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CESIFO WORKING PAPER NO. 3813
CATEGORY 9: RESOURCE AND ENVIRONMENT ECONOMICS
MAY 2012

CESifo *Working Paper No. 3813*

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Abstract

This paper looks at whether immigration can mitigate the Dutch disease effects associated with booms in natural resource sectors. We first derive predicted changes in the size of the non-tradable sector from a small general-equilibrium model à la Obstfeld-Rogoff, supplemented by a resource income and a varying labour supply. Using data for Canadian provinces, we test for the existence of a mitigating effect of immigration in terms of an increase in the size of the non-tradable sector triggered by the positive resource shock in booming regions. We find evidence of such an effect for the aggregate inflow of migrants. Disentangling those flows by type of migrants, we find that the mitigation effect is due mostly to interprovincial migration and temporary international migration. There is no evidence of such an effect for permanent international immigration. Nevertheless, interprovincial migration also results in a spreading effect of Dutch disease from booming to non-booming provinces.

JEL-Code: F220, O150, R110, R150.

Keywords: natural resources, Dutch disease, immigration, mitigation effect.

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May 7, 2012
This paper has been presented at workshops and seminars in Orléans, Louvain, Oxford, Salerno and Munich. We thank the participants for valuable comments and suggestions, in particular Rabah Arezki, Bertrand Candelon, Frédéric Docquier, Gernot Doppelhofer, Michael Funke, Dominique Gross, Mathias Hoffmann, Thorvaldur Gylfason, Fabio Mariani, Simone Moricone, Tobias Müller, Peter Neary, Pierre Picard, Rick van der Ploeg, Giuseppe Russo, Mark Spiegel, Hilke Vandenbusch, Tony Venables and Yves Zenou. We thank Jean-Pierre Maynard from Statistics Canada for providing productivity data. Of course, the usual disclaimer applies.

1 Introduction

"Dutch disease" is considered one of the fundamental mechanisms explaining the so-called "natural resource curse," i.e., the process by which the extraction of a natural resource can lead to a decrease in overall welfare in the long run.[1] The "disease" is evidenced by an appreciation of the real exchange rate and a factor reallocation between sectors (triggered by the windfall income due to the resource extraction). These effects are in turn detrimental to the trade-exposed manufacturing base of a booming economy (Corden and Neary, 1982; Corden, 1984). This leads to what is sometimes called "premature de-industrialization" (Palma, 2008). Such a phenomenon is obviously a main threat for resource-rich developed economies with sound institutions and well-protected property rights, economies such as Norway, Australia, and Canada (Gylfason, 2011). Solutions to overcome the Dutch disease are not straightforward since the problem involves market mechanisms for which it is difficult to control.[2] The implied policy question is how the government can minimize the occurrence of Dutch disease in an economy characterized by natural resource extraction.[3]

The aim of this paper is to investigate whether Dutch disease can be overcome or at least mitigated through a specific market mechanism, that can be market driven, namely, immigration of workers. In the basic model (Corden and Neary, 1982), two specific effects can lead to a decrease in the competitiveness of the trade-exposed manufacturing sector. The first, and most straightforward one, goes through the spending effect that leads to an appreciation of the real

[1]The negative correlation between natural resource endowment and growth has been coined the "natural resource curse" in cross-country studies by Auty (1993) Sachs and Warner (2001). Recent surveys are provided by Ploeg (2011) and Frankel (2010). The natural resource curse includes various mechanisms potentially detrimental to growth. Channels other than Dutch disease involve overconsumption and deviation from the Hartwick rule (Hartwick, 1977; Solow, 1986). The abundance of natural resources might also favour rent-seeking activities and complicate the enforcement of property rights through corruption, conflicts, wars, and predation (Ross, 1999). It has also been shown that the curse goes through lower levels of human capital in resource-rich economies (Gylfason, 2001).

[2]One open question is whether Dutch disease is really a "disease" since the welfare implications are not straightforward. We nevertheless consider this a detrimental development in the long run, especially in the specific case of exhaustible resources. According to Krugman (1987) and Venables (1996), for instance, a significant decrease in the size of the manufacturing sector is dangerous at least for two reasons. First, because of non-convexities, below a critical mass, it is difficult for the manufacturing sector to rebound when the resource boom is exhausted. Second, the manufacturing sector exerts positive externalities on the whole economy, for example, through learning-by-doing effects and technology adoption (Sachs and Warner, 1995; Torvik, 2001).

[3]Norway, a highly centralized country with good institutions, has gone one step further in countering the potential effect of Dutch disease with the creation of a sovereign wealth fund, the second largest in the world, that contains mainly assets in foreign currencies. One of the aims of this diversification is to avoid the over-evaluation of the currency and resulting Dutch disease. Such an implementation of the Hartwick rule, however, can hardly be put into practice in highly decentralized countries such as Canada and Australia, where natural resources are under provincial jurisdiction.

exchange rate and a rise in the size of the non-tradable sector.[4] The second mechanism relies on the reallocation of labour from the trade-exposed manufacturing sector to the resource and the non-tradable sectors. While our contribution is mainly empirical, we first develop a theoretical open macroeconomic model *à la* Obstfeld and Rogoff (1996, Chap. 4), with a varying labour supply, in which the resource boom is modelled as an incoming external income or windfall. The change in the labour supply relaxes the most binding constraint in terms of factor availability. Indeed, while capital is an important production factor, the perfect mobility of capital within Canada on the one hand, and the high mobility of capital between Canada and the rest of the world on the other hand ensures that capital availability is high in each province. We derive the effects on the non-tradable sector of the windfall and of the effects of a labour force varying in size due to immigration. Without immigration, the squeezing of the manufacturing trade-exposed sector and the windfall coming from the resource boom inflate the relative size of the non-tradable sector. This impact is mitigated via an inflow of workers coming from abroad.

We test the predictions of our theoretical model by making the best use of a rich Canadian regional dataset on sectoral production, employment, and migration. More precisely, we use panel data from 1987 to 2007 for the 10 Canadian provinces. For several reasons, the use of regional Canadian data is particularly appealing for assessing the Dutch disease and the mitigation effect of immigration. First, in general, it is difficult in cross-country analysis to disentangle pure Dutch disease effects from other factors, such as institutions. Endogeneity is a delicate issue to handle, given that both the quality of governments and institutions, and the intensity of natural resources extraction might be the *result* of growth performance instead of the cause. By focusing on regions within the same country, regions that share very similar institutions and culture, it is easier to estimate pure Dutch disease effects. Second, Canadian regions are quite heterogeneous in terms of industrial structure. Some provinces are richly endowed with natural resources while others rely mostly on the manufacturing sector. The recent boom in Alberta's tar sands production and in Newfoundland's offshore oil fields provides a kind of natural experiment. Third, labour mobility

[4]Evidence of a link between real exchange rate appreciation and commodity prices is due to Chen and Rogoff (2003b) and Cashin et al. (2004). Evidence in favour of such a mechanism in the specific case of Canada has been provided by several authors, including Beine et al. (2012). There is recent evidence of real exchange rate appreciation due to incoming remittances (Acosta et al., 2009) and to positive shocks to commodity prices (Bodart et al., 2012).

at the regional level comes from various patterns that facilitate identification of the mitigation effect.

Three different migration channels are operative in the case of Canadian provinces. The first channel concerns international permanent migrants arriving under the traditional point system, in which immigrants are selected by federal authorities on the basis of observable individual characteristics.[5] Second, temporary foreign worker programs have been gradually launched by provincial governments in the last 20 years. Interestingly, both the timing and intensity of those programs turn out to be very different across provinces. Finally, we use interprovincial migrant data that allow us to capture net internal immigration flows as well as gross inflows and outflows for each province. Some papers have used intra-state regional data to empirically test for growth effects coming from the resource curse (see Ploeg, 2011, for references). To the best of our knowledge, our analysis of the Dutch disease effects on the employment level is the first analysis that involves regions of the same country. It is also the first paper looking empirically at the role of immigration as a mitigation mechanism for Dutch disease.

Our paper is related to several threads in existing Canadian literature. First, it complements results of recent Canadian studies showing that migration flows exert some effect on regional labour markets. Using time-series and cross-sectional data, the empirical analysis of Gross and Schmitt (2012) shows that the magnitude of temporary worker programs is sufficient to exert a significant effect on the persistence of regional unemployment rates. Our study also confirms previous findings that Dutch disease might have a regional/industrial dimension in Canada. Using a computable general-equilibrium model at the industry level, Dissou (2010) shows that an increase in the price of oil is beneficial to the overall Canadian economy but exerts a negative effect on some industries. The results of the empirical analysis of Beine et al. (2012) suggest that the Canadian dollar is driven by energy prices and that the sharp appreciation of the currency between 2002 and 2007 has been detrimental to the trade-exposed manufacturing sectors.

The main findings of our paper are the following. First, we find in Canada a Dutch disease effect in the form of a rise in the share of the non-tradable sector. Second, the immigration of workers into the booming provinces exerts a mitigating influence on the Dutch disease. The rise

[5]The province of Quebec, however, has been selecting its own permanent economic migrants since 1991.

of the non-tradable sector is lower if the labour supply tends to increase due to the inflow of workers. This finding is fully consistent with the so-called "Alberta effect" as originally identified by Helliwell (1981) and Corden (1984). The inflow of workers seeking to share in the rents in the booming provinces leads to a mitigation effect of the Dutch disease. Some back-of-the-envelope calculations based on our estimates and applied to the province that is booming the most, namely, Alberta, suggest that about half of the increase in the non-tradable sector triggered by the resource income has been mitigated by the inflow of workers. Third, the mitigation effect is stronger with interprovincial migration flows and immigration flows associated with the temporary foreign worker programs. In contrast, immigration of permanent migrants does not seem to mitigate Dutch disease. We ascribe this to the different sensitivities of the migration flows to labour market imbalances.

The paper is organized as follows. Section 2 presents a small theoretical model. Section 3 describes the econometric approach. Section 4 presents the data, while Section 5 reports the results. Section 6 concludes.

2 Theoretical Background

In this section, we present the results of a simple general-equilibrium model capturing the effects of a resource boom, the so-called Dutch disease effect, as well as the mitigation effect exerted by inflow of workers into the economy. We develop a small open-economy model with two explicit sectors, the trade-exposed manufacturing (lagging) sector T, and the non-tradable sector N. The resource sector is not modelled explicitly but is captured through a windfall R. The model builds on the well-known framework of Obstfeld and Rogoff (1996), which has been used extensively to capture the dynamics of real exchange rates and relative sector sizes in a small open economy characterized by full capital mobility. The model is extended here to include a resource windfall and a varying labour supply. This framework is relevant in the context of our analysis that focuses on the dynamics of Canadian provinces. Canadian provinces are fully integrated and Canada as a whole is relatively well connected to the international financial markets. Furthermore, each provincial economy is relatively small, implying that the provincial economies are price takers on the international goods markets. They have no influence on the world interest rate nor its terms of trade, including the export price of their primary commodities.

We relax the assumption of fixed labour by assuming that labour supply can be adjusted through an inflow or outflow of workers.[6] Since our empirical analysis will use Canadian regional data, it is understood that the inflow of workers into the booming regions can come from either international or interregional migration. Both types of inflow contribute to the mitigation effect. However, an inflow into the booming regions stemming from internal migration decreases the labour force in non-booming regions. With this migration channel, Dutch disease can be propagated to non-booming regions by a labour-reallocation effect.

In the basic Dutch disease model of Corden and Neary (1982), the economy is divided into three sectors: the resource (booming) sector B, the trade-exposed manufacturing (lagging) sector T, and the non-tradable sector N. A resource boom occurring in B is detrimental to sector T because of two effects that are mutually reinforcing. First, the extra exports from sector B contribute to an appreciation of the real exchange rate of the economy, decreasing the demand for sector T output. The income generated from sector B increases the demand for sector N, contributing also to the appreciation of the real exchange rate. This is the spending effect. Second, the boom in sector B, and the resulting expansion of the N sector, increase the demand for factors in the economy. In the usual approach to modelling Dutch disease, labour is fixed and capital domestically mobile. Consequently, the boom in sector B and the expansion of sector N increase the scarcity of labour, contributing to a further decline in sector T through a labour-reallocation effect (the so-called resource movement effect). Both contribute to an increase in the relative size of sector N with respect to sector T.

Our model deviates from the core Dutch disease model in two specific ways. First, the booming sector here is captured by a resource windfall R. We abstract from the production process in sector B and concentrate on the effect of the windfall on the relative size of sector N.[7]

[6] The idea that migration may have important effects on countries that experience a sudden income surge is not new and has already been considered theoretically by Corden (1984), Wahba (1998) and Ploeg (2011). Caselli and Michaels (2011) nevertheless observe that interregional migration flows have not happened following oil windfalls among Brazilian communities.

[7] In this respect, we follow a large part of the theoretical literature (see for instance Ploeg, 2011) on the Dutch disease. This assumption is relevant and harmless in our case. First, resource sectors in Canada (tar sand oil, sea oil wells, potash) are very capital intensive. Second, the size of the resource sector in terms of employment is quite limited, even in resource-rich provinces like Alberta. To illustrate, for non-booming provinces, the average

Second, our model assumes homogeneous factors that are mobile across sectors. In the basic model, Corden and Neary (1982) assume one sector-specific factor (capital) and one mobile factor (labour) and amend the model to allow for capital mobility between the two non-resource sectors. Our model should be seen as capturing the long-run adjustment of the economy to the resource boom when all factors are allowed to adjust. Our theoretical results regarding the Dutch disease effect can be compared with the ones obtained by Corden and Neary (1982) in the specific case of capital mobility between the two sectors. Furthermore, the use of a dynamic panel-data model in the econometric framework allows us to capture long-run effects of the resource boom and immigration.

From the model, we derive the prediction regarding the relative size of sector N in the economy in relation to the windfall and the size of the labour force. This relationship will be the focus of the paper and will be estimated in the empirical section. We present here the main structure of the model as well as the two equilibrium relationships. The full derivation can be found in Appendix A.

2.1 Firms

There are two sectors, one producing tradable goods and the other, non-tradable goods. The two sectors are represented by two representative firms. These firms follow Cobb-Douglas technology in a perfectly competitive market.

$$Y_N = A_N K_N^{\alpha_N} (nL)^{1-\alpha_N}, \quad (1)$$

$$Y_T = A_T K_T^{\alpha_T} ((1-n)L)^{1-\alpha_T}, \quad (2)$$

$$\alpha_i \leq 1 \text{ for } i = N,\ T.$$

share of the resource sector in terms of employment is less than 1 per cent. For Alberta, over our investigation period, it oscillates between 4 and 6 per cent of the labour force. For Newfoundland and Saskatchewan, it ranges between 2 and 4 per cent. Finally, adding a third resource sector turns out to lead to a very similar testable equation at equilibrium. With respect to the one considered in this paper, this would lead to including the change in resource sector productivity as the only additional covariate in the equilibrium condition. The results of the growth accounting study by Coulombe (2011) suggest that productivity growth in the natural resource sector can be picked up by the sophisticated error term that we are using in the empirical analysis.

with N for non-traded goods and T for traded ones. Both sectors N and T will draw labour from the total labour force, L, so that the non-tradable sector has a share n and the tradable sector the share $(1-n)$. Total factor productivity A_i is exogenous for each sector. Capital, K_i, is assumed to be fully mobile both between sectors and internationally. Tradable goods compete on the world market, and their price is taken as numéraire. The price of the non-tradable goods in terms of tradable goods, p, can then be interpreted as the terms of trade.

2.2 Households

Consumers maximize utility in the consumption of tradable and non-tradable goods. Aggregate utility takes the following CES-function in those two goods,

$$U = \left[\gamma^{1/\theta}(C_T)^{\theta-1/\theta} + (1-\gamma)^{1/\theta}(C_N)^{\theta-1/\theta}\right]^{\theta/\theta-1}, \tag{3}$$

with aggregate budget constraint,

$$Z = C_T + pC_N = wL + r(Q+R). \tag{4}$$

The parameters γ and θ define the choice between traded and non-traded goods in the utility function, where θ is the elasticity of substitution between the two goods. Consumer income consists of wages from labour and interest from capital ownership. Q represents the total capital owned by citizens, both domestically and abroad. Under the assumption of full capital mobility, capital will move and adjust to changes in labour. For convenience, it is assumed that such capital flows will not change the total capital wealth Q existing in the economy.[8] For instance, part of the economy's productive capital may be foreign owned and other flows can be compensated for by the net foreign asset position of domestic consumers. The resource windfall increases the budget constraint of consumers through an additional capital stock, R. This stock, contrary to the other capital stock (Q), is taken as variable and is entirely domestically owned.

[8]As explained by Obstfeld and Rogoff (1996), this is equivalent to saying that, in the steady state, national consumption equals income with constant national financial wealth Q. National wealth Q is also equal to $B + \delta(K_N + K_T)$ where B is the economy's foreign assets, and δ the (constant) share of domestic ownership of domestic capital. Under full capital mobility, a rise (resp. decrease) in $K_N + K_T$ might be financed (resp. offset) by a proportional fall (resp. rise) in B, leaving total national wealth Q unaffected.

2.3 Equilibrium

The model can be solved using the first-order conditions for production factors and consumption as well as the condition that domestically produced non-tradable goods need to be consumed domestically ($C_N = Y_N$). The solution boils down to a two-equation system for p and n that can be expressed as a function of all exogenous variables, Q, R, A_N, A_T and L. One can take log-differences to express the relationships as relative changes in those variables. This results in a linear form of changes in equilibrium values, where in general hatted values represent log-differences $\hat{x} = \mathrm{d}\ln x$.

Solving for $\hat{p}$, one gets:

$$\hat{p} = \frac{1-\alpha_N}{1-\alpha_T}\hat{A}_T - \hat{A}_N. \tag{5}$$

Equation (1) can be rewritten such that the share of employment in the non-tradable sector is a function of the production variables:

$$n = \frac{Y_N}{A_N k_N^{\alpha_N} L}. \tag{6}$$

Solving for $\hat{n}$ finally leads to the key testable implication of the model. The key relationship is expressed in terms of the change in the relative size of the non-tradable sector as a result of changes in the conditions of the economy:

$$\hat{n} = \frac{\psi_L}{1-\alpha_T}\hat{A}_T - \frac{\alpha_N}{1-\alpha_N}\hat{A}_N - \left(\gamma\theta + (1-\gamma) + \frac{\alpha_N}{1-\alpha_N}\right)\hat{p} + r\frac{\mathrm{d}R}{\mathrm{GNP}} - (1-\psi_L)\hat{L}. \tag{7}$$

Before switching to the estimation of (A.21), a few comments are in order.

First, equation (5) is nothing but the traditional Harrod-Balassa-Samuelson relationship relating the evolution of the real exchange rate to the evolution of the productivities in both non-resource sectors. This equilibrium relationship has given rise to an extensive empirical literature testing for its relevance in cross-country studies (see for instance De Gregorio et al. (1994) among many others). As emphasized by Obstfeld and Rogoff (1996), under full capital mobility, the Harrod-Balassa-Samuelson relationship holds regardless of assumptions relative to the demand side of the model. $\hat{n}$ is driven only by supply factors such as the evolution of productivities in both sectors. As a result, since the Dutch disease effect in this model is introduced through the windfall R in the consumer budget constraint, $\hat{p}$ does not depend on R. The Dutch disease effects show up only in the equation governing $\hat{n}$, which explains why we focus on equation (7) in the empirical part.

Second, it is important to note that the solution involves a system of two independent equations in the sense that $\hat{p}$ does not depend on $\hat{n}$. This allows us to estimate each equation separately. We focus only on equation (7) since Dutch disease effects are specific to this relationship. The estimation of equation (5) is also much less relevant here, given that we focus on regions of the same country rather than on different countries. Furthermore, the validity of the PPP relationship in the short to medium run has been questioned empirically in a large set of studies, suggesting that, in practice, there might exist large deviations from the equilibrium captured in equation (5).[9]

Third, the previous point explains that we use a semi-structural and not a fully structural form of the model. Since we can construct observable values for $\hat{p}$ for each province, it might be better to use equation (7) directly rather than substitute further the equilibrium value of $\hat{p}$. Large empirical deviations from equation (5) might lead to significant measurement errors in $\hat{p}$ or can even lead to some estimation bias of parameters in equation (7) if those deviations are correlated to deviations in this equation.

Fourth, equation (7) predicts how the relative size of the non-tradable sector reacts to changes in exogenous variables. The main insights drawn from the relationship are the following. First and foremost, the equation illustrates the Dutch disease phenomenon in the form of a positive relationship between the windfall R and the relative size of the N sector. The positive elasticity is related to the so-called spending effect. As shown by Corden and Neary (1982), the spending effect leads to an increase of the N sector and a decrease of the T sector, regardless of the assumptions regarding capital mobility. This spending effect is here proportional to the share of capital revenues in total income. Secondly, since $-\left(\gamma\theta + (1-\gamma) + \frac{\alpha_N}{1-\alpha_N}\right) < 0$, an increase in the relative price of the non-traded goods ($\hat{p} > 0$) will dampen the positive impact on n of the resource windfall

[9]See, for instance, Taylor and Taylor (2004).

through a reduction in demand for those goods. This depends on the specific value of the demand parameters, γ and θ.[10]

Finally, the model allows us to identify the role of a change in the total labour ($\hat{L}$) supply available to the traded and non-traded sectors. This impact might be related to the resource movement effect, to the migration impact, or to both. Consider first the case with no migration. In that case, $\hat{L} < 0$ is due to the resource movement effect. The resource movement effect requires the expansion of the resource sector to attract labour, reducing the total labour supply available to the N and T sectors. In practice, while the resource sector is very capital intensive in Canada, it still attracts some labour. The well-known story of weekly flights between St. John's, Newfoundland, and Fort McMurray in Northern Alberta at the heart of the Athabasca region illustrates the attraction of the oil sector for workers. In turn, the labour attraction of the resource sector implies that there is definitely a case for an existing resource movement effect in Canada even though its size might be limited, given the modest share of labour employed in the sector. Given that $\psi_L < 1$, the resource movement effect amplifies the spending effect in our model. This is consistent with the results of Corden and Neary (1982), obtained under full capital mobility between sectors and with the T sector being more capital intensive than the N sector. With labour mobility across provinces and across countries, L can also change with emigration and immigration. Equation (7) makes clear that aggregate immigration, which leads to $\hat{L} > 0$, will offset the resource movement effect (if any) and will mitigate the spending effect associated with R. This is especially the case since provinces that benefit from a resource boom will tend to attract more workers from outside, an aspect of the "Alberta effect" (Helliwell, 1981). Conversely, (provincial) emigration ($\hat{L} < 0$) generates an effect similar to the resource movement effect, reinforcing the spending effect at stake.

[10]More specifically, the basic mechanisms of the spending effect are as follows. The windfall R generates a rise in the demand for all goods, i.e. from both sectors. Given the capacity constraint of the N sector and for a given value of p and L, the increase in the supply of the non-traded goods can be fulfilled only by drawing on labour employed in the T sector. This in turn results in an increase in n. Immigration relaxes the binding constraint of the total labour force, thereby dampening the effect of n.

3 Empirical Model and Econometric Specification

The empirical literature related to Dutch disease can be separated into two strands (Ploeg, 2011). The first looks at the price effect and tests whether the real exchange rate appreciates as a result of a resource boom or a windfall (Beine et al., 2012; Sala-i-Martin and Subramanian, 2003; Bodart et al., 2012; Chen and Rogoff, 2003a). An alternative strand tests the relationship between the resource windfall and the evolution of the economic structure (i.e. the shift away from tradable production).There are fewer studies looking at the latter.[11] We follow this route and test equation (7) directly, relating the share of the non-tradable sector in the economy and the resource boom.

More precisely, equation (7) describes a theoretical relationship between the growth rate in the share of service sector workers and a list of determinants. In this section, we show how this set-up is tested using Canadian regional data where changes to the labour force are driven by interprovincial and international immigration. Given the small number of Canadian provinces (10), we cannot rely only on the cross-section dimension for the empirical analysis. We believe, however, that the great quality and consistency across provinces and through time of the Canadian regional data more than compensate for the small number of cross sections.

To make the best use of the available information, we use a time-series dimension by pooling annual data for the 10 provinces over the 1987-2007 period. Consistent with our theoretical model, we estimate a dynamic panel-data model that allows us to account for long-run effects of resource boom and emigration. Furthermore, in the presence of adjustment costs, employment and industrial structures differ in the short run from their long-run equilibrium.[12] In this perspective, an empirical version of equation (7) takes the general following structure:

$$\Delta n_{i,t} = \xi * n_{i,t-1} + \beta' x_{i,t} + u_{i,t} \tag{8}$$

where $\Delta n_{i,t}$ is the change in the size of the non-tradable sector in province i between time t and $t-1$; $x_{i,t}$ is a vector of controls including measures for the key theoretical determinants, i.e.

[11] Acosta et al. (2009); Harding and Venables (2010); Acosta et al. (2008). See also the stylized facts of Palma (2008).

[12] For instance, Arellano and Bond (1991) have tested employment adjustment using a dynamic panel-data model similar to our model.

$\hat{A}_T$, $\hat{A}_N$, $\hat{p}$, $\frac{\mathrm{d}R}{\mathrm{GNP}}$ and $\hat{L}$. The $u_{i,t}$ are modelled with time dummies, cross-section fixed effects, and an idiosyncratic error term.

In this framework, the estimated β's are the short-run and $-\xi/\beta$ are the long-run effects on the share of employment. Unlike the real exchange rate response to a resource boom, the shift from the tradable sector toward the non-tradable one requires some adjustment of the entire industrial structure. This adjustment can take some time, best captured by long-run changes rather than the short-run effect of the boom. This also explains why we rest on a dynamic panel data model.[13] A necessary condition for the stability of the underlying adjustment mechanism is that the estimated ξ is smaller than zero.

Two points are worth mentioning regarding the empirical model (8). First, it is the change in the service employment share that appears in model (8). In equation (7), it is the growth rate of the employment share. Consequently, the parameters in (8) do not strictly correspond to those in (7) for the same variable. For example, the theoretical parameter of the resource windfall in (7) is proportional to the interest rate. In (8), it is the interest rate times the employment share of the N sector.

Second, even if the structure of the model is simple, the time-series and cross-section dimensions of the data allow for a very sophisticated error term. With time dummies, for all periods, the data are transformed into deviations from the cross-sectional sample mean. Consequently, all common shocks through time, such as the sustained increase in the service employment share, are removed from the analysis. With provincial fixed effects, the data are again transformed into deviations from the time-series mean for each cross section. With this transformation, all idiosyncratic heterogeneity that does not vary through time but is specific to each province is also removed from the analysis.

The estimation of equation (8) requires the use of proxies for the vector of controls $x_{i,t}$. The growth of multifactor productivity for the manufacturing T sector ($\hat{A}_T$) and the N sector ($\hat{A}_N$) appears in (7). In equation (9), because of data availability, we use labour productivity growth in both sectors. Consequently, the contribution of capital stock growth to productivity is included

[13] Harding and Venables (2010) adopt the same philosophy by estimating a panel-data model with proxies for lagged and contemporaneous windfall shocks.

in the error terms (fixed effects, time dummies, or the idiosyncratic component). Migration is assumed to be the only important driver of changes to the labour forces $\hat{L}$.[14] We use three components of migration: interprovincial migration, permanent international migration, and temporary foreign workers. In most of our regressions, interprovincial migration is measured as a net concept. This implies that, contrary to the other two components, net interprovincial migration for one particular province can be positive or negative. One person moving from Ontario to Alberta is recorded twice, once negatively for Ontario and once positively for Alberta. We also present results in some regressions with gross interprovincial immigration and emigration introduced separately.

Thus, in order to match the theoretical model with observable measures of the variables, the following regression model is estimated:

$$\Delta n_{i,t} = \xi * n_{i,t-1} + \beta_1 * \Delta.mlp_{i,t} + \beta_2 * \Delta.slp_{i,t} + \beta_3 * R_{i,t} + \beta_4 * TT_{i,t} + \beta_5 * mig_{i,t} + \lambda_i + \theta_t + \epsilon_{i,t} \quad (9)$$

where λ_i and θ_t are respectively, provincial and temporal fixed effects. The inclusion of provincial and temporal fixed effects is a key advantage of model (9). Their inclusion minimizes the likelihood of important mispecification biases that could lead to improper estimates of key parameters such as the coefficients of the windfall, β_3, and migration, β_5. For instance, if resource-rich provinces display different characteristics in terms of industrial structure, failure to account for those through λ_i (through the use of a pooled OLS estimator) could lead to inconsistent estimates. Likewise, failure to include θ_t could lead to biased estimates if all Canadian provinces experienced some structural deindustrialization over the investigation period.

The term $\Delta.mlp_{i,t}$ proxies $\hat{A}_T$, i.e. productivity growth in the tradable sector, while $\Delta.slp_{i,t}$ proxies $\hat{A}_N$, i.e. productivity growth in the non-tradable sector. $R_{i,t}$ captures the annual resource income experienced in province i, while $TT_{i,t}$ is a measure of the terms of trade p and $mig_{i,t}$ is the total migration flow entering province i at time t. That is, the variable $mig_{i,t}$ is the sum of three different types of migration flows: net interprovincial immigration, immigration under the

[14] Note that changes in the active native population due to demographic trends are, first, not quantitatively important, especially compared with immigration and emigration. Second, those changes are quite similar across provinces and thereby best captured by time fixed effects. An additional advantage to using migration as an indicator of $\hat{L}$ is that those changes are exogenous with respect to L, which is used in the definition of the dependent variable.

temporary working program implemented after 1985, and permanent economic immigration under the traditional Canadian immigration procedures (in particular, the point system). First we look at the role for aggregate immigration, summing up the various types of migration flows. Next, we look at the respective roles for each type of immigration since they gather different types of migrants in terms of skills and responsiveness to market shocks. Finally, we further deconstruct net provincial immigration into gross immigration and gross emigration.

The panel structure with province and time fixed effects minimizes the likelihood of a correlation between $mig_{i,t}$ and $\epsilon_{i,t}$ through the impact of non-observable province-specific or time-specific factors. Endogeneity could arise as a result of reverse causality between between $\Delta n_{i,t}$ and $mig_{i,t}$. It can also arise if unobservable shocks to $\Delta n_{i,t}$ influence immigration in province i at time t.

Given the migration policies regarding international workers, a large part of international migration flows can be considered as truly exogeneous. This holds for both temporary migrants and permanent ones. Economic permanent migration is significantly controlled by the federal government through the point system. The selection of permanent migrants through this system takes time, is biased toward skilled workers, and is not market driven.[15]

Temporary worker programs are mostly controlled by the provinces. The flows are meant to fill positions declared vacant by the local employers. It does not give any clear advantages to any sector (Gross and Schmitt, 2012). Also, provinces put (implicit) limitations on the maximum number of immigrants per year, which means that the number of admitted temporary guest workers is driven by policy considerations.[16]

Endogeneity might be an issue mainly for interprovincial migration that is, unlike international immigration, unregulated. Regarding reverse causality from n to interprovincial migration, one might claim that the importance of the N sector attracts more (fewer) migrants if those migrants are more (less) inclined to work in the N sector rather than the T sector. Nevertheless, the fact that

[15]Interestingly, in March 2012, the Canadian government announced changes to the immigration law that would give more weights to employers' choices in the selection process and would fast-track applications in case of labor-market shortages.

[16]Although provinces do not announce absolute maximum limits, firms need a government-supplied labour market test to show that foreign temporary workers do not serve as substitutes for residents. On the lower boundary, Panel (5) of Figure 1 illustrates for instance that half of the provinces did not really implement temporary worker programs before the end of the 1990s. This reflects policy choices of the provincial governments. Those choices can be related to several factors including ideological attitudes towards immigration.

we consider the change rather than the level of $n_{i,t}$ lowers the case for reverse causality. Regarding unobservable shocks, endogeneity would be a concern if the decrease in the size of the non-tradable sector attracts structurally more or fewer interprovincial migrants in a contemporaneous way, i.e., within a year. Furthermore, interprovincial migration in Canada has been shown not to be driven by short-term changes in the industrial structure. As shown by Coulombe (2006), those flows are driven more by long-run bilateral factors such as urban-rural differences, long-run differentials in unemployment, or productivity differentials. Interestingly, some of those long-run factors are picked up by the provincial fixed effects λ_i in model (9).

The case for an overestimation of the mitigation effect in model (9) requires basically three conditions: (i) $mig_{i,t}$ reacting quite quickly; (ii) a significant part of the provincial immigration flow being driven by the change in the industrial structure; and (iii) this impact being systematic and similar across all provinces and over time.[17] Those three conditions can be questioned in the face of immigration policy in Canada and the nature of migration flows between provinces. Therefore, to sum up, the case for a significant correlation between $mig_{i,t}$ and $\epsilon_{i,t}$ seems quite weak.

A key objective of our paper is to test for a possible mitigation effect induced by immigration. Two complementary approaches might be used to assess the existence of such an effect. First, if migration flows to booming provinces tend to dampen Dutch disease, the point estimate of the resource windfall would be underestimated when estimating equation (9) without migration flows. The influence of migration flows would then be included in the residual and the estimation would suffer from omitted variable bias, unless immigration does not affect the economic structure. The bias is likely to be important given the fact that $R_{i,t}$ and $mig_{i,t}$ are likely to be positively correlated. Indeed, booming provinces will tend to attract migrants either from the rest of the country or from abroad. This is obviously related to the so-called Alberta effect as identified by Helliwell (1981) and Corden (1984). In Canada, resource rents are taxed at the provincial level and key services such as education and health are provided by provincial governments. Consequently booming provinces can attract public rent seeking migrants looking for better public services at

[17]More precisely, since the mitigation effect takes the form of a negative impact of migration on the dependent variable, the mitigation effect will be overestimated (underestimated) in absolute terms if the tradable sector systematically attracts more (fewer) migrants than the non-tradable sector.

lower tax rates.

The previously evoked estimation bias will be corrected when migration flows are entered in the list of controls. In this case, the mitigation effect implies that the point estimate of $R_{i,t}$ (β_3) increases when immigration flows are included in the regressions and that the point estimate of $mig_{i,t}$, β_5 is negative. This approach nevertheless neglects the fact that the mitigation effect of migration might depend on the amplitude of the Dutch disease effect and hence on the size of $R_{i,t}$. To that aim, a second approach for estimating the mitigation effect is to augment specification (9) by adding an interaction term composed of the product of $R_{i,t}$ and $mig_{i,t}$. In this set-up, the presence of a mitigation effect would be reflected by a negative coefficient of the interaction term. Nevertheless, in this latter approach, it is not straightforward to identify the exact size of the mitigation effect.

A final point that we can take into consideration is the issue of cross-sectional heteroscedasticity. The economic structures of Canadian provinces are very heterogeneous. The economies of Quebec and Ontario are much more diversified than those of the other provinces (see Beine and Coulombe, 2003), thanks to a well-diversified manufacturing base. The Western provinces and Newfoundland are more dependent on natural resources. The growth pattern of larger provinces is more stable than that of less-diversified provinces such as Saskatchewan and Newfoundland. Furthermore, oil extraction is concentrated (though not exclusively) in Alberta and Newfoundland.

We use the best empirical methodology, given the small number of cross sections (10). For the first set of results, we use pooled least-squares (PLS) and we rely on generalized least-squares (FGLS) estimations using cross-sectional weighted regressions. The second set of results comes from PLS with cross-section weighted standard errors (PCSE) that allow for asymptotically valid inferences in the presence of cross-sectional heteroscedasticity.

4 Data

In order to proxy the key variables of equation (9), we use data from three different sources: (i) Statistics Canada's special tabulations for all aggregate and sectoral GDP and employment data, (ii) Citizenship and Immigration Canada's data for temporary and permanent international immigration, and (iii) Statistics Canada's CANSIM data for interprovincial migrations (available at http://www.statcan.gc.ca/).

4.1 Measuring output, employment and productivity

The data on aggregate, provincial, and sectoral (manufacturing, service, and natural resource) output (value-added), productivity, employment, and prices were tabulated at our request by the Income and Expenditure Accounts Division of Statistics Canada. Those data allow us to find proxies for $n_{i,t}$, $mlp_{i,t}$, $slp_{i,t}$, $R_{i,t}$ and $TT_{i,t}$. The tradable sector corresponds to the manufacturing sector, while the non-tradable sector is proxied by services.[18] Services include government services. We obtain $n_{i,t}$ by taking the ratio of provincial service employment over the provincial labour force.

The booming sector refers to NAICS 21 (mining, quarrying and oil well industries). Resource income, $R_{i,t}$, is calculated as (nominal) GDP in NAICS 21, divided by nominal GDP of all industries in each province.[19] GDP data are in nominal and chained (2002) GDP dollars, and employment is measured in hours worked. We did not have access to reliable data on the capital stock. Consequently, we use a labour productivity concept (rather than multifactor productivity) to measure $mlp_{i,t}$ and $slp_{i,t}$. Terms of trade at the provincial level ($TT_{i,t}$) are obtained by subtracting the growth of real provincial GDP from the growth of real provincial income. The latter was measured as the ratio of provincial nominal GDP divided by the national CPI (CANSIM Table 326-0021). Data are available on an annual basis from 1984 to 2007.

4.2 Migration

Data on permanent and temporary immigrants were obtained from Citizenship and Immigration Canada (CIC, 2010). Data are available on an annual basis from 1985 to 2009, by province, for various classes of immigrants.

"Temporary immigrants" refer to immigrants under the provincial temporary foreign worker

[18] Acosta et al. (2009) use the same proxies. Harding and Venables (2010) use components of the balance of payments, such as non-resource gross and net exports.

[19] The share of the income generated by the resource sector is a usual measure in the literature. See for instance Sachs and Warner (2001), Acosta et al. (2009), or Harding and Venables (2010) among others. Nevertheless, as a robustness check, we also use the change in the share of the resource income rather than the level.

programs. Every year, the stock of temporary immigrants is considered an addition to the provincial labour force. The programs implement migration schemes meant to provide solutions to temporary shortages in occupational labour. Under these programs, foreign workers are entitled to work for about one year, with a possibility of renewal, with renewal depending on the rate of vacant occupations. As a result, these temporary inflows can be considered highly responsive to labour market conditions.

For the permanent immigration component, we consider only economic immigrants (leaving aside the family and refugee class) because only economic migrants are a direct addition to the labour force. Permanent economic migrants are selected under the point system in Canada. This system allocates points based on a screening of personal characteristics (age, education, language proficiency), which in turn determines whether they obtain a visa. Furthermore, as shown by Coulombe and Tremblay (2009), a large proportion of permanent immigrants tend to concentrate in big citiesToronto, Montreal, and Vancouverwhere the presence of a large diaspora decreases the cost of immigration and integration. Nevertheless, there are fewer guarantees that their skills will match those needed in the sectors facing labour shortages. For the period under study, one might therefore consider permanent migration flows to be much less driven by market conditions than the temporary migrant flows.

Data on interprovincial migration were extracted from the Statistics Canada CANSIM website (Tables 051-0012). These rich and unique regional data are derived from the residence information on income tax returns that Canadians have to fill out every year. Data are available both as net flows for the 10 provinces and as in- and out-migration flows to and from each province. We use data for the 15-to-64 age group. Data on flows are available on a yearly basis from 1971 to 2009. Unlike international migration, interprovincial migration is unrestricted. It is meant to respond quite quickly to relative economic conditions in the Canadian regions. However, social security and unemployment benefits may dampen the responsiveness of internal migration to relative shocks. Furthermore, interprovincial immigrants do not migrate solely for labour market reasons. As demonstrated by Coulombe (2006), a large part of interprovincial migration flows are spouses with children and the return migration of older people who come back to their original province to retire.

Therefore, the final aggregate impact of that type of labour inflow remains uncertain. All three categories of migration are taken as a ratio over the (provincial) labour force (CANSIM Table 282-0055, available from 1987 to 2009).

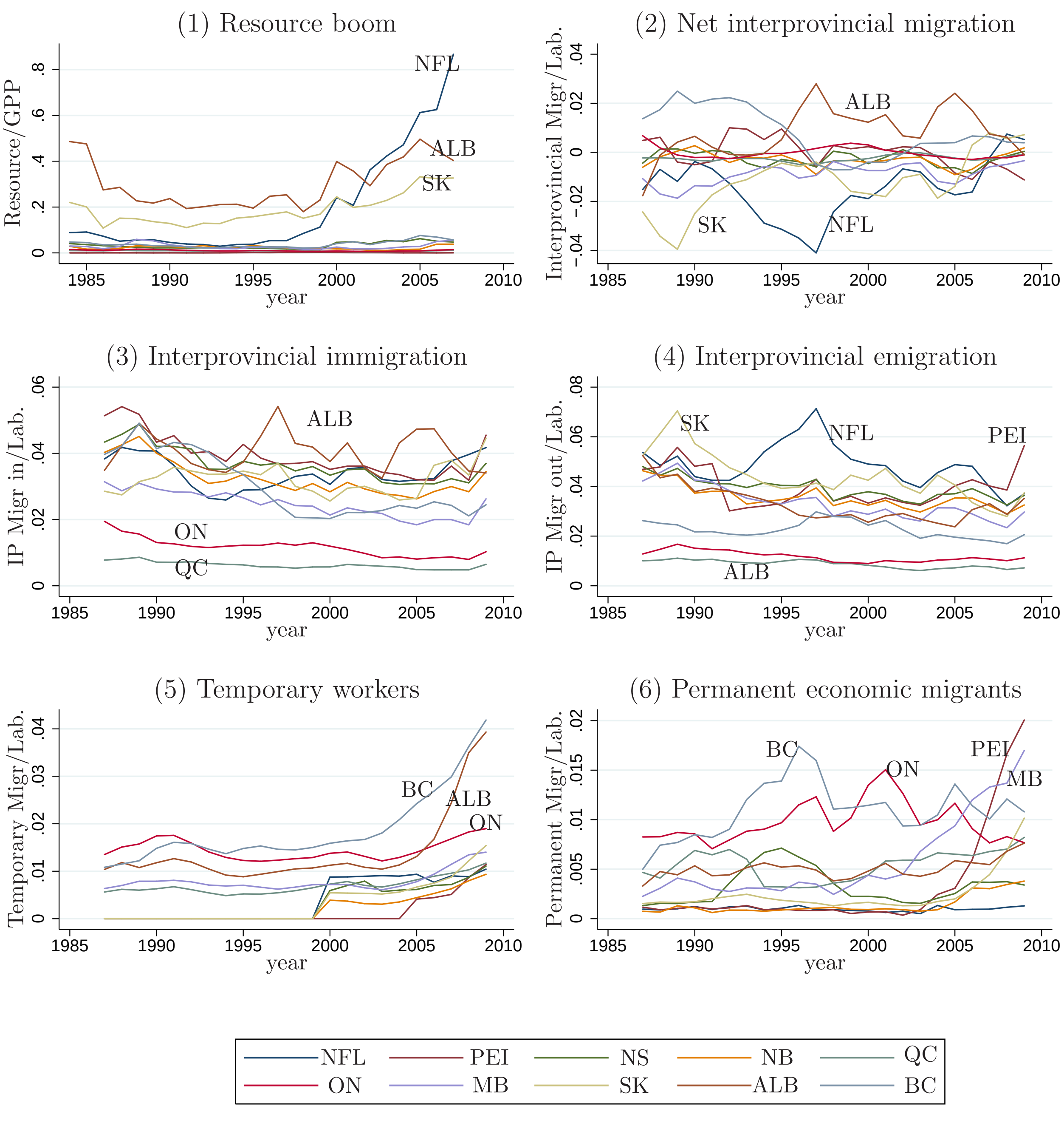
4.3 Evolution 1987-2009

Figure 1 plots the evolution of the key variables over the inspection period (1987-2009). First, with respect to resource booms, Panel (1) makes it clear that Canadian regions did not all experience a global resource boom. Three provinces benefited from a huge increase in resource income: Alberta (mainly oil revenues), Newfoundland (oil), and Saskatchewan (potash, minerals, and oil and gas). The surge was more recent for Newfoundland compared with the other two provinces. For the other seven provinces, the resource income is less important, at least in relative terms.

Regarding labour mobility, the provinces also experienced quite heterogeneous situations. Regarding net interprovincial migrationpanels 2 to 4some provinces such as Alberta have been systematic net receivers in terms of labour. In contrast, for most of the investigation period, Newfoundland experienced net outflows, with a significant number of workers going to Alberta.[20] Nevertheless, with the oil boom in Newfoundland, labour losses have decreased since 1998 and even turned into net inflows at the end of the period. Panel 5 displays the number of immigrants in each province coming under the temporary foreign worker program. It shows that the implementation of those programs differed across provinces. In particular, provinces like British Columbia, Ontario, and Alberta implemented those programs in 1985 and relied increasingly on temporary migrants to match labour market needs. In other provinces, the program was active only at the end of the 1990s and became a non-negligible source of variation in the labour force. The inflows of economic migrants coming under the permanent immigration schemes (Panel 6) also benefited the Canadian provinces. Interestingly, the cross-sectional correlation between permanent and temporary immigration is far from perfect. For instance, some provinces such as Prince Edward Island or, to a lesser extent, Manitoba relied heavily on permanent immigration rather than on temporary worker programs.

[20]Between 2004 and 2006, net interprovincial migration to Alberta accounted for an increase of 114,000, or 3.3 per cent, in Alberta's population. At the peak of the oil boom in 2006, weekly flights were established between Fort McMurray in northern Alberta at the heart of the Athabasca region and St. John's, Newfoundland.

Figure 1: Migration and Windfall



5 Results

To assess the existence and amplitude of a potential mitigation effect of immigration on the Dutch disease, we proceed in different steps. First, we look at the role of total immigration and test for a mitigation effect in two different ways: (i) as a direct effect on the industrial structure, and (ii) through the inclusion of an interaction term between the resource boom and the immigration flows. Second, we disaggregate migration flows into three components, examining the respective role of each type of labour mobility. We then further deconstruct interprovincial migration into inflows and outflows.

5.1 Total immigration

5.1.1 Benchmark regressions

In Table 1, we test for a mitigation effect through the inclusion of total immigration in equation (9). In columns (1) to (2), we omit immigration in the set of explanatory variables. (It is included in the subsequent columns.) We use total migration flows in columns (3) and (5) that are, for each province, the sum of temporary and permanent immigration flows plus net interprovincial immigration. In columns (4) and (6), we subtract permanent migrants from total immigration flows since permanent migrants are expected to respond less to labour market conditions in the provinces. Each specification is estimated using FGLS and PLS.

Interestingly, the estimates of the parameters are all in line with the theoretical equilibrium condition (see equation (7)). Changes in productivities in the two sectors emerge with the expected sign. We also get a negative impact for the terms of trade, which is in line with the restrictions on structural parameters in equation (7).

The point estimates of ξ, which capture the catching-up process of the industrial structure, lie around -0.2 and are highly significant, suggesting a stable adjustment process across the different specifications. This number implies that, after a shock, the provincial economic structure takes approximately 3.5 years on average to make half of the adjustment.

All in all, the data fit with the equilibrium condition derived from the theoretical model. The estimated value of the coefficient relative to the resource variable, $R_{i,t}$, is positive and significant

Table 1: Mitigation effect of total immigration: direct effect

	Dependent variable: change in share of N sector						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation Method	(FGLS)	(PLS)	(FGLS)	(FGLS)	(PLS)	(PLS)	(FGLS)
Lagged dependent	-0.197^{***}	-0.204^{***}	-0.246^{***}	-0.252^{***}	-0.230^{***}	-0.229^{***}	-0.239^{***}
	(5.099)	(4.603)	(6.077)	(6.310)	(4.930)	(4.965)	(6.320)
Change in T sector prod	0.027^{***}	0.024^{***}	0.029^{***}	0.029^{***}	0.027^{***}	0.026^{***}	0.028^{***}
	(4.089)	(3.322)	(4.526)	(4.519)	(3.621)	(3.622)	(4.490)
Change in N sector prod	-0.119^{***}	-0.112^{***}	-0.103^{***}	-0.101^{***}	-0.101^{***}	-0.100^{***}	-0.084^{***}
	(4.696)	(3.838)	(4.097)	(4.044)	(3.430)	(3.407)	3.380
Resource	0.023^{**}	0.022^{**}	0.035^{***}	0.037^{***}	0.031^{***}	0.032^{***}	0.040^{**}
	(2.249)	(1.985)	(3.309)	(3.533)	(2.613)	(2.723)	(2.470)
Terms of trade	-0.044^{***}	-0.036^{***}	-0.055^{***}	-0.055^{***}	-0.044^{***}	-0.044^{***}	-0.031^{***}
	(3.840)	(2.760)	(4.712)	(4.808)	(3.259)	(3.307)	(3.880)
Total immigration	-	-	-0.217^{***}	-0.246^{***}	-0.170^{**}	-0.186^{**}	-0.184^{***}
			(3.235)	(3.733)	(2.176)	(2.437)	(3.400)
R^2	0.518	0.449	0.552	0.560	0.468	0.472	0.488
Observations	210	210	210	210	210	210	210
Time Span	’87-’07	’87-’07	’87-’07	’87-’07	’87-’07	’87-’07	’87-’07

Notes: Year and Province fixed effects always included.
Panel Corrected Standard Errors calculated. FGLS: cross-section weights used.
Columns (3) and (5): total immigration: net interprovincial migration, temporary and permanent immigrants.
Columns (4) and (6): total immigration equals net interprovincial migration and temporary immigrants.
Columns (7): change in R rather than level of R used to capture resource windfall.
Absolute t-statistics in parentheses *** p<0.01, ** p<0.05.

at the 1 per cent level when the migration variable is introduced. The windfall's impact on the size of the non-tradable sector supports a Dutch disease phenomenon. This result concurs with previous findings obtained by Acosta et al. (2009) and Harding and Venables (2010). This result is robust to the measurement of the resource windfall. In column (7), we use the year-to-year change in $R_{i,t}$ rather than the level of $R_{i,t}$, which is the measure used most often (if not the only measure) in the existing literature.[21] Results for both measures are extremely similar.

In columns (1) and (2), when immigration flows are not included as controls, the effect of $R_{i,t}$ is still positive and significant at the 5 per cent level. However, the estimator is negatively biased due to the omission of the immigration flow that, first, tends to exert some mitigation effect and second, is correlated with the windfall (the so-called Alberta effect). This mitigation effect is further confirmed by the direct estimates of the impact of $mig_{i,t}$ associated with total immigration in columns (3) to (6). The point estimates of the migration variable are all negative and significant at the 5 per cent level at least. From an economic point of view, the coefficient of R estimated in columns (1) and (2) is the net effect of Dutch disease, i.e., the spending effect (plus eventually the resource movement effect if any), less the mitigation effect exerted by immigration.

Dropping permanent immigration not only alters the results (columns [4] and [6] versus [3] and [5]) but also leads to an increase in the point estimate of the resource windfall and improves the fit of the data as reflected by the R^2. This results in a higher mitigation effect when immigration is defined only as the sum of interprovincial flows and temporary inflows, excluding permanent migrants. This implies a stronger role for those migration flows in terms of mitigation, compared with international permanent immigration flow. This conjecture will be further explored in the next subsection.

5.1.2 Interaction between migration and resource income

Table 2 looks at the mitigation effect through the interaction between the resource inflow, R, and total immigration, mig. In that set-up, the mitigation effect is supposed to be higher for booming provinces. The estimates of Table 2 support that view. Once again, the coefficient of R increases

[21] One can argue that, at the steady state, a constant level of R will not lead to a change in $n_{i,t}$ and that the change in the resource windfall rather than its level should be used in the regression analysis.

when the interaction term is included, suggesting that immigration plays a role in the adjustment of the economy to the boom. The estimates of the coefficient relative to the interaction term support the view that immigration can mitigate Dutch disease. It also confirms that this effect increases with the size of the resource boom. As in Table 1, the impact is higher when permanent migrants are not included in total immigration flows.[22] For both tables 1 and 2, the effect of migration flows appears to be estimated less accurately with PLS than with FGLS for all models. However, the mitigation effect remains significant under both estimation strategies.

5.2 Types of migration flows

Table 3 gives the estimates of equation (7), when migration inflows are broken down by categories: net interprovincial immigration, temporary immigration, and permanent immigration. In column (3), the mitigation effect is captured with interaction terms involving the resource inflow. As previously explained in Section 4.2, those flows involve different types of migrants that differ in their sensitivities to labour market imbalances. Indeed, the policy objective of the temporary foreign worker programs is to supply workers in sectors in which there is an obvious shortage of labour. These immigrants can thus be viewed as a true addition to the provincial labour force. The same can be said about interprovincial migration, as illustrated by the migration of Ontario workers to Alberta in 2005. These migration flows appear to be motivated by labour market conditions. However, since not all interprovincial migrants are workers, nor are driven solely by economic motives (Coulombe, 2006), the associated elasticity of the interprovincial immigration is expected to be lower than that for temporary migrants. Finally, the selection procedure and the motivation for permanent migrants do not directly relate to booming sectors of some provinces.

The results obtained in Table 3 are consistent with the fact that market sensitivity is a key determinant of the mitigation effect. First, in contrast with the other migration flows, permanent migrants flows do not yield a significant mitigation effect. In columns (1) to (3), the key finding is that the point estimate of the permanent component of migration is never significant. It is also in line with the previous results obtained with total migration, including or excluding permanent

[22] A t-test on the difference of the mean of the estimated coefficients on resource rejects the null of no difference for both specifications.

Table 2: Mitigation effect of immigration: interaction terms

	Dependent variable: change in share of N sector					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	(FGLS)	(PLS)	(FGLS)	(FGLS)	(PLS)	(PLS)
Lagged dependent	-0.197^{***}	-0.204^{***}	-0.212^{***}	-0.213^{***}	-0.210^{***}	-0.211^{***}
	(5.099)	(4.603)	(5.500)	(5.532)	(4.729)	(4.748)
Change in T sector prod	0.027^{***}	0.024^{***}	0.028^{***}	0.028^{***}	0.026^{***}	0.026^{***}
	(4.089)	(3.322)	(4.379)	(4.383)	(3.522)	(3.525)
Change in N sector prod	-0.119^{***}	-0.112^{***}	-0.096^{***}	-0.096^{***}	-0.093^{***}	-0.093^{***}
	(4.696)	(3.838)	(3.705)	(3.707)	(3.062)	(3.070)
Resource	0.023^{**}	0.022^{**}	0.033^{***}	0.033^{***}	0.027^{**}	0.027^{**}
	(2.249)	(1.985)	(3.079)	(3.095)	(2.334)	(2.334)
Terms of trade	-0.044^{***}	-0.036^{***}	-0.047^{***}	-0.048^{***}	-0.039^{***}	-0.040^{***}
	(3.840)	(2.760)	(4.209)	(4.278)	(3.047)	(3.092)
Total immigration × Resource	–	–	-0.611^{***}	-0.675^{***}	-0.556^{**}	-0.610^{**}
			(2.590)	(2.659)	(2.122)	(2.153)
R^2	0.518	0.449	0.539	0.540	0.465	0.465
Observations	210	210	210	210	210	210
Time Span	’87-’07	’87-’07	’87-’07	’87-’07	’87-’07	’87-’07

Notes: Year and Province fixed effects always included.
Panel Corrected Standard Errors calculated. FGLS: cross-section weights used.
Columns (3) and (5): total immigration: net interprovincial migration as well as temporary and permanent immigrants.
Columns (4) and (6): total immigration equals net interprovincial migration and temporary immigrants.
Absolute t-statistics in parentheses *** p<0.01, ** p<0.05.

economic migration. In all columns of Table 3, the point estimates of the other two components have the expected negative sign and are significant at least at the 5 percent level. Second, the respective elasticities of temporary and interprovincial migration are also consistent with the key role of market sensitivities: the point estimate of the impact of temporary migrants is on average twice as much as that associated with net interprovincial migration. In all, the results support the view that the mitigation effect is associated with migration flows that are more market driven.

Columns (2) and (5) break down net interprovincial migration further into emigration and immigration. Interestingly, the associated coefficients of emigration and immigration are almost identical (with opposite signs, of course). They suggest that changes in the labour supply affect the share of the tradable and non-tradable sectors in the way predicted by the model. Also, an important implication of that result is that interprovincial emigration can act as an important channel to spread the effects of Dutch disease between provinces: one worker migrating from a non-booming province (say Ontario) to a booming province (say Alberta) will not only mitigate the Dutch disease in the latter province but also propagate the effect in the former. As emphasized in Section 2.3, interprovincial emigration operates like a resource movement effect. This does not mean that the resource windfall spreads to the other provinces through this channel but rather through the loss of labour in favour of the booming province.

5.3 Robustness

5.3.1 Endogeneity

Up until now, the estimation of equation (9) has assumed that all right-hand-side variables are exogenous or at least not correlated with $\epsilon_{i,t}$. This is consistent with the underlying theory. Nevertheless, in practice, it might be desirable to assess whether our estimation results are robust when accounting for endogeneity issues. We address three specific channels of endogeneity. We first adress concerns of possible correlation of our measure of the windfall with the error term. Then we look at possible endogeneity of immigration flows. Finally, we check whether our estimates are robust through additional sources of endogeneity through GMM estimation.

Instrumentation of the windfall.

Table 3: Mitigation effect of total immigration: types of migration flows

	Dependent variable: change in share of N sector				
	(1)	(2)	(3)	(4)	(5)
Estimation Method	(FGLS)	(FGLS)	(FGLS)	(FGLS)	(FGLS)
Mitigation effect	(Direct)	(Direct)	(Interaction)	(Direct)	(Direct)
Lagged dependent	−0.259***	−0.259***	−0.222***	−0.262***	−0.262***
	(6.280)	(6.251)	(5.820)	(6.436)	(6.387)
Change in T sector prod	0.029***	0.029***	0.026***	0.030***	0.029***
	(4.494)	(4.391)	(4.136)	(4.599)	(4.472)
Change in N sector prod	−0.101***	−0.101***	−0.096***	−0.101***	−0.101***
	(4.072)	(4.038)	(3.853)	(4.082)	(4.046)
Resource	0.037***	0.037***	0.046***	0.037***	0.037***
	(3.542)	(3.525)	(3.729)	(3.540)	(3.529)
Terms of trade	−0.052***	−0.052***	−0.046***	−0.053***	−0.052***
	(4.414)	(4.391)	(3.893)	(4.470)	(4.448)
Net interprovincial immigration	−0.234***	-	−0.824**	−0.240***	-
	(3.526)		(2.192)	(3.629)	
Interprovincial immigration	-	−0.240**	-	-	−0.252**
		(2.068)			(2.191)
Interprovincial emigration	-	0.240**	-	-	0.239**
		(2.028)			(2.025)
Temporary immigration	−0.450**	−0.450**	−2.995***	−0.475**	−0.477**
	(2.114)	(2.084)	(3.250)	(2.275)	(2.257)
Permanent immigration	0.129	0.125	5.982	-	-
	(0.613)	(0.594)	(1.603)		
R^2	0.566	0.566	0.566	0.566	0.565
Observations	210	210	210	210	210
Time Span	’87-’07	’87-’07	’87-’07	’87-’07	’87-’07

Notes: Year and Province fixed effects always included. FGLS: cross-section weights used.
Column (3): migration variables are interacted with resource income.
Absolute t-statistics in parentheses *** p<0.01, ** p<0.05.

The first channel of endogeneity is related to our measure of the windfall R as well as to the measure of the industrial structure (n) in equation (7). Indeed, dropping the i subscript, R is measured as the ratio of the windfall associated to the natural resources to provincial GDP, which in turn is the sum of production in the N and in the T sector of province plus the production of the resource sectors. A shock to the N sector in some provinces (suppose for instance provincial government services are reduced) will jointly affect our measures of n and R, creating some correlation between R and the error term. This will in turn affect our estimation of the Dutch disease, as well as the impact of the other variables. The solution to that econometric issue is to instrument R with some variable exogenous with respect to n. We follow this route by using indexes of the variation of R associated to the evolution of world commodity prices for the relevant commodities in each province. The world prices of oil, potash, natural gaz or wood are set on the international financial markets and are obviously unrelated to the industrial structure of the Canadian provinces. Canada is a small open economy, and each of its provinces is even smaller with no influence on the international price of their produced commodities. In contrast, a rise in the world price of commodities generates a significant change in R in commodity-rich provinces, as exemplified by the oil boom in Alberta over the 2002-2007 period. Our expectation is that the variability of R associated to shocks to the world commodity prices is far more important than the variation due to shocks to Y_N or to Y_T. Instrumenting R with world commodity prices allows to check that our expectation is correct.

More precisely, for each commodity-producing province we build the following instrument. For each province, we compute the product of the share of the main commodity in the provincial GDP and its world price index provided the production of this commodity represents a significant share in provincial output.[23] For some provinces like British Colombia or Alberta which are rich in more than one commodity, we also generate a second instrument involving the second commodity, following the same computation. In order to reflect resource endowments and to avoid changes in weights due to production shifts driven by price changes, we fix the weights to their value in the middle of the investigation period, i.e. in 1997.[24]

[23]Basically, the resource-rich provinces are British Columbia (Wood and Gaz), Alberta (Oil and Gaz), Saskatchewan (Potash) and New Foundland (Oil after 1997).

[24]The commodity price indices are drawn from the IMF database of primary commodity prices. They are expressed in USD (see www.imf.org/np/res/commod/index.asp). The data used to compute the provincial weights

Table 4: Mitigation effect of total immigration: Instrumentation of the windfall.

	Dependent variable: change in share of N sector			
	(1)	(2)	(3)	(4)
Lag dependent	$-.225^{***}$	-0.230^{***}	-0.225^{***}	-0.231^{***}
	(5.434)	(5.324)	(5.347)	(5.235)
Change in T sector prod	0.027^{***}	0.028^{***}	0.026^{***}	0.028^{***}
	(4.260)	(4.466)	(4.153)	(4.340)
Change in N sector prod	-0.100^{***}	-0.097^{***}	-0.103^{***}	-0.100^{***}
	(3.629)	(3.520)	(3.717)	(3.606)
Resource	0.031^{***}	0.029^{**}	0.034^{***}	0.032^{***}
	(2.613)	(2.511)	(2.778)	(2.622)
Terms of trade	-0.043^{***}	-0.042^{***}	-0.042^{***}	-0.042^{***}
	(3.134)	(3.117)	(3.036)	(2.994)
Total immigration	-0.173^{***}	-0.155^{**}	-	-
	(2.579)	(2.294)		
Net interprovincial immigration	-	-	-0.156^{**}	-0.129^{*}
			(2.087)	(1.693)
Temporary immigration	-	-	-0.473^{*}	-0.449^{*}
			(1.751)	(1.649)
Permanent immigration	-	-	0.035	0.046
			(0.119)	(0.157)
R^2	0.501	0.516	0.479	0.490
Observations	206	202	206	202
# Instruments	1	2	1	2

Notes: Year and Province fixed effects always included. Cross-section weights used for standard errors.
Columns (1) and (3): instrument of R: share of main commodity in provincial GDP.
Columns (2) and (4): instruments of R: shares of two first commodities in provincial GDP .
Absolute t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Panel IV regressions. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4 presents the estimation results instrumenting R. Columns (1) and (3) report the results obtain with one instrument, while columns (2) and (4) provide the findings obtained with two instruments. Columns (1) and (2) give the results for the mitigation effect of aggregate immigration, while columns (3) and (4) consider the impact of immigration broken down by type of flows. Basically, the estimation results of Table 4 show that our findings are robust to the possible endogeneity of R. The estimated coefficients are in line with the benchmark regression, for both cases in terms of the number of instruments. In particular, the estimation of the Dutch disease effect of the windfall is in line with previous findings. The mitigation effects are also quite similar with respect to previous estimates.

Instrumentation of immigration

As mentioned before, the second channel is the potential correlation between immigration flows and shocks to the industrial structure. While we can reasonably assume that international migration is quite exogenous since it is highly controlled by the federal and provincial immigration authorities, this is not the case for interprovincial migration. To account for this potential channel of endogeneity, we estimate model (9) by instrumenting either interprovincial net migration or total immigration. We instrument those variables using lagged immigration flows of international permanent and temporary migrants. The idea is quite intuitive. Job opportunities and job vacancies tend to decrease as a result of inflows of international migrants. Therefore, provinces that have previously received relatively more migrants tend to be less attractive to interprovincial migrants. In other terms, there is some substitution over time between international migrants and interprovincial migrants. Since the process of filling jobs takes time, this substitution shows up only after a while.

Our first-stage regression results are fully consistent with this story.[25] Net interprovincial immigration tends to be negatively affected by two-period lagged international permanent and temporary migrants. Both coefficients are negatively significant at a 1 per cent level in the first-stage, suggesting that they are strong instruments. Furthermore, the over-identification test

of each commodity comes from Statistics Canada (CANSIM 381-005). Note also that the breakdown by sector at the provincial level is not available for all years. The share of some sectors like Potash is not always reported for the sake of statistical secrecy and is included in the broad mining category.

[25]Detailed first-stage regressions are available upon request.

supports the validity of the exclusion hypothesis. The same holds for total immigration, albeit less obviously. This is not surprising, given that total immigration includes international immigration that can be considered as exogenous. Furthermore, while past international migration is negatively correlated with contemporaneous net interprovincial migration, the same does not hold for contemporaneous international immigration.

Columns (1) to (4) in Table 5 report the estimation results of equation (9) with instrumental variables. Columns (1) and (2) report the results for total immigration while columns (3) and (4) give the results, broken down by type of immigration flow. The main results are fully in line with the benchmark regressions. First, total immigration exerts a negative effect on the share of the N sector. Second, we find some mitigation effect for net interprovincial migration as well as temporary international immigration. Furthermore, the amplitudes of the estimated elasticities are in the same range of those estimated in the benchmark regressions. This suggests that our results are not driven by the possible endogeneity of interprovincial migration.

Further GMM test of remaining endogeneity.

Besides endogeneity of interprovincial migration and the windfall, model (9) might suffer from endogeneity (or more broadly from mispecification) coming from other channels. Endogeneity might result from the fact that there are obvious deviations from the underlying assumptions in the theory and the observed reality at stake. For instance, one might think that, in practice, the share of employment in the non-tradable sector, n, might influence the real exchange rate, p, causing the two-equation system to be interdependent. Similarly, learning-by-doing effects would make productivity endogenous to the economic structure (Gylfason et al., 1999; Torvik, 2001). In the same perspective, the Obstfeld-Rogoff model assumes full employment while in reality some provinces face significant unemployment levels (Gross and Schmitt, 2012). Therefore, it might be desirable to test for the empirical relevance of our specification. Strictly speaking, any specification test supporting our model does not rule out such endogenous effects. However, it might indicate that feedback effects in our case are either too weak, slow, or well captured by the time and province fixed effects.

To tackle this potential endogeneity problem, we proceed to a General Methods of Moments (GMM) estimation of equation (9) by making the best use of the cross-section and time-series dimension of our data. The idea is quite simple. We can split the sample into two sub-periods and estimate a system of equations for each sub-sample. The same model is estimated jointly for the first and second samples with parameter restrictions on all coefficients that imply the coefficients do not change over time. It allows us to compare the sample-specific estimates with the ones in the benchmark regression and, in turn, to test for the relevance of the specification.

Technically speaking, the additional number of moment conditions in the GMM estimation is equal to the number of parameters times the number of sub-samples. The use of additional moment conditions allows us to conduct an over-identification test. Failure to reject the null hypothesis tends to suggest that the model in the benchmark regression does not suffer from misspecification.

The results of this GMM estimation are reported in columns (5) and (6) of Table 5. The results indicate that the GMM estimation does not reject the restriction that the coefficients are equal between the two sub-periods at conventional significance levels and that our model is correctly specified. The impact of temporary international immigration is less significant, which might be explained by the fact that temporary migration flows became generalized across provinces only in the second sub-period.

5.3.2 Accounting for Nickell bias and non-stationarity

The dynamic nature of model (9) raises two further econometric issues. First, there is a potential issue of non-stationarity of the dependent variable, i.e., $n_{i,t}$. Two straightforward arguments in favour of stationarity can nevertheless be put forward: (i) $n_{i,t}$ is a proportion that is, by definition, bounded; and (ii) the point estimate of the lagged dependant variable is highly significant and around -0.2. Nevertheless, it might be desirable to test explicitly for the presence of a unit root. To that aim, Appendix B reports the results of the panel unit root test of Pesaran (2007). This test allows for the presence of cross-sectional dependence. The results support the stationarity of $n_{i,t}$, which is in line with the fact that our estimations of model (9) in Table 1 give a significantly negative value for the ξ parameter.

The second issue is the fact that the fixed-effect estimator in model (9) is subject to the Nickell bias (Nickell, 1981). Indeed, the model is equivalent to a model explaining the share

Table 5: Mitigation effect of total immigration: IV and GMM results

	Dependent variable: change in share of N sector					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	(IV)	(IV)	(IV)	(IV)	(GMM)	(GMM)
Lagged dependent	−0.263***	−0.291***	−0.267***	−0.281***	−0.243***	−0.265***
	(4.500)	(4.780)	(4.480)	(4.730)	(5.650)	(6.040)
Prod Growth in T	0.035***	0.035***	0.035***	0.033***	0.034***	0.034***
	(4.530)	(4.200)	(4.340)	(3.790)	(5.640)	(5.580)
Prod Growth in N	−0.076**	−0.072*	−0.077**	−0.076*	−0.085***	−0.083***
	(2.060)	(1.880)	(1.960)	(1.870)	(3.770)	(3.600)
Resource	0.045***	0.050***	0.047***	0.050***	0.030***	0.030***
	(3.450)	(3.560)	(3.510)	(3.290)	(3.520)	(3.890)
Terms of trade	−0.060***	−0.059***	−0.060***	−0.059***	−0.041***	−0.042***
	(3.860)	(3.880)	(3.800)	(3.810)	(3.850)	(3.800)
Agg. immigration	−0.400**	−0.544***	-	-	−0.222***	-
	(2.220)	(2.560)			(3.020)	
Net interp. immigration	-	-	−0.443**	−0.525**	-	−0.254***
			(2.240)	(2.170)		(3.540)
Temporary immigration	-	-	−0.554*	−0.551*	-	−0.350*
			(1.880)	(1.800)		(1.710)
Permanent immigration	-	-	−0.072	−0.051	-	0.104
			(0.330)	(0.236)		(0.600)
R^2	0.401	0.337	0.384	0.355	-	-
F-stat First stage	6.63	4.39	8.50	5.50	-	-
Nber Overid Rest	1	1	1	1	6	8
Overid Test (p-value)	0.61	0.67	0.86	0.95	0.09	0.10
Observations	190	200	190	200	210	210
Time Span	'87-'07	'87-'07	'87-'07	'87-'07	'87-'97, 98-'07	'87-'97, 98-'07

Notes: Year and Province fixed effects always included. Cross-section weights used for standard errors.
Columns (1) and (3): instruments of aggregate immigration: 2-period lagged international perm. and temp. migration.
Columns (2) and (4): instruments of net interprov. immigration: 1-period lagged internat. perm. and temp. migration.
Absolute t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

of the non-tradable sector as a function of its lagged value (and other covariates). The lagged dependent variable turns out to be correlated with the error term, making the fixed-effect estimator inconsistent with small samples in terms of time periods (T).[26] This bias is larger the lower the number of time periods but vanishes for $T \to \infty$ (but not for $N \to \infty$). Therefore, concerns about the Nickell bias have arisen mostly in cases with large N and small T, for instance, in datasets involving individual observations. Given that we have 22 time periods, one might argue that the Nickell bias is not a major issue in our analysis. Nevertheless, as a of robustness check, one might look for estimates accounting for the Nickell bias.

One possibility is to estimate directly model (9) using GMM with expanded moment conditions that control for the bias. One can, for instance, rely on the popular methods of Arellano and Bond (1991), Arellano and Bover (1995) or of Blundell and Bond (1998). As stressed by Baltagi (2008), these methods are mostly appropriate with relatively large N, and specifically N much larger then T, since they use the time-dimension for the moment conditions. Given that we have $N = 10$, those estimators are subject here to caution. Such dynamic panel GMM estimators also face problems in the presence of cross-sectional dependence, a feature that is expected here due to the strong links among Canadian provinces. An alternative way of checking the robustness of our estimates is to rely on a bias-corrected fixed-effect estimator based on the Kiviet (1995) adjustment. The Kiviet (1995) adjustment requires the use of a consistent estimator and a correction order. We use three supposedly consistent estimators (Anderson and Hsiao, 1982; Arellano and Bond, 1991; Blundell and Bond, 1998) and two correction orders $O(T^{-1})$ and $O((NT)^{-1})$. The results of the Kiviet-adjusted estimates are reported in Table B.2 in Appendix B.

Estimates in Table B.2 show that our initial estimates are robust to the solution of the Nickell bias, based on the Kiviet (1995) adjustment. Both the values and the significance of the parameters of equation (9) are extremely similar across estimation methods. In particular, we find strong support for the Dutch disease effects of resource income and for a mitigation effect through total immigration.

[26] We abuse the notation for T and N here. It should not be confused with notations for the tradable and non-tradable sectors. They refer here to the cross-section and time-series dimensions of the data sample. We keep those notations since these are the traditional ones in the econometric literature on panel data.

5.4 Economic relevance of the results and further discussions

To gauge the economic relevance of our results, we consider a few back-of-the-envelope calculations in the specific case of a booming province, Alberta, that enjoyed a significant resource boom between 2002 and 2007. The boom was triggered by a sharp increase in the world price of oil. The average contribution of the resource sector to the gross provincial product jumped from 24.3 per cent before 2002 to 40.7 per cent afterwards. Over the same period, total immigration in Alberta increased from 1.7 per cent of total labour per year on average to 3.1 per cent afterwards. A high percentage of migrants came from other provinces (1.3 per cent of net immigration) and through the temporary foreign worker program (1.4 per cent), the rest consisting of permanent immigrants. Using model (8) and the estimates of Table 1, one can compute the implied Dutch disease effects as well as the mitigation effect exerted by immigration flows. Given the average share of the non-tradable sector in Alberta, all things being equal, the resource boom led to an annual increase of about 1.9 per cent in the size of the non-tradable sector, of which about half (1 per cent) was mitigated by the inflow of workers. In terms of percentage points, the share of the non-tradable sector increases from 74.7 to 76.0 per cent without migration, and to 75.2 per cent with the mitigation exerted by immigration. In this specific case, total immigration dampens 52 per cent of the total Dutch disease effect. Figures are quite similar if we take into account the type of immigration flows. Based on the estimates of Table 3, the increase in the non-tradable sector amounts to 2.0 per cent and 0.8 per cent, respectively, without and with immigration. This is a mitigation effect of 61 per cent.

Cumulated effects are more difficult to compute. One of the reasons is that those calculations assume that the other determinants, such as productivities or the terms of trade, do not change. This is unrealistic over a medium-run horizon. The second reason is that, without immigration, Alberta could not have benefited from such a large boom, since some workers migrated specifically to the oil industry. In other words, resource income shocks and immigration flows are correlated, which makes separate calculations quite cumbersome. Third, computing cumulated effects imposes linear assumptions, which are likely to be violated over time. Finally, the previous calculations take the specific case of Alberta, a relatively small province. This means that, in relative terms, both the resource income and the immigration flows are important. It is therefore not surprising that, at first glance, those effects appear substantial. If we look at other provinces, the impact is less significant. For instance, if we take Ontario, the largest province that did not boom and that tended to lose labour through interprovincial emigration, the effect is much more moderate. Specifically, given the size of the provincial labour force, the spreading effect of Dutch disease through the net emigration of Ontarian workers as captured in Table 3 is modest. Furthermore, our theoretical background assumes full employment, which is not observed in practice. If some Ontario emigrants to Alberta were previously unemployed, the spreading effect is lower than theoretically identified. It therefore is much more likely that Dutch disease affects Ontario more through the real appreciation of the Canadian dollar caused by the surge in commodity prices (Beine et al., 2012).

Our results are therefore fully consistent with the "Alberta effect" as previously identified by Corden (1984) and Helliwell (1981). The windfall associated with a boom increases the attractiveness of the province through public investment and amenities funded by the taxes raised by the provincial government. This attracts migrants, either from other provinces or from abroad. This immigration in turn mitigates the Dutch disease effect. It should be stressed that this mechanism works regardless of the existence of a resource movement effect. In other words, the resource sector does not need to attract workers from other sectors for the mitigation effect to take place. If the resource sector attracts workers, then immigration mitigates both the spending and the resource movement effects of the boom. If the resource sector does not attract workers, only the spending effect is mitigated.

One might also claim that part of the mitigation effect of the Dutch disease is associated with the attraction of capital; our results do not rule this out. In the long run, complementarity between labour and capital prevails, both in resource and other sectors. Labour is therefore also needed for the sectors to survive or to expand. Given the integration of Canada, both internally and internationally, capital is not expected to be the binding factor in the long run. In contrast, there is evidence that labour supply has significantly constrained the development of some activities in Canada. The fact that temporary workers and their employers are subject to strict regulation and labour market tests but nonetheless their share is increasing for all provinces, especially since 2000, shows that labour demand has regularly exceeded labour supply in many sectors. In that respect, our paper quantifies the mitigation effect that is associated primarily with the binding factor, namely, labour.

Recently, there were many heated debates between Canadians about the positive and negative effects of resource extraction at the Canadian level. For instance, the prime minister of Ontario emphasized that oil extraction in Alberta leads to a significant decrease in Ontario's exports of manufacturing goods.[27] In terms of policy implications, our analysis shows that temporary foreign worker programs are an important tool for mitigating possible undesirable spillovers of that kind. Unlike interprovincial migration that leads to unequally distributed effects across provinces, the inflow of temporary foreign workers benefits all provinces in terms of mitigation. Furthermore, these programs are mostly controlled at the provincial level, which allows provincial authorities to tailor the intensity of the programs to the need.

6 Conclusion

This paper addresses the issue of Dutch disease and the possible mitigation effect associated with an inflow of workers. The Dutch disease effect at stake here is an increase in the size of the non-tradable sector of the economy, benefiting from a resource income. The components of the Dutch disease addressed here are the traditional spending effect associated with the resource windfall and, to a lesser extent, the resource movement effect due to the attraction of workers by the resource sector. We first present a model with a varying labour supply due to the inflow of workers. In that model, immigration dampens the increase in the size of the non-tradable sector. Furthermore, the model identifies the other determinants of the size of the non-tradable sector at equilibrium. These include both the resource and the non-tradable sectors' productivities and relative prices between regions.

We test the predictions of the model using data on Canadian provinces over the period ranging from 1987 to 2009. Canada is an interesting case study since it includes booming and non-booming provinces. Provinces such as Alberta, Saskatchewan, and Newfoundland enjoy windfalls from the extraction of natural resources, while other provinces like Quebec and Ontario rely much more on

[27] See Globe and Mail, February 27, 2012.

manufacturing activities. Previous studies clearly emphasize the case of Dutch disease in Canada due to the strong increase in the price of the commodities produced in Canada. An additional appealing feature about using Canada for this study is that data on immigration and emigration are available at the provincial level, along with data on international migration. This allows us to account for the mitigation effect associated with different types of migration, namely, temporary international immigration, permanent international immigration, and interprovincial migration. Finally, the possibility of investigating the Dutch disease phenomenon within regions of the same country allows us to control for national factors such as institutions. This is important, given the literature's emphasis on institutional factors in explaining the natural resource curse.

We find confirmation of Dutch disease in Canadian provinces. Booming provinces tend to face an increase in the share of the non-tradable sector at the expense of the tradable sector. This impact is larger the greater the resource income shock. Immigration tends to mitigate this effect. Our results are fully consistent with the so-called "Alberta effect" identified theoretically in early studies of the 1980s. Our analysis is the first one testing explicitly for such an effect associated with immigration. It also shows that this mitigation effect is associated with specific immigration flows, namely, those involving temporary foreign workers as well as interprovincial migrants. Those migration flows are most responsive to labour market conditions within each province. In contrast, permanent immigrants who are selected through the traditional federal point system do not dampen the increase in the non-tradable sector.

This observed inefficiency of the permanent immigrant program in dampening regional Dutch disease is likely to change in the future when the modifications to the selection mechanism, announced by the Canadian federal government in March 2012, are fully implemented. With the proposed changes, more weight would be given to labour market conditions; candidates with a job offer from a Canadian employer would be fast-tracked. In the actual process, lags between application and eventual admission are measured in years and the selection does not take into consideration the choices of Canadian employers. With the proposed changes, Canadian employers would substitute for civil servants as immigration agents. With the changes, we predict that the permanent immigrant program would exert the same mitigation effect as the temporary immigrant program.

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A Appendix: Model Derivation

A.1 Supply side

There are two sectors, N and T with Cobb-Douglas technology.

$$\begin{aligned} Y_N &= A_N K_N^{\alpha_N} (nL)^{1-\alpha_N}, && \text{(A.1)} \\ Y_T &= A_T K_T^{\alpha_T} ((1-n)L)^{1-\alpha_T}, && \text{(A.2)} \\ & \alpha_i \leq 1 \text{ for } i = N,\ T. \end{aligned}$$

A.2 Demand side

Consumers maximize utility in the consumption of tradable and non-tradable goods. Aggregate utility takes the following CES-function in those two goods,

$$U = \left[\gamma^{1/\theta}(C_T)^{\theta-1/\theta} + (1-\gamma)^{1/\theta}(C_N)^{\theta-1/\theta}\right]^{\theta/\theta-1}, \tag{A.3}$$

with aggregate budget constraint,

$$Z = C_T + pC_N = wL + r(Q+R), \tag{A.4}$$

with p the relative price of non-tradable goods in terms of tradable goods. R is the resource windfall coming from the extraction of natural resources. Q is the total domestic financial wealth that includes K_N and K_T and that is, under full capital mobility, supposed to be constant with :

$$Q \equiv B + \delta(K_N + K_T), \tag{A.5}$$

with B being the domestic assets held on the rest of the world, and δ the share of domestic ownership of capital producing domestically.

A.3 Non-tradable goods

The nature of non-tradable goods implies the following constraint:

$$C_N = Y_N. \tag{A.6}$$

Using equation (A.6), the share of the non-tradable sector can be expressed as:

$$n = \frac{Y_N}{A_N k_N^{\alpha_N} L}, \tag{A.7}$$

where $k_N \equiv \frac{K_N}{nL}$.

A.4 First-order conditions

First order conditions for capital, labour, and consumption are given by :

$$\begin{aligned} p_i \alpha_i A_i k_i^{\alpha_i - 1} &= r, && \text{(A.8)} \\ p_i (1-\alpha_i) A_i k_i^{\alpha_i} &= w, && \text{(A.9)} \\ \frac{\gamma}{1-\gamma} \frac{C_N}{C_T} &= p^{-\theta}, && \text{(A.10)} \\ & && \text{(A.11)} \end{aligned}$$

for $i = N,\ T$. Note that by normalization, $p_T = 1$ and $p_N = p$.

Using the budget constraint (equation (A.4), equation (A.6) can be rewritten as

$$C_N = \frac{Z(1-\gamma)p^{-\theta}}{\gamma + (1-\gamma)p^{1-\theta}}. \tag{A.12}$$

A.5 Equilibrium values for p and n

Equilibrium value for p can be derived by combining (A.8) and (A.9),

$$p = \left(\frac{1-\alpha_T}{1-\alpha_N}\right)^{1-\alpha_N} \frac{\alpha_T^{\alpha_T \frac{1-\alpha_N}{1-\alpha_T}}}{\alpha_N^{\alpha_N}} \frac{A_T^{\frac{1-\alpha_N}{1-\alpha_T}}}{A_N} r^{\alpha_N - \frac{\alpha_T(1-\alpha_N)}{1-\alpha_T}}. \tag{A.13}$$

Rewriting (A.7) by using (A.8)-(A.12) gives

$$n = \left(\frac{(1-\alpha_N)(1-\gamma)p^{-\theta}}{\gamma + (1-\gamma)p^{1-\theta}}\right)\left(\left(\frac{r}{\alpha_T^{\alpha_T} A_T}\right)^{\frac{1}{1-\alpha_T}}\left(\frac{Q+R}{(1-\alpha_T)L}\right)\right). \tag{A.14}$$

A.6 Comparative Statics

Equilibrium values of endogeneous variables can be expressed in relative variations, with $\widehat{x} = \mathrm{d}\ln(x)$. Due to perfect capital mobility, we have that $\hat{r} = 0$. Note that, by choice of the numeraire, $\widehat{p_T} = 0$.

The comparative statics of $\hat{n}$, $\hat{r}$ and $\hat{w}$ are given by:

$$\hat{n} = \hat{c}_N - \alpha_N \hat{k}_N - \hat{A}_N - \hat{L}, \tag{A.15}$$

$$\hat{r} = 0 = \hat{p}_i + \hat{A}_i + (\alpha_i - 1)\hat{k}_i, \tag{A.16}$$

$$\hat{w} = \hat{p}_i + \hat{A}_i + \alpha_i \hat{k}_i. \tag{A.17}$$

Due to perfect mobility of factors between sectors that implies full equalization of wage, the last equation can be reexpressed as:

$$\hat{w} = \frac{1}{1-\alpha_T}\hat{A}_T.$$

The comparative statics for consumption, wealth, and p (the real exchange rate) are given by:

$$\hat{c}_N = \hat{z} - [\gamma\theta + (1-\gamma)]\hat{p}, \tag{A.18}$$

$$\hat{z} = \psi_L(\hat{w} + \hat{L}) + \psi_K \hat{R}, \tag{A.19}$$

$$\hat{p} = \frac{1-\alpha_N}{1-\alpha_T}\hat{A}_T - \hat{A}_N. \tag{A.20}$$

where ψ_j refers to the share of income of factor $j = K,\ L$ in total income. Those shares are defined as

$$\psi_L = \frac{wL}{wL + r(Q+R)}, \quad \psi_K = \frac{r(Q+R)}{wL+r(Q+R)},$$

with $\psi_L + \psi_K = 1$.

All those expressions can be combined to get the equilibrium value of the change in n:

$$\hat{n} = \frac{\psi_L}{1-\alpha_T}\hat{A}_T + \psi_K\hat{R} - \left(\gamma\theta + (1-\gamma) + \frac{\alpha_N}{1-\alpha_N}\right)\hat{p} - \frac{1}{1-\alpha_N}\hat{A}_N - (1-\psi_L)\hat{L}. \tag{A.21}$$

B Appendix: Unit Roots and Nickell (1981) Bias

B.1 Unit root tests

Results on unit root tests on $n_{i,t}$ are presented in this section. The panel unit root test with cross sectional dependence is the one proposed by Pesaran (2007). The unit root test boils down to a t-test for $H_0 : \bar{\rho_i^*} = 0$ in the following regression model involving the variable of interest $y_{i,t}$:

$$\Delta y_{i,t} = \alpha_i + \rho_i^* y_{i,t-1} + d_0\bar{y}_{t-1} + \sum_{j=0}^{p} d_{j+1}\Delta\bar{y}_{t-j} + \sum_{k=1}^{p} c_k \Delta y_{i,t-k} + \varepsilon_{i,t}.$$

The test statistics of the unit root test is denoted by $\bar{t}$. Critical values for α equal at 1, 5 and 10 percent are reported, too. See lower panel of Table B.1.

Table B.1: Cross Dependence and panel unit root test on $n_{i,t}$

lag length		1	2	3
		Cross-sectional dependence test		
$\bar{\hat{r}}$		0.150	0.174	0.119
CD		4.60***	5.36***	3.65***
		Panel Unit Root test		
Critical Value	1%		−2.60	
(T=20, N=10)	5%		−2.34	
	10%		−2.21	
$\bar{t}$		−2.67***	−2.46**	−2.36**

Cross-sectional dependence (CD) and cross-section augmented DF (CADF) tests following Pesaran (2004a, 2007).
$\bar{\hat{r}} = \left(\frac{2}{N(N-1)}\right) \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{r}_{ij}$, and $CD = \left[\frac{TN(N-1)}{2}\right]^{1/2} \bar{\hat{r}}$
CD is asymptotically normally distributed around $H_0 : \bar{\hat{r}} = 0$
$\bar{t}$ is the simple average of the individual t-statistics on ρ_i^* and has critical values for H_0 : unit root, reported in Pesaran (2007, Table II(b)).
: stat. < 5% crit. val., *: stat. < 1% crit. val.

These unit root tests allow us to account for two important features of the data. First, they are conducted in a panel framework. Results from univariate unit root tests tend to reject the null hypothesis of a unit root in $n_{i,t}$ for most series. Nevertheless, for a subset of series, the null was not rejected. The results are not presented here due to space constraints but are available on request. One reason for the non-rejection of the unit root is the low power of those tests, which is amplified here by the small number of time-series observations ($T = 21$). The second feature is that the panel unit root tests should allow for the presence of cross-sectional dependence. Cross-sectional dependence is expected here due to the significant economic links among Canadian provinces. This is confirmed by the results of the test of cross-sectional dependence proposed by Pesaran (2004b). The underlying null hypothesis is $H_0 : \bar{\hat{r}} = 0$. The test statistic CD is asymptotically normally distributed. (See upper panel in Table B.1.)

Results are presented in Table B1. Both tests are computed for three lag structures, i.e. 1, 2 and 3 lagged values of the dependent variable.

B.2 Nickell bias and Kiviet-corrected fixed-effect estimates

This section presents the results of the fixed-effect (FE) estimates of model (9) using bias corrections in the spirit of Kiviet (1995). Basically, the idea of the Kiviet adjustment is based on an estimation of the Nickell bias in case of fixed T. Nickell (1981) already provided an estimation of the bias of the FE estimator for $N \to +\infty$ of order $O(1/T)$. Kiviet (1995) derives an approximation of the bias of higher order.

The Kiviet-adjusted estimates of model (9) are based on the use of a consistent estimator in presence of some dynamics. The estimation of the model using those consistent estimators provides an estimate of the bias for a given order, which in turn is used to adjust the initial estimates of the FE estimator. Three consistent estimators are used here: Anderson and Hsiao (1982) (AH hereafter), Arellano and Bond (1991) (AB), and Blundell and Bond (1998) (BB). Two orders of correction are used: $O(1/T)$ and $O(1/NT)$.

Table B.2: Robustness test: Kiviet-adjusted FE estimation.

	Dependent variable: change in share of N Sector							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimator	FGLS	PLS	AH	AB	BB	AH	AB	BB
Bias correction			$O(1/T)$	$O(1/T)$	$O(1/T)$	$O(1/NT)$	$O(1/NT)$	$O(1/NT)$
Lagged dependent	-0.260^{***}	-0.232^{***}	-0.213^{***}	-0.177^{***}	-0.144^{***}	-0.218^{***}	-0.175^{***}	-0.151^{***}
	(0.041)	(0.059)	(0.053)	(0.047)	(0.044)	(0.051)	(0.047)	(0.045)
Change in T sector	0.030^{***}	0.027^{**}	0.027^{***}	0.027^{***}	0.027^{***}	0.027^{***}	0.027^{***}	0.027^{***}
	(0.007)	(0.010)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Change in N sector	-0.100^{***}	-0.100^{***}	-0.100^{***}	-0.100^{***}	-0.100^{***}	-0.100^{***}	-0.100^{***}	-0.100^{***}
	(0.025)	(0.022)	(0.029)	(0.024)	(0.026)	(0.028)	(0.024)	(0.026)
Resource	0.037^{***}	0.032^{***}	0.033^{***}	0.033^{***}	0.031^{***}	0.033^{***}	0.030^{***}	0.031^{***}
	(0.011)	(0.008)	(0.011)	(0.009)	(0.010)	(0.011)	(0.009)	(0.010)
Terms of trade	-0.056^{***}	-0.044^{***}	-0.043^{***}	-0.041^{***}	-0.040^{***}	-0.043^{***}	-0.041^{***}	-0.041^{***}
	(0.012)	(0.010)	(0.012)	(0.010)	(0.011)	(0.012)	(0.010)	(0.011)
Total immigration	-0.245^{***}	-0.188^{**}	-0.190^{***}	-0.181^{***}	-0.184^{***}	-0.190^{***}	-0.180^{***}	-0.184^{***}
	(0.061)	(0.070)	(0.070)	(0.057)	(0.063)	(0.068)	(0.057)	(0.063)
Observations	210	210	210	210	210	210	210	210
Provinces	10	10	10	10	10	10	10	10

Columns (3)-(8): reported corrected FE estimates using Anderson-Hsiao (AH), Arellano-Bond (AB) and Blundell-Bond (BB) with bias correction of Order(1/X). Standard errors are reported in parentheses. In columns (1)-(2) robust standard errors; in (3)-(8) bootstrap standard errors using 100 replications.
***: $p<0.01$, **: $p<0.05$.