Dutch Disease and the Mitigation Effect of Migration: Evidence from Canadian Provinces*

Michel Beine†

Serge Coulombe‡

Wessel N. Vermeulen§

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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 with a resource income and a varying labor supply. Using data for Canadian provinces, we test for the existence of a mitigating effect of immigration in terms of the 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 mostly due 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 Classification: F22, O15, R11, R15

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†CREA, University of Luxembourg, IRES, CREAM and CES-Ifo, michel.beine@uni.lu

‡University of Ottawa, scoulomb@uottawa.ca

§CREA, University of Luxembourg, wessel.vermeulen@uni.lu

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, in the long run, to a decrease in overall welfare.[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 like Norway, Australia and Canada.[2] Solutions to overcome the Dutch disease are not straightforward since the problem involves market mechanisms that can hardly be controlled for.[3] The implied policy question is how the government can minimize the occurrence of Dutch disease in an economy characterized by natural resource extraction.[4]

The aim of this paper is to investigate whether Dutch disease can be overcome or at least mitigated through a specific market mechanism, namely immigration of workers. In

[1] The negative correlation between natural resource endowment and growth in cross-country studies has been coined the "natural resource curse" by Auty (1993) and Sachs and Warner (2001). Recent surveys are provided by van der Ploeg (2011) and Frankel (2010). The natural resource curse includes various potential growth-detrimental mechanisms. Other channels than Dutch disease involve overconsumption and deviation from the Hartwick rule (Hartwick, 1977 and 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] See for instance Gylfason (2011) on the role of sound institutions in developed countries for turning the resource curse into some success, with special focus on Norway.

[3] 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 exhaustable 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 (Torvik, 2001).

[4] Norway, a highly centralized country, 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, which 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 can however hardly be put into practice in highly decentralized countries such as Canada and Australia, where natural resources are provincial jurisdictions.

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 exchange rate and a rise in the size of the non tradable sector.[5] The second mechanism relies on the reallocation of labor 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, Chapter 4), with varying labour supply, in which the resource boom is modeled as an incoming external income or windfall. We derive the effects of the windfall, and effects of a labour force varying in size due to immigration on the non-tradable sector. 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 sectorial production, employment and migration. More precisely,b we use panel data from 1987 to 2007 for the ten Canadian provinces. The use of regional Canadian data is particularly appealing for assessing the Dutch disease and the mitigation effect of immigration. First, it is, in general, 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 which share very similar, if not identical institutional conditions, it is easier to estimate pure Dutch disease effects. Second, Canadian regions are quite heterogenous in terms of industrial structure. Some provinces are richly endowed in natural resources while others rely mostly on the manufacturing sector. The recent booms of Alberta's tar sands

[5] See van der Ploeg (2011) and Frankel (2010) for a synthesis. Evidence of a link between real exchange rate appreciation and commodity prices are 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. (2009). There is recent evidence of real exchange appreciation due to incoming remittances Acosta et al. (2009) and due to positive shocks to commodity prices Bodart et al. (2012).

production and Newfoundland off shore oil fields provides a kind of natural experiment. Third, labour mobility at the regional level come from various patterns which 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 coming under the traditional points system, in which immigrants are selected by the federal authorities on the basis of observable individual characteristics.[6] We also use immigration data from the temporary foreign worker programs that 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, allowing 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 van der Ploeg, 2011, for some references). To the best of our knowledge, our analysis of Dutch disease effects on the employment level is the first one involving regions of the same country. It is also the first paper looking empirically at the role of immigration as a mitigation mechanism of Dutch disease.

Our paper is related to several strands of the existing literature. Firstly, it complements results of recent Canadian studies showing that migration flows exert some effect on regional labour markets. Using time series and cross-section 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 effects on some industries. The results of the empirical analysis of Beine, Bos and Coulombe (2009) 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.

[6]For more than ten years now, the province of Quebec has been selecting its own permanent economic migrants.

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

The paper is organized as follows. Section 2 presents a small theoretical model *à* la Obstfeld-Rogoff capturing Dutch disease and the role of immigration. Section 3 describes the econometric approach. Section 4 is devoted to the presentation of the data, while Section 5 reports the results. Section 6 concludes.

2 Theoretical Background

In this section, we present the results of a small general equilibrium model capturing the effect of a resource boom, the so called Dutch disease effect, as well as the mitigation effect exerted by inflow of workers in 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 modeled explicitly, but captured through a windfall R. The model builds on the well-known framework of Obstfeld and Rogoff (1996) which has been extensively used to capture the dynamics of real exchange rates and relative sector sizes in a small open economy characterized with full capital mobility. It is extended here to include a resource windfall and a varying labour supply. This framework is relevant in the context of our analysis focusing on the dynamics of Canadian provinces. Canadian provinces are fully integrated and Canada as a whole is perfectly connected to the international financial markets. Furthermore, each provincial economy is relatively small, implying that it is price taker on the international good markets. It has no influence of the world interest rate r, nor its terms of trade including the export price of its primary commodities.

We relax the assumption of fixed labor by assuming that labor supply can be adjusted through an inflow or outflow of workers.[7] Since our empirical analysis will use Canadian regional data, it is understood that the inflows of workers in the booming regions can come from either international or interregional migration. Both types of inflows contribute to the mitigation effect. However, an inflow in the booming region coming from internal migration decreases the labor force in non-booming regions. With this migration channel, Dutch disease can be propagated to non-booming regions by a labor-reallocation effect.

In the basic Dutch disease model of Corden and Neary (1982), the economy is divided in 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 for modelling Dutch disease, labor 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 labor-reallocation effect (the so called resource movement effect). Both contribute to an increase of the relative

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

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 is here 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.[8] The model can be seen as an extension of Obstfeld and Rogoff (1996, Chapter 4) introducing an external resource income and non-constant labour. The economy studied in the theoretical model is small and the rest of the world economy is unaffected by this windfall and adjustment of the domestic Canadian economy.

Second, our model assumes homogeneous factors which are mobile across sectors. While in the basic model Corden and Neary (1982) assume one sector specific factor (capital) and one mobile factor (labour), they 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 to 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 to capture long-run effects of the resource boom and immigration.

We derive from the model the prediction regarding the relative size of sector N in the economy in relation to the windfall and the size of the labor force. This relationship will be the key estimated one in the empirical part. We present here the main structure of the model as well as the two equilibrium relationships.

[8] In that respect, we follow a large part of the theoretical literature (see for instance van der Ploeg (2011)) on the Dutch disease. This assumption is relevant and harmless in our case. First, resource sectors in Canada (tar sand oil, see oil dwells, 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 share of the resource sector in terms of employment is less than 1%. For Alberta, over our investigation period, it oscillates between 4 and 6% of the labour force. For New Founland and Saskatchewan, it ranges between 2 and 4%. 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 include only the change in resource sector productivity as the only additional covariate in the equilibrium condition. Since the change in labour productivity in the resource sector has been constantly higher than the ones in the two other sectors, this omitted variable will be picked up by the provincial fixed effects of booming provinces. Also, multifactor productivity in the resource sector is difficult to measure on an annual basis given its volatile and low share of labour.

2.1 Firms

There are two sectors, one producing tradable goods and the other one producing non-tradable goods. Firms follow Cobb-Douglas technology in a perfectly competitive market.

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

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 fully mobile between sectors and internationally. Tradable goods compete on the world market, and their price is taken as numeraire. 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.[9] For instance, part of the economy's productive capital may be foreign owned and other flows can be compensated 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.

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 $\hat{p} = \mathrm{d}ln(p)$ and $\hat{n} = \mathrm{d}ln(n)$.

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 relation-

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

ship 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:

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

Before switching to the estimation of (30), a couple of important comments are in order.

First, equation (5) is nothing else that 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 capita mobility, the Harrod-Balassa-Samuelson relationship holds regardless assumptions relative to the demand side of the model. $\hat{n}$ is driven by only supply factors such as the evolution of productivities in both sectors. As a result, since the Dutch disease effect in this model kicks in 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 notice that the solution involves a system of two independent equations in the sense that $\hat{p}$ does not depend on $\hat{n}$. This allows 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 empirically questioned in a large set of studies, suggesting that in practice, there might exist large deviations from the equilibrium captured in equation (5) (see for instance Taylor and Taylor (2004) on this).

Third, this last 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 directly equation (7) rather than to substitute further the equilibrium value of $\hat{p}$ into equation (7). 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 of equation (7).

Fourth, equation (7) gives a prediction on 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, equation (7) 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 effect leads to an increase of the N sector and a decrease of the T sector regardless the assumptions on 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 through a reduction in demand for those goods. This depends on the specific value of the demand parameters, γ and θ.

Finally, the model allows to identify the role of a change in the total labor supply available to the traded and non traded sectors ($\hat{L}$). This impact might be related either to the resource movement effect, to the impact of migration or to both. Consider first the case with no migration. In that case, $\hat{L} < 0$ due to the resource movement effect. The resource movement effect requires that the expansion of the resource sector attracts 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, New Foundland, and Fort McMurray in Northern Alberta at the heart of the Athabasca region illustrates the attraction of workers by the oil sector. This implies that there is definitely case for an existing resource movement effects in Canada even though its amplitude might be limited given the modest share of labour employed in the resource sector. Given that $\psi_L < 1$, the resource movement effect amplifies the spending effect in our model, a case which 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 to R.[10] This is especially the case since provinces that benefit from a resource boom will tend to attract more workers from outside.[11] Conversely, (provincial) emigration ($\hat{L} < 0$) generates an effect similar to the resource movement effect, reinforcing the spending effect at stake.

3 Empirical model and econometric specification

The empirical literature related to Dutch disease can be separated into two strands (van der Ploeg, 2011). The first looks at the price effect, and test whether the real exchange rate appreciates as a result of a resource boom or a windfall (Beine et al., 2009; Sala-i-Martin and Subramanian, 2003; Bodart et al., 2012; Chen and Rogoff, 2003a). An alternative strand tests the relationship between the evolution of the economic structure (the shift away from tradable production). There are fewer studies looking at the latter.[12] We follow this route and directly test equation (7) 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 labor force are driven by interprovincial and international immigration. Given the small number of Canadian provinces (ten), we cannot rely on the cross-section dimension only for the empirical analysis. We believe, however, that the great quality and consistency

[10] In other terms, we estimate a mitigation effect of immigration net of the resource movement effect. In presence of the latter, this implies that the pure mitigation effect due to immigration is underestimated.

[11] This has been identified originally by for instance as the 'Alberta' effect

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

across provinces and through time of the Canadian regional data more than compensates for the small number of cross sections.

In order to make the best use of the available information, we use a time series dimension by pooling annual data for the ten provinces over the 1987-2009 period. Consistent with our theoretical model, we estimate a dynamic panel data model which allows to account for long-run effects of resource boom and emigration. In this perspective, an empirical version of (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. $\hat{A}_T$, $\hat{A}_N$, $\hat{p}$, $\frac{\mathrm{d}R}{\mathrm{GNP}}$ and $\hat{L}$. The $u_{i,t}$ are modeled 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 towards the non-tradable one requires some adjustment of the entire industrial structure. This adjustment can take some time, best captured by the 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 γ 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.

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

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 wiped out from the analysis. With cross-section 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 which is specific to each province, is also wiped out 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 labor productivity growth in both sectors.[14] Consequently, the contribution of capital stock growth to productivity is included 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 labor forces $\hat{L}$.[15] 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 vari-

[14]Given the low share of labour in the resource sector, the measurement of multifactor productivity through labour productivity would be much more an issue for that sector. Furthermore, the labour share is highly volatile at the annual frequency in the resource sector, since it depends on the size of the boom.

[15]Note that changes in the active native population due to demographic trends are first not quantitatively important, especially compared to immigration and emigration. Second those changes are quite similar across provinces, thereby best captured by time fixed effects. An additional advantage to use 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.

ables, the following regression model is estimated:

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

where c_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 c_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.[16]

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 tradable sector. $R_{i,t}$ captures the annual resource income experienced in province i, while $TT_{i,t}$ is a measure of the term of trade 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 coming under the temporary working program implemented after 1985, and permanent economic immigration under the traditional Canadian immigration procedures (in particular the point system). We first 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 decompose 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 $\Delta n_{i,t}$ and $mig_{i,t}$. It can also arise if unobservable shocks to $\Delta n_{i,t}$ influence immigration

[16]Dutch disease might be seen as "premature" or "excess" deindustrialization (see Palma, 2008).

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 both for temporary migrants and for 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 towards skilled workers and is not market driven. Temporary worker programs are mostly controlled by the provinces. The flows are meant to fill up vacant positions declared by the local employers. It does not give any clear advantages to any sector (see 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.[17]

Endogeneity might be an issue mainly for interprovincial migration which 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 or less migrants if those migrants are more or less inclined to work in the N sector rather than the T sector. Nevertheless, the fact that 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 more or less interprovincial migrants in a contemporaneous way, i.e. within a year. The case for an overestimation of the mitigation effect in model (9) basically requires three conditions: (i) $mig_{i,t}$ reacts quite quickly; (ii) a significant part of the provincial immigration flow is driven by the change in the industrial structure; and (iii) this impact should be systematic and similar across all provinces and over time.[18] Those three conditions can be questioned in the face of immigration policy in Canada and the nature of migration flows between

[17] 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 boundery, Panel (2) of figure 1 illustrates for instance that half of the provinces did not implement temporary worker programs before the end of the 90s. This reflects policy choices of the provincial governments. Those choices can be related to several factors including ideological attitudes towards immigration.

[18] 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 (less) migrants than the non-tradable sector.

provinces. 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 more driven 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 c_i in model (9). Therefore, to sum up, the case for a significant correlation between $mig_{i,t}$ and $\epsilon_{i,t}$ seems quite low.

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). One reason why it is particularly the case in Canada is that resource rents are taxed at the provincial level, which in turn allows those provinces to develop infrastructures, social services and amenities that attract new migrants.

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 made up of the product of $R_{i,t}$ and $mig_{i,t}$. In this setup, the presence of a mitigation effect would be reflected by a negative coefficient of the interaction term. In this latter approach, it is nevertheless not straightforward to identify the exact size of the mitigation effect.

We use the best empirical methodology given the small number of cross sections (10). One point that we can take into consideration is the issue of cross-sectional heteroskedasticity. The economic structures of Canadian provinces are very heterogenous. The economies of Quebec and Ontario are much more diversified than the other ones (see Beine and Coulombe, 2003) thanks to a well-diversified manufacturing base. The other provinces are more dependent on natural resources. The growth pattern of larger provinces is more stable than in the less diversified provinces such as Saskatchewan and Newfoundland. Furthermore, oil extraction is concentrated (though not exclusively) in Alberta and Newfoundland. For the first set of results, we use pooled least squares (PLS) and we rely on cross-section weight standard errors (PCSE) that allow for asymptotically valid inferences in the presence of cross-sectional heteroskedasticity. The second set of results comes from generalized least-squares (FGLS) estimations using cross-sectional weighted regressions.

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 sectorial GDP and employment data, (ii) Citizenship and Immigration Canada data for temporary and permanent international immigration, and (iii) Statistics Canada 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 to our request by the Income and Expenditure Accounts Division from 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.[19] Services include government services. We obtain $n_{i,t}$ by taking the ratio of provincial service employment over the provincial labour force.[20]

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.[21] 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 labor 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 2009.

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 programs. Every year, the stock of temporary immigrants is considered an addition to the provincial labour force.[22] The programs implement migration schemes meant to provide solutions to temporary shortages in occupational labour. Under these programs,

[19] 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.

[20] One might discuss the empirical relevance of $n_{i,t}$, i.e. the relative share of the non tradable sector, as the right measure of Dutch disease. Indeed, one might have at the same time an increase in $n_{i,t}$ along with an expansion of the tradable goods sector. Nevertheless, in the presence of non linearities in the evolution of the tradable sector (VanWijnbergen (1996) Krugman (1987)) or in the presence of positive spillovers such as learning by doing effects from the tradable sector to the non tradable sector (Sachs and Warner (1995), Torvik (2001)), a decrease in the share of the non tradable sector might be detrimental in the long run for the total productivity of the economy.

[21] 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.

[22] See Gross and Schmitt (2012) for a thorough description of the temporary foreign worker programs of the Canadian provinces.

foreign workers are entitled to work for about one year, with a possibility of renewal. Renewal depends on the rate of vacant occupations. As a result, these temporary inflows can be considered highly responsive to labour market conditions.

For the permanent component, we consider only economic immigrants and leave aside the family and refugees class. The reason is that only the 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 the Visa. Furthermore, as showed by Coulombe and Tremblay (2009) a large proportion of permanent immigrants tend to concentrate in the large cities of Toronto, Montreal, and Vancouver where the presence of a large diaspora decreases the cost of immigration and integration.[23] Nevertheless, there are fewer guarantees that their skills will match those needed in the sectors facing shortage of labour. One might therefore consider permanent migration flows to be much less driven by market conditions than the temporary migrants.

Data on interprovincial migration were extracted from the Statistics Canada CANSIM website (tables 051-0012). This rich and unique regional data is derived from the residence information on income tax returns that Canadians have to fill out every year. Data is available both as net flows for the ten 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 is 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 between 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 labor market motives. As demonstrated by Coulombe (2006), a large part of interprovincial migration flows are spouses with children and the return migration of older people that come back to their original province for their retirement.

[23]See among others Beine et al. (2011) on the network effect of diasporas in international migration.

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).

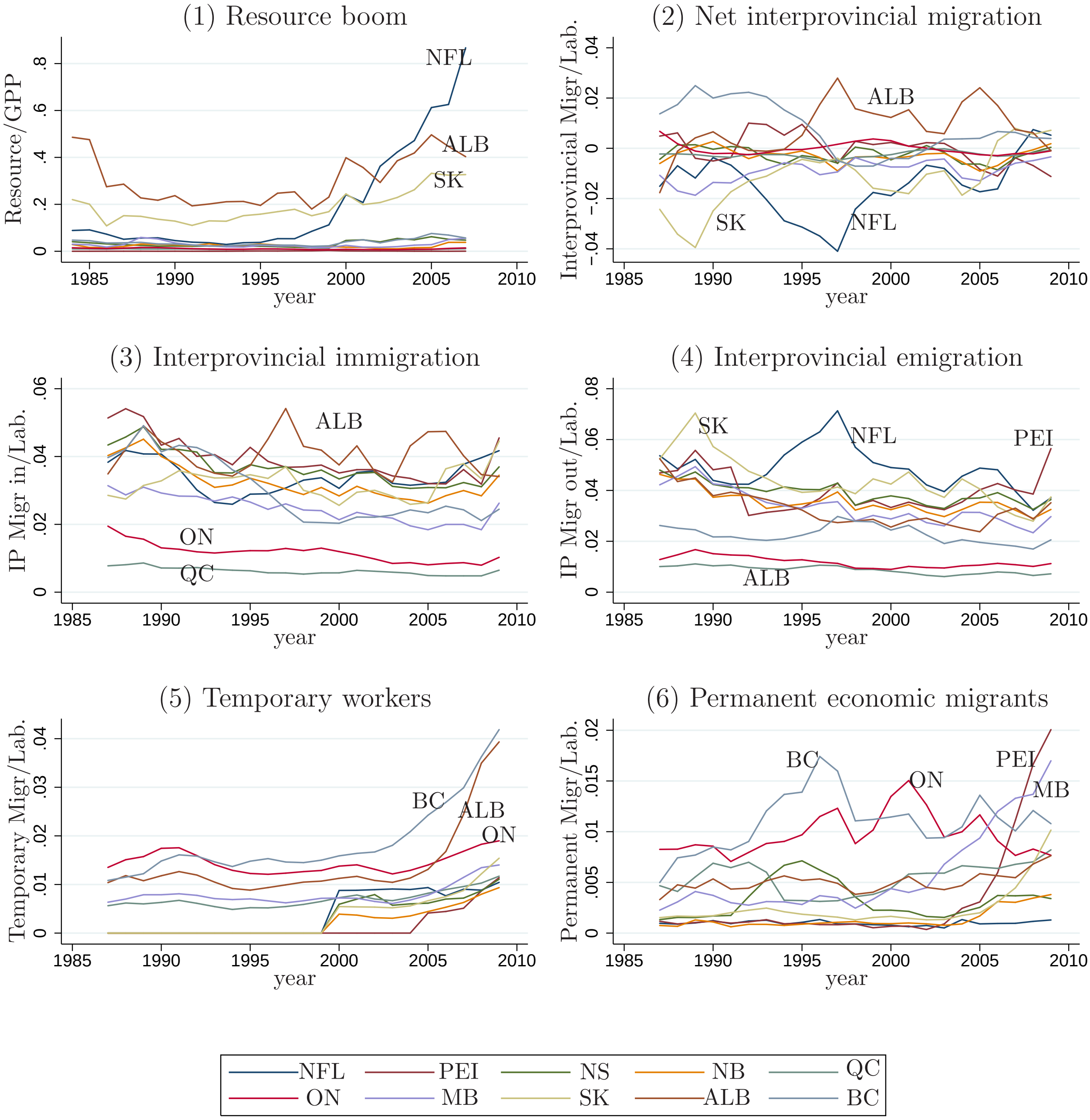
4.3 Evolution 1987-2009

Figure 1 plots the evolution of the key variables over the inspection period (1987-2009). First, with respect to resource booms, panel (1) makes clear that Canadian regions did not all experience a global resource boom. Three provinces benefitted from a huge increase in resource income: Alberta (mainly oil revenues), Newfoundland (oil) and Saskatchewan (potash). The surge was more recent for Newfoundland compared to 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 heterogenous situations. Regarding net interprovincial migration, panels (2)-(4), some provinces, like Alberta, have been systematically 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.[24] Nevertheless, with the oil boom taking place in Newfoundland, labour losses have decreased since 1998 and have 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 increasingly relied on temporary migrants to match labour market needs. In other provinces, the program was active only at the end of the 90s 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 benefitted the Canadian provinces. Interestingly, the cross sectional correlation between permanent and temporary immigration is far from

[24] 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



perfect. For instance, some provinces, like Prince Edward Island, or to a lesser extend Manitoba, relied heavily on permanent immigration rather than on temporary worker programs.

5 Results

In order to assess the existence and amplitude of a potential mitigation effect of Dutch disease, we proceed in different steps. First, we look at the role of total immigration. We test for a mitigation effect in two different ways, i.e. (i) as a direct effect on the industrial structure, and (ii) through the inclusion of an interaction terms 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 decompose interprovincial migration between 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 (8). In columns (1)-(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) which is, 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 they 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 come out 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 α which captures the catching-up process of the industrial structure lie around -0.2 and are highly significant, suggesting a stable adjustment process

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, * p<0.1

across the different specifications. This number implies that after a shock, the provincial economic structure takes on average approximately 3.5 years to make half of the adjustment.

All in all, the data fits 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 at the 1 percent 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 most often (if not the only) used measure in the existing literature-.[25] Results are extremely similar between both measures .

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 percent level. However, the estimator is negatively biased due to the omission of the immigration flow, which 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 percent 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 out permanent immigration does not only alter the results (columns (4) and (6) versus (3) and (5)), but it 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 dfor those migration flows in terms of mitigation, compared to international permanent

[25] 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.

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 setup, 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 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 suggests that this effect increases with the size of the resource boom. As in Table 1, the impact seems higher when permanent migrants are not included in total immigration flows. 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. They 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 Newfoundland 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 by economic motives solely, the associated elasticity of the interprovincial immigration is expected to be lower than the one for temporary migrants. Finally, the selection procedure

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 X 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, * p<0.1

and the motivation of 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 economic migration. In all columns of Table 3, the points 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 migration and interprovincial are also consistent with the key role of market sensistivities: the point estimate of the impact of temporary migrants is on average twice as much as the one associated to net interprovincial migration. All 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) further break down net interprovincial migration 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 labor 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 for 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 propagates 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 labor in favour of the booming province.

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, * p<0.1

5.3 Robustness

5.3.1 Endogeneity

So far the estimation of equation (9) has assumed that all right hand side variables are exogenous or at least uncorrelated 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 possible endogeneity issues. We address two specific alternative sources of endogeneity.

The first source of endogeneity is the possible correlation between immigration flows and shocks to the industrial structure, as discussed before. 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 less obvious for interprovincial migration. To account for the possible endogeneity of interprovincial migration, 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 vacancy tend to decrease as a result of inflows of international migrants. Therefore, provinces that received relatively more migrants previously tend to be less attractive for interprovincial migrants. In other terms, there is some substitution over time between international migrants and interprovincial migrants. Since the process of job filling takes time, this substitution shows up only after a while. Our first-stage regression results are fully consistent with this story. Net interprovincial immigration tend to be negatively affected by two-period lagged international permanent and temporary migrants. Both coefficients are negatively significant at a 1% level in the first-stage, suggesting that these are strong instruments. Furthermore, the overidentification test supports the validity of the exclusion hypothesis. The same holds for total immigration, albeit less obviously. This is not surprizing 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 4 report the estimation results of (9) with instrumental variables. Columns (1)-(2) report the results for total immigration while columns (3) and (4) give the results when breaking down flows by immigration type. The main results are fully in line with the benchmark regressions. First, total immigration exerts a negative results 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 range of those estimated in the benchmark regressions. This suggests that our results are not driven by the possible endogeneity of interprovincial migration.

Beside interprovincial migration, model (9) might suffer from other possible sources of endogeneity. The issue of endogeneity here might come 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 n might influence p, causing the two-equation system to be interdependent. To assess the robustness to other sources of endogeneity, we proceed to a GMM estimation of equation (9) taking benefit of the combination of cross-section and time-series observations. The idea is quite simple. The cross-sectional dimension allows us to split the sample into two sub-periods and estimate a system of equation for each sub-samples. The same model is estimated jointly for the first and second sample with parameter restrictions on all coefficients that imply that the coefficients do not change over time. It allows to compare the sample specific estimates and the ones in the benchmark regression and in turn allows 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 subsamples. The use of additional moment conditions allows us to conduct an overidentification 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 4. The results indicate that the GMM estimation does not reject the restriction that the coefficients are equal between the two subperiods at conventional significance levels.

The impact of the temporary international immigration is less significant, which might be explained by the fact that the pattern of temporary migration is very different across the two sub-periods.

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 favor of stationarity can nevertheless be put forward: (i) $n_{i,t}$ is a proportion which 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 explicitly test 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 γ 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 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 mostly arisen in cases with large N and small T, for instance in datasets involving individual observations. Given that we have 22 periods of time, 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 (1) using the Generalized Method of Mo-

[26]We abuse 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.

Table 4: 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

ments (GMM). One can, for instance, rely on the popular methods of Arrellano and Bond (1991) or Arellano and Bover (1995). As stressed by Baltagi (2008), these methods are mostly appropriate with relatively large N. Given that we have $N = 10$, those estimators are subject here to caution. GMM estimators also face problems in the presence of cross-sectional dependence, a feature which is expected here due to the strong links between 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; Arrellano and Bond, 1991 or Arellano and Bover, 1995) 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 of 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 of total immigration.

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. Consider Alberta, which has 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 share of the resource sector in gross provincial product jumped from 24.3% of before 2002 to 40.7% after. Over the same period, total immigration in Alberta increased from 1.7% of total labour per year on average, to 3.1% after. A high share of the migrants came from other provinces (1.3% net immigration) and through the temporary foreign worker program (1.4%), the rest being made up 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, *ceteris paribus*, the resource boom led to an annual increase in the size of the non-tradable sector of about 1.9%, of which about half (1%) 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% without migration, and to 75.2% with the mitigation exerted by immigration. In this specific case, total immigration dampens 52% 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 of the non-tradable sector amounts to 2.0% and 0.8%, respectively, without and with immigration. This is a mitigation effect of 61%.

Cumulated effects are more difficult to compute. One 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 benefitted 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 important. 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 be 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 employement, which is not observed in practice. if some Ontarian emigrants to Alberta were previously unemployed, the spreading effect is lower than theoretically identified. It therefore is much more likely that Dutch disease impacts Ontario more through the real appreciation of the Canadian dollar caused by the surge in commodity prices (Beine et al., 2009).

Our results are therefore fully consistent with the 'Alberta' effect as previously identified by Corden (1984) and Helliwell (1981). The windfall associated to boom raises 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 efect. It should be stressed that this mechanism works regardless 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 it does not, only the spending effect is mitigated. In Canada, given that the resource sectors are mostly capital intensive, the Dutch disease effect is dominated by the spending effect. Nevertheless, while possibly moderate, there is some resource movement effect as exemplified by the weekly flights of workers organized to Fort McMurray in Alberta at the peak of the oil boom in 2006.

One might claim that part of the mitigation effect of the Dutch disease goes also through the attraction of capital (see Raveh (2012) for instance). Our results of course do not rule out that the mitigation effects are also associated to the attraction of capital. In the long run, complementarity between labour and capital prevails, both in resource sectors and in the other sectors. Labour is therefore also needed for the sectors to survive of 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 mere fact that quotas set for the inflow of temporary workers are most of the time reached in a lot of provinces show that labour demand has regularly exceeded labour supply in a lot of sectors. It that respect, our paper quantifies the mitigation effect which is primarily associated to the binding factor, namely labour.

The were a lot of recent tough debates between Canadian 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

Ontarian 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 benefit all provinces in terms of mitigation. Furthermore, they are mostly controlled at the provincial level, which allows provincial authorities to taylor-adjust the intensity of those programs.

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 benefitting from a resource income. The components of the Dutch disease that is 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. Those include both sectors' productivities and relative prices between regions.

We test the predictions of the model using data on Canadian provinces over the period ranging from 1989 to 2009. Canada is an interesting case study since it includes booming and non-booming provinces. Provinces like Alberta, Saskatchewan, and Newfoundland enjoy subsequent windfalls from the extraction of natural resources, while other ones like Quebec and Ontario, rely much more on manufacturing activities. Previous studies clearly emphasize the case of a Dutch disease in Canada due to the strong increase in the price of the commodities produced in Canada. An additional appealing feature of Canada 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 as-

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

sociated 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 a 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 higher the resource income shock. Immigration tends to mitigate this effect. Our results are fully consistent with the so called Alberta effect theoretically identified in early studies of the 80's. Our analysis is the first one testing explicitly for such an effect associated to immigration. It also shows that this mitigation effect is associated to 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 that are selected through the traditional federal point system do not dampen the increase in the non-tradable sector.

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A Model derivation

A.1 Supply side

There are 2 sectors, N and T with Cobb-Douglas technology.

$$
\begin{aligned}
Y_N &= A_N K_N^{\alpha_N} (nL)^{1-\alpha_N}, && (10)\\
Y_T &= A_T K_T^{\alpha_T} ((1-n)L)^{1-\alpha_T}, && (11)\\
& \alpha_i \leq 1 \text{ for } i = N,\ T.
\end{aligned}
$$

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,

$$U = \left[\gamma^{1/\theta}(C_T)^{\theta-1/\theta} + (1-\gamma)^{1/\theta}(C_N)^{\theta-1/\theta}\right]^{\theta/\theta-1}, \tag{12}$$

with aggregate budget constraint,

$$Z = C_T + pC_N = wL + r(Q + R). \tag{13}$$

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 which includes K_N and K_T and which is, under full capital mobility, supposed to be constant with :

$$Q \equiv B + K_N + K_T \tag{14}$$

with B being the domestic assets held on the rest of the world.

A.3 Non tradable goods

The nature of non tradable goods implies the following constraint:

$$C_N = Y_N. \tag{15}$$

Using equation (??), the share of the non tradable sector can be expressed as :

$$n = \frac{Y_N}{A_N k_N^{\alpha_N} L}. \tag{16}$$

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

A.4 First order conditions

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

$$p_i \alpha_i A_i k_i^{\alpha_i - 1} = r, \tag{17}$$

$$p_i (1-\alpha_i) A_i k_i^{\alpha_i} = w, \tag{18}$$

$$\frac{\gamma}{1-\gamma}\frac{C_N}{C_T} = p^{-\theta}. \tag{19}$$

$$\tag{20}$$

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

Using the budget constraint (equation (13), equation (15) can be rewritten as

$$C_N = \frac{Z(1-\gamma)p^{-\theta}}{\gamma + (1-\gamma)p^{1-\theta}}. \tag{21}$$

A.5 equilibrium values for p and n

Equilibrium value for p can be derived by combining (17) and (18),

$$p = \left(\frac{1-\alpha_T}{1-\alpha_N}\right)^{1-\alpha_N} \frac{\alpha_T^{\alpha_T \frac{1-\alpha_N}{1-\alpha_T}}}{\alpha_N^{\alpha_N}} \frac{A_T^{\frac{1-\alpha_N}{1-\alpha_T}}}{A_N} r^{\alpha_N - \frac{\alpha_T(1-\alpha_N)}{1-\alpha_T}}. \tag{22}$$

Rewriting (16) by using (17)-(21) gives

$$n = \left(\frac{(1-\alpha_N)(1-\gamma)p^{-\theta}}{\gamma+(1-\gamma)p^{1-\theta}}\right)\left(\left(\frac{r}{\alpha_T^{\alpha_T}A_T}\right)^{\frac{1}{1-\alpha_T}}\left(\frac{Q+R}{(1-\alpha_T)L}\right)\right). \tag{23}$$

A.6 Comparative statics

Equilibrium values of endogeneous variables can be expressed in relative variations, with $\widehat{x} = dln(x)$. 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:

$$\hat{n} = \hat{c}_N - \alpha_N\hat{k}_N - \hat{A}_N - \hat{L}, \tag{24}$$

$$\hat{r} = 0 = \hat{p}_i + \hat{A}_i + (\alpha_i - 1)\hat{k}_i, \tag{25}$$

$$\hat{w} = \hat{p}_i + \hat{A}_i + \alpha_i\hat{k}_i, \tag{26}$$

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:

$$\hat{c}_N = \hat{z} - [\gamma\theta + (1-\gamma)]\hat{p}, \tag{27}$$

$$\hat{z} = \psi_L(\hat{w} + \hat{L}) + \psi_K\hat{R}, \tag{28}$$

$$\hat{p} = \frac{1-\alpha_N}{1-\alpha_T}\hat{A}_T - \hat{A}_N. \tag{29}$$

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

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

, with $\psi_L + \psi_K = 1$.

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

$$\hat{n} = \frac{\psi_L}{1-\alpha_T}\hat{A}_T + \psi_K \hat{R} - \left(\gamma\theta + (1-\gamma) + \frac{\alpha_N}{1-\alpha_N}\right)\hat{p} - \frac{1}{1-\alpha_N}\hat{A}_N - (1-\psi_L)\hat{L}. \quad (30)$$

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% are reported, too. See lower panel of Table B.1.

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 available upon requests but are not presented here in order to save space. One reason for 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 important economic links between 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 statistics 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.

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 $<$ 10% crit val, **: stat $<$ 5%, ***: stat$<$1%.

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 is in turn used to adjust the initial estimates of the FE estimator. Three consistent estimators are used here: Anderson and Hsiao (1982) (AH hereafter), Arrellano 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, *: p<0.1.