 1987 to 2010"



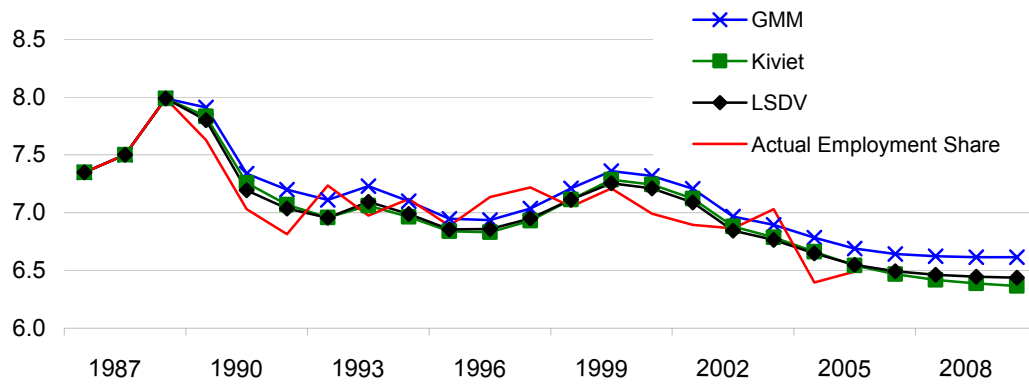
"Saskatchewan, high trade exposed manufacturing employment share, 1987 to 2010"



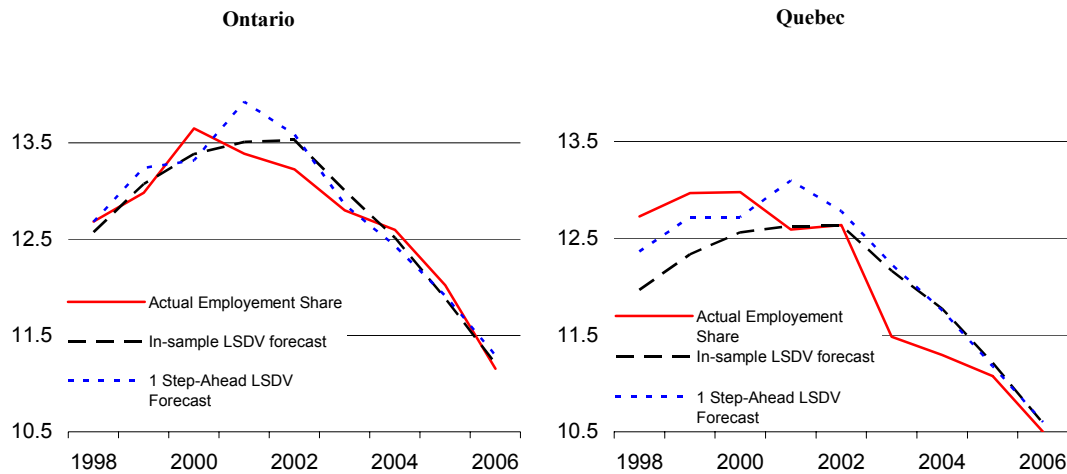
"Alberta, high trade exposed manufacturing employment share, 1987 to 2010"



"British Columbia, high trade exposed manufacturing employment share, 1987 to 2010"



Appendix B. Results of the rolling one-step-ahead LSDV forecast¹⁰



Globally, the results are very close to the in-sample LSDV forecast results, showing that the model is robust not only in-sample, but also out-of sample. The only noticeable differences were encountered at the turning points of the observed employment share. However, that was to be expected since the lag dependent variable is included in the list of controls.

¹⁰ The LSDV one-step-ahead forecast method used in the paper is as follows: An LSDV estimation was done based on the data from 1987 to 1998. The resulting coefficients were then used to forecast the 1999 employment share. Then, observations from 1987 to 1999 were used to run a new regression and to get new coefficients that allowed the authors to estimate an employment share for 2000. The process was then repeated for each additional year by adding one observation and running a new regression. Then the new coefficients were then used to forecast the next period employment share.

Appendix C. List of industries by degree of exposure to international trade

NAICS	Industries	Degree of exposure
311	Food	Low
312	Beverage and tobacco products	Low
313	Textile mills	High
314	Textile product mills	High
315	Clothing	High
316	Leather and allied products	High
321	Wood products	High
322	Paper	High
323	Printing and related support activities	Low
324	Petroleum and coal products	Low
325	Chemical	High
326	Plastics and rubber products	High
327	Non-metallic mineral products	Low
331	Primary metals	Low
332	Fabricated metal products	High
333	Machinery	High
334	Computer and electronic products	High
335	Electrical equipment, appliances and components	High
336	Transportation	High
337	Furniture and related products	High
339	Miscellaneous	High

Appendix D. Definitions and data sources

Employment share in manufacturing industries with a high degree of exposure to international trade

1987 to 2006 data

Sum of employment in manufacturing industries with a high degree of exposure to international trade (aggregation at the NAICS three-digit level based on the Labour Force Survey) divided by the total labour force, by province

Source: Statistics Canada (Labour Force Survey) and author calculations

Provincial business cycle

1987 to 2006 data

For a given province, computed with real final demand and the HP filter

Source: Statistics Canada (Cansim Table 384-0002) and author calculations

Provincial trade-weighted tariffs

1987 to 2006 data

Provincial trade-weighted tariffs from 1987 to 1998 from Beine and Coulombe (2007). Constant after 1998.

Source: Beine and Coulombe (2007) and author calculations

Real effective exchange rate

1987 to 2006 data

Nominal exchange rate between Canada and its major trade partners (CERI), deflated by the consumer price index from 1987 to 2006. The CERI countries are the United States, European Union, Japan, China, Mexico, United Kingdom and South Korea. Designed to be a summary measure of the Canadian dollar's movements against the currencies of its important trading partners, the CERI updates the weights and composition of the currency basket based on IMF-calculated trade weights. The weights used to calculate the index from 1996 to the present are based on trade data

for 184 countries over the 1999–2001 period and encompass trade in non-energy commodities, manufactured goods and services. Before 1996, the weights are based on trade data over the 1989–1991 period. We have also experience with two- and three-year moving-average of the real effective exchange rate in preliminary works.

Sources: Statistics Canada (Cansim Table 176-0064 and 383-0008); Bank of Canada; IMF World Economic Outlook Database (April 2007) and author calculations

U.S. real gross domestic product business cycle

1987 to 2006 data

Computed with quarterly U.S. real gross domestic product and the HP filter

Source: Statistics Canada (Cansim Table 451-0010) and author calculations

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