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Resource Income and the Effect on Domestic Neighbours: A case study on Canadian Provinces

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Resource Income and the Effect on Domestic Neighbours: A case study on Canadian Provinces

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Abstract

Resource income in a multi-regional setting allows for differentiated impacts of windfalls on the industrial development of each region. A resource exporting region suffers from Dutch disease through a spending effect and a real exchange rate appreciation. Whereas, a neighboring region will suffer from the real exchange rate appreciation but the increased demand from the region with the resource income of tradable goods will increase the traded good sector in the neighboring region. For a 2-region 2-sector model the equilibrium conditions on the labour allocation between the sectors are derived taking into account resource potential windfalls. The model is tested on and supported by a panel dataset of Canadian provinces.

JEL: C23, E24, F16, F41, R11

Keywords: Dutch Disease, interregional and international trade.

1 Introduction

The economic literature on resource exploitation and industrial structure has highlighted the demand and real exchange rate effects of the exporting country on the development of its other sectors, often referred to in the context of Dutch disease (see Frankel, 2010; van der Ploeg, 2011, for reviews on the topic). This literature on the economic effects of natural resources and Dutch disease is centered around the macroeconomic effects on the country or region in which the natural resources are located. Corden and Neary (1982) provide the baseline framework which establishes that under certain conditions, a tradable manufacturing goods sector will decline (relatively) to the resource sector and non-tradable services sector following the development of the resource sector due to spending, real-exchange rate and labour reallocation effects. This declining manufacturing sector is often viewed as adverse to the economic future of a country but could very well be an economically efficient response. An early review with consideration of many different cases is given in Corden (1984).

However, when resources are geographically concentrated, it is possible that the region with the resource sector benefits from its proceeds while macroeconomic side effects are negatively affecting neighbouring regions. For instance, resource exports are related to a real currency appreciation. So, regions that share a currency with a resource exporting neighbour, but do not receive the resource windfall could be net losers of the resource production due to their loss of international competitiveness.

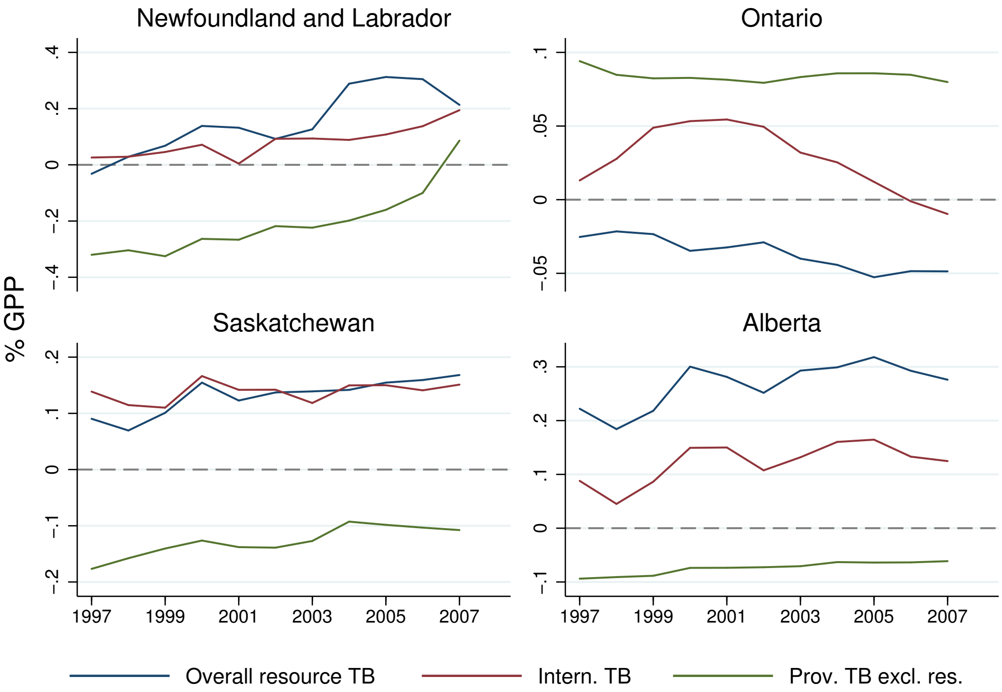
Nevertheless, neighbouring regions can also benefit indirectly from their neighbour's fortune through extra demand for their goods from those neighbours. It is this indirect benefit that has been overlooked thus far in the discussion on the macroeconomic consequences of resource exploitation. This paper incorporates interregional trade effects in a theoretical general equilibrium framework with an emphasis on the relative employment between sectors. It derives a structural condition for these employment levels which is then tested on a panel of Canadian provinces.

The trade effects of natural resources among regions are considered theoretically by Venables (2011), which highlights in particular the effects of differentiated trade-cost between regions and the rest of the world in different trade regimes. The theoretical implications are the same as in this paper: in a free trade regime (or with very low trade costs) among nations, there are trade (and welfare) enhancing effects for the resource poor region, even when controlling for price changes.

On the empirical side, this paper fits in a growing set of literature that uses regional data to measure the effects of resource exploitation on the economy and institutions (see van der Ploeg, 2011, for references and Beine, Coulombe and Vermeulen, 2012 on Canada). Firstly, such an approach benefits empirical methods by using consistent and comparable data of high quality. Secondly, the often geographically sparse allocation of resources makes regions within a country behave similar to what would be expected at an international level, where some countries have large resources exports and others none. Thirdly, by looking at the most direct trading partners of regions, namely their neighbouring regions in the same country, it is possible to capture the effect a resource exporting region has on its neighbours through interregional trade.

For Canada as a whole, the differentiating effect of natural resource production on other sectors in Canada was estimated by Dissou (2010) in a computable general equilibrium model. He finds that the effect on different sectors is heterogenous due to their different characteristics in production and due to the extend production goods are exported. He highlights further the dominance of a country level perspective used by studies on Canada and its resource exports, as opposed to sectoral or regional analysis. This paper goes some way in addressing this issue by incorporating both multiple sectors and regions

Figure 1: International, interprovincial & resource trade



Overall resources trade balance (TB) refers to the sum of provincial and international trade balances for mineral fuels, petroleum and coal. International trade balance is the self explanatory. The provincial trade balance excludes the interprovincial trade of resources. Data comes from Statistics Canada, retrieved from the CANSIM website, tables 386-0002. Special made tables from Statistics Canada where used to calculate ratios of Gross Provincial Product (GPP), see Section 3.

in the theory and empirics with a specific emphasize on the Canadian case.

Beine, Bos and Coulombe (2012) discusses the issue of the impact of the real exchange rate appreciation caused by oil exports and the negative impact for the competitiveness of non-resource exporting provinces in Canada. Using time-series analysis on the real exchange rate they are able to capture the impact of the resource exports on its exchange rate. This real exchange rate effect has been a nuisance for provinces that do not have resources themselves and are dependent on exports of manufacturing goods. A second effect, much less noted, is that non-resource producing provinces also benefit from their resource exporting neighbours through extra demand for their goods.

In order to visualize the potential impact of the before described trade dynamics Figure 1 plots several trade relations of four Canadian provinces: three major resource producers: Newfoundland, Saskatchewan and Alberta, and resource poor Ontario.[1]The figure plots the international trade balance, the resource trade balance, and the interprovincial trade balance four these four provinces. The resource trade balance is the total balance, national and international in resources.

[1]Appendix A presents a monochrome version of Figure 1.

There are some observations to be made with respect to the provincial trade balance. Firstly, the three major resource producers all have an international trade surplus. This international dimension here is mainly the United States which is the most important international trading partner for all provinces. Secondly, this international trade surplus is explained to a large extend by their overall resource exports, as is evident from the level and correlations of the two lines. This is important since it establishes that resource rich provinces have international trade surpluses that finance their interprovincial trade deficits. For Alberta the resource exports line is significantly higher than the overall international trade balance. This means that Alberta trades part of its resources for goods from abroad, but the variation of the surplus tracks very closely the variation of the value of its resource exports.[2] Thirdly, Ontario as the economically most important province has a consistent interprovincial trade surplus. This surplus also holds at the bilateral level (not shown), that is, bilateral trade statistics of Ontario with Alberta, Saskatchewan and Newfoundland show a consistent trade surplus for Ontario. Finally, Newfoundland & Labrador appears to be a slightly different case compared to Saskatchewan and Alberta. It shares the very high interprovincial trade balance for the second half of the 1990s while the growing resource production helps the positive international trade balance. However, in the later years it runs an almost balanced provincial trade balance while the international trade balance is increasing, with net resource exports decreasing. One of the reasons for these observations is that Newfoundland is not exporting its resources directly abroad but transports part of it to other Canadian provinces for further processing.

These stylized facts support the idea that there is a relationship between trade patterns and resource exports. This paper will develop a general equilibrium model that is in line with these facts. Furthermore, the empirical exercise will test whether resource production of resource rich provinces drives in part the interprovincial trade surplus for resource poor provinces in such away that it has an impact on their sectoral employment, while controlling for productivity processes, price effects as well as unobserved time and provinces fixed effects.

Such interprovincial trade imbalances and potential processing demand from oil-rich provinces present opportunities for those provinces that feel negatively affected by the real exchange rate dynamics that are caused by exports of resources. Although a resource poor region may become less competitive towards the rest of the world (due to an appreciating currency), the extra demand coming from its neighbouring provinces, that have surpluses to spend or resources to process can, at least partly, substitute for lost international demand.

[2]It has been well established that there is still a difference in trade patterns between Canadian provinces, and between the US and the provinces, even under the well integrated markets and free trade regimes (McCallum, 1995; Helliwell, 1998; Helliwell & Verdier, 2001; Coulombe, 2003). This phenomenon is consistent with the observation that resource rich provinces do not use all their resource export surpluses for imports from abroad, but instead import from their neighbouring provinces.

The decline of the manufacturing sector's opportunities following a resource driven exchange rate appreciation has been termed Dutch disease. In that framework, this study argues that the real exchange rate appreciation effect is present for both regions that export resources and those that do not. However, the resource poor regions sharing the same currency do not only experience adverse effects on their manufacturing sector. They face additional regional exports that helps to mitigate the potential loss for the industrial employment.

In this paper the industrial structure is derived in a general equilibrium framework. In order to capture correctly the effect of neighbour's demand the framework needs to include explicitly at least two trading regions. Using such a framework results in an equilibrium expression of the industrial structure in terms of labour allocation among sectors that produce goods that can be traded and those that cannot. This framework offers a single equation that captures the situation for both provinces that export resources to the rest of the world and those that benefit from the surpluses such provinces create.

This structural equation is tested on a panel of Canadian provinces over the period 1987-2007. The empirical model supports findings found in the literature on a direct de-industrialisation for those provinces that export resources and the negative effect of the real exchange rate appreciation of the Canadian dollar on the other provinces. However, the regressions also confirm that those provinces that do not export resources themselves benefit from the extra demand for their tradable goods coming from the regions that do export resources. It is this demand effect that causes the major resource boom in some Canadian provinces to have a potentially beneficial effect for those provinces that happen to have no natural resources of their own.

Since this paper looks at changing patterns of industrialisation, competitiveness and trade, it abstains from making predictions on the long term growth effects of resource exploitation which is otherwise widely debated. For instance, it has been argued that a declining manufacturing or tradable goods sector can harm long term growth (Krugman, 1987; Torvik, 2001) but evidence for this hypothesis is mixed (Sachs & Warner, 2001; Mehlum, Moene & Torvik, 2006; Raveh, 2012).

The remainder of this paper is the following: Section 2 sets out the theoretical model and derives the equilibrium condition on the labour allocation, Section 3 discusses the data, methods and presents the results. Finally, Section 4 concludes.

2 The Theoretical model

The main framework for the theoretical consideration relies on a set of standard equations that have been used in the literature to model economies in a general equilibrium framework. The model here can be related to that used by Corsetti, Martin and Pesenti (2007) with some simplifications. Extensive margins are not modeled in this paper (the number of goods in each sector is normalized and kept constant), but a non-tradable goods sector is included following Hamano (2012).

The use of such more micro-founded models instead of those often used to analyze international macroeconomic issues, for instance the framework used in a series of papers starting with Obstfeld and Rogoff (2000), rests mostly in the underlying assumptions of which factors are allowed to adapt in the model. Many macroeconomic models that look at international movements of goods and assets with changing international prices leave the domestic industrial structure unchanged. However, it is this industrial structure which is the focus in this paper. In effect this model is a mirror image to the open macroeconomic models such as those of Obstfeld and Rogoff that envisage adaptions to external shocks through international prices or trade account reversals but not industrial structure (Obstfeld & Rogoff, 2005, p.87).

With respect to the literature of resource income this model contributes by taking into account the neighbouring region. Most models in this literature use a small open economy framework where the country or region receiving the resource windfall does not affect its neighbours (Corden & Neary, 1982; Beine, Coulombe & Vermeulen, 2012). This paper provides an extension by including a neighbouring country or region which is affected by the region receiving the windfall through the demand for its tradable goods.

The resource windfall is added as an endowment shock to the budget constraint of the representative consumer. In that respect this is still a partial equilibrium model. One region establishes a trade surplus to the rest of the world by exporting its natural resource, which is not further used in consumption or production. This trade surplus counts as an endowment shock to the budget constraint of the resource exporting province and can subsequently be spend on goods from the rest of the world or on imports from a neighbouring region. When it is spend on imports from the neighbouring region a trade deficit with this region occurs, and the neighbour region's tradable sector benefits in terms of increased exports. However, the rest of the world is not further modeled.

The following subsections will set out a two-region, two-sector general equilibrium model. The neighbouring region's variables are denoted with asterisk. The model is set out for the home region and unless otherwise stated similar expressions hold for the neighbouring region. There are L households at home, and L^* in the neighbour. The labour market in each country is perfectly integrated, so that wages between the sectors are equal. There is no government sector modeled.

2.1 Firms

In both regions there exists a continuum of firms producing each a single variety in the interval $h_i \in [0,1]$, $i = N, T$. Subscript N refers to variables of the non-tradable goods and T to those of tradable goods. Each firm produces a single variety of a good, N or

T. The firms act in a monopolistically competitive market where they set prices based on demand but further disregard the effect of their price setting on the overall price index of a region.[3] Non-tradable goods are restricted to be produced and consumed in the same region. Each firm uses only labour for the production of a good with constant returns to scale. The labour productivity α_i is a fixed parameter that may differ between sectors and regions. Firms use a unit of labour $l(h_i)$ to produce a good $y(h_i)$.

$$y(h_N) = \alpha_N l(h_N), \tag{1}$$
$$y(h_T) = \alpha_T l(h_T), \tag{2}$$

for the production of non-tradable and tradable goods respectively. For each sector the individual companies are integrated over their unit mass,

$$\begin{aligned} Y_N &= \int_0^1 \alpha_N l(h_N)\,\mathrm{d}h_N = \alpha_N \int_0^1 l(h_N)\,\mathrm{d}h_N = \alpha_N L_N, \\ Y_T &= \int_0^1 \alpha_T l(h_T)\,\mathrm{d}h_T = \alpha_T \int_0^1 l(h_T)\,\mathrm{d}h_T = \alpha_T L_T. \end{aligned}$$

Production size is determined by total demand for each good, where demand is the sum of consumption $c(h_i)$ for each good and for the tradable good this includes the foreign demand.

$$y(h_T) \geq Lc(h_T) + (1+\tau)L^* c^*(h_T), \tag{3}$$
$$y(h_N) \geq Lc(h_N). \tag{4}$$

Home production for the tradable goods equals the total consumption of this good in both markets, while taking into account iceberg shipping costs to the neighbour, τ. The non-tradable output has to satisfy only home demand.

With prices $p(h_T)$ and $p(h_N)$ of domestic prices of domestically produced varieties, $p^*(h_T)$ of the foreign price of home exports to foreign and $p(f_T)$ of home imports, and exchange rate ε.[4] Profits are given by

$$\pi(h_T) = Lp(h_T)c(h_T) + \varepsilon p^*(h_T)L^* c^*(h_T) - wl(h_T), \tag{5}$$
$$\pi(h_N) = Lp(h_N)c(h_N) - wl(h_N). \tag{6}$$

Similar conditions exist for the neighbour.

[3] The result do not depend on this market structure. For instance, using two representative firms for each sector that act as in perfect competition would still provide similar predictions.

[4] The exchange rate ε is the relative price of labour, thus w/w^*, not necessarily in different currencies. This revaluation metric is necessary since each region's prices are denominated in their corresponding wage rates. Therefore, it allows for regional prices differences.

2.2 Households

The households utility is a function of consumption and labour, where consumption is a basket of all varieties through a composition of tradable and non-tradable products.

$$U = \ln(C) - l \tag{7}$$

$$C = \left[\delta^{\frac{1}{\rho}} C_T^{1-\frac{1}{\rho}} + (1-\delta)^{\frac{1}{\rho}} C_N^{1-\frac{1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \tag{8}$$

$$C_T = \left[\int_0^1 c(h_T)^{1-\frac{1}{\sigma}}\,\mathrm{d}h_T + \int_0^1 c(f_T)^{1-\frac{1}{\sigma}}\,\mathrm{d}f_T\right]^{\frac{\sigma}{\sigma-1}},\ C_N = \left[\int_0^1 c(h_N)^{1-\frac{1}{\sigma}}\,\mathrm{d}h_N\right]^{\frac{\sigma}{\sigma-1}} \tag{9}$$

where $c(h_T)$, $c(f_T)$ and $c(h_N)$ are demand for each home tradable good, neighbours' tradable good and the home non-tradable good. C is the basket of all goods and ρ the elasticity of substitution between tradable and non-tradable goods, assumed to be between zero and one. C_T is the basket of tradable goods consisting of both home tradable goods and tradable goods of the neighbour. C_N is the basket of non-tradable goods. For both these baskets σ is the elasticity of substitution between the varieties.

Domestic households own home firms thus potential profits are shared evenly among all residents,

$$\Pi \equiv L^{-1}\left(\int_0^1 \pi(h_T)\,\mathrm{d}h_T + \int_0^1 \pi(h_N)\,\mathrm{d}h_N\right). \tag{10}$$

Where Π represents the total profit per person in the home region. Similar expressions hold for the neighbour.

Consumers face a budget constraint which equates the cost of consumption to total income from production.

$$\int_0^1 p(h_T)c(h_T)\,\mathrm{d}h_T + \int_0^1 p(h_N)c(h_N)\,\mathrm{d}h_N + \int_0^1 p(f_T)c(f_T)\,\mathrm{d}f_T = \Pi + wl + R/L. \tag{11}$$

The resource is represented as an endowment in the budget constraint that is equally shared among all workers in the respective region. This simple representation is the result of several assumptions. Firstly, the resource is neither consumed (demanded) by the own or neighbouring region's citizens nor used in the production of the other goods. Secondly, it acknowledges there is a rest-of-the-world to which resources are exported which results in a surplus equal to the value of the exported resources. Thirdly, the production of resource does not require a production factor that is shared with the other factors, such as labour, nor is the production of such resource done by foreign firms that transfer profits abroad.

Corden and Neary (1982) set out a general equilibrium framework and differentiate between two effects, the spending effect and the resource movement effect. The spending effect is the real appreciation and decline of the tradable goods sector due to the extra income, whereas the resource movement effect is due to the the attraction of labour to the resource producing sector. Modeling the resource as an endowment in the budget constraint is sufficient to capture to spending effect. The assumption that no labour is required for the production of R could be relaxed and would allow for the resource movement effect. However, this effect is not essential for the development of the argument since both the spending effect and resource movement effect work in the same direction with respect to employment in the tradable goods sector. Moreover, the use of labour in the resource industry is often quite limited relative to the rest of the economy, which makes the endowment structure a convenient and relative harmless simplification.

The ownership of resource rents is a delicate issue for policy makers. What R summarizes in this context is all the rents that are finally distributed to consumers. Part of the resource rents may have been used for payment of capital, repayment of investors abroad or transfers of profits abroad in case of foreign owned firms. In the end, in this model R is all what is left for the consumer.

2.3 Market clearing and first order conditions.

Consumers will demand goods according to their marginal utilities.

$$C_T = \delta \left(\frac{P_T}{P}\right)^{-\rho} C, \quad C_N = (1-\delta)\left(\frac{P_N}{P}\right)^{-\rho} C, \tag{12}$$

$$c(h_T) = \left(\frac{p(h_T)}{P_T}\right)^{-\sigma} C_T, \quad c(f_T) = \left(\frac{p(f_T)}{P_T}\right)^{-\sigma} C_T, \quad c(h_N) = \left(\frac{p(h_N)}{P_N}\right)^{-\sigma} C_N, \tag{13}$$

where P is the price index on total consumption basket C, P_T the price index on tradable goods and P_N the price index on non-tradable goods. These indices are based on the goods prices,

$$P = \left[\delta P_T^{1-\rho} + (1-\delta) P_N^{1-\rho}\right]^{\frac{1}{1-\rho}}, \tag{14}$$

$$P_T = \left[\int_0^1 p(h_T)^{1-\sigma}\,\mathrm{d}h_T + \int_0^1 p(f_T)^{1-\sigma}\,\mathrm{d}f_T\right]^{\frac{1}{1-\sigma}}, \quad P_N = \left[\int_0^1 p(h_N)^{1-\sigma}\,\mathrm{d}h_N\right]^{\frac{1}{1-\sigma}}. \tag{15}$$

Using these expressions, the consumer budget constraint can be rewritten,

$$PC = \Pi + wl + R, \tag{16}$$

and the first order condition for consumption versus labour is,

$$C = P^{-1}, \quad l = w. \tag{17}$$

Firms maximize operation profits in monopolistic competition taking the demand for each variety into account. Equilibrium prices are then determined by productivity and a mark-up,

$$p_T = \frac{\sigma}{\sigma - 1}\frac{1}{\alpha_T}, \quad p_N = \frac{\sigma}{\sigma - 1}\frac{1}{\alpha_N}, \quad p_T^* = \frac{1+\tau}{\varepsilon}\frac{\sigma}{\sigma - 1}\frac{1}{\alpha_T}. \tag{18}$$

where the last term is the price of home goods sold in the neighbour (exports). Using these conditions for equilibrium prices, the price indices can be expressed in terms of individual goods prices,

$$\begin{aligned} P_T = p_T B^{\frac{1}{1-\sigma}},\ P_T^* = (p_T^*)\,(B^*)^{\frac{1}{1-\sigma}}, \quad \text{where} \\ B \equiv 1 + \phi\left(\frac{\varepsilon p_T^*}{p_T}\right)^{1-\sigma},\ B^* \equiv 1 + \phi\left(\frac{\varepsilon p_T^*}{p_T}\right)^{\sigma-1}. \end{aligned} \tag{19}$$

The term $B^{(*)}$ reflects how price changes between regions are affected by the trade costs. If trade costs are zero, the price of the consumption basket is a weighted average between the prices for the home and foreign traded goods, while with trade costs the costs of of imported goods is increased.

Finally, besides the consumer budget constraint the model requires a constraint on the use of factors,

$$Ll \geq \int_0^1 \frac{y(h_T)}{\alpha_T}\,\mathrm{d}h_T + \int_0^1 \frac{y(h_N)}{\alpha_N}\,\mathrm{d}h_N. \tag{20}$$

The expression states that the use of labour for production in both sectors combined cannot exceed the total labour in the region.

2.4 Equilibrium

Starting from the budget constraint (11) and using the first order conditions for consumption and the equilibrium price conditions, the equilibrium aggregate budget constraint is rewritten to a condition on total demand equal to total income,

$$Lp_T^{1-\sigma}P_T^{\sigma}C_T + Lp_T^{1-\sigma}\phi P_T^{\sigma}C_T + Lp_N C_N = p_N Y_N + p_T Y_T + R. \tag{21}$$

Using the constraint on total demand for home tradable goods, (3), and the constraint on domestic production and consumption of the non-tradable goods, (4), the budget can be rewritten as the trade balance with the neighbouring region.

$$\underbrace{Lp_T^{1-\sigma}\phi P_T^{\sigma}C_T}_{\text{imports}} = \underbrace{L^* p_T^{1-\sigma}\phi\varepsilon^{-\sigma}\left(P_T^*\right)^{\sigma}C_T^* + R}_{\text{exports}}. \tag{22}$$

Equation (22) explains the sustainability of the chronic export deficit that a resource province such as Alberta can run to the other provinces. Without the resource income gained from exports to the rest of the world, the trade balance equation would boil down to a balanced trade condition as in Corsetti et al. (2007). Naturally, a balanced trade condition is a rather long term condition, while with international borrowing and lending the current account can be in surplus or deficit for a long time, with the capital account reflecting the counter balance. Since there is no role for capital in this model this condition is a severe simplification for the short term but should approximate the long term behavior.[5]

The labour allocation for a province using the equilibrium conditions is determined by the combination of (1)-(4). Let labour be allocated as,

$$L_T + L_N = (1-n)L + nL = L,$$

where n represents the share of home labour employed in the non-tradable sector. Then using the first order conditions for consumption and (22), demand for labour in the tradable sector is,

$$(1-n)L = L_T = \delta\frac{p_T^{-\sigma}}{\alpha_T}\left(P_T^{\sigma-\rho}P^{\rho}LC + \phi\varepsilon^{-\sigma}\left(P_T^*\right)^{\sigma-\rho}\left(P^*\right)^{\rho}L^*C^*\right).$$

Demand for labour in the non-tradable sector is similarly derived,

$$nL = L_N = (1-\delta)\alpha_N^{-1}P_N^{-\rho}LC^{1-\rho}.$$

By now, the two equations ruling the demand for labour have no special term for the endowment factor. Indeed, the only way through which it affects the equilibrium labour allocation is through demand, C and C^* which increases with resource income in (16). Taking the ratio of the two equation results in a single expression of the industrial structure in terms of labour demand,

$$\frac{n}{1-n} = \frac{1-\delta}{\delta}\left(\frac{\alpha_T}{\alpha_N}\right)^{1-\rho}\frac{LC^{1-\rho}}{B^{\frac{\sigma-\rho}{1-\sigma}}LC^{1-\rho} + \phi\varepsilon^{-\sigma}\left(\frac{\alpha_T}{\alpha_T^*}\right)^{\sigma-\rho}\left(B^*\right)^{\frac{\sigma-\rho}{1-\sigma}}L^*\left(C^*\right)^{1-\rho}}. \tag{23}$$

The intuition is as follows. When the budget of, say, the home region expands, con-

[5] Additionally, in the case of Canadian provinces, the resource rich provinces are mostly spending their rents rather then saving the proceeds in a sovereign wealth fund. In consequence the role for the trade balances is larger than that for the capital account.

sumption demand for both non-tradable (numerator) and tradable goods (denominator) increases. Whether this demand effect from the own region increases or decreases the relative size of the non-tradable sector employment depends on the prices and demand parameters. With price index factor $B > 1$ and given previous evidence it is likely that own demand will increase the non-tradable sector employment over tradable. Beside the demand effect, relative labour productivity between the two sectors in home determine labour allocation where an increase in a sectoral productivity decreases the corresponding relative employment.

Demand for the tradable goods is divided between own demand and demand coming from the neighbour, C^*. For easy understanding, assume that it is the neighbouring region that experiences a resource windfall and consequently has an increase in general demand. This increase of demand includes demand for tradable goods and imported goods in particular. The effect of the home region would be an unambiguous increase of the tradable sector employment. This magnitude of the effect is subject to relative price changes and trade costs. The higher the trade cost, e.g. due to distance, the lower the demand effect of the neighbouring windfall on home labour allocation.

If the resource in a country would be evenly allocated over all provinces, this model would still predict a labour reallocation to the non-tradable sector due to the increase of the relative price of goods. Similarly, two provinces with both their own resource exports to the rest of the world would keep each other's industrial sector in balance through increased demand for tradable goods for each of them, while their non-tradable goods sector would still increase.

In linearized form the equation suggests that the change in labour allocation is determined conceptually by three main factors, supply factors that govern the differences of productivity between the sectors, demand factors for the non-tradable goods sector, and demand factors for the tradable goods sector. A formal total derivation of the different factors in the equilibrium condition is presented in Appendix B. These factors can then be summarized as follows,

$$\begin{aligned} \hat{z} &= b_1 \frac{\mathrm{d}}{\mathrm{d}x} \textit{supply effects} + b_2 \frac{\mathrm{d}}{\mathrm{d}x} \textit{demand effects } N + b_3 \frac{\mathrm{d}}{\mathrm{d}x} \textit{demand effects } T, \\ & \quad \text{where } \hat{z} \equiv \frac{\mathrm{d}}{\mathrm{d}x} \frac{n}{1-n} \end{aligned}$$

and b_1, b_2, and b_3 are some constant multipliers. The fraction $z \equiv n/(1-n)$, is an increasing function in the share of service sector employment, n. Therefore, instead of solving for n the differentiation is done on the transformation $\frac{n}{1-n}$. The analysis of partial impacts of the supply and demand effects can then be done on bases of the signs of the multipliers. Moreover, this transformation becomes useful in the empirical section since it has the benefit of making the variable no longer bounded between 0 and 1, as n is by definition, but between 0 and infinity. With the transformation to logs in the empirical part this becomes a completely unbounded variable.

3 Empirical evidence

The theoretical model is tested on the prediction of relative labour allocation among the two sectors. The relevant factors for this allocation include both supply and demand effects from the own regions as well as demand effects from the foreign region.

The data used for the testing is based on Canadian provinces to which the theoretical model easily translates. Firstly, Canadian provinces are all of a respectable size that a study on their industrial and services employment makes sense. Secondly, although the provinces share a currency, the span of the entire country, and consequently the distance between one province and the next can be substantial, allowing for the existence of regional price indices and trade costs of goods is a factor in the mobility of goods and services. Thirdly, there are multiple provinces that produce a considerable amount of resources such as Alberta in the west and Newfoundland in the east, but also Saskatchewan and British Columbia have non-negligible resource output. Although partly for domestic consumption, most of the resource is directly exported, mainly to the USA. It is this aspect of the economic circumstances of Canada that makes it particularly fit for the analysis.

The theoretical model includes the resource windfall as an endowment shock rather than a valuable traded good exported to a neighbouring region. This choice is critical for the theoretical prediction but seems to be a fitting assumption for the Canadian case. Finally, Canada's economic weight is centered around the provinces of Ontario and Quebec, both of which have no serious own resource production and function. Therefore, along with the smaller atlantic provinces, as they function as the test case to what extend resource poor provinces can benefit indirectly through interregional trade.

3.1 Data and econometric aspects

3.1.1 Data

Data on production factors and size has been produced on request by Statistics Canada.[6] The data gives detailed information on production value, labour productivity, hours worked among other variables per province and year for aggregate service sector, manufacturing sector and resource sectors. The translation from tradable and non-tradable sectors, as used in theory, to service and manufacturing as often used by statistical agencies is not automatic. Many services are or have become tradable either physically or through accounting gimmicks and not all manufacturing goods are necessarily tradable.

[6] The source is the same as in Beine, Coulombe and Vermeulen (2012)

Additionally, the service sector includes the provincial and federal government for which production value is not always easy to measure. Nevertheless, this translation from theory to empirics has served quite well in previous studies and is repeated here. Resource income is measured by the production value of the primary goods production coming from mining, quarreling and oil and gas production.

Regional price indices and interprovincial migration numbers are obtained from CANSIM website. The Canadian Dollar exchange rate was obtained from Datastream. Data on temporary workers were obtained from Citizenship and Immigration Canada. This data is available for the ten Canadian provinces (therefore excluding the northern provinces and territories) over a period of 21 years, starting in 1987.

3.1.2 Estimation model

The econometric model to be estimated with a Fixed Effect estimation (FE) and Feasible Generalized Least Squares (FGLS) is,

$$\begin{aligned} lz_{i,t} &= \gamma lz_{i,t-1} + \beta_1 \Delta Man\_LP_{i,t} + \beta_2 \Delta Ser\_LP_{i,t} + \beta_3 Prov\_ToT_{i,t} \\ &\quad + \beta_4 R_{i,t} + \beta_5 R^*_{i,t} + \beta_6 Mig_{i,t} + \beta_7 cad_t + u_{i,t}. \\ u_{i,t} &= \alpha_i + \delta t + \varepsilon_{i,t}, \\ &\text{where } lz_{i,t} \equiv \ln\left(\frac{n_{i,t}}{1-n_{i,t}}\right). \end{aligned} \tag{24}$$

The subscripts refer to the provinces, i, of which there are 10, and years, t, 1987 - 2007. Man_LP and Ser_LP, for manufacturing and services labour productivity respectively, are directly observed in the dataset and included as first time-differences in logs. These are the prime supply factors. Based on the theoretical model, their coefficients are expect to be $\beta_1 > 0$, and $\beta_2 < 0$. The provincial price factor $Prov\_ToT$ is measured by taking the ratio provincial consumer price index over the overall Canadian price index and its coefficient is expected to have $\beta_3 < 0$.

The demand effects are modeled only through an increase of resource income. Naturally, this is not the only factor that may change provincial consumption pattern. The underlying assumption is that resource income presents nevertheless a sizeable shock while other processes, e.g. productivity changes or government induced shocks can be captured by the cross-section fixed effect and the time-trend apart from the other control variables.

The own resource income, R is measured by the production value of the aggregate resource sector in the province, $\beta_4 > 0$. The measure of foreign resource income, R^*, the construction of which is discussed below, is expected to have to the opposite sign of R, $\beta_5 < 0$.

The sum of temporary foreign workers and interprovincial migration is taken as a measure of changing labour forces, Mig. Changes in the labour force are an important factor for the Canadian dataset as presented in Beine, Coulombe and Vermeulen (2012), and are also captured in the theoretical model. Finally, the Canadian dollar, *cad*, is included to capture the international terms of trade effects, that are affecting all provinces, irrespective of whether they export resources or not and is expected to have $\beta_7 < 0$.

The dynamic structure is motivated by the long-time span of the data, which is much longer than the number of cross-section, and should therefore allow for some dynamic modeling of the equilibrium condition. The lag dependent variable captures the convergence speed over time after a shock. The coefficient needs to be between 0 and 1 to guarantee a well behaving convergence process. The error is composed of cross-section time-fixed effects, a_i, a time trend, t and an *i.i.d.* error $\varepsilon_{i,t}$. Many of the time constant differences between provinces, such as size and the industrial structure at the starting point, length of borders etc, are controlled with the inclusion of the cross-section fixed effects. Shocks in the rest of the world that affect all provinces more or less evenly, such as the easiness of international trade, global economic environment etc., are captured by the time trend.

The use of a time trend, t, as opposed to a more general (and more often used) set of time dummies is motivated by two factors. Firstly, the inclusion of the Canadian dollar, which is common to all provinces, would cause a perfect collinearity problem with the independent time fixed effects.[7] Secondly, similar collinear effects could result with the construction of the foreign resource which may have a small cross-sectional variation, as shall be shown below.

Time fixed effects are usually included for two reasons. Firstly, for unobserved cross-section constant effects that are correlated with the regressors. The use of a linear trend will only partly correlate with such unobserved correlated effects. For robustness, estimations with independent time fixed effects, but with the loss of the Canadian dollar variable will be presented. The second reason for using time effects is to limit serial correlation in the error. For this feature the trend variable appears sufficient and a measure for serial correlation will be presented in the results. Nevertheless, fully robust standard errors are always calculated.

3.1.3 Construction of neighbour's resource impact

The resource windfall of neighbours will be captured by a weighted sum of all provinces for each time period.

$$R^*_{i,t} = \sum_{j=1}^{10} (w_{i,j} R_{j,t}), \quad w_{i,j} = 0 \quad \text{if} \quad i = j. \tag{25}$$

[7] A trade weighted real exchange rate would mitigate part of this, but it is still unlikely that the time-dummies would give consistent estimates.

The choice of the weights $w_{i,j}$ is chosen beforehand.[8] Two sets of weights are used, the first and most important are weights based on the geographical (road) distance between the capital of two provinces, $d_{i,j}$, and a normalisation constraint,

$$\begin{aligned} w_{i,j} &= 1/d_{i,j}, \\ \sum_{j=1}^{10} w_{i,j} &= 1. \end{aligned} \tag{26}$$

This weighting will consequently include for each province all the other Canadian provinces. Hence, neighbour is taken in a broader meaning to include all provinces in Canada. In contrast, the second set of weights is based on whether provinces share borders, making them direct neighbours. An indicator function determines when a province share a border with another,

$$d_{i,j} \begin{cases} 1 & \text{if } i \text{and } j \text{share a border,} \\ 0 & \text{otherwise.} \end{cases} \tag{27}$$

The weights are then again standardized to sum to one for each cross-section.

Distance need not be the only factor that captures the impact of a province. By using the $R_{j,t}$ (j province being the neighbour of province i), defined as the share of resource production over provincial product, it is implicitly assumed that the relative size of such a province relative to its neighbours is irrelevant. For instance, Alberta's resource production is relatively bigger for a province such as Prince Edward Island, than it is to Ontario. So it may be expected that for two provinces, at the same distance, the effect of neighbours resource production is bigger for the economically smaller province. Therefore, an alternative measure for $R_{j,t}$ is to use the production value of the resource and measure it as a fraction of the total provincial product of province i.

Finally, another measure that will be used is the resource trade balance as presented in Figure 1. If anything, this is the most direct measure of what could be expected to drive regional trade. The downside of this measure is that it is only available for 11 years, from 1997 onwards.

Table 1 gives an overview of the result of these variables compared to the provincial own resource production.[9] Newfoundland, Saskatchewan and Alberta jump out in terms of their own resource production. In the constructed distance weighted neighbour's resource measure, the difference are not as stark. For all provinces the measure picks up a sizeable part of the resource production of the other provinces. For some provinces this can be

[8]Such a transformation is closely related to methods used in Spatial econometrics. However, analysis of different models did not reflect the need to use more advanced spatial modeling for the error term while the spatial transformation used for the exogenous regressor can be consistently estimated using linear regression methods.

[9]Note that by taking the 21 and 11 year time average the numbers are not as different among the provinces as the yearly data that is used for the estimations.

Table 1: Resource measures

		Average over 1987-2007			1997-2007
		Neighbours' resource product, weighted			Distance wght
	Own resource	Dist.	Dist. & size	Common brd.	Trade Balance
Newfoundland	0.214	0.041	0.218	0.016	−0.003
Prince Edward Isl.	0.001	0.049	0.636	0.090	0.005
Nova Scotia	0.032	0.040	0.079	0.080	−0.005
New Brunswick	0.023	0.039	0.102	0.064	−0.006
Quebec	0.008	0.052	0.016	0.083	0.005
Ontario	0.010	0.057	0.008	0.019	0.012
Manitoba	0.029	0.129	0.235	0.101	0.083
Saskatchewan	0.192	0.095	0.266	0.159	0.047
Alberta	0.290	0.082	0.023	0.115	0.029
Britisch Columbia	0.038	0.141	0.088	0.290	0.095

quite large in particular when compared to their own production. Prince Edward Island, Quebec and Ontario are all such cases. Secondly, provinces with own production are still surrounded by provinces that have also a sizeable production, such as Saskatchewan and indeed Alberta.

The distance and size weighted measure increases the variation relative to the distance weighted measure. Indeed, Prince Edward Island is now highly susceptible to effects of Newfoundland and Alberta, while the Ontario's and Quebec's indices are reduced. Similarly, for the common border weighted measure, there are larger cross-sectional differences. The three western provinces, Saskatchewan, Alberta and British Columbia, have the largest values as they benefit from each other, while the atlantic provinces have similarly larger values as with the distance weighted measure. Interestingly, Ontario, Canada's economic centre, has the the lowest value after Newfoundland, suggesting that it is barely affected by the resource income of the other provinces. Finally, the trade balance notes generally lower values, since it nets out imports and other factors from the production process. However, a similar pattern of exposure to regional trade is visible.

All provinces are located at a considerable distance to each other and the measure only excludes a province' own resource. Since there is only a limited amount of provinces with significant resource production the measure of foreign resource income is strongly correlated among the cross-section. The variable $R^*_{i,t}$ behaves effectively as a cross-section fixed time-moving variable making it impossible to estimate meaningfully separate time-dummies, which is the reason to use a trend variable instead.

A priori it is unclear which of these measures captures the demand effect best. Table 1 shows that the different methods of constructing the variable have quite different results on the mean and although they are positively correlated the levels are not all very high. The three measures are essentially rescaled relative to each other, while the scale factor is constant over time. Therefore, any misspecification will be captured also by the province fixed effects, while the time variation of R^* is what matters for the estimation of the coefficients.

Subjectively, one could prefer the distance and size weighted measure or the trade balance as the most appropriate measure, but their construction requires more steps and a simple measure may be preferred instead. Given their mean and correlation, each measure seems to capture a slightly different aspect of this neighbour's demand. So the best evidence for a regional export demand from resources would be if the estimation is not particular sensible to the choice of measure.

3.1.4 Measures of correlation

The inclusion of neighbouring provinces' resource income points to larger aspect of the dataset. Canadian provinces are by construction highly correlated with each other. When this cross-sectional dependence is not properly addressed, it can cause econometric problems, such as biased estimators. For this reason each regression will report a statistic measuring the cross-sectional correlation in the errors. At the same time there may be serial correlation present as well, given the relative long timespan of the data and the dynamic model that is used. Although the standard errors are robust to serial correlation it may be desirable to report the extend of this correlation as well especially since time fixed effects are not always included but a trend is used instead.

In order to measure spatial and serial correlation two statistics are reported for each regression. The two statistics measure an average correlation based on the residuals. Let X be a $T \times N$ matrix filled with the residuals of a regression, where T is the number of time observations, and N the number of cross-section.[10] Then the statistics are calculated for serial correlation and spatial correlation as follows,

$$serial\ correlation = \frac{1}{T-1}\sum_{t=2}^{T} corr(X[t,.], X[t-1,.]) \tag{28}$$

$$spatial\ correlation = \begin{pmatrix} N \\ 2 \end{pmatrix}^{-1} \sum_{p=1}^{N-1}\sum_{s=p+1}^{N} corr(X[.,p], X[.,s]). \tag{29}$$

Where $corr(x, y)$ indicates the correlation coefficient between the vectors x and y. In effect the serial correlation measure calculates the mean of the correlations with the previous period for each cross-section and all periods. The spatial correlation calculates the mean correlation between two cross-sections for the entire period. Naturally, the measures are not a test on whether the assumptions of the underlying estimator are valid. Instead the measures will be reported in order to give an indication to potential issues regarding serial and spatial correlation in the errors.

[10]Note that T, and N here have no relation to the indicators of sectors as used in the theoretical section.

3.1.5 Endogeneity

Many of the variables can be argued to be endogenous in the model. For instance, learning-by-doing effects could reverse causality between the productivity parameters and the labour allocation. Own resources are normally thought to be exogenous, but by measuring resource production as a share of total provincial product it could include endogenous terms. Migration can be endogenous when, for instance, labour mobility is explicitly related to the industrial structure and not just through wages and prices. Indeed, perhaps the only variable that can be thought to be exogenous is the neighbours resource, which captures the demand effect from neighbours. However, what matters for the mechanism is that neighbours spend their international surpluses on imports from the other Canadian provinces. If this choice is in part determined by the size of a province' industrial sector, the demand effect is endogenous too.

The instrumental variables approach is appropriate when there is suspicion of a limited number of endogenous variables and there are suitable excluded instruments available. Considering the range of potential issues highlighted, it would be better to have a more general test. The Hansen J-statistic calculated in an over-identified General Method of Moments (GMM) estimation is such a test when we gain the over-identification not through excluded instruments but by putting the long time span to good use.

The moment condition in a pooled estimation translates the moment condition to the entire sample, for all i and t. However, since the dataset has a considerably long time span, it is possible to split the sample in two periods, and estimate the equation jointly for the two periods. Then with a single restriction on one of the parameters, say the lagged dependent variable, the system is over-identified and the Hansen J-statistic indicates whether the system is appropriately specified.[11]

The restriction on the coefficient of the lagged dependent variable comes rather natural. Since this variable indicates the long-term convergence of the equation, it can be expected that it is constant between the two time periods. The other variables are allowed to have different coefficients between the two periods, which allows to inspect the coefficient stability over the entire sample. On the other hand, since the sample is split, the sample that can be used for each coefficient is reduced to that of each sub-period, which may impact their variances.

To be clear, the GMM-estimation is not precisely the same estimation as the fixed effect or FGLS. Most importantly, the weight matrices used for the calculation of the parameters differs between them. The FGLS estimator is preferred choice of the estimation for its capacity to explicitly take into account the correlated nature of the sample and provides the optimal weight matrix. Therefore, the GMM estimation are not expected to outperform the estimation of the coefficients in terms of statistical significance. The first

[11]A similar strategy was employed in Beine, Coulombe and Vermeulen (2012).

and main reason for using the GMM method is to obtain a test on the endogeneity of the system.

3.2 Results

Table 2 presents the results of the estimation of (24) using Fixed Effect estimation and FGLS. For both methods the different measures of neighbours resource are estimated. Note first that all coefficients have the expected sign and most of them are significant among the different estimations and the system is stable given the coefficient on the lagged dependent variable. The overall fit is high, which is partly due to the inclusion of the fixed effects.

Of main interest is the effect of the neighbours resource of which the four measures are estimated. Each measure is significant and only the distance and size weighted measure in the fixed effect estimation is at the 10% level. FGLS estimates the coefficients generally with a greater precision. Each measure indicates a significant negative effect on of neighbours resources on the own labour allocation. The negative sign indicates that the demand effect for tradable goods coming from resource rich provinces indeed helps to preserve labour employed in that sector.

The fourth measure (Res Bal in columns (4) and (8)), uses the resources trade balance that was pictured for several provinces in Figure 1. Due to data availability this measure is only available from 1997 onwards and hence the estimation sample is reduced. One of the by-effects is the loss in precision for the coefficients on the service sector labour productivity and the own resource.

The correlation coefficients indicated for each regressions do not indicate that there exist severe issues for the estimations. Serial correlation is relatively low, while the spatial correlation is even lower. Although the Canadian provinces are very integrated with each other and expected to correlate, the combination of the control variables and the fixed effects appears sufficient to capture this integration and the robust standard errors should give a correct indication of the variance of the estimators.

Table 3 explores the relevance of including some control variables and robustness to independent time indicators. Firstly, the exclusion of the exchange rate of the Canadian dollar reduces the effect of the neighbours demand. This is an important aspect that was largely ignored by the theoretical model, namely what happens to Canada with respect of the world in terms of prices and competitiveness? It has been widely reported in popular media as well as in academic literature that an important exporting but non-resource province such as Ontario suffers greatly from real exchange effects that are caused by oil exports of other provinces (Beine, Bos & Coulombe, 2012). The results above, based on a theoretical model, suggested that there are also demand effects for such provinces. Therefore, the aim is to disentangle two demand effects that an arbitrary non-resource-

Table 2: Impact of neighbours' resources on industrial structure

	Dependent variable: log of Services over Manufacturing Employment							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Standard Fixed Effect				FGLS with province dummies			
Lag. dep.	0.739***	0.710***	0.696***	0.641***	0.722***	0.695***	0.694***	0.651***
	(0.071)	(0.067)	(0.082)	(0.054)	(0.043)	(0.044)	(0.046)	(0.070)
Man LP	0.133**	0.133**	0.125**	0.185**	0.123***	0.125***	0.118***	0.185***
	(0.058)	(0.058)	(0.054)	(0.061)	(0.034)	(0.034)	(0.034)	(0.051)
Ser LP	−0.275***	−0.293***	−0.283***	−0.054	−0.272***	−0.291***	−0.288***	−0.076
	(0.080)	(0.085)	(0.077)	(0.075)	(0.063)	(0.065)	(0.066)	(0.086)
Prov. ToT	−0.247***	−0.233***	−0.266***	−0.152	−0.299***	−0.262***	−0.303***	−0.182
	(0.051)	(0.050)	(0.052)	(0.203)	(0.063)	(0.065)	(0.065)	(0.116)
Own Res	0.124***	0.098**	0.135***	0.097	0.156**	0.106*	0.137**	0.089
	(0.036)	(0.039)	(0.031)	(0.075)	(0.062)	(0.063)	(0.063)	(0.095)
Neighbours Resource								
Dist.	−0.466**				−0.490***			
	(0.150)				(0.112)			
Border		−0.213***				−0.187***		
		(0.058)				(0.051)		
Dist. & size			−0.107*				−0.112***	
			(0.055)				(0.037)	
Res Bal				−0.964**				−0.850***
				(0.381)				(0.289)
Migr	−0.870	−0.958	−1.044	−1.526**	−1.226***	−1.167***	−1.209***	−1.488***
	(0.540)	(0.562)	(0.635)	(0.542)	(0.376)	(0.381)	(0.401)	(0.572)
US$/C$	0.136**	0.125*	0.101	−0.164*	0.139***	0.117***	0.103***	−0.149**
	(0.055)	(0.057)	(0.056)	(0.077)	(0.032)	(0.031)	(0.030)	(0.064)
Trend	0.006***	0.006***	0.005***	0.010***	0.006***	0.006***	0.005***	0.010***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)
Obs.	210	210	210	110	210	210	210	110
R^2	0.863	0.862	0.859	0.655				
ser. cor.	0.043	0.039	0.066	0.180	0.045	0.045	0.069	0.165
spat. cor.	0.000	0.003	0.017	0.060	0.001	0.006	0.015	0.065

Ser. cor and spat. cor, refer to the serial and spatial correlation measures as defined in the text. Robust standard errors in parentheses. *** p <0.01, ** p <0.05, * p <0.1

exporting province potentially experiences: demand coming from their neighbour and demand coming from abroad.

For example, if Alberta would increase resource exports to the US, it demands more goods from, say, Ontario. But Alberta's oil exports cause the Canadian dollar to appreciate, decreasing Ontario's export to the US. Hence, for a non-booming province, resource income in another province can have two opposing effects.

In this model the identification relies on the Canadian dollar value. A neighbour's resource income should stimulate a province' manufacturing sector while the Canadian dollar captures the lost competitiveness to the rest of the world. Interestingly, since both variables are caused by the same factor, resource exports, it is even possible that the so far estimated coefficient on foreign resource income was underestimated in an absolute sense, since it correlated with the omitted Canadian dollar that has the opposite effect.

Comparing models (1) and (2) in Table 3 indicates that this intuition could be correct. The exclusion of the Canadian exchange rate decreases (absolutely) the impact of the neighbours resource. So the impact of the neighbours resource demand is underestimated since it is correlated with the omitted exchange rate that captures lost demand from abroad.

The exclusion of migration from the model results in a severe downward bias of the own resource impact, an issue already noted in Beine, Coulombe and Vermeulen (2012). It can be expected that people move to the province that has a booming resource sector, while such migrants have a potential mitigating effect on the reallocation of labour between the manufacturing and service sector.

Models (4)-(7) repeat the FGLS estimation with independent time dummies as opposed to a linear trend. The inclusion of such time effects would be appropriate if there are unobserved time effects that are correlated with any of the control variables. On the other hand, this estimation is not preferred for two reasons. Firstly, as explained in section 3.1.3, the constructed resource variables may lack a certain cross-sectional variation, while their means are wiped out with the time fixed effects. Secondly, due to the inclusion of such time fixed effects the Canadian exchange rate, which is constant among the provinces, drops out.

The results in Table 3 indicate that the neighbours resource measure is still affecting the industrial structure of the provinces, but the effect appears reduced and less significant than before. This reduction is expected based on the limited cross-sectional variation of the measure. Nevertheless, the estimation is robust to the inclusion of such time effects.

Finally, Table 4 presents the results of the GMM estimation and the test on endogeneity set out in section 3.1.5. The estimation is done based on estimation with a trend, columns (1)-(4), and estimation with independent time effects, columns (5)-(8).

Columns (1) and (5) estimate the model without a restriction firstly. Comparing the lagged dependent variables of the two sub-periods reveals that this long-run coefficient

Table 3: Some alternative specifications

	Dependent variable: log of Services over Manufacturing Employment						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Time fixed effects			
Lag dep.	0.722***	0.696***	0.751***	0.742***	0.715***	0.705***	0.728***
	(0.043)	(0.045)	(0.042)	(0.043)	(0.043)	(0.045)	(0.065)
Man LP	0.123***	0.109***	0.099***	0.159***	0.155***	0.150***	0.232***
	(0.034)	(0.034)	(0.034)	(0.035)	(0.034)	(0.034)	(0.050)
Ser LP	−0.272***	−0.168***	−0.183***	−0.488***	−0.508***	−0.527***	−0.123
	(0.063)	(0.061)	(0.063)	(0.134)	(0.135)	(0.134)	(0.191)
Prov. ToT	−0.299***	−0.284***	−0.224***	−0.296***	−0.277***	−0.304***	−0.279**
	(0.063)	(0.064)	(0.062)	(0.062)	(0.063)	(0.062)	(0.113)
Own Res.	0.156**	0.145**	0.069	0.192***	0.178***	0.199***	0.181*
	(0.062)	(0.063)	(0.058)	(0.060)	(0.062)	(0.060)	(0.093)
Neighbours Resource							
Dist.	−0.490***	−0.305***	−0.272**	−0.277			
	(0.112)	(0.104)	(0.109)	(0.171)			
Border					−0.100*		
					(0.052)		
Dist. & size						−0.072**	
						(0.036)	
Res Bal							−0.741**
							(0.317)
Migr	−1.226***	−1.183***		−1.389***	−1.435***	−1.495***	−1.937***
	(0.376)	(0.375)		(0.358)	(0.357)	(0.369)	(0.518)
US$/C$	0.139***						
	(0.032)						
Trend	0.006***	0.005***	0.004***				
	(0.001)	(0.001)	(0.001)				
Obs.	210	210	210	210	210	210	110
ser. cor.	0.045	0.060	0.077	0.015	0.016	0.032	0.062
sp. cor.	0.001	0.018	−0.003	−0.131	−0.131	−0.131	−0.060

FGLS estimation. Column (1) repeated from Table 2. Ser. cor and spat. cor, refer to the serial and spatial correlation measures as defined in the text. Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: GMM estimation and test for Endogeneity

	Dependent variable: log of Services over Manufacturing Employment							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Trend differenced				Period differenced			
	First sub-period							
Lag. dep.	0.763***	0.746***	0.697***	0.724***	0.710***	0.738***	0.720***	0.734***
	(0.058)	(0.063)	(0.083)	(0.059)	(0.054)	(0.060)	(0.083)	(0.058)
Man. LP	0.113*	0.115*	0.107*	0.117*	0.086	0.081	0.091*	0.088
	(0.061)	(0.063)	(0.055)	(0.061)	(0.056)	(0.059)	(0.054)	(0.057)
Ser. LP	−0.692***	−0.673***	−0.643***	−0.652***	−0.958***	−0.972***	−0.938***	−0.962***
	(0.222)	(0.203)	(0.147)	(0.183)	(0.213)	(0.211)	(0.179)	(0.213)
Prov. ToT	−0.267***	−0.265***	−0.291***	−0.219***	−0.215***	−0.208**	−0.253***	−0.226***
	(0.064)	(0.061)	(0.057)	(0.057)	(0.079)	(0.082)	(0.089)	(0.082)
Own Res.	0.132**	0.135**	0.134***	0.088	0.154**	0.135*	0.133**	0.127*
	(0.053)	(0.053)	(0.043)	(0.057)	(0.076)	(0.071)	(0.059)	(0.070)
N. Res.	−0.353***	−0.373***	−0.186***	−0.205***	0.268	0.273	−0.080	−0.029
	(0.134)	(0.129)	(0.068)	(0.056)	(0.280)	(0.272)	(0.085)	(0.075)
Mig.	−0.792	−0.901	−1.007	−1.021	−0.841	−0.663	−0.787	−0.780
	(0.593)	(0.600)	(0.740)	(0.646)	(0.531)	(0.569)	(0.638)	(0.531)
US$/C$	−0.236***	−0.232***	−0.217***	−0.236***				
	(0.071)	(0.068)	(0.065)	(0.066)				
	Second sub-period							
Lag. dep.	0.728***				0.795***			
	(0.078)				(0.077)			
Man LP	0.131*	0.129*	0.111	0.124*	0.197***	0.203***	0.171***	0.197***
	(0.070)	(0.068)	(0.069)	(0.068)	(0.045)	(0.039)	(0.040)	(0.038)
Ser LP	−0.085	−0.088	−0.104	−0.107	−0.170	−0.210	−0.220	−0.190
	(0.094)	(0.098)	(0.100)	(0.113)	(0.191)	(0.191)	(0.177)	(0.202)
Prov. ToT	−0.221***	−0.213**	−0.226**	−0.208**	−0.233***	−0.260***	−0.271***	−0.243***
	(0.082)	(0.085)	(0.095)	(0.081)	(0.070)	(0.074)	(0.083)	(0.081)
Res.	0.145***	0.143***	0.146***	0.114**	0.172***	0.176***	0.194***	0.146***
	(0.038)	(0.039)	(0.048)	(0.048)	(0.040)	(0.038)	(0.044)	(0.053)
N. Res.	−0.191	−0.196	−0.078	−0.174***	−0.260	−0.216	−0.064	−0.173**
	(0.172)	(0.174)	(0.056)	(0.067)	(0.225)	(0.210)	(0.052)	(0.069)
Mig.	−1.033*	−0.974	−1.194	−0.911	−1.504***	−1.649***	−1.741***	−1.553***
	(0.611)	(0.599)	(0.743)	(0.612)	(0.500)	(0.545)	(0.644)	(0.523)
US$/C$	0.030	0.032	0.033	0.013				
	(0.059)	(0.061)	(0.063)	(0.055)				
Obs.	210	210	210	210	210	210	210	210
J-test *p*-val.	0.701	0.750	0.550		0.339	0.412	0.576	

Linear GMM with multiple moment conditions from sub-periods. First sub-period: 1987–1996; Second sub-period: 1997–2007. Hansen *J*-test *p*-value based on 1 over-identification restriction: coefficient on lagged dependent variable is the same between periods. N. R refers to neightbour's resource, columns (1), (2), (5) & (6) Distance weighted, (3) & (5) Distance and size weighted, (4) & (8) shared border. Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

is rather stable over time and restricting the estimation to estimate the same coefficient for both periods is not limiting the estimation (a formal test on the coefficients does not reject this hypothesis). This restriction then causes over-identification and this over-identification allows to test the general appropriateness of the model using the Hansen J-test, the p-value of which is reported at the bottom of the table. While the model varies between the method of controlling for time effects and the use of neighbours resource measure, the test never rejects the models.[12]

However, with the time-fixed effects the coefficients on neighbours resource are not statistically significant at the usual levels, since the t-statistics fluctuate around 1. This lack of precision is probably due to three factors. Firstly, the lack of cross-sectional variation in those measures as argued before. Secondly, the reduced sample used for the estimation since each coefficient (except for the restricted one) is estimated with about half the sample. Thirdly, the difference in the weight matrix used for the estimation between the GMM and FGLS estimation. The second and third point are also expected to play a role for the coefficients in columns (1)-(4). Nevertheless, the GMM estimation is completely consisted with the previous results and, as argued before, the emphasize on these results is on the overall test of the specification rather than the individual coefficients.

It is interesting to note that the model, by using the lagged dependent variable, has some form of endogeneity included by construction, known as the Nickell-bias (Nickell, 1981). Nevertheless, this bias is expected to be reduced with the length of the time span. As the GMM results indicated, even with a sample split of two periods, this bias might be of limited concern.

4 Conclusion

The literature on resource windfall already established the macroeconomic effects in countries and provinces that have sizeable exports of resources. This paper established that its neighbours are also directly affected by these exports. Canadian provinces serve as an excellent test case for the measurement of economic effects of resource exports. The high quality data from its autonomous and industrially differentiated provinces, that nonetheless interact intensively with each other, allows to precisely measure effects on the provinces.

Using a general equilibrium framework, the equilibrium condition on sectoral employment is derived. This expression predicts a set of factors that influence supply and demand for both goods, with a particular emphasize on how neighbors' incomes affect the demand for home exportable goods. This equilibrium condition is translated to an estimable equation on employment and a set of independent variables, among which own and neighbours resources.

[12] See (Appendix C) for the test where all parameters are restricted between the two sub-periods.

The panel estimations establishes that a province' resource production affects its neighbours in several ways. Their exports do not only affect their neighbours through the appreciation of the exchange rate as found previously, but also through a change in the interprovincial trade pattern. A trade surplus that a resource exporting province established with the export of resources to the rest of the world is spend on a trade deficit with its closest trade partners, its neighbouring provinces. This demand for additional export goods is sizeable enough to have a statistically and economically significant effect in terms of sector sizes in both provinces that have themselves resource exports and those that do not.

References

Beine, M., Bos, C. & Coulombe, S., (2012), Does the Canadian economy suffer from Dutch disease?, *Resource and Energy Economics*, *34*(4), 468–492.

Beine, M., Coulombe, S. & Vermeulen, W. N., (2012, May), Dutch disease and the mitigation effect of migration - evidences from Canadian provinces, CESifo working paper 3813, Center for economic studies and Ifo institute for economic research.

Corden, W. M., (1984), Booming sector and Dutch disease economics: survey and consolidation, *Oxford Economic Papers*, *36*, 359–380.

Corden, W. M. & Neary, J. P., (1982, December), Booming sector and de-industralisation in a small open economy, *The Economic Journal*, *92*, 825–848.

Corsetti, G., Martin, P. & Pesenti, P., (2007), Productivity, terms of trade and the 'home market effect', *Journal of International Economics*, *73*, 99–127.

Coulombe, S., (2003, December), International trade, interprovincial trade, and Canadian provincial growth, Working Paper 40, Industry Canada Research Publication Program.

Dissou, Y., (2010), Oil price shocks: sectoral and dynamic adjustments in a small-open developed and oil-exporting economy, *Energy Policy*, *38*(1), 562–572.

Frankel, J. A., (2010, March), The natural resource curse: a survey. NBER working paper 15836, National Bureau of Economic Research, Cambridge, Massachusetts.

Hamano, M., (2012), The Harrod-Balassa-Samuelson effect and endogenous extensive margins, *Journal of the Japanese and International Economies*, Forthcoming.

Helliwell, J. F., (1998), National borders trade and migration, *Pacific Economic Review*, *2*, 165–185.

Helliwell, J. F. & Verdier, G., (2001), Measuring internal trade distances: a new method applied to estimate provincial border effects in canada, *The Canadian Journal of Economics*, *34*(4), 1024–1041.

Krugman, P., (1987), The narrow moving band, the Dutch Disease, and the competitive consequences of Mrs. Thatcher, *Journal of Development Economics*, *27*, 41–55.

McCallum, J., (1995, June), National borders matter: Canada-U.S. regional trade patterns, *The American Economic Review*, *85*(3), 615–623.

Mehlum, H., Moene, K. & Torvik, R., (2006), Institutions and the resource curse, *The Economic Journal*, *116*, 1–20.

Nickell, S. N., (1981), Biases in dynamic models with fixed effects, *Econometrica*, *49*, 1417–1426.

Obstfeld, M. & Rogoff, K., (2000, September), Perspectives on OECD economic integration: implications for US current account adjustment, Working Paper, UC Berkeley.

Obstfeld, M. & Rogoff, K., (2005), Global current account imbalances and exchange rate adjustments, *Brookings Papers on Economic Activity*, *2005*(1), 67–123.

Raveh, O., (2012, June), Dutch disease, factor mobility, and the Alberta effect - the case of federations, Hebrew University of Jerusalem.

Sachs, J. D. & Warner, A. M., (2001), Natural resource and economic development. the curse of natural resources, *European Economic Review*, *45*, 827–838.

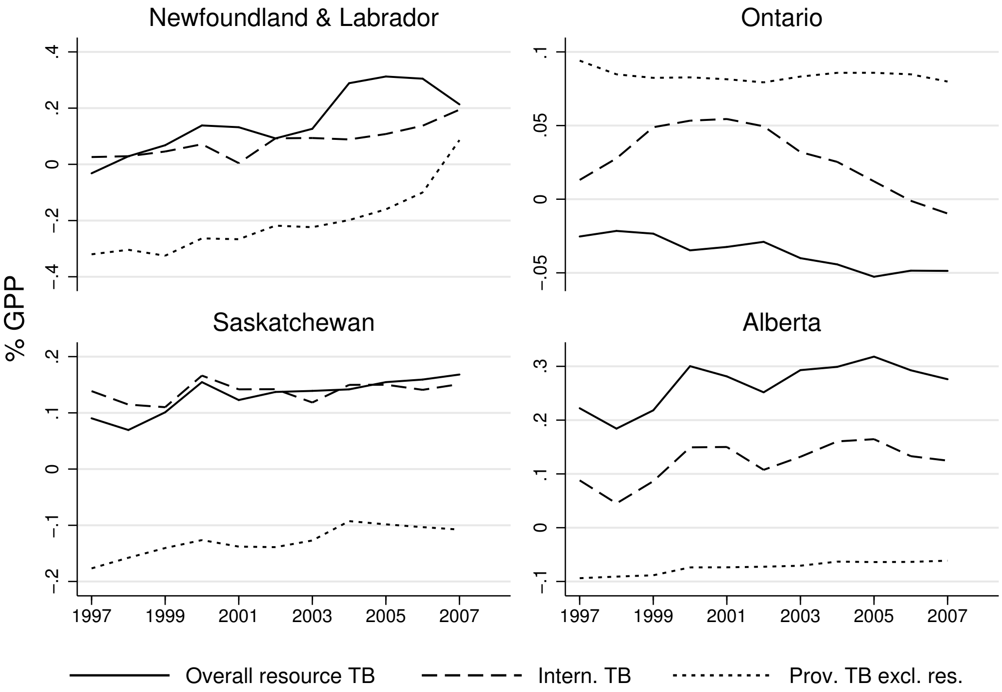
Torvik, R., (2001), Learning by doing and the dutch disease, *European Economic Review*, *45*, 285–306.

van der Ploeg, F., (2011, June), Natural resources: curse of blessing?, *Journal of Economic Literature*, *49*(2), 366–420.

Venables, A. J., (2011, August), Economic integration in remote resource-rich regions, In R. Barro & J. W. Lee (Eds.), *Cost & benefits of economic integration in asia*, Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford, Oxford University press.

Appendix A Figure 1

Figure 1: Trade between Alberta, Ontario and Quebec



Appendix B Linearized equilibrium condition

This appendix sets out the total derivative of the equilibrium equation of labour allocation with respect the exogenous variables, α_T, α_N, α_T^*, L, L^*, R, R^* by using the other equilibrium conditions on the budget constraint and price in the text and a symmetric equilibrium. Prices, p_T, p_N, p_T^* and the prices indices of which they are part, are determined by the productivity variables. However, for easy of conception it is fruitful to keep track of the supply effects and price effects that changes in productivity entail.

$$\frac{n}{1-n} = \frac{1-\delta}{\delta}\left(\frac{\alpha_T}{\alpha_N}\right)^{1-\rho} \frac{LC^{1-\rho}}{B^{\frac{\sigma-\rho}{1-\sigma}}LC^{1-\rho} + \phi\varepsilon^{-\sigma}\left(\frac{\alpha_T}{\alpha_T^*}\right)^{\sigma-\rho}(B^*)^{\frac{\sigma-\rho}{1-\sigma}}L^*(C^*)^{1-\rho}} \tag{23}$$

Let $z \equiv \frac{n}{1-n}$ and hatted variables, $\hat{x}$, be the relative change. The objective is to define $\hat{z}$ in terms of changes in the exogenous variables.

$$\hat{z} = (1-\rho)(\hat{\alpha}_T - \hat{\alpha}_N) + \frac{u}{v}(\hat{u} - \hat{v})$$

where u is the numerator in (23) and v the denominator. Let ψ_x be the share of total income from factor x, and a_H be the share of demand for tradable goods from home and a_F from foreign

$$\hat{u} = \hat{L} + (1-\rho)\hat{C}$$

$$\hat{v} = a_H\left(\frac{\sigma-\rho}{1-\sigma}\hat{B} + \hat{L} + (1-\rho)\hat{C}\right) + a_F\left((\sigma-\rho)(\hat{\alpha}_T - \hat{\alpha}_T^*) + \frac{\sigma-\rho}{1-\sigma}\hat{B}^* + \hat{L}^* + (1-\rho)\hat{C}^*\right)$$

Further expressing the variables $\hat{B}$, $\hat{B}^*$, $\hat{C}$ and $\hat{C}^*$,

$$\hat{C} = \psi_\pi\hat{\pi} + \psi_L\hat{L} + \frac{\mathrm{d}R}{\pi + L + R} - \hat{P},$$
$$\hat{C} = \psi_\pi^*\hat{\pi}^* + \psi_L^*\hat{L}^* + \frac{\mathrm{d}R^*}{\pi^* + L^* + R^*} - \hat{P}^*$$

$$\hat{B} = \phi(1-\sigma)\left(\frac{\varepsilon p_T^*}{p_T}\right)^{1-\sigma}(\hat{p}_T^* - \hat{p}_T) = \phi(1-\sigma)(\hat{p}_T^* - \hat{p}_T)$$
$$\hat{B}^* = \phi(\sigma-1)(\hat{p}_T^* - \hat{p}_T)$$

and profits and price indices, $\hat{\pi}$, $\hat{\pi}^*$, $\hat{P}$ and $\hat{P}^*$

$$\hat{\pi} = \hat{w} + \hat{L}$$

$$\hat{\pi}^* = \hat{w}^* + \hat{L}^*$$

$$\begin{aligned}
\hat{P} &= \delta\left(\frac{P_T}{P}\right)^{1-\rho}\hat{P}_T + (1-\delta)\left(\frac{P_N}{P}\right)^{1-\rho}\hat{P}_N \\
\hat{P}_T &= \left(\frac{p_T}{P_T}\right)^{1-\sigma}\hat{p}_T + \left(\frac{p_T^*}{P_T}\right)^{1-\sigma}\hat{p}_T^* \\
\hat{p}_N &= \left(\frac{p_N}{P}\right)^{1-\sigma}\hat{p}_N
\end{aligned}$$

$$\hat{p}_T = -\hat{\alpha}_T,\ \hat{p}_T^* = -\hat{\alpha}_T^*,\ \hat{p}_N = -\hat{\alpha}_N.$$

$$\begin{aligned}
\hat{P} &= \delta P^{\rho-1}P_T^{\sigma-\rho}p_T^{1-\sigma}(-\hat{\alpha}_T - \hat{\alpha}_T^*) + (1-\delta)P^{\rho-1}P_N^{\sigma-\rho}p_N^{1-\sigma}(-\hat{\alpha}_N) \\
\hat{P}^* &= \delta P^{*\rho-1}P_T^{*\sigma-\rho}p_T^{*1-\sigma}(-\hat{\alpha}_T - \hat{\alpha}_T^*) + (1-\delta)P^{*\rho-1}P_N^{*\sigma-\rho}p_N^{*1-\sigma}(-\hat{\alpha}_N^*)
\end{aligned}$$

combining the expressions (assuming tradable and non-tradable goods have equal shares in consumption, and prices are initially 1).

$$
\begin{aligned}
\hat{z} \;=\;& (1-\rho)(\hat{\alpha}_T - \hat{\alpha}_N) + (1-\alpha_H)(1+(1-\rho)(\psi_L+\psi_\pi))\hat{L} \\
& +(1-\rho)(1-\alpha_H)\left(\frac{\mathrm{d}R}{\pi+L+R} - \hat{P}\right) \\
& +(a_H\phi + a_F(1-\phi))(\sigma-\rho)(\alpha_T - \alpha_T^*) + \\
& -a_F\left((1+(1-\rho)(\psi_L^* + \psi_\pi^*)\hat{L}^* + (1-\rho)\left(\frac{\mathrm{d}R^*}{\pi^*+L^*+R^*} - \hat{P}^*\right)\right)
\end{aligned}
$$

$\hat{P}$ and $\hat{P}^*$ can be further substituted and will combine with the other productivity variables. For the estimation these substitutions are not done. Instead both interregional price term and the external price term, the price of the Canadian dollar, are included.

The derivation confirms the affect of resource income that was already seen from the original equilibrium condition. Own resource R will increase the allocation of labour to the non-tradable sector, while a neighbour's resource income will increase demand for tradable goods and allocate labour accordingly.

Appendix C GMM endogeneity test with more restrictions

Table 5 presents GMM results based on a system of two subperiods where all parameters are restricted to be equal between the periods.

Table 5: GMM estimation and test for Endogeneity

	Dependent variable: log of Services over Manufacturing Employment					
	(1)	(2)	(3)	(4)	(5)	(6)
	Trend differenced			Period differenced		
Lag. dep.	0.714***	0.662***	0.673***	0.713***	0.716***	0.702***
	(0.075)	(0.088)	(0.069)	(0.076)	(0.091)	(0.079)
Man. LP	0.110**	0.093**	0.117***	0.148***	0.139***	0.157***
	(0.043)	(0.039)	(0.045)	(0.051)	(0.046)	(0.050)
Ser LP	−0.288***	−0.341***	−0.324***	−0.489***	−0.498***	−0.417***
	(0.075)	(0.080)	(0.092)	(0.088)	(0.081)	(0.101)
Prov. ToT	−0.255***	−0.255***	−0.218***	−0.240***	−0.244***	−0.221***
	(0.044)	(0.034)	(0.044)	(0.049)	(0.055)	(0.055)
Own Res.	0.137***	0.102***	0.080**	0.167***	0.158***	0.141**
	(0.047)	(0.029)	(0.038)	(0.050)	(0.044)	(0.056)
N. Res	−0.532***	−0.108**	−0.254***	−0.001	−0.072	−0.125**
	(0.121)	(0.055)	(0.045)	(0.232)	(0.053)	(0.063)
Migr.	−1.030**	−0.977	−1.036*	−1.410***	−1.443**	−1.608***
	(0.526)	(0.653)	(0.553)	(0.521)	(0.567)	(0.534)
US$/C$	0.149***	0.124**	0.138***			
	(0.045)	(0.051)	(0.050)			
Observations	210	210	210	210	210	210
J-test	0.010	0.014	0.033	0.219	0.342	0.266

Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.