Vertical fiscal transfers and the location of footloose activity across a country regions(*)

P. Moncarz[†], S. Freille[† ¥], A. Figueras[†], and M. Capello[† ¥]

[†] *Universidad Nacional de Córdoba*

[¥] *Universidad Católica de Córdoba*

[¥] *IERAL de Fundación Mediterránea*

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Extending Martin and Rogers' FCM including non-tradable goods and public employment we analyse the effect on economic activity location that follows to changes on the regional distribution of transfers. An increase in the share of transfers a region receives positively affects the production of manufactures the higher are: transaction costs of goods produced under increasing returns to scale; the share of transfers that goes directly to consumers instead of local governments; the elasticity of substitution between differentiated goods; the share of consumers' expenditure on manufactures *via-as-vis* on non-traded goods.

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1. Introduction

Among the different goals of national-level governments is to help easing the regional disparities in social and economic outcomes between sub-national regions. To this end, most federal countries have specific financial arrangements between the different tiers of government aimed at ensuring homogeneous levels of public goods provision across the regions. In most cases, these arrangements involve some form of tax-sharing and vertical transfers according to different criteria, but usually along both devolutive and redistributive bases.

Several federal countries have designed alternative schemes for implementing these tax-sharing agreements. In Brazil, both regional states and municipalities receive transfers from the federal government.[1] In Australia, federal transfers are critical to state budgets representing as much as

(*) Corresponding author: Pedro E. Moncarz, Facultad de Ciencias Económicas, Universidad Nacional de Córdoba. Av. Valparaíso s/n. Ciudad Universitaria. Córdoba. 5016. Argentina. E-mail: pedro.moncarz@gmail.com. We thanks financial support from FONCyT (PICT Grant 2012-00805) and MinCyT (PID Grant 2008-46).

[1] There are several different programmes but the most relevant are the *Fundo de Participacao dos Estados e do Distrito Federal* (FPE) a scheme through which the federal government allocates money to the Brazilian States in a clear redistributive fashion whereby the poorer northern and north-eastern States receive nearly 85% of the total fund while

50% of total revenues. The largest transfer is that corresponding to the proceeds of the goods and services tax (GST) followed by other specific transfers.[2] Similarly, the unconditional Equalization Transfer in Canada accounts for more than 80% of total federal transfers to the provinces. In Argentina, most intergovernmental fiscal relations take place under the *Régimen de Coparticipación Impositiva* which introduces criteria for vertical and horizontal distribution of funds.[3] Even non-federal countries often have some form of financial arrangements between the central and local governments. One recent example is the significant changes in intergovernmental relations in China introduced in 1994 when the Chinese government engineered the Tax-Sharing System (TSS) reform aimed at improving the efficiency of sub-national spending and reducing horizontal inequalities.[4]

While this topic has often attracted the attention of scholars, it has only in recent years become more actively researched due to several reasons. Firstly, the fact that several countries have moved towards more federal forms of government in the last 30 years has prompted scholars to analyze these and other related topics in more detail. Additionally, the growing importance of regions as clusters of economic activity has also highlighted the relevance of inter-governmental financial relations. Finally, although only a small number of countries are federally organized by law, they use up around half of the earth's surface area and their citizens make up more than 40% of the world's population.[5] Furthermore, a large part of the literature is focused on studying the economic and political determinants of federal transfers while the strand that focuses on the economic and social effects of transfers has been given less attention. Our paper contributes to this latter literature

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the rest goes out to the richer, southern States. Additionally, there is also the *Fundo de Participacao dos Municipios* (FPM) which accounts for as much as 40% of total municipal revenues, and it is also structured on redistributive criteria.

[2] There are two central types of transfers to the states and territories; the General Purpose Payments (GPP), which consist of automatic untied transfers and the Specific Purpose Payments (SPP), which consist of earmarked funds for specific areas such as health, education, transport and housing.

[3] Although the current implementation of the *Régimen de Coparticipación Impositiva* was agreed in 1988, the tax-sharing agreements and transfers between the federal government and the provinces have existed for almost 80 years.

[4] After the 1994 reform, taxes are classified in three categories: central, local and shared taxes between the central and local governments. Alongside with two separate tax administration systems, the government created a third scheme by establishing the tax rebate system and the equalization transfer system based on the relation between fiscal capability and expenditure needs of local governments. The Chinese TSS reform is explained in more detail in Zhang and Martinez-Vazquez (2003).

[5] This recent interest on the effects of inter-governmental transfers has also been fuelled by the experiences of some of the most heavily populated countries which, are either federal by law (India and the Russian Federation) or share some trademark federalist traits.

by means of investigating the role of federal untied transfers in regional convergence, particularly the regional distribution of footloose production.

The paper is organised as follows. In section 2 we discuss briefly the literature on the effects of capital flows, foreign aid and the Dutch disease. In section 3 we present some casual evidence on the relationship between the distribution of federal transfers and manufacturing production. In section 4 we develop a simple and parsimonious model inspired on the New Economic Geography literature. Section 5 concludes.

2. Capital flows, foreign aid, and the Dutch disease

The neoclassical theory, under its usual set of assumptions, predicts that in response to a difference in the rates of return there should be a net flow of capital from richer to poorer countries, such that the later would grow faster producing a convergence in per capita income between these two groups of countries. However there is plenty of evidence where observed outcomes are not in line with the theoretical predictions. Almost twenty years ago an influential neoclassical author like Robert Lucas[6] pointed out that the direction of capital flows were quite different from those suggested by the theory. A *paradox* that appears to have become stronger as time (and globalisation) moves forward. Even more striking is the fact that capital appears to flow in the direction from poor countries to rich ones.

These findings have led some authors to suggest for the need of government intervention. The question that then arises is what could be the effects of capital inflows on less developed regions? The answers are not homogeneous, and even contradictory. On the one hand, we have works such as Clemens *et al.* (2004) pointing out that capital flows are beneficial for poorer regions; on the other hand works such that of Rajan and Subramanian (2008) point out to a potentially negative effect derived from capital inflows. All these contributions deal with the issue of international capital mobility. To the best of our knowledge there has been no attempt to study the phenomenon

[6] Lucas (1990).

at the sub-national level[7]. Because of this, most of the literature we rely on refers to the problem from an international perspective.

To some extent, but with the required qualifications, the debate resembles the controversy between J. M. Keynes and Bertil Ohlin regarding the transfers required to fulfil the payments imposed on Germany after its defeat in the First World War. This controversy centred around the effects that such transfers would produce both on the recipient countries but mostly on Germany, the "donor". However, the debate then was kept under a static framework. Currently, the debate incorporates a dynamic dimension to this problem by looking at the effects that such transfers could have on the structure of production of countries that benefit from a positive net capital flow, and how this could affect the achievement of what we may call as the new "*El Dorado*" or, in more technical terms, sustainable growth.

There exists evidence that supports the idea that, under some circumstances, the aid received by less developed regions may end up becoming an *iron life vest*. In the early fifties, Samuelson (1952) analysed the problem under a macro framework assuming a two-country Walrasian model, concluding that the *transfer paradox* was not logically viable. Later, other studies relaxed some of Samuelson's assumptions and suggested that the *transfer paradox* was indeed a possible outcome under a Walrasian model if: a) there were more than two countries (Gale, 1974, Chichilnisky, 1980); b) a general equilibrium trade model is used (Bhagwati *et al*., 1983; Yano, 1983); and c) free trade was absent (Brecher and Bhagwati, 1982). Hirschman (1958) also suggested the *transfer paradox* could work through changes in relative prices, with foreign aid increasing the relative price of non-tradable goods because of the expansion of domestic demand.

The empirical evidence is scarce and limited to the case of international transfers. Yano and Nugent (1999) address the problem using a small economy model which receives exogenous foreign aid and is unable to affect its terms of trade. The model also assumes capital and labour are domestically mobile across sectors but not internationally. There are three goods, one non-tradable

[7] There are some references in the literature that recognize this point without going into a detailed study of this phenomenon. See for example Torvik (2002).

and two goods that are internationally traded. The authors distinguish between two potential effects: a) an import substitution effect; and b) a domestic good effect. While the authors find that the import substitution effect is absent in most of the 44 countries included into their sample, the domestic good effect shows a negative contribution to growth, offsetting, at least partially, the direct positive effects from foreign aid.

Rajan and Subramanian (2008) provide more conclusive evidence in their examination of the effects of international capital flows on the process of development. More specifically, they look at if less developed countries that experienced a faster growth were also the most dependants on foreign savings. The outcome the authors arrive to suggests countries that have resorted to less foreign financing have grown faster. They conclude that the dependency on foreign capital may produce a perverse outcome through the appreciation of the local currency, that if large enough may produce a Dutch disease like phenomenon, affecting negatively the competitiveness of sectors that are crucial if a sustainable growth is to be achieved, such as is the case of manufacturing production. Similarly, in a recent survey paper, Doucouliagos and Paldam (2009) conclude that foreign aid has been largely ineffective in fostering economic growth and that one plausible explanation for this result is the Dutch disease effect on the exchange rates of the countries on the recipient end.

Up to now, we have limited our discussion to the Dutch disease problem in its standard context, that of international transfers. Within our framework, the Dutch disease is the phenomenon with negative consequences that may follow after an (important) increase in foreign capital inflows. The increase in foreign capital flows produces an increase in the demand of both tradable and non-tradable goods. The higher demand for tradable goods could be met by an increase in imports and a reduction of exports, which would also help to counteract the appreciation of the local currency that follows after the initial flow of foreign capital. However, if the possibility of satisfying the increasing demand for the non-tradable goods is restricted by rigidities on the supply side, this would provoke a further appreciation of the local currency, and therefore hurting in the short-run

the international competitiveness of domestic producers; even the long-run competitiveness may also be affected if the economy is less attractive to local and foreign investors.

If the nominal exchange rate is fixed, the increase in foreign capital inflows would lead to an increase in the supply of the domestic currency, resulting in an increase in domestic prices, which is equivalent to an appreciation of the local currency through a reduction in the nominal exchange rate. In the case of a country, it is possible to counterbalance the negative effects of an increase in foreign capital inflows through restrictive fiscal and/or monetary policies. This alternative is of course absent in the case of regions which belong to a single economy, since they share the same currency. Thus, the recommendation to compensate for the negative effects of an increase in transfers is to achieve a higher productivity and to increase the capacity to produce non-tradable goods, which would help to reduce the pressure on the relative price of these goods.

3. Vertical fiscal transfers and the regional location of manufactures: some evidence for selected federal countries

In this section we look at some evidence on the relationship between federal transfers and regional manufacturing production. We have collected data for six federal countries: Argentina, Australia, Brazil, Canada, Mexico and Spain.[8] The main variables are all in per capita terms and have been standardized to allow for easier comparison[9]. For each country, we consider the most significant transfer component which usually corresponds to some concept of current (automatic) transfers[10]. The following figures show a side-by-side view of the standardized regional transfers per capita and

[8] We have time series data on transfers and regional GDP for all countries and data on industry GDP for all countries but Argentina. In all cases our goal was to maximize the length of the time series to infer long-run behavior at the cost of using periods with different lengths. Data for Argentina goes from 1962 to 2001, Australia from 2000 to 2010, Brazil from 1995 to 2009, Canada from 1999 to 2008, Mexico from 1994 to 2010, and Spain from 1995 to 2009. Since for most countries the time period for which data were available was not very long, we are not able in this section to speculate on the long term relationship between the variables.

[9] Since both series are standardized, the diagrams for the two periods are not directly comparable in absolute values –i.e. a higher value of a region's transfers per capita may have associated a lower standardized value if the mean of the distribution grows over time and thus have a darker shade in a diagram- although they provide an insight of the relative position of a region in terms of both regional transfers and GDP.

[10] This is not always straightforward since all the countries have different tax-sharing schemes and the number and type of transfers vary significantly across the different federations. Whenever possible, we decided to use the most relevant transfer fund in each category. If it was not possible to determine whether a specific transfer fund was automatic or non-automatic, we excluded it from our data analysis.

GDP per capita in both the start and end year in our sample for each country (darker shades correspond to higher levels of the corresponding variable). See Table 1 for a description of variables and sources.

All the figures contain two graphs each depicting information on federal transfers to regional governments (left panel) and regional manufacturing GDP (right panel) on different years. The information contained in each graph provides a basic overview of the relationship between transfers and regional manufacturing production. Looking at each graph it is evident that, with only a few exceptions[11], regions with higher amount of per capita transfers are also those which have the lowest industrial GDP per capita (i.e. regions with darker shades on the left panel are associated with lighter shades on the right panel and *vice versa*). However, this evidence could be biased if there were economy-wide shocks -or worse, region-specific shocks- on the years chosen for a particular country/region[12]. In order to limit this potential limitation, we decided to plot both variables in the start and end year for each country. In doing so, we are able to look at these diagrams at two different points in time and gain some insights about how the relationship between transfers and manufacturing GDP evolves over time.

Looking at the diagrams for each country, it becomes evident that no clear pattern emerges. There are some countries where regions which receive larger amounts of per capita transfers than a few decades ago have actually worsened their position relatively to the sample mean in the recent period[13]. Argentina and Mexico show a similar pattern with the positions of the different regions being relatively stable over the selected period of time and in some cases a worsening in the relative position. In Argentina, provinces like Chaco (CHA), Santiago (SGO), Formosa (FOR) and Tierra del Fuego (TDF) have all improved their relative transfer position during the forty year period ranging from 1962 to 2001 yet their position with respect to regional GDP has not improved relative

[11] The most notable exceptions are the regions of Cantabria and La Rioja in Spain, Campeche in Mexico, Tasmania in Australia, and the provinces of Santa Cruz and Tierra del Fuego in Argentina.

[12] As we noted before, we are not afforded a great deal of flexibility to choose from different years since in most cases data were not available for both variables for a long period of time.

[13] Recall that these are standardized numbers so the amount each region receives is adjusted by the mean and standard deviation of the corresponding year. This means that when looking at the standings of specific regions in recent years, we emphasize the evolution of these variables relative to the other regions rather than in absolute terms.

to the regional average and has actually worsened for Chaco (CHA) and Tierra del Fuego (TDF)[14]. Similarly, provinces whose transfer position has not changed [Rio Negro (RNG), Chubut (CHU), Santa Fe (SFE) and La Pampa (LPA)] or worsened [Neuquén (NQN), Mendoza (MZA), and Santa Cruz (SCR)] have kept or improved their relative production position over the same period. It is important to note that in the case of the provinces in the Patagonia region [Neuquén (NQN), Río Negro (RNG), Chubut (CHU), Santa Cruz (SCR) and Tierra del Fuego (TDF)] a large fraction of their incomes comes from oil and gas royalties, specially at the end of the period.

In Mexico, there have not been significant changes in the transfer position of the different regions in the period 1994-2010. It is worth noting, however, that several regions [Hidalgo (HI), Tabasco (TA), Baja California Norte (BS) and Sonora (SO)] have actually worsened their transfer position without significant changes in their relative manufacturing position. Most of the other regions have maintained their relative position in relation with transfers per capita but only a few have experienced changes in their relative manufacturing position. These are the cases of Chihuahua (CI), Cohauila (CO) and Nuevo León (NL) which have worsened their relative manufacturing position. The Campeche (CA) region, despite having maintained a similar transfer position has gone from below-average industrial GDP to the highest manufacturing GDP per capita of all the regions in this period. One likely explanation for this is that the share of industrial GDP in total GDP in Campeche (CA) has grown to represent almost 85% mainly due to the extraordinary growth of oil production in the state since the late 90's[15].

In the case of Brazil, there have not been significant changes in how transfers were redistributed between 1995 and 2009, with most of the States keeping their relative positions; the most any State changed is two places. However, despite the stability in the distribution of transfers it is possible to observe some important changes in the case of manufacturing GDP, with only 8 out of 27 States

[14] It is important to note that Tierra del Fuego (TDF) is a special case since both population and the amount of automatic transfers have increased significantly over this period; population experienced a ten-fold increase while the proportion of the Co-participación fund that goes to the province has experienced a significant increase due to the special regime that applies to the region.

[15] Oil production in Campeche (CA) as a proportion of total oil production in the country grew from 36% in the 80's, to almost 60% in the 2000-2008 period. Additionally, Campeche has one of the lowest rates of population growth among the Mexican states.

maintaining their position unchanged, while the rest have either worsened [Roraima (RR) 11 positions, Amapá (AP) 7 positions, Sergipe (SE) 6 positions, and Pará (PA) 4 positions] or improved [Bahia (BA) 7 positions, Rondônia (RO) 6 positions, Distrito Federal (DF) and Paraíba (PB) 5 positions, and Ceará (CE) 4 positions] up to eleven positions. Moreover, only in two cases, Ceará (CE) and Piauí (PI), the relative positions in terms of transfers and GDP moved in the same direction, with both States improving on the two dimensions. This results suggest that we may need to look elsewhere than changes in transfers to explain changes in the industry GDP per capita.

The other three federal countries we have gathered data for are, unlike the first three, developed economies. While federal transfers do not appear to worsen the position of regional manufacturing production over time, they do not seem to have a positive impact which tends to perpetuate regional inequalities in terms of manufacturing production. This is clearly the case of Spain where the regions that have improved their transfer position [Madrid (MA) and Cantabria (CN)] have actually maintained (or worsened) their relative manufacturing position. Still, the changes in both transfers per capita and regional manufacturing GDP are less marked than in the previous countries[16]. Even less dramatic is the case of the Australian Federation. In this case, there seems to be much greater stability on the transfer and manufacturing position of the Australian regions. This may be due to the way transfers are allocated in Australia, Equalization Transfers to close the sub-national fiscal gap, or due to the fact that we have a very short time period which prevents us from observing dramatic changes in either variable. In any case, it is very likely that the evidence that regional differences at the outset in manufacturing are much less striking than in Argentina, Mexico and Spain explains this stability.

[16] Here we use the transfers corresponding to the Tributos Cedidos which are taxes whose collection the Spanish state bestow upon the autonomous communities. Some of these are given entirely to the autonomous communities and in other cases a given percent it's assigned to the autonomous communities. The regime of inter-jurisdictional arrangements was changed in 2009 with the *Sistema de Financiación de las Comunidades Autónomas de Régimen Común*. Since it was unclear whether these transfers or the transfers corresponding to the *Fondo de Suficiencia* (transfers from the central government to the regional communities to compensate for horizontal inequalities) were most appropriate to capture a concept of automatic transfers, we also produced diagrams using the latter. Due to space limitations we do not include those graphs here but are available from the authors upon request. In fact, these maps show more clearly the lack of relationship between transfers per capita and manufacturing GDP.

Finally, the situation in Canada appears slightly different from the Australian case and significantly different from the other countries. Despite the short time period, there is some evidence that regions which have improved their transfer position over time have also improved their relative manufacturing position, such is the case of the provinces of Manitoba (MAN) and Nunavut (NVT), while Ontario (ONT) has seen a relative deterioration in terms of GDP. Most of the other Canadian provinces preserve both their transfer and manufacturing position over this period; in fact, if anything it would seem that transfers per capita and regional manufacturing GDP move in the same direction as is the case for the provinces of Alberta (ALB), Saskatchewan (SAS) and Manitoba (MAN) and also for Quebec (QUE) and Newfoundland and Labrador (NL).

While these figures are intuitively enough to grasp the idea that a change in the relative position of transfers per capita may have diverse effects, or none at all, for the different countries, they do not provide conclusive evidence of the relationship between transfers and manufacturing production. In fact, the evidence presented so far suggests that there is significant heterogeneity in the relationship between unconditional federal transfers to regional governments and their manufacturing GDP. In order to provide a bit more rigorous analysis, we now estimate a standard cross-section convergence equation, where the dependant variable is the simple average of annual growth rates of regional (provincial) manufacturing GDP per capita. As explanatory variables, we include the level of regional (provincial) manufacturing GDP per capita at the beginning of the period, and the simple average of annual growth rates of federal transfers received by regional (provincial) governments. In three cases, Argentina, Brazil and Canada, there is evidence of conditional convergence, while for Australia the opposite result arises. With regards the role of transfers, only for Brazil they show a positive and statistical significant effect on GDP growth, while for Australia they appear to have shown a negative impact on convergence of manufacturing production. For the remaining four countries the estimated coefficients are not statistical significant.

In Table 3 we present some additional quantitative evidence. Here we use all available information to estimate a panel-data convergence equation. Now the dependant variable is annual growth rate of

regional (provincial) manufacturing GDP per capita. As explanatory variables, we include the lagged level of regional (provincial) manufacturing GDP per capita and the annual growth rate of federal transfers received by regional (provincial) governments. For all countries but Canada, there is evidence of conditional convergence, however the values of the estimated coefficients are almost equal to zero. As in the cross-section case, in Brazil there appears to be a positive effects of transfers on the growth rate of manufacturing value added. The same result also emerges for Argentina and Canada but the estimates are much lower than in the Brazilian case, specially for the Argentina. Also, let us remember that for Argentina we are using total GDP instead of that of the manufacturing sector.

The simplicity of our specifications call for caution on the interpretation of the results. For instance the short time period we have data for. Moreover, due to the lack of the necessary data, we cannot explore for the possibility of a reverse causality, since it may be the case that the way in which transfers are distributed among the different regions are a function of how production is distributed regionally, and not the other way around. However, this last issue may lack some relevance, since with the exception for Argentina, we are using industrial GDP, and assuming that if transfers are endogenous, they would respond more to total GDP differences than to differences in industrial GDP. Despite of these concerns, if something emerges clearly is that there seems to be sufficient heterogeneity in the relationship between federal transfers and regional manufacturing GDP among the selected countries.

In the next section we present a simple theoretical model to try to shed some light on our findings, specially the absence of a clear relationship between our two variables of interest.

4. The model

As the casual evidence presented in the previous section shows, there appears to be no clear relationship between unconditional vertical transfers and the distribution of manufacturing

production. If something emerges from the data is the heterogeneity across the six countries we gathered data for, as well as within some of the countries themselves.

To try to shed some light on the empirical evidence just summarized in the previous section, we now develop a simple model to try to explain why a priori could be not possible to establish a clear relationship between the two variables that we are interested in, becoming an empirical matter what relationship, if any, there exists between them.

With this purpose, we extend Martin and Rogers (1995) Footloose Capital Model (FCM) to analyse how changes in the distribution of transfers from the Federal to State governments affect the regional location of manufacturing production. We extend the FCM by including in each region a sector that produces a non-traded good and a local government which uses public resources to hire public employment.

Firstly we will present the full model, and then when we look at the effects of transfers on the location of manufacturing production, we will work with two alternative cases, depending on the number of sectors we consider. The full model includes four sectors, agriculture, manufactures, and a non-traded sector in each of the two regions the country is divided in. Both, the agricultural good and the non-traded goods are produced under constant returns to scale (CRS) using only labour (L). The production of manufactures presents increasing returns to scale (IRS), and involves the use of capital (K) as a fixed cost, and labour (L) as a variable cost. The market for manufactures is organised as a monopolistically competitive market *à la* Dixit-Stiglitz, where each firm in the market produces a differentiated variety. Trade of manufactures between the two regions is subject to positive transport costs, which take the well-known Samuelson's iceberg type. The markets for the agricultural good as well as those of the non-traded goods are perfectly competitive. Trade of the agricultural good between the two regions is costless. By definition, each non-traded good is sold only in the region it is produced. We assume also that labour is perfectly mobile between sectors but immobile between regions, capital, instead, is mobile between regions. There are also two levels of governments, a national government and two local governments. The national

government, which we do not model explicitly taxes all capital revenues[17] and transfers them to the two regions. These transfers can go either to the local governments or be received directly by consumers. Local governments use all transfers they receive to hire employees[18]; this assumption may seem a bit extreme, but it is done in order to prevent for the public sector to have a role on the relative demand for different goods. Consumers get no utility from public employment..

Consumers

Consumers in each region have a two-tier utility function. The first tier takes a Cobb-Douglas form, and is defined over the consumption of the agricultural good, the non-traded good and a composite of manufactures. More specifically, the utility function for the representative consumer living in region *i* can be stated as follows:

$$u_i = \left(c_{A,i}\right)^{\beta_A} \left(c_{NT,i}\right)^{\beta_{NT}} \left(c_{M,i}\right)^{\beta_M} \qquad \text{with } \beta_A + \beta_{NT} + \beta_M = 1$$

where $c_{A,i}$ is the per-capita consumption of the agricultural good, $c_{NT,i}$ is the per-capita consumption of the non-traded good produced in region *i*, and $c_{M,i}$ is the per-capita consumption of the composite of manufactures. β_A, β_{NT} and β_M are the expenditure shares the consumer spends on the consumption of each good.

The $c_{M,i}$ composite takes the following CES form:

$$c_{M,i} = \left[\sum_{h \in N} c_i(h)^{\alpha}\right]^{\frac{1}{\alpha}} \qquad 0 < \alpha < 1$$

where $c_i(h)$ is the units consumed of any given variety *h*, and $N=n_1+n_2$ is the total number of manufacture varieties, n_1 and n_2 are the number of varieties produced in regions 1 and 2 respectively. From the consumer maximisation problem we have that the consumption of each manufactured variety by all consumers living in region *i* is equal to:

[17] This assumption is made based on the literature on public finance which suggests it is more efficient for a Federal government, instead of state level governments, to tax footloose activities or factors that are potentially mobile across regions.

[18] Public employment can be also interpreted as a kind of non-traded good.

$$C_i = \frac{\left(pT_i^j\right)^{-\sigma}}{\left(PM_i\right)^{1-\sigma}} \beta_M E_i \qquad \sigma = \frac{1}{1-\alpha} > 1$$

where pT_i^j is the consumer price of a variety consumed in region *i* and produced in region *j*, PM_i is the manufacture price index in region *i*, E_i is the total income[19] of consumers living in region *i*, and σ is the elasticity of substitution between manufactured varieties[20]. The assumption that trade of manufactures is subject to iceberg-type costs means the following relationships between consumer and producer prices:

$$pT_i^j = pT^j \qquad \text{if } i = j$$

$$pT_i^j = \tau pT^j \qquad \text{if } i \neq j$$

where $\tau > 1$ are iceberg transport costs, and pT^i and pT^j are the producer prices in regions *i* and *j* respectively. The notion of iceberg transport costs means that for one unit of the good consumed in region *i*, τ units need to be shipped from *j*.

Total consumption of the other two goods are equal to:

$$C_{A,i} = \frac{\beta_A E_i}{pA}$$

$$C_{NT,i} = \frac{\beta_{NT} E_i}{pNT_i}$$

Producers

As stated above, production of the agricultural good and the two non-trade goods are subject to constant returns to scale, and uses only labour. More specifically, we assume the following production functions:

$$A_i = LA_i$$

$$NT_i = LNT_i$$

[19] Since there is no saving in the model, income is equal to expenditure.

[20] For *N* large enough, σ is also the price elasticity of demand of each variety.

where LA_i and LNT_i are the units of labour used in the production of agriculture and the non-traded sector in region *i*. From the producer problems for each of the two sectors, the prices of the agricultural and non-traded goods are:

$$pA_i = pNT_i = w_i$$

where w_i is the wage rate in region *i*. The assumption that the agricultural good has no transport cost between regions means that, if there is a positive production of it in both regions, in equilibrium we have $w_i=w_j=w$. This is not necessarily the case when we consider an economy with no agricultural sector.

In the case of the production of manufactures, this uses capital and labour. The total cost of any given variety produced in region *i* is given by:

$$CT_i = \pi_i F + a\ w_i x_i$$

where *F* is the requirement of capital, which does not depend on the scale of production x_i, *a* is the requirement of labour for each unit of production, and π_i is the rate of return for capital.

From the profit maximisation problem we obtain that the producer price in region *i* is:

$$pT^i = a\frac{\sigma}{\sigma-1}w_i$$

Additionally, the assumption of free entry and exit of firms means that in equilibrium firms obtain zero profits $\left(pT^i x_i - aw_i x_i - \pi_i F = 0\right)$, such that the scale of production of each manufacture variety produced in region *i* is equal to:

$$x_i = \frac{\pi_i F(\sigma-1)}{aw_i}$$

By choice of units we can assume $a = \frac{\sigma-1}{\sigma}$ and *F=1*, such that we get:

$$pT^i = w_i$$

$$x_i = \frac{\pi_i \sigma}{w_i}$$

The assumption that there is no trade cost for the agricultural good means that producer prices are the same in both regions, $pT^i = pT^j$.

Capital rent and total income

Under Dixit-Stiglitz competition in the manufacturing sector, the rent of capital, also called operating profits, is a proportion of total sales (at the producer price): $\pi_i = \left(pT^i x_i\right)/\left(F\sigma\right)$.

Total income is the sum of labour income plus the revenue from capital rent. As we assumed before, capital is mobile between regions, however capital owners remain always at the same location. In the absence of a national government that captures all capital income through taxes, we assume that independently where capital is used each unit is evenly owned between the populations of the two regions. Then, if $L_1=L_2$, residents in each region receive half of total operating profits, which are equal to: $\beta_M E^W/F\sigma$, where E^W is total income, that under the assumption that there is no savings is equal to labor income plus operating profits: $E^W = \left(w_i L_i + w_j L_j\right) + \left(\beta_M E^W\right)/\left(F\sigma\right)$. Solving for E^W we get:

$$E^W = \frac{\left(w_i L_i + w_j L_j\right)F\sigma}{F\sigma - \beta_M} \quad (21)$$

Now, let us assume that there exist a national government that taxes all capital income, and redistribute it between the two regions, with a proportion $0 \le e_i \le 1$ going to region *i*, and a proportion $0 \le \left(1-e_i\right) \le 1$ going to region *j*. Additionally, a proportion $0 \le \phi \le 1$ of these transfers go directly to consumers, while the remaining percentage $0 \le \left(1-\phi\right) \le 1$ goes to local governments, which use these transfers to finance public employment. Under these assumptions capital rent going to all consumers is equal to $\phi\beta_M E^W/F\sigma$, such that world income is:

$$E^W = \frac{\left(w_i L_i + w_j L_j\right)F\sigma}{F\sigma - \beta_M \phi}$$

[21] From the expression for E^W we need $F\sigma > \beta_M$ for the model have a solution.

From all the above we have that total incomes in regions *i* and *j* are:

$$E_i = w_i L_i + e_i \phi \frac{\beta_M E^W}{F\sigma}$$

$$E_j = w_j L_j + (1 - e_i) \phi \frac{\beta_M E^W}{F\sigma}$$

Equilibrium conditions

In each market the equilibrium condition is given by the equality between demand and supply, in particular we have:

- ***Agriculture***

$$\frac{\beta_A E^W}{pA} = LA_i + LA_j$$

When the agriculture sector is included we assume that both regions have a positive production of good A, meaning that both LA_i and LA_j are positive. This assumption is guaranteed if total spending on the agricultural good, namely $\beta_A E^W$, is greater than the maximum value of the agriculture production by either region, namely $pA(\max\{L_i, L_j\})$. This assumption guaranties that $w_i = w_j = w$.

- ***Non-traded goods***

$$\frac{\beta_{NT} E_i}{pNT_i} = LNT_i$$

$$\frac{\beta_{NT} E_j}{pNT_j} = LNT_j$$

- ***Local government budgets***

As stated above, the national government, which we do not model here explicitly, taxes all capital revenue, and redistributes it between the two regions, in a proportion e_i for region *i* and $(1 - e_i)$ for region *j*. From these transfers only a proportion (1-ϕ) goes to the local governments, which use these transfers to hire labour. Remembering that total operating profits are equal to $\beta_M E^W / F\sigma$, government budgets are in equilibrium when:

$$\frac{e_i(1-\phi)\beta_M E^W}{F\sigma} = LG_i w_i$$

$$\frac{(1-e_i)(1-\phi)\beta_M E^W}{F\sigma} = LG_j w_j$$

where LG_i and LG_j are the numbers of public employees in regions *i* and *j*.

- ***Manufactures***

The equilibrium condition for each manufacture variety produced in region *i* is given by:

$$x_i = \frac{\left(pT^i\right)^{-\sigma}}{\left(PM_i\right)^{1-\sigma}}\beta_M E_i + \frac{\tau\left(\tau pT^i\right)^{-\sigma}}{\left(PM_j\right)^{1-\sigma}}\beta_M E_j$$

where the first and second terms on the right hand side are, respectively, the total demand, including the quantity that melts in transit, by consumers of regions *i* and *j* of each variety produced in region *i*. A similar condition holds for region *j*:

$$x_j = \frac{\tau\left(\tau pT^j\right)^{-\sigma}}{\left(PM_i\right)^{1-\sigma}}\beta_M E_i + \frac{\left(pT^j\right)^{-\sigma}}{\left(PM_j\right)^{1-\sigma}}\beta_M E_j$$

In the two conditions above PM_i and PM_j are the manufactured price indices which are equal to:

$$PM_i = \left[n_i\left(pT^i\right)^{1-\sigma} + n_j\left(\tau pT^j\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

$$PM_j = \left[n_i\left(\tau pT^i\right)^{1-\sigma} + n_j\left(pT^j\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Choosing units such that *F=1*, the number of varieties n_i and n_j are equal to the stock of capital in each region K_i and K_j. If the country stock of capital is normalised to 1 we have $n_i=k_i$ and $n_j=(1-k_i)$, where k_i is the share of capital located in region *i*. Additionally, if $a = \frac{\sigma-1}{\sigma}$ the price indices reduce to:

$$PM_i = \left(k_i\left(w_i\right)^{1-\sigma} + (1-k_i)\left(\tau w_j\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

$$PM_j = \left(k_i \left(\tau w_i \right)^{1-\sigma} + \left(1 - k_i \right) \left(w_j \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Furthermore, in the case there is an agriculture sector such that wages equalise across regions, and using the wage rate as *numeraire* (w=1) we obtain:

$$PM_i = \left(k_i + \left(1 - k_i \right) \tau^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

$$PM_j = \left(k_i \tau^{1-\sigma} + \left(1 - k_i \right) \right)^{\frac{1}{1-\sigma}}$$

- ***Regional labour markets***

$$L_i = LA_i + LM_i + LNT_i + LG_i$$

$$L_j = LA_j + LM_j + LNT_j + LG_j$$

where labour demands by the manufacturing sectors are $LM_i = n_i a x_i$ and $LM_j = n_j a x_j$.

4.1 Transfers and the long run equilibrium

We now analyse the distribution of manufacture production as a response to changes in the distribution of transfers from the national government. We divide the analysis in two cases. Firstly, we consider an economy where all sectors are present. Secondly, we consider a model with no agricultural sector.

Case 1: a model with agriculture, manufactures, non-traded goods and local governments

The existence of the agricultural sector, together with the assumption of positive productions in both regions, namely that total spending on the agricultural good ($\beta_A E^W$) is greater than the maximum value of the agriculture production by either region ($pA(\max\{L_i,L_j\})$), means that wages are equalised across the two regions ($w_i = w_j = w$).

As pointed out before, operating profits are a proportion of total sales: $\pi_i = pT^i x_i / F\sigma$. If units are appropriately chosen such that: $a=(\sigma-1)/\sigma$, $F=1$, $K=1$, $L_i+L_j=1$, and the wage rate is the *numeraire* ($w=1$), for a given distribution of capital, operating profits reduce to:

$$\pi_i = \left[\frac{\delta_i}{k_i + (1-k_i)\tau^{1-\sigma}} + \frac{\tau^{1-\sigma}(1-\delta_i)}{k_i\tau^{1-\sigma} + (1-k_i)} \right] \frac{\beta_M E^W}{\sigma}$$

$$\pi_j = \left[\frac{\tau^{1-\sigma}\delta_i}{k_i + (1-k_i)\tau^{1-\sigma}} + \frac{(1-\delta_i)}{k_i\tau^{1-\sigma} + (1-k_i)} \right] \frac{\beta_M E^W}{\sigma}$$

where $\delta_i = s_{Li} \frac{\sigma - \beta_M \phi}{\sigma} + \phi e_1 \frac{\beta_M}{\sigma}$ is the share of region i in total income E^W, $s_{Li} = \frac{L_1}{L_1 + L_2}$ is the share of region i in total population, and total income is equal to $E^W = \frac{\sigma}{\sigma - \beta_M \phi}$.

If transfers from the national government are received only by the local governments ($\phi=0$), region i's share in total income becomes equal its participation in total population $(\delta_i = s_{Li})$, and total income reduces to $E^W=1$. Then we have:

$$\pi_i = \left[\frac{s_{Li}}{k_i + (1-k_i)\tau^{1-\sigma}} + \frac{\tau^{1-\sigma}(1-s_{Li})}{k_i\tau^{1-\sigma} + (1-k_i)} \right] \frac{\beta_M}{\sigma}$$

$$\pi_j = \left[\frac{\tau^{1-\sigma}s_{Li}}{k_i + (1-k_i)\tau^{1-\sigma}} + \frac{(1-s_{Li})}{k_i\tau^{1-\sigma} + (1-k_i)} \right] \frac{\beta_M}{\sigma}$$

$$\pi_i - \pi_j = \left[\frac{s_{Li}}{k_i + (1-k_i)\tau^{1-\sigma}} - \frac{(1-s_{Li})}{k_i\tau^{1-\sigma} + (1-k_i)} \right] (1-\tau^{1-\sigma}) \frac{\beta_M}{\sigma}$$

When $\phi=0$ we have from the equilibrium conditions that traded and no-traded markets are not affected, directly nor indirectly, by changes in how transfers are distributed between the two regions. In the case of the budget government conditions, changes in e_i allow the government which receives larger (lower) transfers to hire more (less) people. Then, to labour markets to clear the region where public employment increases (decreases) the number of people employed in the agricultural sectors

must fall (rise). Employment levels in the non-traded sectors and in manufactures remain unchanged.

As we can observe, when ϕ=0 operating profits do not depend, directly nor indirectly, on how the national government distribute the transfers between the two regions: $\frac{\partial \pi_i}{\partial e_i} = \frac{\partial \pi_j}{\partial e_i} = 0$.

Moreover, the distribution of capital in the log run, that is the one for which π_i - π_j = 0 depends only on the distribution of population. Solving for k_i we get:

$$k_i \begin{cases} = 0 & \text{if } s_{Li} \le \dfrac{\tau^{1-\sigma}}{1+\tau^{1-\sigma}} \\ = \dfrac{s_{Li}\left(1+\tau^{1-\sigma}\right)-\tau^{1-\sigma}}{1-\tau^{1-\sigma}} & \text{if } \dfrac{\tau^{1-\sigma}}{1+\tau^{1-\sigma}} < s_{Li} < \dfrac{1}{1+\tau^{1-\sigma}} \\ = 1 & \text{if } s_{Li} \ge \dfrac{1}{1+\tau^{1-\sigma}} \end{cases}$$

Thus, for a non core-periphery equilibrium we have k_i is an increasing function of s_{Li}, the share of region i in the population, with $\frac{\partial k_i}{\partial s_{Li}} = \frac{1+\tau^{1-\sigma}}{1-\tau^{1-\sigma}} > 1$.

As Figure 8 shows, if regions are symmetric, when s_{Li}=1/2, the optimum distribution of capital is also symmetric: k_i=1/2.

A different scenario emerges when $\phi > 0$. From the expressions for π_i and π_j, changes in the way transfers are distributed, namely changes in e_i, affect π_i and π_j through changes in δ_i. Remembering that $\delta_i = s_{Li}\frac{\sigma-\beta_M\phi}{\sigma} + \phi e_1 \frac{\beta_M}{\sigma}$, and increase in e_i increases δ_i. Then, if we were in a long run equilibrium situation, as e_i changes the economy moves out of the equilibrium such that it is necessary a different distribution of the capital stock to re-establish the equilibrium. The direction of the change in k_i required to achieve a new long run equilibrium depends on how π_i and π_j reacts to changes in δ_i and k_i.

From the equilibrium conditions for the non-traded goods and the local government budgets[22] it can be show that $\frac{\partial LNT_i}{\partial e_i} > 0$, $\frac{\partial LG_i}{\partial e_i} > 0$, $\frac{\partial LNT_j}{\partial e_i} < 0$ and $\frac{\partial LG_j}{\partial e_i} < 0$, such that an increase in the transfers received by region *i* increases employment in the public and the non-traded sectors.

Subtracting π_j from π_i we have:

$$\pi_i - \pi_j = \left[\frac{\delta_i}{k_i + (1-k_i)\tau^{1-\sigma}} - \frac{(1-\delta_i)}{k_i \tau^{1-\sigma} + (1-k_i)} \right] (1-\tau^{1-\sigma}) \frac{\beta_M E^W}{\sigma}$$

Then, for the long run $(\pi_i - \pi_j = 0)$ we can derive the expression for k_i as a function of the parameters of the model:

$$k_i \begin{cases} = 0 & \text{if} \quad \delta_i \le \dfrac{\tau^{1-\sigma}}{1+\tau^{1-\sigma}} \\ = \dfrac{\delta_i (1+\tau^{1-\sigma}) - \tau^{1-\sigma}}{1-\tau^{1-\sigma}} & \text{if} \quad \dfrac{\tau^{1-\sigma}}{1+\tau^{1-\sigma}} < \delta_i < \dfrac{1}{1+\tau^{1-\sigma}} \\ = 1 & \text{if} \quad \delta_i \ge \dfrac{1}{1+\tau^{1-\sigma}} \end{cases}$$

Thus, for a non core-periphery equilibrium we have k_i is an increasing function of e_i (trough change in δ_i), the share of transfers received by region *i* (see Figure 9), with $\frac{\partial k_i}{\partial e_i} = \frac{\phi \beta_M}{\sigma} \frac{1+\tau^{1-\sigma}}{1-\tau^{1-\sigma}} > 0$.

Additionally, the rate at which k_i changes increases with ϕ, the share of transfers that goes directly to consumers (see Figure 10). The reason for this outcome is that as ϕ increases, the larger is $\partial \delta_i / \partial e_i$, such that for a given distribution of *K*, a given change in e_i produces a larger change in $\pi_i - \pi_j$, so the change in k_i required to achieve a new long run equilibrium, namely $\pi_i = \pi_j$, is also larger.

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[22] $\beta_{NT}\left(s_{Li} + \phi e_i \frac{\beta_M}{\sigma - \beta_M \phi}\right) = LNT_i$; $\beta_{NT}\left((1-s_{Li}) + \phi(1-e_i)\frac{\beta_M}{\sigma - \beta_M \phi}\right) = LNT_j$; $\frac{e_i(1-\phi)\beta_M}{\sigma - \beta_M \phi} = LG_i$ and $\frac{(1-e_i)(1-\phi)\beta_M}{\sigma - \beta_M \phi} = LG_j$.

Finally, $\frac{dk_i}{de_i} > 0$ means $\frac{dLT_i}{de_i} > 0$ and $\frac{dLT_j}{de_i} < 0$[23], such that together with $\frac{\partial LNT_i}{\partial e_i} > 0$, $\frac{\partial LG_i}{\partial e_i} > 0$, $\frac{\partial LNT_j}{\partial e_i} < 0$ and $\frac{\partial LG_j}{\partial e_i} < 0$, we need $\frac{dLA_i}{de_i} < 0$ and $\frac{dLA_j}{de_i} > 0$ in order to labour markets to clear in each region.

The reason for these different outcomes, depending on $\phi = 0$ or $\phi > 0$, is explained because in the first case, independently of how the national government distributes transfers between the two regions, total incomes in each region remain constant. This means that there is no incentive for firms to change location and move from the region transfers are taken away to the region which receives larger transfers. On the other hand, when $\phi > 0$ regions' income shares are a positive function of the proportion of transfers received. Then, as e_i increases region *i*'s market increases relative to the one of region *j*, such that operating profits increase in region *i* and decrease in region *j*. In response to this, firms find profitable to move from region *j* to region *i*. As firms move from region *i* to region *j*, operating profits falls in region *i* and increase in region *j*, this continues until operating profits equalise once again in both regions.

Case 2: a model without agricultural sector

The existence of a positive production in both regions by the agricultural sector guaranties that $w_i = w_j = w$. As we saw above this feature simplifies greatly the model, but at the cost of having a positive and monotonic relationship between the distributions of manufactures and fiscal transfers across regions. This is not necessarily the case when the agricultural sector is excluded, such that only in some very special occasions, the completely symmetric case, wage rates in both regions will be identical.

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[23] Le us remember that the scale of production is a positive function of operating profits and that $\frac{\partial \pi_i}{\partial e_i} > 0$ and $\frac{\partial \pi_j}{\partial e_i} < 0$.

Using the same normalisations as above, namely $F=1$, $K=1$, $L_i+L_j=1$, $a=(\sigma-1)/\sigma$, and choosing the wage rate in region i as *numeraire* ($w_i=1$), operating profits reduce to:

$$\pi_i = \left[\frac{\delta_i}{k_i + (1-k_i)(\tau w_j)^{1-\sigma}} + \frac{\tau^{1-\sigma}(1-\delta_i)}{k_i \tau^{1-\sigma} + (1-k_i)(w_j)^{1-\sigma}} \right] \frac{\beta_M E^W}{\sigma}$$

$$\pi_j = (w_j)^{1-\sigma} \left[\frac{\tau^{1-\sigma}\delta_i}{k_i + (1-k_i)(\tau w_j)^{1-\sigma}} + \frac{(1-\delta_i)}{k_i \tau^{1-\sigma} + (1-k_i)(w_j)^{1-\sigma}} \right] \frac{\beta_M E^W}{\sigma}$$

where $\delta_i = \frac{s_{Li}(\sigma - \beta_M \phi)}{(s_{Li} + (1-s_{Li})w_j)\sigma} + \frac{e_i \beta_M \phi}{\sigma}$ is the share of region i in total income E^W, $s_{Li} = \frac{L_1}{L_1 + L_2}$ is the share of region i in total population, and total income is equal to $E^W = (s_{Li} + (1-s_{Li})w_j)\frac{\sigma}{\sigma - \beta_M \phi}$.

Now changes in the way transfers are distributed between the two regions will have an effect on wage rates affecting also capital rewards. On the other hand, the distribution of capital affects the equilibrium wage rates. This feature of the model introduces as it happens in Krugman's Core-Periphery model a circularity which makes not possible to achieve closed form solutions.[24] Because of this new feature of the model, the analysis in this section is based solely on numerical simulations.

The behaviour of the model when the agricultural sector is excluded depends on the values taken by four parameters. Two of these parameters depend on consumers' preferences, the distribution of expenditure between manufactures and the non-traded good (β_M), and the elasticity of substitution (σ). The other two parameters are to some extent policy choices; one is the share of transfers that go directly to consumers (ϕ), while the other is transaction costs (τ) which can be affected by the public sector (i.e. through infrastructure investment).

[24] In Krugman (1991) model the circularity arises because consumers migrate in response to differences in real wages. The FCM of Martin and Rogers (1995) breaks this circularity because even when capital is mobile, the distribution across regions of operative profits is constant.

As shown in Figure 11, the simulations show that in the four cases, the larger the value these parameters take, the more likely an increase in the share of transfers received by a region would result in an increase in its share of manufacturing firms. The intuition behind these results is very straightforward. The first result that emerges for the different parameter configurations in the simulations reported in Figure 11 is that as the share of transfers region *i* (e_i) receives increases, the larger its participation in the country income given by the parameter δ_i. Then, how this extra income is expended will have different effects on the location of manufacturing production. Let us now look at the intuition behind each of the four different cases:

a. A larger elasticity of substitution means that consumers care less about the number of manufactures varieties so they tend to consume more of domestically produced varieties in order to save on transportation costs. So, as the share of transfers (e_i) region *i* receives increases, the extra income is mostly expended in locally produced varieties, increasing the rate of return of local firms and attracting those located elsewhere.

b. The intuition is relatively similar in the case of β_M, the share of income expended in manufactures instead of the non-trade good. In this case, the larger β_M is, the larger is the share of income coming from transfers that is expended in manufacturing goods than in the non-traded good. Once again, the increasing demand for manufactures in the region which is benefited from the increase in transfers raises the return to capital attracting firms from the other region.

c. With respect to the first of the policy choice parameters, transactions costs (τ), the larger these are the more consumers tend to consume domestically produced varieties in order to save on transaction costs. So, as a region income increases because of the increase in transfers it receives, the larger demand for varieties produced locally increases profits of local firms attracting those located in the other region.

d. Finally, we have the case of the ϕ parameter, the share of transfers going directly to consumers instead of local governments. In one extreme, when ϕ is equal to zero, transfers from the Federal

government increases the consumption of manufactures only indirectly, trough the wages paid by the local government with the transfers it receives. However, as ϕ becomes positive, part of these transfers, those received directly by consumers, go directly to the consumption of manufactures, as well as also indirectly whilst $\phi < 1$, such that the demand effect is larger in this second case, making more profitable to firms to relocate to the region which benefits from higher transfers.

5. Summary and Conclusions

At the international level there is still an open debate on the role of transfers on economic growth and development. From the theoretical discussion about the *transfer paradox* to the empirical evidence, it appears to be no conclusive answer. At the sub-national level, the evidence is scarcer, with most of the analysis focusing on the political economy of transfers than on their economic impact, in particular in the regional shaping of production. The causal evidence presented in section 3 shows that, a priori, there not exist a clear correlation between transfers and location of footloose activities. This presumption is confirmed using a relatively simple model inspired on the New Economic Geography. As it is shown in section 4, the final outcome depends on factors that are out of control of the public sector, i.e. consumer preferences, as well as other variables over which governments can influence on, such as to whom transfers are directed to and transaction costs. Thus, here also it becomes an empirical matter what relationship, if any, there exists between unconditional vertical transfers and the location of footloose activities.

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Table 1. Data description and sources

Country	Variable	Description	Source	Period
Argentina	Transfers	Automatic transfers per capita ("Coparticipación")	Departamento de Economía, Universidad Nacional de La Plata	1962-2001
	GDP	Regional Gross Domestic Product per capita		
Australia	Transfers	Current grants and subsidies per capita to Australian Regions	Australian Bureau of Statistics	2000-2010
	GDP	Total manufacturing income per capita		
Brazil	Transfers	Automatic transfers per capita ("Fundo de participacao dos estados FPE")	Ministério de Fazenda – COPEM	1995-2009
	GDP	Gross value added of manufacturing sector at basic prices	Instituto Brasileiro de Geografía e Estatística	
Canada	Transfers	Federal cash transfers per capita Canadian regions	Department of Finance Canada	1997-2008
	GDP	Manufacturing gross domestic product per capita	Statistics Canada	
Mexico	Transfers	Automatic transfers per capita ("Participaciones Federales")	Instituto Nacional de Estadística y Geografía (INEGI)	1994-2010
	GDP	Manufacturing Gross Domestic Product per capita		
Spain	Transfers	Shared taxes per capita ("Tributos cedidos")	Dirección General de Coordinación Financiera con las CCAA y las EELL	1995-2009
	GDP	Manufacturing Gross Domestic Product per capita	Instituto Nacional de Estadísticas	

Figure 1. Regional transfers and total GDP, 1962 and 2001: Argentina

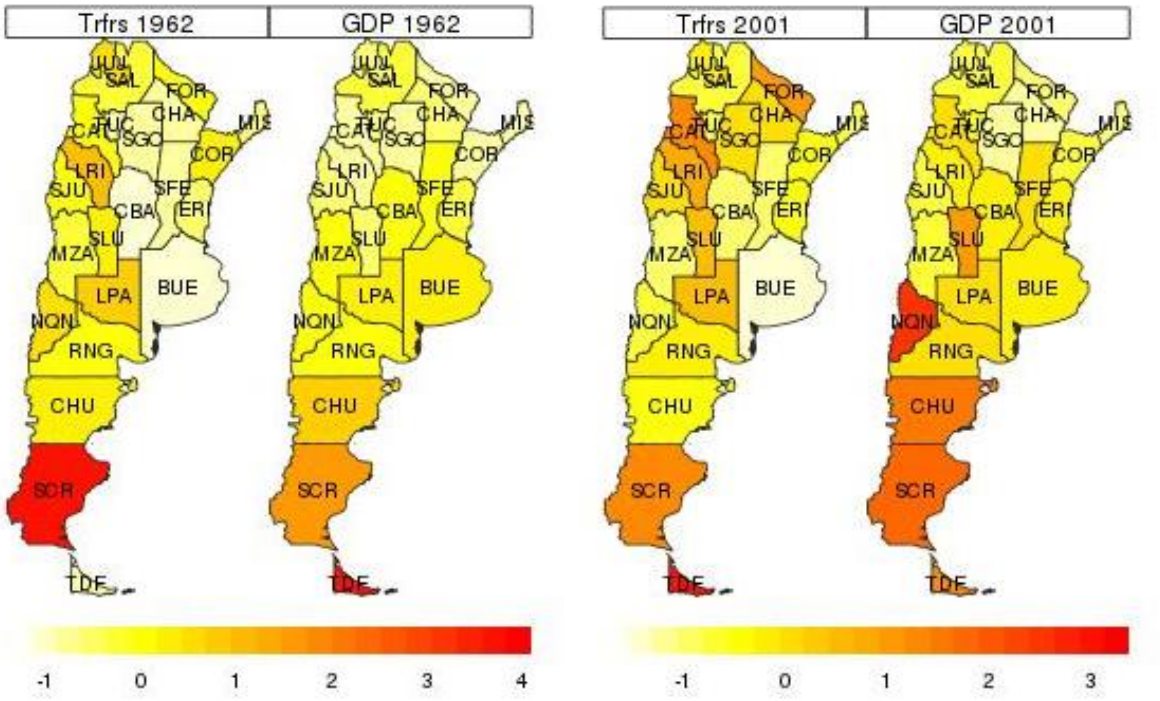


Figure 2. Regional transfers and industry GDP, 1994 and 2010: Mexico

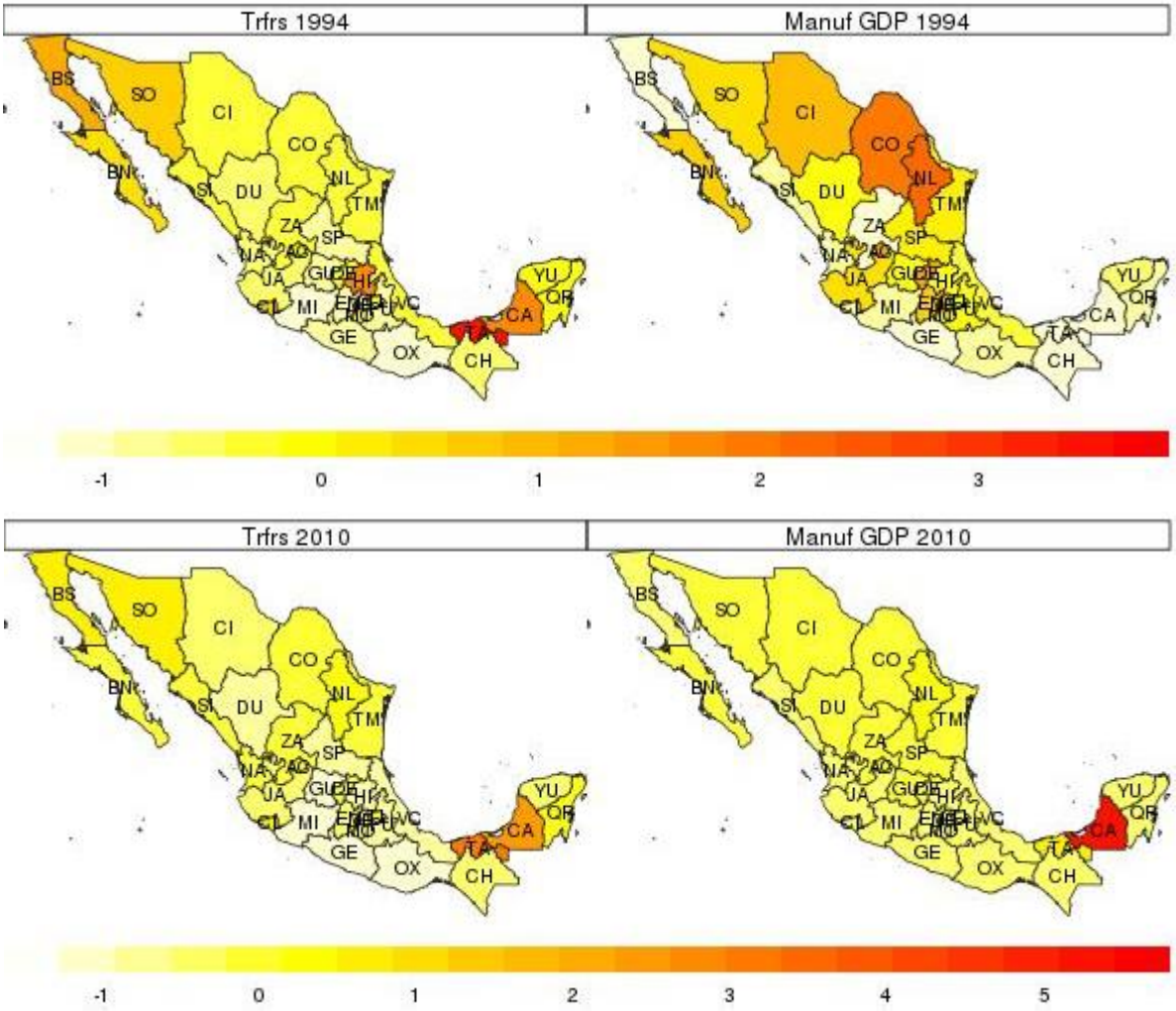


Figure 3. Regional transfers and industry GDP, 1995 and 2009: Brazil

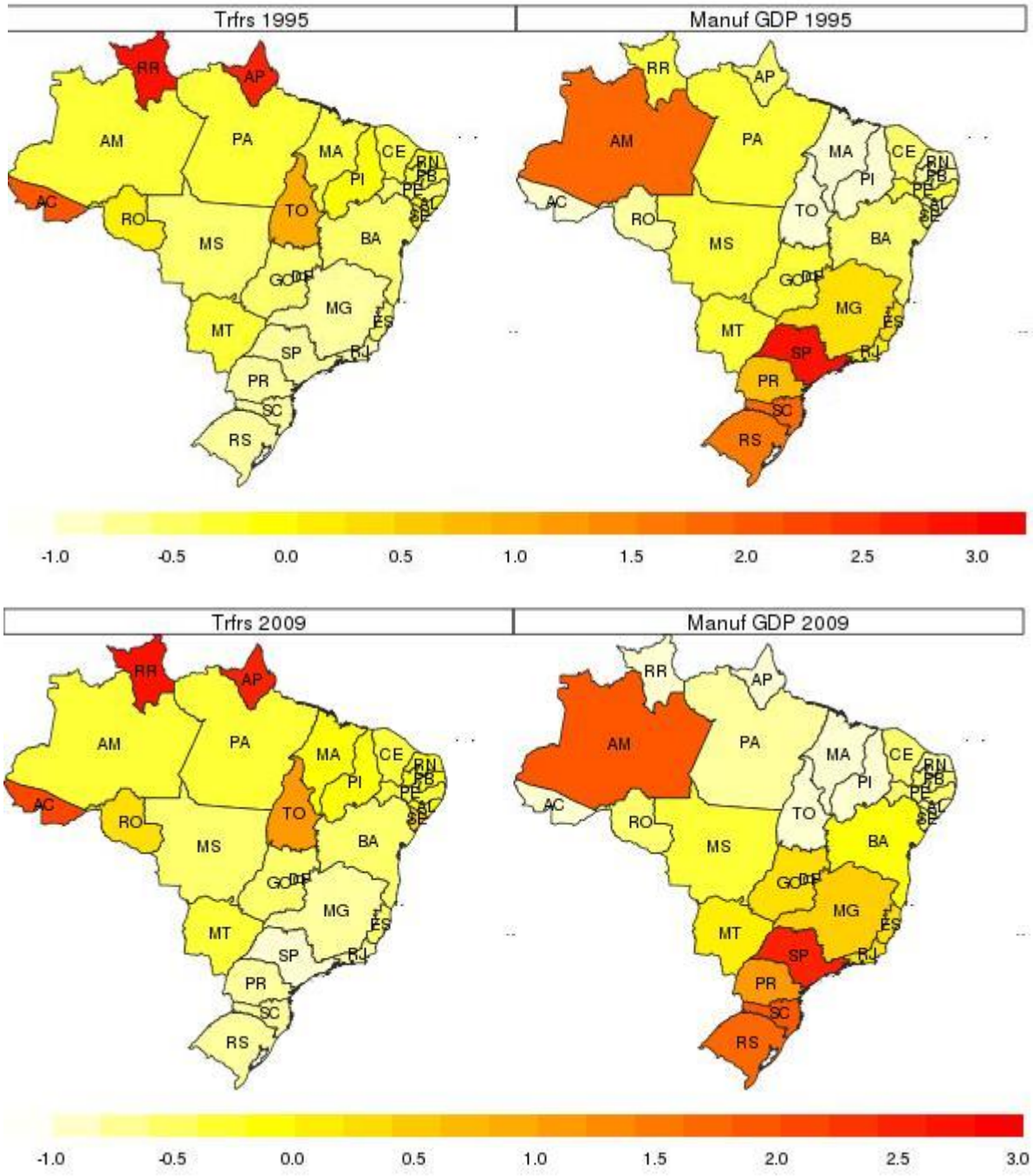
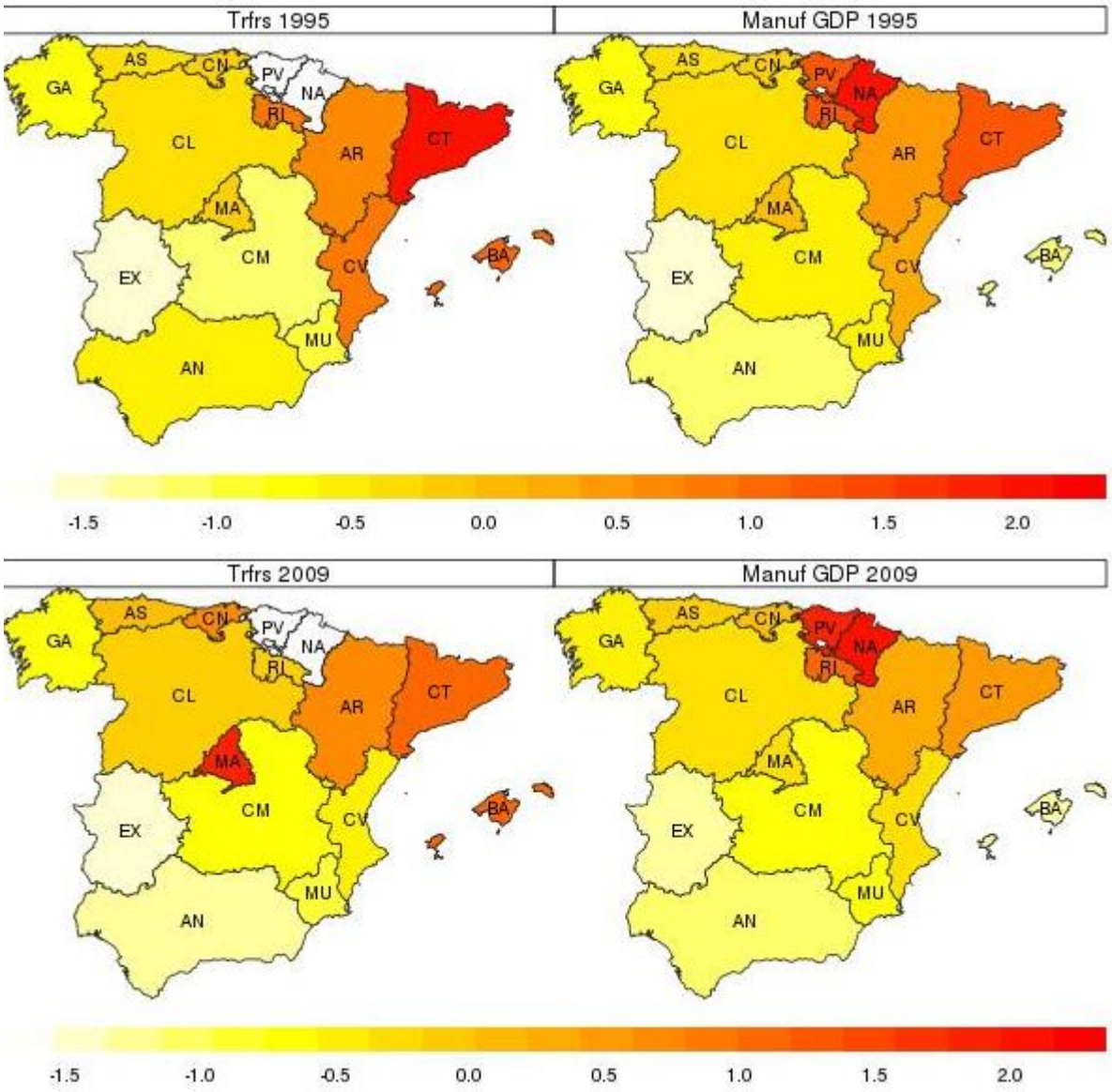


Figure 4. Regional transfers and industry GDP, 1995 and 2009: Spain



Note: transfers data for Navarra (NA) and País Vasco (PV) are not available

Figure 5. Regional transfers and industry GDP, 2000 and 2010: Australia

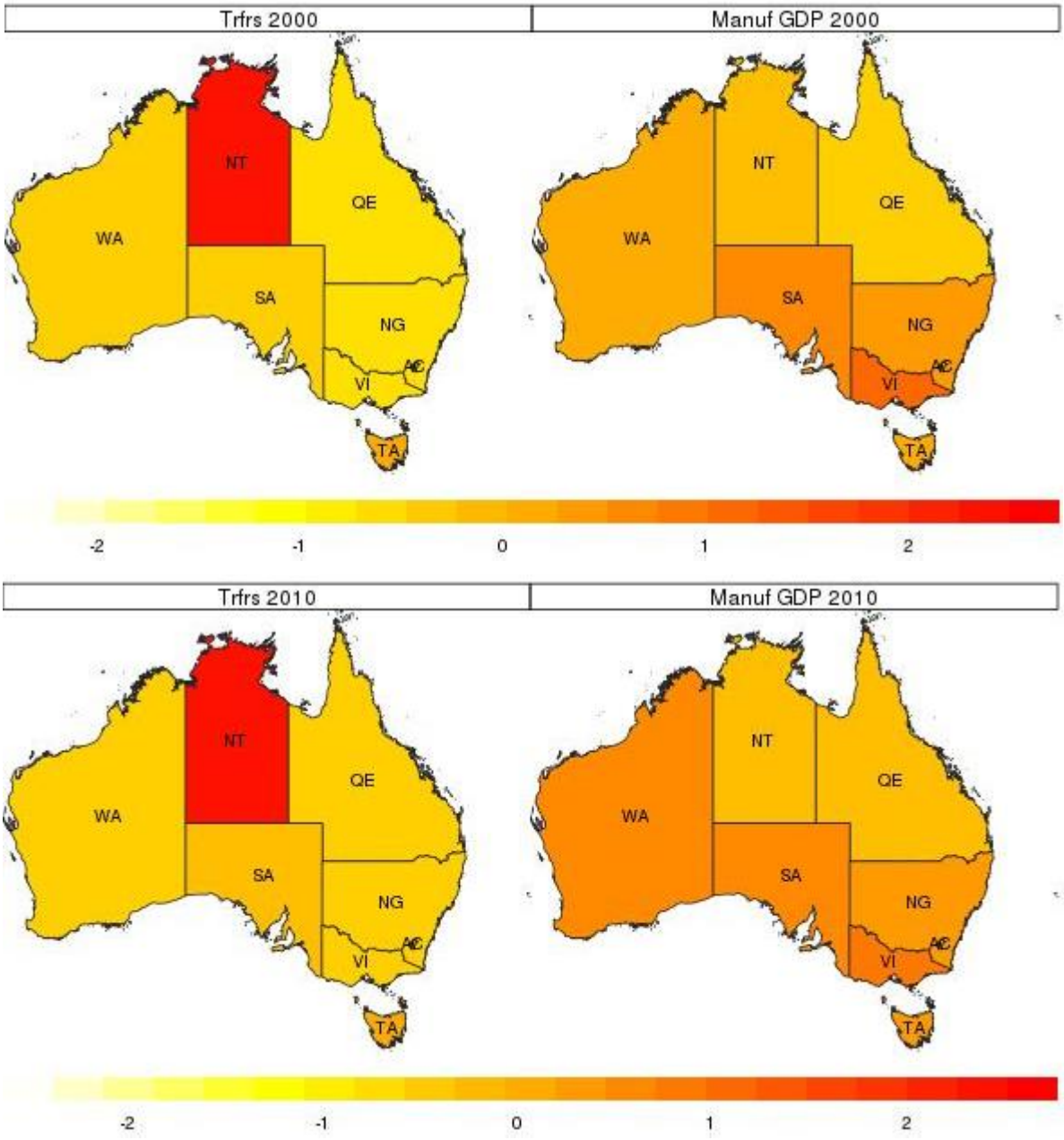


Figure 6. Regional transfers and industry GDP, 1999 and 2008: Canada

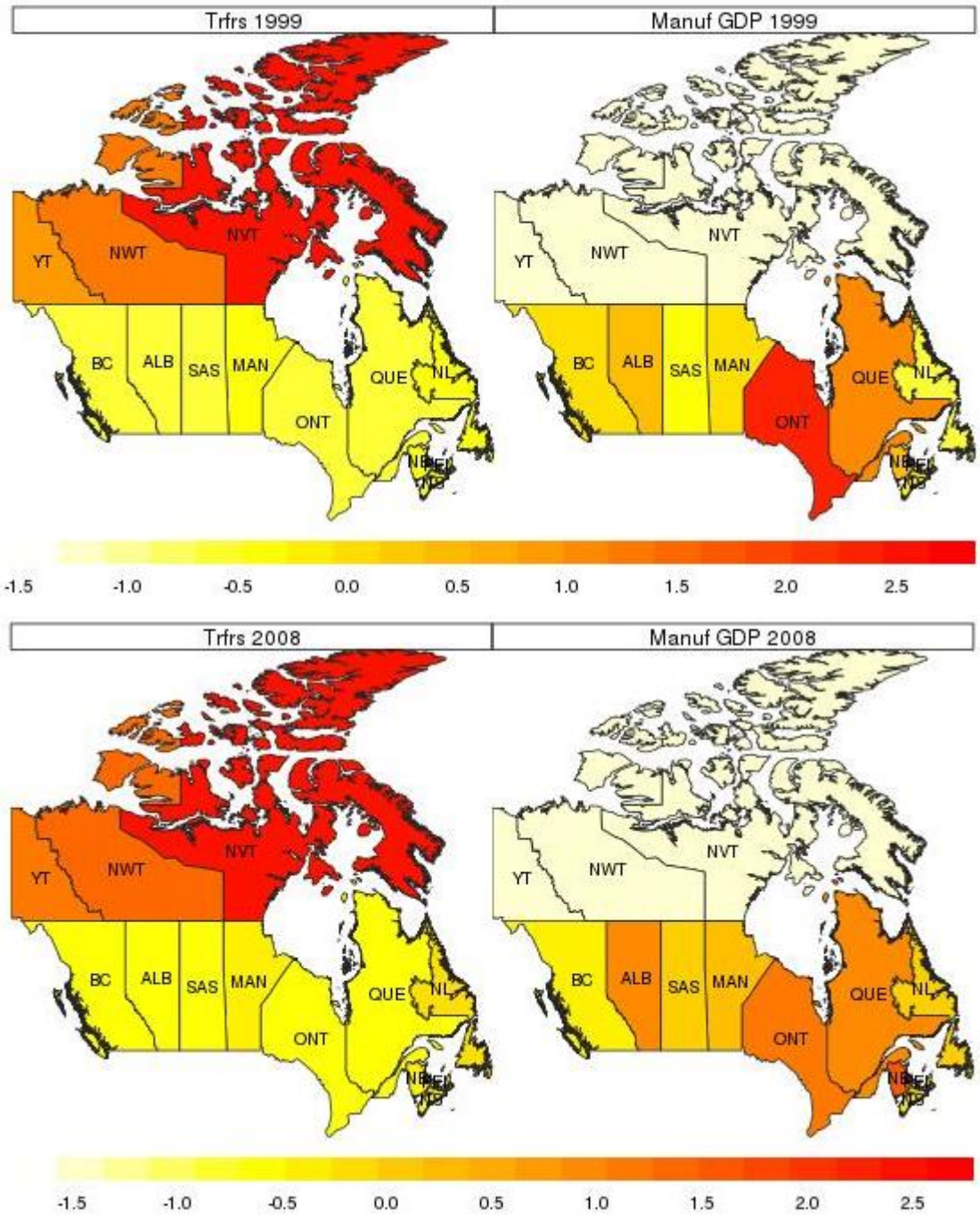


Table 2. β-convergence (cross-section)

$$\Delta GDPpc_{i,(t,t0)} = \alpha + \beta \ln\left(GDPpc_{i,t0}\right) + \gamma \Delta TRpc_{i,(t,t0)} + e_{i,t}$$

	ARG	**AUS**	**BRA**	**CAN**	**MEX**	**SPA**
β	-0.0073**	0.0189**	-0.0161**	-0.0186**	-1.0027	-0.0039
	(0.003)	(0.005)	(0.006)	(0.008)	(0.809)	(0.008)
γ	-0.0013	-0.8210*	1.8392*	0.3134	-5.5070	0.0438
	(0.060)	(0.342)	(1.021)	(0.501)	(13.334)	(0.128)
Observations	23	8	27	13	32	14
R-squared	0.128	0.626	0.348	0.428	0.120	0.082
Period	1962-2001	2000-2010	1995-2009	1999-2008	1994-2010	1995-2009

The dependent variable is the average of annual growth rates of regional (provincial) manufacturing GDP per capita for all cases but for Argentina. All monetary values were at 2001 constant prices. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. β-convergence (panel-data)

$$\Delta GDPpc_{i,(t,t-1)} = \alpha + \beta \ln\left(GDPpc_{i,t-1}\right) + \gamma \Delta TRpc_{i,(t,t-1)} + \delta_t + \eta_i + e_{i,t}$$

	ARG	**AUS**	**BRA**	**CAN**	**MEX**	**SPA**
β	-3.7e-06**	-9.4e-05*	-2.8e-04***	-1.1e-06	-4.6e-05***	-1.8e-05*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
γ	0.0167**	0.0910	2.3414**	0.1064*	4.0508	-0.0003
	(0.008)	(0.430)	(1.087)	(0.060)	(4.572)	(0.005)
Observations	895	80	378	117	512	196
R-squared	0.249	0.441	0.186	0.329	0.100	0.871
N° Cross-sections	23	8	27	13	32	14
Period	1962-2001	2000-2010	1995-2009	1999-2008	1994-2010	1995-2009

All regression include time and cross-section fixed effects. The dependent variable is the annual growth rates of regional (provincial) manufacturing GDP per capita for all cases but for Argentina. All monetary values were at 2001 constant prices. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 8

Region *i*'s share in manufacturing firms and the distribution of transfers

(***L_i=L_j=0.5, τ=1.05; σ=10, β_M=0.25, β_A=0.55, β_{NT}=0.2, ϕ=0, w=1***)

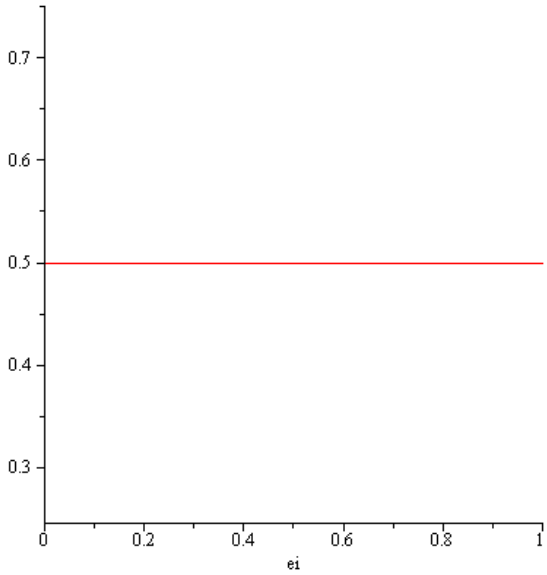


Figure 9

Region *i*'s shares in manufacturing firms and the distribution of transfers

(L_i=L_j=0.5, τ=1.05; σ=10, β_M=0.25, β_A=0.55, β_{NT}=0.20, w=1)

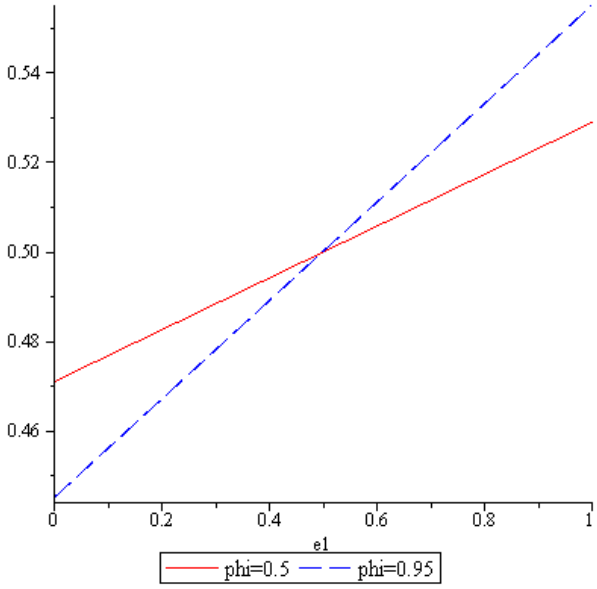


Figure 10

Rate of capital relocation and distribution of transfers between consumers and local governments (ϕ)

(L_i=L_j=0.5, τ=1.05; σ=10, β_M=0.25, β_A=0.55, β_{NT}=0.2, w=1)

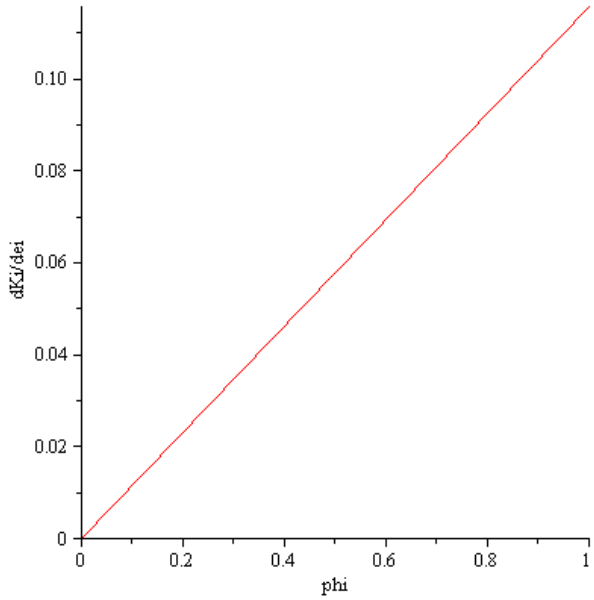
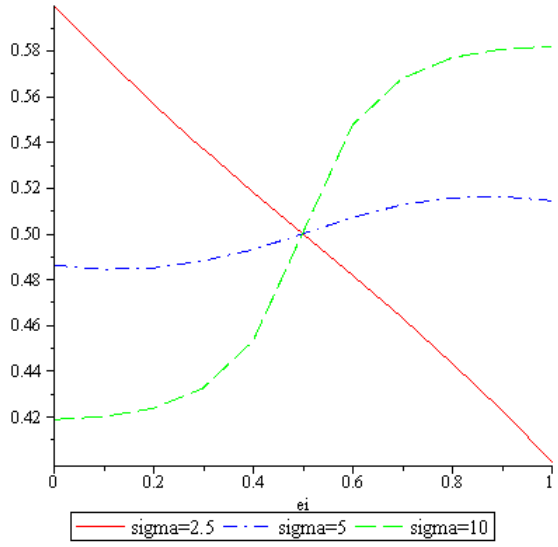


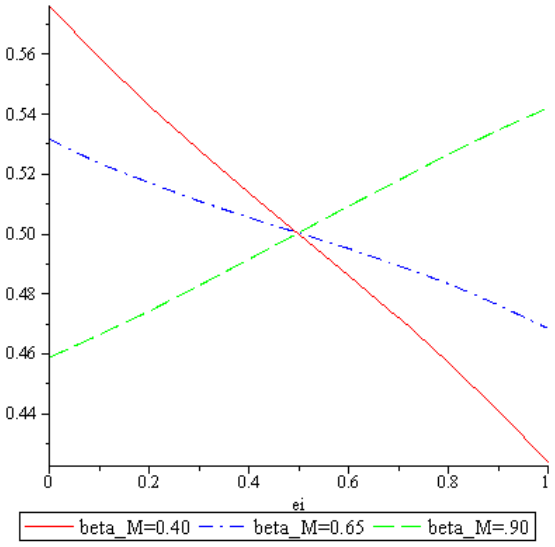
Figure 11

Share of Region *i* in the number of manufacturing firms

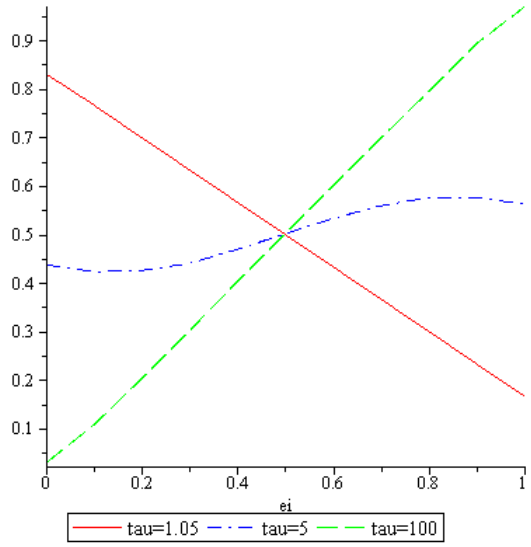
(β_M=0.8; L_i=L_j=0.5; K=1; τ=2; ϕ=0.5; w_i=1)



(σ=2.5; L_i=L_j=0.5; K=1; τ=2; ϕ=0.95; w_i=1)



(β_M=0.8; L_i=L_j=0.5; K=1; ϕ=0; σ=2.5; w_i=1)



(β_M=0.8; L_i=L_j=0.5; K=1; τ=2; σ=5; w_i=1)