Spatial Interaction Regional Model for the Mexican Economy (SIRMME): a special case for Mexico City metropolitan area

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1. Introduction

This paper is implementing for the economy of Mexico City, a strategy of modeling regional growth through a methodology that stresses top-down and bottom-up approaches. This type of strategy has been discussed in recent years (Capello, 2007) and it offers an interesting avenue to study the economic interaction between regions and their national or macro-regional counterpart economy. Even though these new approaches have been empirically implemented for the European region, they are practically absent in the empirical research of regional growth into the main Latin-American economies (such as Brazil or Mexico). This paper contributes to overcome, at least for the Mexican case, this lack of top-down vs bottom-up methodological strategies by studying the regional dynamics of Mexico City, which is the second biggest city in the world and whose GDP represents 25% of Mexico's GDP.

The rest of the paper contains five more sections. In section 2 is discussed briefly the regional modeling strategies than can be found in the literature; in section 3, we estimate a macro-national model that explains the role of each component of the aggregate demand on the Mexican economy growth during the period 1993-2007; in section 4, we propose a regional model that explains the

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differential growth between Mexico City economy and the whole country's economy (2000-2005) through a spatial interaction model among the municipalities of Mexico City; in section 5, we present a simulation exercise that evaluates spillover effects of "human capital" on the differential growth among the micro/regions of Mexico City; and finally, we conclude with some remarks in section 6.

2. Theoretical Background

Regional modeling, as a technique for structural analysis, policy impact assessment and forecasting, has wide range of approaches; among them we can list the following: Economic base models, input-output models, social accounting matrix models, Econometric models, Econometric and Input-Output Integrated models (Ec IO), Computable General Equilibrium models (Loveridge, 2004). In this paper we restrict ourselves to the use of econometric models and their spatial version.

Regional econometric models have their antecedents in the pioneering work that, in the case of the United States, was leaded in the sixties and seventies by Bell (1967), Klein (1969), Glickman (1971), and Adams, Brooking and Glickmans (1975), among many others. The econometric methodology employed in these early works estimated the relations between variables mainly from a Keynesian perspective, with the use of annual data. The specification of regional models was performed through a replica of the functional structure of national models, thus considering the region as a "small country".

These models used a methodology called Top-Down, under which the regional model was a kind of satellite to a nation wide model, which was able to specify endogenous regional equations through the use of variables at the national level. Top-Down methodology was limited, to the extent that a regional economy receives shocks from the whole country, but there is no feedback process from regional economies to the national economy. Values of the national variables were simply distributed through the regions.

Over the years, the Top-Down methodology has been modified, allowing some sort of endogenization from national impacts; such is the case of models in which regional equations are specified using a decomposition of impacts. In this decomposition the regional growth of a variable in a specific sector is constructed from the sectoral growth and a spreading that represents the growth attributable to regional characteristics (Bassiliere et.al. 2008), which can be represented as:

$$y_{ij,t} = s_{ij,t} + r_{ij,t} \qquad (1)$$

where $s_{ij,t} = \bar{y}_{ij,t}$ is the growth of the variable in the sector i of region j in period t, $\bar{y}_{i,t}$ is the national growth of sector i at time t, and $r_{ij,t}$ is the regional growth of the variable in the region j in sector i, in period t. The regional difference can be expressed as follows:[1]

$$r_{ij,t} = y_{ij,t} - \bar{y}_{i,t} \qquad (2)$$

Endogenization of regional growth is achieved by specifying an econometric equation to explain the regional difference $r_{ij,t}$ (see section III), while the national share is determined exogenously in a nation wide model (see section II).

Although Top-Down models can not account for regional effects, were very popular to the extent that they have the advantage of requiring little data and being able to flexibly model individual regions (Clifford, 1982). This last aspect is very relevant when one considers that the lack of regional data is a reality in many countries, especially in developing countries. The lack of information limits the scope for disaggregation of the model, and usually leads to the use of regional

[1] To separate national and regional effects, one can use a Shift and Share analysis of this variable, as Bassiliere et.al. (2008) suggest. Here we follow Capello (2007) who uses the difference of national and regional growth rates: $s = \Delta Y_N - \Delta Y_r$.

variables constructed by the model´s author, a situation which necessarily implies a trade-off between disaggregation and data quality (Gustely and Ireland, 1980).

Bottom-up models assume that the national aggregate are an average of the regions (Capellini, et.al., 1987) These models have the advantage of allowing endogenous estimates for regional variables, which in another kind of modeling would have to be exogenous, and it ensures consistency between regional and national variables. In addition, it allows interaction between regions. The bottom-up models are considered to be more consistent with the modern approach of regional growth seen as competitive, bottom-up, endogenous and cumulative process (Capello, 2007).

A breakthrough in the construction of regional models is achieved by building hybrid models that combine a top-down approach with bottom-up one, the result being more realistic models (Bolton, 1980; Glickman, 1982; Courbis, 1994).

Whether or not the best approach is Top-Down or Bottom-Up modeling, two problems in the regional models exist. First, the difficulties of highlighting inter-regional exchanges, which are difficult to take into account due to information gaps, given the notable lack of regional and multiregional I-O matrices , and the lack of regional exports and imports statistics (Lemelin, 1980). Second, the problems to incorporate spatial spillover effects on growth, that necessarily happen when there are agglomeration economies of some sort. The concentration of economic activity in space, considered by Krugman (1991), as the most prominent feature of the regional distribution of economic activity, necessarily leads to highlight the effects of spatial spillovers and the externalities involved in these processes.

In the specification and estimation of regional models, one can find an innovation in recent years, that consists in incorporating spatial effects to modeling either spatial dependence or spatial spillovers of the localization process of economic activity. Spatial Econometrics allows working with spatial dependence through uniequational models and more recently, through multi equation models (Rey and Boarnet, 2004). A variant of these models is the one proposed by Capello (2007), and is used in this work, which allows for a multi equation model estimate, which combines both national and regional macroeconomic variables. The macro equations are estimated in the standard way, while regional equations incorporate spatial effects. The link between the equations is obtained from a simulation algorithm that allows the regional dynamics to play an active role in explaining the national dynamic.

The result of these recent efforts, and upon which the model proposed in this papers is based, is a combination of Top-Down and Bottom-Up approaches, multi equation systems using a mix of spatial and non-spatial specifications in the behavioral equations, and the use of a simulation algorithm to link the regions considered in the model with the national economy.

2. The Macro-National Model

The macroeconomic model advanced in this section runs along the lines of Roberta Capello (2007)'s regional model, where the economic growth in a country is explained in a "keynesian fashion" by components of the aggregate demand (private consumption, private and public investment, exports and imports of goods and services). Likewise, these demand components make an endogenous system which is itself determined by economic policy instruments (interest rate, exchange rate and government spending) and economic policy targets (inflation and unemployment).

In addition to the elements proposed by Capello (2007) to build up the macro model, we consider specific structural conditions of Mexican economy in particular those emerged from the North American Free Trade Agreement (NAFTA) where Canada, USA and Mexico are the country members. One of these structural conditions is the new role of the public sphere in the economy which was drastically modified since the government of Salinas de Gortari (Mendoza, M.A., 2000); in particular, the share of public investment in GDP decline from 10.4% in 1981 to 4.6% in 1988 and around 3.5% nowadays. For this reason, the Mexico´s macroeconomics model proposed in this paper considers private and public investment (consumption) in a separate way in order to evaluate the economic public instruments on growth.

Since NAFTA, the external sector of the Mexican economy has increased drastically its contribution to GDP: exports plus imports represented 35% of GDP in 1993, now they represent 95% of GDP. Even though Mexican economy benefited at the beginning from NAFTA, the positive effects vanished quickly because it was not possible to overcome the huge dependence that the Mexican economy has historically had on capital goods and raw materials imports. Therefore, NAFTA provoked a strong dependence of Mexican exports on USA economic cycle (Garcés, D., 2008; Gutiérrez *et al*., 2005). For that reason, we decide to include the USA GDP in the export equation in the macro model and, if we consider more standard models, we also modify the impact of foreign direct investment and its relationship with imports (see below).

In resume, in this macroeconomic model prevails a Keynesian approach that has been used elsewhere to study the Mexican economy (Castro, Loría y Mendoza, 1997; Urzúa, Esquivel, Lagunes y de la Cruz, 2000; Ruiz y Venegas, 2007), in where the economic growth is explained by different income effects on components of aggregate demand and the multiplier effect due to an expansionary fiscal policy. In addition, our model takes into account the strong dependence of the Mexican economy on USA economy.

National Growth Rate

The national growth rate is determined by a “pseudo” identity equation which is built up from national accounts: national income plus goods and services imports (Y+M) is equal to the sum of private consumption, private investment, government consumption and investment, and exports of goods and services (*Cp+Ip+Cg+Ig+X*).

After applying the total differentiation method to the accounting identity and doing some algebraic manipulations, we get the following expressions:

$$Y = Cp + Ip + Cg + Ig + X - M$$

$$\Delta Y = \frac{\partial Y}{\partial Cp}\Delta Cp + \frac{\partial Y}{\partial Ip}\Delta Ip + \frac{\partial Y}{\partial Cg}\Delta Cg + \frac{\partial Y}{\partial Ig}\Delta Ig + \frac{\partial Y}{\partial X}\Delta X - \frac{\partial Y}{\partial M}\Delta M$$

$$\frac{\Delta Y}{Y} = \frac{\partial Y}{\partial Cp}\frac{Cp}{Y}\frac{\Delta Cp}{Cp} + \frac{\partial Y}{\partial Ip}\frac{Ip}{Y}\frac{\Delta Ip}{Ip} + \frac{\partial Y}{\partial Cg}\frac{Cg}{Y}\frac{\Delta Cg}{Cg} + \frac{\partial Y}{\partial Ig}\frac{Ig}{Y}\frac{\Delta Ig}{Ig} + \frac{\partial Y}{\partial X}\frac{X}{Y}\frac{\Delta X}{X} - \frac{\partial Y}{\partial M}\frac{M}{Y}\frac{\Delta M}{M}$$

$$\frac{\Delta Y}{Y} = \eta_{YCp}\frac{\Delta Cp}{Cp} + \eta_{YIp}\frac{\Delta Ip}{Ip} + \eta_{YCg}\frac{\Delta Cg}{Cg} + \eta_{YIg}\frac{\Delta Ig}{Ig} + \eta_{YX}\frac{\Delta X}{X} - \eta_{YM}\frac{\Delta M}{M}$$

In order to simplify the last expression, the growth rates are identified with lower caps, for example $\Delta y_t = \frac{\Delta Y}{Y}$, such that the national growth equation is reduced to:

[3] $\Delta y_t = \eta_{Ycp}\Delta cp_t + \eta_{Yip}\Delta ip_t + \eta_{Ycg}\Delta cg_t + \eta_{Yig}\Delta ig_t + \eta_{Yx}\Delta x_t - \eta_{Ym}\Delta m_t + u_{y,t}$

Equation [3] establishes that the national income growth is equal to the weighted sum of the components of the aggregate demand in where we also find the income elasticity of each demand component $(\eta_{Yj},\ j = cp, ip, cg, ig, x, m)$ at time *t*.

Private consumption growth

From a Keynesian framework, the private consumption growth rate depends positively on income growth:

[4] $\Delta cp_t = \alpha_0 + \alpha_1 \Delta y_{t-1} + u_{cp,t}$

Where α_0 is the autonomous income growth component and $\alpha_1$is the income elasticity of consumption, i.e. marginal propensity to consume multiplicated by the inverse of mean consumption, which measures how much the private consumption raises when the income growth is increased (with a temporal lag)

Private investment growth

The private investment growth equation has a traditional structure, it depends positively on income growth rate, negatively on interest growth rate (Δi_{t-1}), negatively on a competitive indicator such as the labour cost growth rate (Δulc_{t-1}) and positively on foreign direct investment measured as proportion of domestic investment Δfdi_{t-1}:

[5] $\Delta ip_t = \beta_1 \Delta y_{t-1} - \beta_2 \Delta i_{t-1} - \beta_3 \Delta ulc_{t-1} + \beta_4 \Delta fdi_{t-1} + u_{ip,t}$

Exports growth

In the export growth equation, we consider a positive relationship with the external income ($\Delta yusa_{t-1}$), negative with the labour cost growth rate (Δulc_{t-1}) and positive with the nominal exchange growth rate(Δe_{t-1}):

[6] $\Delta x_t = \gamma_1 \Delta yusa_{t-1} - \gamma_2 \Delta ulc_{t-1} + \gamma_3 \Delta e_{t-1} + u_{x,t}$

Imports growth

The import growth depends positively on demand or national income change, negatively on nominal exchange growth rate and positively on internal inflation(Π_{t-1}):

[7] $\Delta m_t = \delta_1 \Delta y_{t-1} - \delta_2 \Delta e_{t-1} + \delta_3 \Pi_{t-1} + u_{m,t}$

Structural and reduced forms

With the structural and reduced forms of the macroeconomic model, we proceed to define an econometric estimation method, likewise, we study the stability conditions of the model, and the endogenous versus exogenous variables as well (Green, 2003). In equation 8 is presented the model specification in its structural form jointly with a matrix representation of each of its components. Looking at the *m* endogenous variables Γ in equation [8], it can concluded at first sight that the model has recursive characteristics: the matrix is diagonal superior. However, due to the majority of the endogenous variables are explained by lagged national income (θ), the system is dynamic; and in order to find the so called reduced form, the system has to be resolved in its structural form.

[8] $\boldsymbol{\Gamma y}_t = \boldsymbol{\theta y}_{t-1} + \boldsymbol{\beta x}_{t-1} + \boldsymbol{u}_t$

where

$$\boldsymbol{\Gamma} = \begin{bmatrix} 1 & -\eta_{Ycp} & -\eta_{Yip} & -\eta_{Yx} & -\eta_{Ym} \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad \boldsymbol{y}_t = \begin{bmatrix} \Delta y_t \\ \Delta cp_t \\ \Delta ip_t \\ \Delta x_t \\ \Delta m_t \end{bmatrix} \quad \boldsymbol{\theta} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ \alpha_1 & 0 & 0 & 0 & 0 \\ \beta_1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ \delta_1 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boldsymbol{\beta} = \begin{bmatrix} \eta_{Ycg} & \eta_{Yig} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\beta_2 & -\beta_3 & \beta_4 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\gamma_2 & 0 & \gamma_1 & \gamma_3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -\delta_2 & \delta_3 \end{bmatrix} \quad \boldsymbol{x}_{t-1} = \begin{bmatrix} \Delta cg_t \\ \Delta ig_t \\ \Delta i_{t-1} \\ \Delta ulc_{t-1} \\ fdi_{t-1} \\ \Delta yusa_{t-1} \\ \Delta e_{t-1} \\ \Pi_{t-1} \end{bmatrix} \quad \boldsymbol{u}_t = \begin{bmatrix} u_{y,t} \\ u_{cp,t} \\ u_{ip,t} \\ u_{x,t} \\ u_{m,t} \end{bmatrix}$$

The reduced form is derived from finding the equilibrium vector system solution of $\boldsymbol{y}_t$, which implies *t =t-1*. The solution is equation 9:

[9] $\boldsymbol{y}_t = [\Gamma - \theta]^{-1}\beta\boldsymbol{x}_t + [\Gamma - \theta]^{-1}\boldsymbol{u}_t$

where

$$[\Gamma - \theta] = \begin{bmatrix} 1 & -\eta_{Ycp} & -\eta_{Yip} & -\eta_{Yx} & -\eta_{Ym} \\ -\alpha_1 & 1 & 0 & 0 & 0 \\ -\beta_1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ -\delta_1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Note that the matrix $\Gamma - \theta$ is not triangular, in fact it has a simultaneous system structure, where convergence and equilibrium conditions exist only when all the characteristic roots are less than 1 in module $\|\lambda_m\| < 1$. Once the system is in its reduced form is possible to have the long term multipliers (*Mul*) –see equation 10, and measure by simulation methods the effects of fiscal and monetary policy tools, competitiveness, USA economic dynamic and inflation on economic growth and aggregated demand determinants.

[10] $Mul = \partial\boldsymbol{y}_t / \partial\boldsymbol{x}_t = [\Gamma - \theta]^{-1}\beta$

Methodology and econometric results

As we pointed out before, the macro model studied here is a dynamic system that has to be analyzed through its reduced form (see equation 9). In this equation, the aggregate components (consumption, investment, exports, imports) are resolved simultaneously by the lagged national income growth, which is conditioned on structural's parameters linked to endogenous and lagged endogenous variables, as we can see in matrix $[\Gamma - \theta]$, this is what typically is known as *simultaneous equation bias* (Hamilton, 1994).

To solve the problem of *simultaneous equation bias,* different estimation methods have been proposed which basically can be classified in two groups: those dealing with *limited information* [two-stage least squares (*2SLS*) and instrumental variables (IV)] and those dealing with *complete information* [three-stage least squares (*3SLS)*, full information maximum likelihood (*FIML*) and generalized method of moments (*GMM*)], and according to the specific estimating process of each equation is included individual information or whole system information. From our perspective, it is better working with complete information methods because it allows getting asymptotic conditions when the $\boldsymbol{n} \times \boldsymbol{m}$ degree of freedoms are increased (where ***n***'s are the number of obs. and ***m*** the endogenous variables or system equations number). In this sense, it is more efficient to work with *FIML* rather instead of *3SLS* methods because both are equivalent when the *equation system* is exactly identified and it is asymptotically more *efficient* when the system is over identified. On the other hand, the *GMM* estimator is equivalent to *FIML* and *3SLS* when is assumed that innovations have homoscedastic variance and, it is more efficient when the variance is heteroscedastic (Green, 2003; Hamilton, 1994).

Table 1 shows the estimations of the macroeconomic model's structural parameters by *OLS*, *FIML* and *GMM* procedures. Most of the parameters are significant at the 95% level, but the consumption equation's constant term and the labor cost growth coefficient in the exports function are both significant only at the 90% level (these statistical inferences were made by *OLS* estimations). The coefficient of determination is between 0.55 and 0.66 in the consumption, investment, exports and imports growth equations; and it is 0.95 for the pseudo identity equation. These results are in acceptable ranges for the case of models with stationary variables (Hendry, 1995). One might have been expected good results using a ,*FIML* procedure, however some variables lost statistical significance under this estimation and in other variables the expected sign of the coefficient changed. In this sense, it must be emphasized that the labor cost and exchange rate variables lost statistical significance and that the interest rate is just now significant at 85% level; in the same way, foreign direct investment (as proportion of the gross fixed capital formation) is at 95% significance level. Finally, in the imports function estimations, we find that under *FIML* procedures, the exchange rate devaluation and inflation are not significant at 95% level. The best econometrics results were obtained by using the GMM estimator; under this estimation, all system parameters were highly significant at 95% level and they have the expected sign as expected by theory.

Table 1: Macroeconomic model estimation

Independent variables with one lag	Private consumption growth model			Private investment growth model			Exports growth model			Imports growth model		
Constant	**0.52** (0.78)	**1.59** (1.99)	**0.54** (4.54)									
Real GDP growth	**0.91** (6.79)	**0.76** (2.06)	**0.91** (35.3)	**2.58** (6.27)	**2.66** (2.32)	**2.75** (42.1)				**1.37** (5.37)	**2.16** (2.03)	**1.38** (41.37)
Interest rate growth				**-0.11** (-3.68)	**-0.05** (-1.41)	**-0.10** (-21.03)						
Labour cost growth rate				**-0.74** (-3.97)	**-0.84** (-2.47)	**-0.86** (-26.35)	**-0.21** (-1.64)	**-0.04** (-0.13)	**-0.21** (-9.30)			
Log foreign direct investment (as proportion of domestic investment)				**1.03** (3.33)	**2.34** (1.94)	**3.45** (34.62)						
Real GDP USA growth							**2.37** (10.51)	**2.51** (5.10)	**2.38** (37.17)			
Nominal exchange growth							**0.20** (3.87)	**0.22** (1.76)	**0.20** (14.29)	**-0.42** (-4.44)	**0.13** (0.88)	**-0.41** (-46.91)
Inflation rate										**0.82** (6.33)	**0.32** (1.71)	**0.81** (57.72)
Estimation method	OLS	FIML system	GMM system	OLS	FIML system	GMM system	OLS	FIML system	GMM system	OLS	FIML system	GMM system
Number of observations	55	275	275	55	275	275	55	275	275	55	275	275
R-squared	**0.55**	**0.52**	**0.55**	**0.65**	**0.63**	**0.68**	**0.62**	**0.60**	**0.62**	**0.66**	**0.39**	**0.66**

Pseudo identity: OLS

$$\Delta y_t = 0.56\Delta cp_t + 0.10\Delta ip_t + 0.12\Delta cg_t + 0.02\Delta ig_t + 0.14\Delta x_t - 0.08\Delta m_t, \quad R^2 = 0.98$$

Pseudo identity: FIML

$\Delta \boldsymbol{y_t} = \mathbf{0.55}\Delta \boldsymbol{cp_t} + \mathbf{0.11}\Delta \boldsymbol{ip_t} + \mathbf{0.13}\Delta \boldsymbol{cg_t} + \mathbf{0.01}\Delta \boldsymbol{ig_t} + \mathbf{0.16}\Delta \boldsymbol{x_t} - \mathbf{0.10}\Delta \boldsymbol{m_t},$ **R^2 =0.97**

Pseudo identity: GMM

$\Delta \boldsymbol{y_t} = \mathbf{0.54}\Delta \boldsymbol{cp_t} + \mathbf{0.13}\Delta \boldsymbol{ip_t} + \mathbf{0.12}\Delta \boldsymbol{cg_t} + \mathbf{0.03}\Delta \boldsymbol{ig_t} + \mathbf{0.17}\Delta \boldsymbol{x_t} - \mathbf{0.13}\Delta \boldsymbol{m_t},$ **R^2 =0.97**

Nota: *t student in brackets; GGM instruments:* $\Delta cg_t, \Delta ig_t, \Delta y_{t-1}, \Delta i_{t-1}, \Delta ulc_{t-1}, fdi_{t-1} \Delta yusa_{t-1}, \Delta e_{t-1} and \Pi_{t-1}$

Theoretical results and economic policy implications

Given the econometric results of the macroeconomic model under GMM method, we propose the following economic inferences about growth dynamics in Mexico and their economic policy implications.

Pseudo identity equation. The national income growth function estimation shows, as expected, that the greatest elasticity comes from the private consumption (0.54%); moreover, if the government consumption is also considered, total consumption can explain until 0.66% of the national income growth. In second place of impact is the external sector component in where the exports and imports elasticity are 0.17% and 0.13% respectively. These results show how important the exports function is to the national income growth. But by the same token, it also shows the weakness of the external component due to the high imports dependence because the external sector net effect is highly reduced: the external sector elasticity or the net exports hardly is hardly 0.04%. Finally, the main impact of government in generating economic growth comes from its consumption spending (0.12%) in contrast to its investment spending (0.03%).

Consumption function. The keynesian specification of the consumption function shows the existence of an autonomous part (0.54), nevertheless, the main element that explains consumption is the income dynamic (0.91). The income elasticity of consumption equation is pretty close to most of Mexican estimations done by the literature, but this results differs from Capello's (2007) estimations for the European Community countries. The marginal propensity to consumption derived from the estimated elasticity is 0.65 in averages for all the period analyzed, which suggests that an important part of the economic agents are saving money.

Private investment function. The classical finding in the Keynesian private investment estimation is that the income accelerator is the most important component that explains investment decisions; however, for the Mexican case, foreign direct invest (as proportion of the gross fixed capital formation) is the main factor in explaining the private investment equation. The second one is the income accelerator followed by competitiveness and interest rate.

Exports function. As expected, USA income is the most important variable in the Mexican exports equation. Its elasticity is 2.38 which is very similar to the found in other studies. We also see that competitiveness of Mexican goods is not affected by exchange rate devaluation or wage costs reduction because the elasticity in both cases is very small. In fact, these two last factors do not have any relevant impact on exports.

Imports function. The income elasticity is the most important component in the imports equation which confirms that the Mexican economy has a strong dependence on imports. This also shows that import substitution depends more on internal price growth (inflation) than on exchange rate devaluation.

Data characteristics

We use quarterly data to estimate the macroeconomic model (see table 2). The data comes from National Institute of Statistics and Geography (INEGI), the Central Bank (Banxico) and the Bureau of Economic Analysis (BEA). Nevertheless, not all series were available in quarterly frequency and, some aggregation data criteria (with available monthly information was considered to build the complete quarterly series. Next we present the mains characteristic of the data used: aggregate demand data is in millions of constant pesos of 1993 and they are reported by INEGI; foreign direct investment is a quarterly series in millions of dollars (FDI_{dol}) which have to be converted to constant pesos through the nominal exchange rate and the implicit gross fixed capital formation deflator; interest rate was proxied by CETES in 28 days (BANXICO); labor cost was measured through the index of unitary costs of the manufacturing sector working force; USA GDP is a quarterly series in constant millions of dollars (2005 base); the exchange rate (pesos to USA dollars) was used to consider foreign currency obligations; and finally, the monthly national consumer price index (BANXICO) with base june = 2002 was used to obtain the quarterly index price.

Table 2. Macro variables

	Deinfition	*Period*	*Source*
Real GDP growth Δy_t	$\ln\left(\frac{Y_t}{Y_{t-4}}\right)*100$	1993-2007	INEGI
Private consumption growth Δcp	$\ln\left(\frac{Cp_t}{Cp_{t-4}}\right)*100$	1993-2007	INEGI
Private investment growth Δip	$\ln\left(\frac{Ip_t}{Ip_{t-4}}\right)*100$	1993-2007	INEGI
Government consumption growth Δcg	$\ln\left(\frac{Cg_t}{Cg_{t-4}}\right)*100$	1993-2007	INEGI
Government investment growth Δig	$\ln\left(\frac{Ig_t}{Ig_{t-4}}\right)*100$	1993-2007	INEGI
Goods and services exports growth Δx	$\ln\left(\frac{X_t}{X_{t-4}}\right)*100$	1993-2007	INEGI
Goods and services imports growth Δm	$\ln\left(\frac{M_t}{M_{t-4}}\right)*100$	1993-2007	INEGI
Interest rate-growth (CETES a 28 días) Δi	$\ln\left(\frac{Cetes_t}{Cetes_{t-4}}\right)*100$	1993-2007	BANXICO
Labor cost growth (index of unitary costs of the manufacturing sector working force) Δulc	$\ln\left(\frac{Unitarycost_t}{Unitarycost_{t-4}}\right)*100$	1993-2007	INEGI
Foreign direct investment (as proportion of the gross fixed capital formation) Δfdi	$\ln\left(\frac{FDI_t}{FDI_{t-4}}\right)*100$	1993-2007	BANXICO
Foreign direct investment growth (as proportion of the gross fixed capital formation) FDI	$\left(\left(\frac{FDI_{dol,t}}{DefFBC_{t-4}}\right)*e\right)/FBC_t$	1993-2007	BANXICO e INEGI
GDP USA growth $\Delta yusa_t$	$\ln\left(\frac{Yusa_t}{Yusa_{t-4}}\right)*100$	1993-2007	BEA
National Consumer Price Index (INPC) Π_t	$\ln\left(\frac{INPC_t}{INPC_{t-4}}\right)*100$	1993-2007	BANXICO

3. Regional Model

In this section, we describe the regional model that explains the growth dynamics of Mexico City at Municipality level. As we discussed before, and along the lines of Capello (2007), the main task of the model is to explain, through regional factors associated to the metropolitan area, the growth differentials between the municipalities of the metropolitan area of Mexico City and the whole country. The regional factors considered in this study invoke modern theories of regional growth (Capello-Nijkamp), from which we specially pay attention to both endogenous growth determinants and interactive behavior and processes that take place in space. The regional model that we display below takes into account *structural resources* as quality of human capital and population dynamics, *sector activity resources* in manufacturing and services and self-employment activities, and finally *territorial structure resources* as roads density, distance to the center of the metropolitan area and spatial structure in the way of regional growth dependence among neighboring regions. This last component can be a good proxy of the role of agglomeration economies which is a central element in the literature of the New Economic Geography.

3.1 Descriptive data

The regional area of study is the metropolitan area of Mexico City which has around 20 million inhabitants and it is the second largest metropolitan area in the world only behind Tokyo with a population of 30 million. The metropolitan area of Mexico City has a political-administrative division that consists of 75 municipalities spreading basically over two federal states (Mexico State and the Federal District).[2] As we can see in table 3, the population of Mexico City represents around 19% of the total population in the country but its demographic determinants (fertility, migration and mortality) are less dynamic to the registered in other regions of the country, which translates in a relative loss of contribution of Mexico City population (as we can see in table 3, growth country population has been higher). The economic activity of Mexico City is very important for the country (see table 3), because its GDP covers almost the 25% of the country GDP (in 2005); however note also, as in the case of its population, that the contribution of Mexico City GDP has decreased since 1995 meaning that other regional areas (for instance, those closer to the USA border) have increased its share on GDP.

[2] There is one municipality, Tizayuca, that is located in the federal state of Hidalgo. It is important to mention that we rely on the classification of CONAPO to delimit the metropolitan area of Mexico City.

Table 3. Comparative data between Mexico City and the Country

	Mexico City	Mexico	Differential
Avg annual GDP growth 2000-2005	1.34	1.81	-0.47
Ratio GDP Mexico city / GDP Mexico 1995	27.72		
Ratio GDP Mexico city / GDP Mexico 2000	26.93		
Ratio GDP Mexico city / GDP Mexico 2005	24.90		
Population avg annual growth 2000-2005	0.90	1.16	-0.26
Ratio Population Mexico city / Pop. Mexico 1995	18.98		
Ratio Population Mexico city / Pop. Mexico 2000	18.87		
Ratio Population Mexico city / Pop. Mexico 2005	18.63		

The main task of the regional model is to explain the regional differential growth component[3] :

$$\Delta Y_r = \Delta Y_N + D_r \qquad (11)$$

Where the ΔY_r and ΔY_N denote the GDP growth of the region and the whole country respectively, and D is the regional differential component.

Figure 1 shows the time series of the GDP growth rate in Mexico City and the whole country during the period 1994-2005. The figure depicts clearly that Mexico City, as indicated by the blue line in the figure, most of the time grew less than the country GDP during the last two decades: the average differential during the period was -1.07, that is, Mexico City grew around one percentage point less than the country. This poor performance of the city has been widely discussed in the literature, and several factors have been considered as explanations, among them, the relocation of the manufacturing activity from Mexico City toward the north of the country (see Hanson 1998). In this sense, note in table 2 that the annual growth of the Gross Value Added during the period 1999-2004 in the country manufacturing sector was 2.20% while in Mexico City was negative (-3.42%). Moreover, the decline in the growth of manufacturing firms has been faster in the case of the metropolitan area of Mexico City than the country. As we can see

[3] Which is similar to equation (1)

below, one of the elements that might explain the poor performance of the Mexico City is its increasing loss of potential in the manufacturing activity.

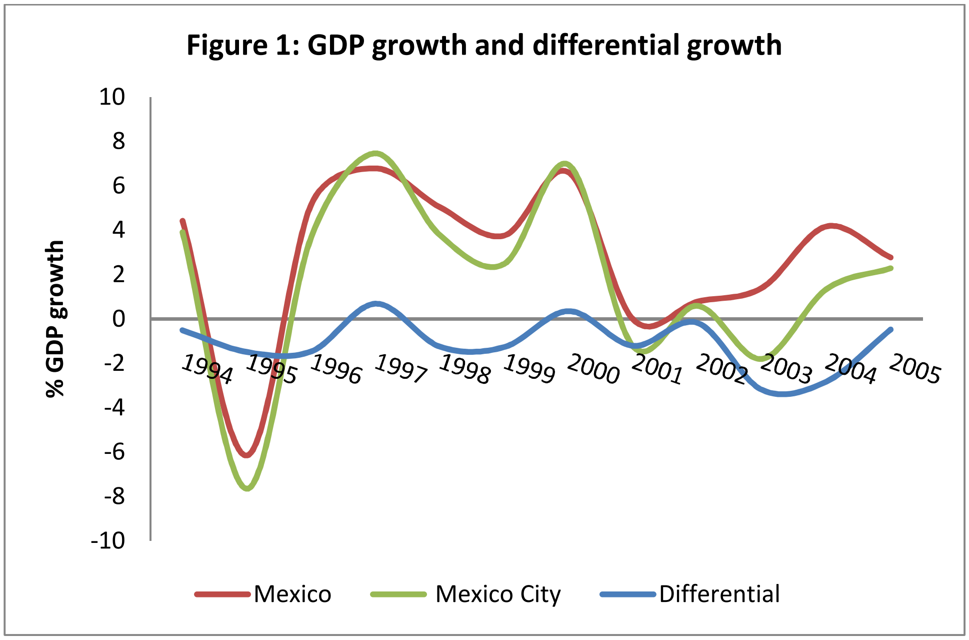


Table 4. Manufacturing and service activities

Annual growth of firms 1999-2004		
Sector	Mexico City	México
Manufacturing	-1.35%	-0.83%
Services	1.14%	1.58%

Annual Growth of Gross Value Added 1999-2004		
Sector	Mexico City	México
Manufacturing	4.16%	10.24%
Services	16.24%	16.30%

Before presenting the regional model, it is interesting to point out some spatial dependence indicators of the economic activity in México City. Table 5 shows that the GDP growth in Mexico City –at municipality level-- during the period 2000-2005 exhibits statistically significant spatial dependence (0.20), as measured by the Moran Index, which is very close to the calculated for the whole country (0.22). Nvertheless, note in table 5 that the GDP per capita exhibits more spatial autocorrelation for the case of Mexico City in each of the years considered. These elements indicate us that the spatial structure component could play an important role in the regional growth dynamics not only among regions (Federal States) but also inside the regions as in the case of the metropolitan area of Mexico City. We will see ahead that the spatial autocorrealtion of GDP growth remains even when controlling for potential explanatory variables of growth.

Table 5: Spatial dependence in regional GDP indicators

Spatial autocorrelation in GDP per capita	Mexico City	Mexico
1995	0.3209	0.2692
2000	0.3750	0.2604
2005	0.3750	0.2811
Spatial autocorrelation in GDP growth 2000-2005	0.2002	0.2148

Note: The Moran Index is used to calculate spatial dependence. All measures are statiscally significant at 99% by Monte Carlo procedures. A first order contiguity matrix is used for calculations.

3.2 Specification of the regional model

The main purpose of this sub-section is to present the regional model that explains the differential growth between Mexico City and the country. The equation analyzed is the following:

$\Delta Y_r - \Delta Y_N = D_r =$ *f(structural resources, territorial and spatial structure, economic activity sector)* (12)

where ΔY_r is defined as the average annual growth of real GDP at municipality *r* during the period 2000-2005; likewise, ΔY_N is defined as the average annual growth of real GDP in the country during the period 2000-2005.

In equation 12, the explanatory variables considered in the ***A) structural resources*** group are growth of education years during 2000-2005 (*gHC*), population growth during 2000-2005 (*gPop*), an internal migration variable measured as the net immigration flow in 2000 (multiplied by 1000) divided by the mean population in the period 1995-2000 (*NI*), energy consumption per capita (kilowatts) in 2000 (*ECpc*), share of the employment in the professional-technical service sector that we call it "creative class" (*CClass*)[4]; the explanatory variables considered in the ***B) territorial and spatial structure*** group are Road Density (*RD*) measured as meters of roads per Km^2, the square of density roads (DR^2) as a variable that measures congestion effects, a *monocentric variable* defined as the euclidian distance in meters that separates each municipality from the center of the metropolitan area (*DistCenter*), a regional dummy variable that indicates whether the municipality is located in the Federal District (*FD*), *spatial spillovers* proxied through the differential annual growth of the neighboring municipalities (*WD*); and finally, the explanatory variables used in the ***C) economic activity sector*** group are the growth of manufacture firms during 1999-2004 (*gMF*), the growth of service firms during 1999-2004 (*gSF*), share of the total firms that are micro-firms (less than 10 employed persons) in the manufacturing sector *(micMF*), share of firms that are micro-firms (less than 10 employed persons) in the service sector *(micSF*), share of the occupied population that live in the region that is self-employed and does not employed working force *(SelfEmp)* –this is a proxy of *informality*.

[4] We follow some of the guidelines of Fingleton et al (2007) to build this variable. But, the meaning and relevance of the variable to understand the economics of the cities comes from the work of Richard Florida (2005).

Tabla 6. Descriptive statistics for the explanatory variables

	Obs.	Mean	Standard deviation	Min value	Max value
Differential growth	76	0.02	0.06	-0.10	0.18
Annual GDP growth	76	0.04	0.06	-0.08	0.20
Growth of education years pop. over 15 years 2000-2(	76	0.09	0.03	0.04	0.17
Population growth during 2000-2005	76	0.12	0.19	-0.17	1.19
Energy Consumption - Kws per capita in 2000	76	327.41	496.88	4.05	2730.93
Road Density - Meters of roads per km^2	76	1397.55	1646.65	6.71	6343.55
Share of self-employement	76	0.22	0.05	0.15	0.45
Growht of employment in the service sector 99-2003	76	11.02	74.24	-0.59	649.00
Growth of manufacturing sector firms 99-2003	76	0.30	0.65	-0.83	5.44
Growth of service sector firms 99-2003	76	0.10	0.30	-0.61	0.86
share of micro manufacturing firms respect to the total of firms	75	0.10	0.04	0.02	0.34
share of micro service firms respect to the total of firms	75	0.83	0.08	0.57	0.94
Net internal migration flow (migrants per 1000 persons)	76	16.41	40.59	-86.23	172.35
share of the employment in professional-technical service sector that is part of the "**creative class**"	76	0.35	0.21	0.00	1.00
Monocentric variable. Meters from the center of the city	76	30789.09	15938.48	0.00	67682.80

Table 6 shows the descriptive data of the explanatory variables at municipality level. For example, despite the fact that the metropolitan area as whole has a negative growth differential (see figure 1), the average growth differential among the municipalities is positive (0.02) but it exists important regional variations (i.e. the Federal District municipalities had in average a growth differential of -0.02 while the Mexico State municipalities had a positive growth differential of 0.03); likewise, the population grew in average 12% between 2000 y 2005 but in contrast the population increase in average in the municipalities that are located in the Federal District by a rate of only 3.4%; the average net immigration flow was positive in 2000 (16.4 immigrants per 1,000 persons); the manufacturing firms grew in average 30% between 1999 y 2003 but those firms located in the Federal District grew only 3.4%, in the same way the service firms grew in average 9.5% but its growth was negative among the municipalities of the Federal District (-6%). Finally, it is important to highlight from table 4 that most of the firms in the metropolitan area are micro firms in service sector (less than 10 employed persons) –note that in average 83% of the firms fall in this category, while only 9.5% of the total firms are in average micro manufacturing firms. An interesting variable to mention is the so called "creative class" which, under our classification, represents in average 35% of the occupied persons that are considered professionals or technicians in the sector services.[5]

To study econometrically equation 12, we propose the following linear specification in a cross-section setting:

$$D_{r,2000-2005} = \propto + \beta_i gHC_{r,2000-2005} + \beta_i gPop_{r,2000-2005} + \beta_i ECpc_{r,2000} + \beta_i CClass'_{r,2004} + \beta_i RD_{r,2000} + \beta_i RD^2_{r,2000} + \beta_i DistCenter_r + \beta_i FD_r + gMF_{r,1999-2003} + \beta_i gSF_{r,1999-2003} + \beta_i SelfEmp_{r,2000} + \beta_i gEmplServ_{r,1999-2004} + \beta_i micMF_{r,2004} + \beta_i micSF_{r,2004} + \varepsilon_r \quad (13)$$

where ε is a random disturbance term.

In order to take into account spatial spillovers, the following specification is also estimated:

$$D_{r,2000-2005} = \propto + \rho WD_{r,2000-2005} + \beta_i gHC_{r,2000-2005} + \beta_i gPop_{r,2000-2005} + \beta_i ECpc_{r,2000} + \beta_i CClass'_{r,2004} + \beta_i RD_{r,2000} + \beta_i RD^2_{r,2000} + \beta_i DistCenter_r + \beta_i FD_r + \beta_i gMF_{r,1999-2003} + \beta_i gSF_{r,1999-2003} + \beta_i SelfEmp_{r,2000} + \beta_i gEmplServ_{r,1999-2004} + \beta_i micMF_{r,2004} + \beta_i micSF_{r,2004} + \varepsilon_r \quad (14)$$

To compare the performance among different specifications, we estimated also a slightly modified version of equation 13 and 14 in where the "creative class" is substituted for the "net immigration flow" variable and the population growth variable is dropped out because immigration flow explains it (in the next section we estimate a subordinated equations that explain both variables). Table 7 depicts the results for both models with their associated statistical tests. Model

[5] However, it is important to indicate that, in average, only 1.8% of the formal employment is considered to be employed in a professional or technical service sector.

1.A presents the estimations of equation (13) by OLS procedures, without the spatial spillover variable (*WD*) and considering immigration variable instead of population growth . In this model, the growth of education years in the active population (*gHC)* and the net immigration flow (*NI*) are the only significant variables that are explaining the differential growth in the municipalities of the metropolitan area of Mexico City. Nevertheless, this model presents spatial autocorrelation in the error term (as indicated by the spatial dependence tests) and a spatial auto-regressive model is suggested as alternative; therefore, the spatial spillovers considered in equation (14) are well justified by the data used. Model 1.B presents the estimations with the spatial lag of the differential growth (*WD*)[6] , the results indicate that additionally to *gHC* and *NI,* the spatial lag variable and the share of micro manufacturing firms are also statiscally significant to the model.

In model 2.A of table 7, the *creative class* and *population growth* variables are introduced in the model, and the immigration variable is removed to avoid problems of endogenity. The model seems to perform better than model 1.A as indicated by the log likelihood and the normality tests, and now the share of micro service firms and the "creative class" variables emerge both also as significant to the model. But in spite of that, the model continues presenting spatial autocorrelation in the error term. The spatial dependence tests also suggest, and more clearly than in the case of model 1.A, an auto-regressive model as alternative. The results of this model are showed in the last panel of table 4. As expected, the spatial spillover variable is significant and the *gHC* and *creative class* too, but also it is interesting to observe that there is now other block of variables that are contributing to the model with negative effects (the monocentric variable, the consumption of energy per capita and the growth of the occupied population in the service sector). As in the case of model 1.B, the model 2.B has a better performance that its counterpart model without spatial spillovers.

So far, we advance in this section a regional model that explains the differential growth between GDP growth at municipality level and GDP growth at macro level (*i.e*. the country). The model proposed relies on some theoretical

[6] A first order contiguity weight matrix is used to calculate the differential growth of municipality neighbors.

elements that are considered in modern regional models (Capello-Nijkamp, 2009). In particular, we try to emphasize the role of spatial interaction among micro-regions as a mean to approximate either some of the forces that the New Economic Geography stresses (i.e. agglomeration economies) or some less mainstream components like no-pecuniary externalities(i.e. technological diffusion or/and human capital spillovers). We show that these elements could be important in the regional dynamics of Mexico City. Likewise, we put special attention in the regional model to the interplay between manufacturing and service sector activity, because there is a strong debate, at least for the Mexico City case, about whether the underperformance of Mexico City economy respect to the country is associated to the loss of dynamism in the manufacturing activity. In any case, our results indicate that manufacturing activity (in small enterprises) is also contributing to growth and, even the increase of employment in the whole service sector might affect negatively regional growth. Nevertheless, it would be a big mistake to derive that all activity associated to the "service sector" is harmful to the Mexico City economy; in specific, our results indicate that the employment share in the professional-technical service sub-sector (that we called "*creative class*") is contributing positively to growth. This is important to highlight because rescues a central element that is currently discussed in the modern economic city literature that emphasizes the role of location decisions of workers instead of location decisions of firms (see Glaeser 2007-*The economic approach to cities, mimeo*., Florida 2005, Storper-Scott 2009).

TABLE 7 Regional model estimation for the Mexico City Economy

Variable	Model 1.A Coefficient	Model 1.B Coefficient	Model 2.A Coefficient	Model 2.B Coefficient
WDr,2 000-2005	-	0.2473	-	0.2596
	-	(0.1423)**	-	(0.1405)***
α	-0.0764	-0.0585	-0.0873	-0.0703
	(0.0771)	(0.0681)	(0.0785)	(0.0684)
gHCr, 2000-2005	0.7801	0.6697	0.8275	0.7021
	(0.3674)***	(0.3259)***	(0.4099)***	(0.3620)***
gPopr , 2000-2005	-	-	-0.0345	-0.0301
	-	-	(0.0440)	(0.0386)
ECpcr, 2000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)*
Cclassr, 2004	-	-	0.0644	0.0602
	-	-	(0.0366)**	(0.0319)**
RDr, 2000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
(RDr)^2, 2000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DistCenterr	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)**
FDr	0.0115	0.0119	-0.0153	-0.0109
	(0.0275)	(0.0245)	(0.0234)	(0.0209)
gMFr, 1999-2003	0.0104	0.0095	0.0101	0.0095
	(0.0120)	(0.0106)	(0.0129)	(0.0113)
gSFr, 1999-2003	0.0346	0.0241	0.0285	0.0180
	(0.0266)	(0.0235)	(0.0268)	(0.0235)
SelfEmpr, 2000	0.0241	0.0247	-0.0773	-0.0659
	(0.1598)	(0.1411)	(0.1601)	(0.1398)
gEmplServr ,1999-2004	-0.0058	-0.0061	-0.0064	-0.0067
	(0.0047)	(0.0041)	(0.0048)	(0.0042)*
micMFr , 2004	0.1975	0.2522	0.1837	0.2438
	(0.1778)	(0.1574)*	(0.1783)	(0.1555)*
micSFr , 2004	0.0549	0.0380	0.1166	0.0941
	(0.0622)	(0.0552)	(0.0692)**	(0.0605)*
NI	0.0004	0.0003	-	-
	(0.0002)**	(0.0002)**	-	-
R2	0.345531	0.375981	0.35526	0.388899
R2 adjs	0.208304		0.207287	
Log Likelihood	116.799	118.077	117.369	118.815

	FD	p-value
Jarque-Bera	2	0.024
Breusch-Pagan test	13	0.565
Koenker-Bassett test	13	0.907
White	104	0.982

Spatial dependence test

TEST	Model 1.A MI/DF	Model 1.A VALUE	Model 1.A PROB	Model 2.A MI/DF	Model 2.A VALUE	Model 2.A PROB
Moran's I (error)	0.085	2.091	0.030	0.091	2.150	0.030
Lagrange Multiplier	1	2.462	0.110	1	2.832	0.090
Robust LM (lag)	1	2.720	0.090	1	3.030	0.080
Lagrange Multiplier	1	1.151	0.283	1	1.316	0.251
Robust LM (error)	1	1.409	0.235	1	1.515	0.218
Lagrange Multiplier	2	3.871	0.144	2	4.347	0.114

	Model 1.B MI/DF	Model 1.B VALUE	Model 1.B PROB	Model 2.B MI/DF	Model 2.B VALUE	Model 2.B PROB
Breusch-Pagan HETEROSKEDAS	13	10.700	0.636	14	15.414	0.350
Likelihood Ratio Test	1	2.555	0.110	1	2.8937	0.089

*** Significant at 95% level

** Significant at 90%

* Signficant at 88%.

4. Simulation of spatial spillovers

In this section, we present a spatial simulation exercise using the regional model of the last section. The simulation consists in evaluating the effect of an increment in the "years of education" over the differential growth among the municipalities of Mexico City. In order to understand the spatial diffusion process, we use a reduced version of model 14 in where it is only highlighted the parameter associated to the spatial lag (ρ) and the one linked to the education years (β); the rest is compacted to $X_{r,t}$.

$$D_{r,t} = \propto + \rho W D_{r,t} + \beta gHC_{r,t} + X_{r,t} + \varepsilon_{r,t}$$

The spatial diffusion impacts are obtained through the spatial equilibrium solution for $D_{r,t}$ in the next equation:

$$D_{r,t} = (I - \rho W)^{-1}(\propto + \beta gHC_{r,t} + X_{r,t} + \varepsilon_{r,t})$$

The spatial diffusion process generated by an increment of education years at municipality "r" over its own differential growth and the one registered with the neighboring municipalities, is obtained throughout the next derivative of the regional model at spatial equilibrium:

$$\partial D_{r,t} \big/ \partial gHC_{r,t} = (I - \rho W)^{-1}\beta$$

The last equation can be rewritten as a spatial diffusion process of the effects in the following way:

$$\partial D_{r,t+1} \big/ \partial gHC_{r,t+1} = (I + \rho W + (\rho W)^2 +,,, + (\rho W)^{\tau})\beta$$

The interesting thing of this last equation is that the first effect is identified by β, the second one is identified by $(\rho W)\beta$, and so on, until the last effect is specified by $(\rho W)^{\tau}\beta$. The sum of all spatial effects (or total spatial effects) has the equilibrium value, $(I - \rho W)^{-1}\beta$, only if $\rho < 1$ and W is a positive matrix.

4.1 Simulation scenarios

The solution of the regional model at equilibrium is used, to measure the spatial effects and to evaluate the spatial diffusion given by an increment of 10% in education years over the differential growth at both the municipality that receives the "shock" and the rest of municipalities in the metropolitan area.

With the purpose to evaluate some issues regarding with the advantages (disadvantages) of being economically located at the center (periphery) of Mexico City, we choose the municipalities of Cuauhtémoc (In the Federal District) and Tlalnepantla (State of Mexico) located close to the center, and the municipalities of Isidro Fabela (State of Mexico) and Magdalena Contreras (D.F) located at the periphery. The main results of the simulation exercise are the following:

1. An increment by 10% in education years in the municipalities chosen generate direct growth on the differential growth of the municipality receiving the shock between 6.9% and 7.5%. The municipality of Cuauhtémoc (at Federal District) has the greatest increment in its differential growth and, on the other side, the municipality of Magdalena Contreras (located toward the south of the city) receives the weakest impact (see table 8).
2. It is interesting to see that the municipality which is farthest from the center, Isidro Fabela, has not only the highest direct effect but also it develops the larger spatial diffusion effects (see blue circles in the Maps). Also it is important to point out that Isidro Fabela´s spatial diffusion effects impacts heavily on municipalities located at the Federal District which are located at the southwest part (Cuajimalpa and Magdalena Contreras).-see map 3.
3. The municipality which is closest to the center (Cuauhtémoc) is the one that receives the higher direct impact of a 10% change in education years (7.5% increase in its differential growth), however it has the lowest spatial spillover effects on differential growth of other municipalities (see table 8). A similar situation occurs with Tlalnepantla which is located in an industrial area of the State of Mexico closer to the center; however, in contrast to Cuauhtémoc, Tlalnepantla has a higher degree of economic

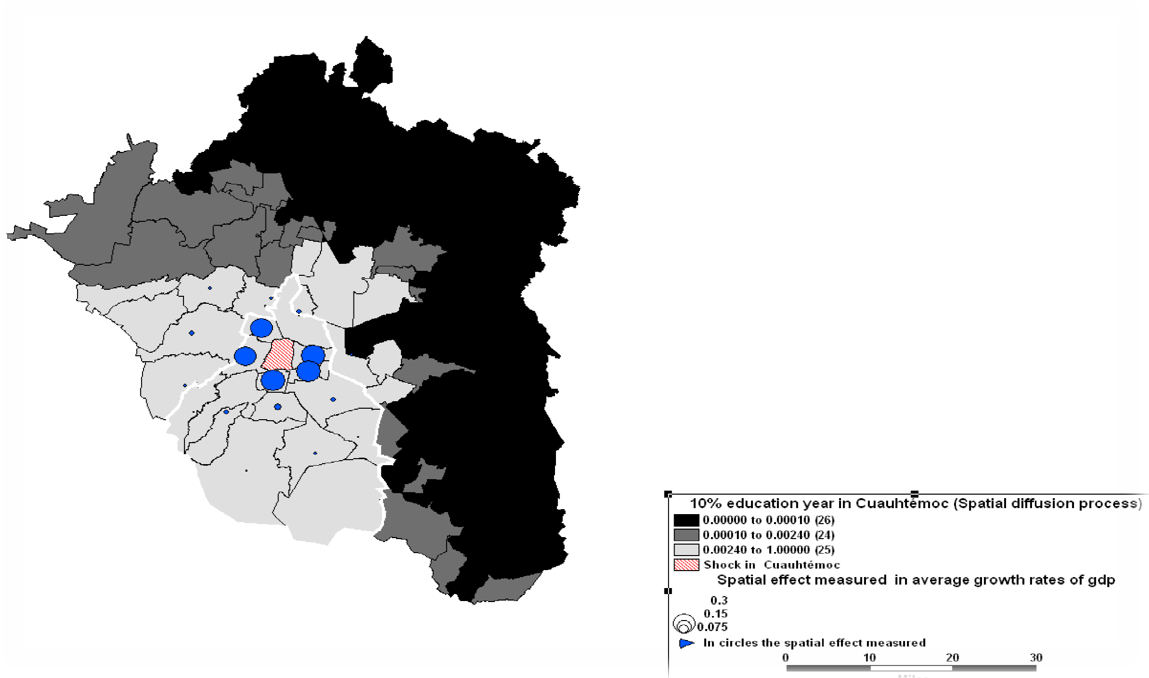
interdependence with their neighbors because of the industrial character of the area.

4. Another interesting case is Magdalena Contreras which is located at the southwest side of the Federal District (map 4), it has similar spatial spillover characteristics that Isidro Fabela; that is, its spillovers go beyond to the neighboring municipalities (note in map 4 that the spillover effect from this municipality reaches the other extreme of the city in municipalities at southeast).

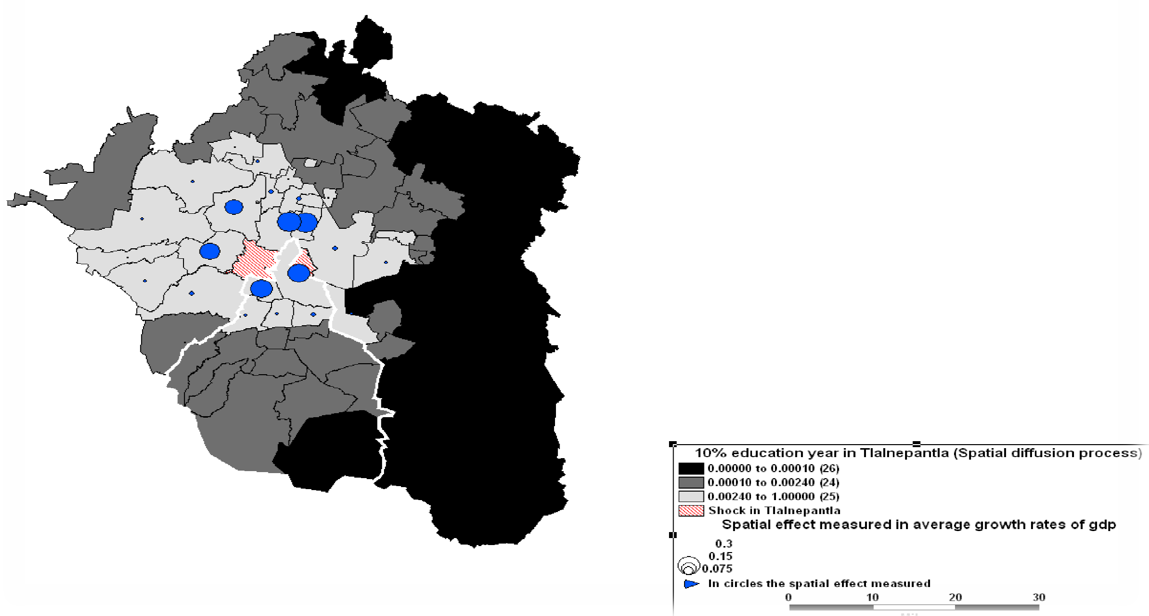
Tabla 8: Spatial diffusion of the effects of 10% increase in education years on differential growth: the case of municipalities located either in the center or the periphery of the metropolitan area of Mexico City.

	Cuauhtémoc	**Tlalnepantla**	**Isidro Fabela**	**Magdalena Contreras**
Direct impact (inside the municipality)	7.5	7.3	7.3	6.9
Spatial diffusion impacts (over the rest of municipalities)	2.1	2.1	3.3	2.2
Total impact	9.6	9.3	10.6	9.1
Number of municipalities that concentrate more than 80% of impacts	5	6	7	6
Municipalities with higher spatial impacts	1. Benito Juárez 2. Venustiano Carranza 3. Iztacalco 4. Miguel Hidalgo 5. Azcapotzalco	1. Tultitlán 2. Coacalco de Berriozábal 3. Gustavo A. Madero 4. Azcapotzalco 5. Atizapán de Zaragoza 6. Cuautitlán Izcalli	1. Cuajimalpa de Morelos 2. La Magdalena Contreras 3. Nicolás Romero 4. Atizapán de Zaragoza 5. Jilotzingo 6. Huixquilucan 7. Villa del Carbón 8. Naucalpan de Juárez	1. Tlalpan 2. Cuajimalpa de Morelos 3. Álvaro Obregón 4. Ecatzingo 5. Tepetlixpa 6. Isidro Fabela

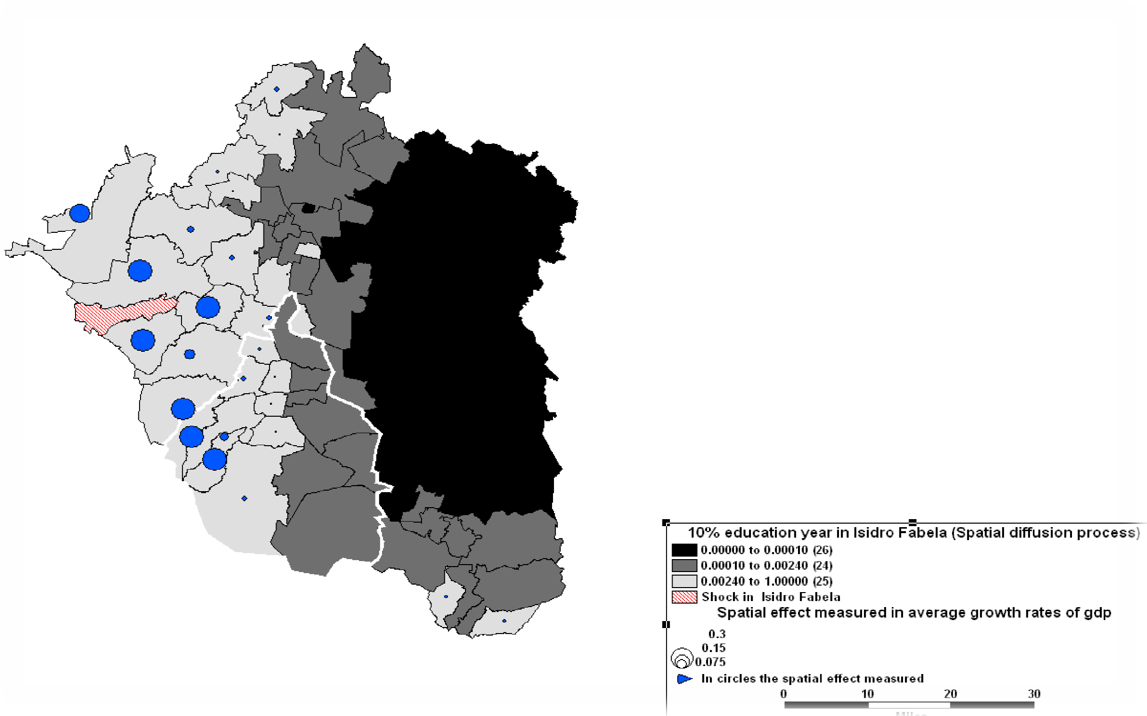
Map 1 : Spatial spillover effects on differential growth among municipalities produced by an increase of 10% in education years in the municipality of Cuauthémoc (Federal District)



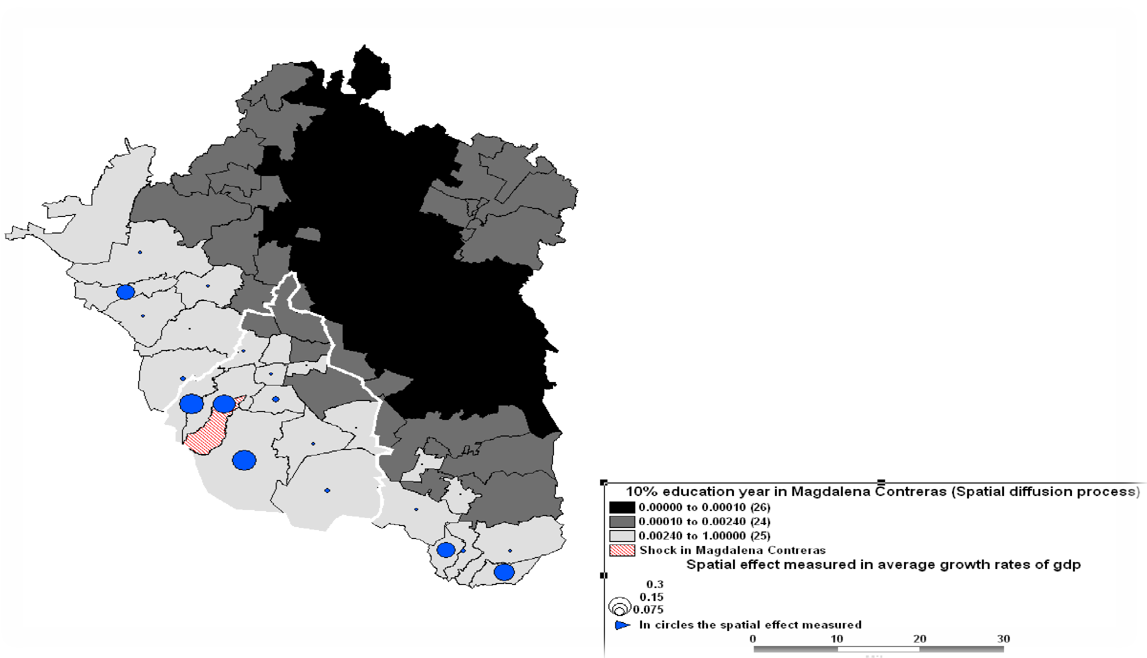
Map 2 : Spatial spillover effects on differential growth among municipalities produced by an increase of 10% in education years in the municipality of Tlalnepantla (State of Mexico)



Map 3 : Spatial spillover effects on differential growth among municipalities produced by an increase of 10% in education years in the municipality of Isidro Fabela (State of Mexico)



Map 4 : Spatial spillover effects on differential growth among municipalities produced by an increase of 10% in education years in the municipality of Magdalena Contreras (State of Mexico)



6. Final Remarks

The model presented in this paper, called it *SIRME*, is in initial stage of development. Because Mexico City continues being the main economic engine of Mexico, we decide to have a first top-down vs bottom up modeling of regional growth through the interaction between Mexico City and the whole country´s economy. But it remains for the next stages of modeling to take into account also the interaction between Mexico City and the other metropolitan areas across the country.

So far, our results indicate that typical findings of traditional macro models applied to Mexico´s economy (such as the relevance of the export growth equation, the dependence in the USA business cycle, loss of government spending to promote growth, etc.) must be considered to model also local economic growth; and the methodological approach used in this paper can give some guidelines to have a first approximation. On the other hand, it is not a mystery that in order to have a better picture about regional dynamics is necessary to consider a modeling approach relying on "regional microfoundations" (such as agglomeration economies, human capital stock, no-pecuniary externalities, natural resources, dynamic population, etc.); these last elements can be well studied in a wide range of econometric models among them the spatial econometric approach (that is used in this paper to model regional growth in Mexico City). Under this last framework is possible to detect –as found in this research, that variables associated to "human capital", internal migration, the "creative class", micro-firms and spatial interaction among micro-regions are conditioning the differential growth between Mexico City and the whole country during the last ten years. Because there is a natural linkage between "regional microfoundations" and "the components of aggregate demand" (in a recursive way), our next step is to model growth-transmission effects from a process located at the top (bottom) of the system to the rest of the system and viceversa.

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