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SPATIAL EFFECTS ON MACROECONOMIC EQUILIBRIUM

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ABSTRACT

This paper analyses if several spatial variables coming from cities and transportation system affect money market specially the income velocity of circulation. Assuming a unit-elastic aggregate demand function and considering money velocity as a conventional variable, fluctuations in the velocity of circulation caused by some non-strictly economic variables, can affect output and prices level. The empirical specification has been deduced from Baumol and Tobin model for transaction money demand, and has the income velocity of circulation as endogenous variable and the country's first city population, the population density, the passenger-kilometers transported by railways, and several ratios referred to some geographical variables, as regressors. This model has been applied across 64 countries during the period 1978-1991. Panel data techniques has been used for estimating the model. Estimation results indicate that most of the explanatory variables are significant. Moreover, the another variable a part from velocity, which affects the unit-elastic aggregate demand curve is the quantity of money in the equilibrium, M, that we will take as a new endogenous variable for checking if the explanatory variables of velocity can also affect the quantity of money. The equilibrium is finally affected by these spatial variables by means of a multiplier effect, and prices and output levels maybe influenced.

Key words: spatial variables, transportation, income velocity of circulation, panel data.
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1. **INTRODUCTION**

Spatial issues are generally neglected in conventional macroeconomic modeling, because the goods market is usually assumed to be in perfect competition. In fact, most spatial models are microeconomic and do not embody the money market. Incorporating space into macroeconomic models implies to consider product differentiation, and hence imperfect competition in goods market, as indicate in Gabszewicz and Thisse (1980), and in Thisse (1993). New Keynesian economics seems the framework in which space can be embodied in macroeconomic modeling. So, real rigidities due to agglomeration economies which lead to increasing returns to scale and hence coordination failures, together with the probable existence of nominal frictions due to near-rationality, cost-based prices and the externalities coming from aggregate demand fluctuations, can cause nominal rigidities and hence can provoke that money would not be neutral because the output fluctuates, according to Nishimura (1992). Space generates generally imperfect competition and real rigidities, but if space could also cause some nominal frictions which provokes fluctuations in aggregate demand, then space can be responsible of some nominal rigidities, an hence can cause indirectly non neutrality in money. Moreover, not only there are a great difficulty to include the space in a macroeconomic model, but also in reverse, is not still possible to introduce the money market in a spatial microeconomic model.

The best microeconomic model which incorporates the money in a framework of imperfect competition is the model of Blanchard an Kiyotaki (1987), which considers monopolistic competition with product differentiation in Dixit-Stiglitz sense. In this model, households choice between a composite good, and money. Following the Dixit-Stiglitz (1977) approach, each household has a CES utility function because is the best form to introduce money in the choice of consumer, and faces a usual budget constraint. The household problem is to maximize the utility function subject to the budget constraint and, as a result of this optimization, we will have the individual demand functions. Then, we can obtain the aggregate demand function by aggregating these individual demands:

$$Y = \frac{\sum_{j=1}^{n} P_j Y_j}{P} = \frac{g}{1-g}\frac{M}{P} \qquad \{1\}$$

Where Y is the real income, and g is a constant. M is money in equilibrium and P is the prices level. This aggregate demand function is one-elastic, and reflect apparently a neo-quantitative theory of money, where the coefficient (g/(1-g)) play the role of income velocity of circulation (V). The parameter g is the exponent of real money balances in the CES utility function. This microeconomic aggregate demand function has two versions in macroeconomics: A neoclassical form, used from Fisher (1911), until Lucas (1973), where V is considered a constant. The other version is considered in a new-keynesian framework, basically in Blanchard, Mankiw and Corden; in this version V can be not constant. Then, if the macroeconomic aggregate demand function considered in our problem is typically unit-elastic such as Lucas (1973) or Corden (1980) case: P.y = M.V, fluctuations in the amount of money (M) can affect output (y) in a Keynesian framework. In a Neoclassical framework, fluctuations in the amount of money affect level of prices (P) only, because money velocity (V) is constant in this model. In a conventional Keynesian model, the income velocity of circulation is not a relevant variable because the aggregate demand function here considered is not generally unit-elastic, and V results an erratic variable. One important question that we are worried about, is: If income velocity of circulation is neither constant nor a erratic ratio, but it is a conventional variable, can then V affect the output or prices? Maybe the income velocity of circulation (V) was a variable neither so erratic as some authors say, nor a short-run constant as others say. The fact that V was identically equal to the ratio of two macroeconomic variables such as nominal income and the stock of money, both measured in nominal terms, means that V was only measurable as a real figure. Surely, it should be somewhat more considered Irving Fisher's (1911) observation, in the sense of velocity being a variable also depending on the state of transports and communications' infrastructure, as well as institutional factors apart from the well-known macroeconomic variables such as the price level, real income, the interest rate, the inflation rate or, conversely, the stock of money. A preliminary attempt in this analysis has been made by Mulligan and Sala i Martin (1992). These authors estimate a money demand function using data for 48 US states covering the 1929-1990 period, where population density was included as an additional explanatory variable. They find a significant role for this variable in the explanation of US money demand patterns during that period.

The main aim of this paper is to analyze whether several space variables stemming from the cities and transportation systems would affect the quantity of money demanded in the equilibrium, and hence the income velocity of circulation. In this model, the income velocity of circulation is theoretically not constant but it is a variable incorporated in some unit-elastic aggregate demand functions such as the Corden case. We study the possible relationship between money velocity (as a proxy for money demand), and several space variables, fundamentally derived from the Baumol-Tobin model of transactions demand for money. The specification of this model is in section 2 of this paper and section 3 contains an application. Finally in section 4 there are some implications in the macroeconomic equilibrium and the section 5 contains the conclusions.

2. **THEORETICAL MODEL**

In this section, we will study the possible existence of a relationship between economic geography variables and velocity and, in such a case, to specify a model which embodying some of the considerations made previously. As a starting point for this analysis, we will establish some previous hypotheses. First, with the aim of simplifying the process, we will assume that money is only demanded for transactional purposes. This restriction does not mean any loss of generality regarding the results, and might be relaxed by including the precautionary and speculative motives in the equation of the demand for money. Second, we assume that money market is in equilibrium. Third, we will use as the money stock the M1 money aggregate, that is, currency in the hands of the public plus sight deposits. The specification of the model will be based in the three following points: i) some expansion on the Baumol-Tobin model for transaction money demand. ii) An unit-elastic aggregate demand MV, where V is considered as a conventional variable. iii) The spatial central places theory starting from Christaller and Lösch.

Under these assumptions, we will follow, first, the transactions demand for money approach due to Baumol (1952) and Tobin (1956). This is a Keynesian-type approach in which the optimum number of exchanges between bonds and money made by an individual agent, is related with individual nominal income. Other additional restriction is given by the consideration of a representative agent, which obtains with a monthly frequency a certain level of nominal income (Y_m). If the volume of every exchange between bonds and money is always the same (Z) and the agent makes n exchanges, it can be said that:

$$nZ = Y_m \qquad \{2\}$$

The average monthly balance (m) will be in any case Z/2, and, because of that:

$$m = Z/2 = Y_m/(2n) \qquad \{3\}$$

that is, given the number of exchanges and people's nominal income, we can know the average money balance in nominal terms kept by the agent (m). If the nominal interest rate is r, the opportunity cost of keeping money will be:

$$rm = rY_m/(2n). \qquad \{4\}$$

We will assume that the agents incur a fixed nominal cost (b) every time an exchange is made. The total cost of keeping money for frequent transactions versus keeping bonds will be:

$$C = bn+(rY_m)/(2n) \qquad \{5\}$$

The number of monthly exchanges is optimom when the cost is minimum

$$\partial C/\partial n = 0 = b-(rY_m)/(2n^2) \Rightarrow \; n = (rY_m/2b)^{1/2} \qquad \{6\}$$

and it is easy to show that second derivatives fulfill condition of minimum. The average nominal balances that minimize the cost of maintaining money by agent and month is :

$$m = (bY_m / 2r)^{1/2} \qquad \{7\}$$

An agent obtains an income of $12Y_m$ per year and makes 12n exchanges. The annual nominal average balances (m_a) by individual is:

$$m_a = 12Y_m / (2(12n)) = Y_m /(2n) = m \qquad \{8\}$$

If we assume that the total population of the country is (PO), the total money demand for transactions (MD) is:

$$MD = PO.m_a = PO.m = (PO.b(12Y_m.PO)/(24r))^{1/2} \qquad \{9\}$$

where ($12Y_m$.PO) is the aggregate annual nominal income (Y). If the money market is in equilibrium we have that MD = MS (money supply) = M(quantity of money in circulation). The income velocity of circulation is defined as V = Y/M, and after substituting we have:

$$V = (24rY/PO.b)^{1/2} \qquad \{10\}$$

and separating the nominal interest rate:

$$V = (24(\rho + \pi)Y / PO.b)^{1/2} \qquad \{11\}$$

where π is the inflation rate and ρ the real interest rate. The last expression explains V as a function of some conventional macroeconomic variables, except for PO. The total number of optimal exchanges that the total population of the country made during a year is:

$$N = 12n.PO = (6rY.PO/b)^{1/2} \qquad \{12\}$$

and hence:

$$V = (24rY/(b.PO))^{1/2} = (2/PO)(6rY.PO/b)^{1/2} = 2N/\ PO \qquad \{13\}$$

which is a result similar to that obtained in Barro (1991). N is the total number of annual exchanges in the country but also means the number of journeys for changing money to make annual transactions. Perhaps there exists correlation between the number of exchanges made within a certain area during a year, and the total number of journeys made during that time in that area for made several transactions. These journeys are made by several transport systems. We only consider two of them ir our model: road and railway transport but not air, sea and walking transportation, because the impact on land of these last systems is small. At the same time, there are, as usually passenger and freight transportation.

The application of the model which we try to specify is going to take place in the context of the so-called metropolitan areas, in a broad sense. The basic configuration of these ones comes from the analysis by Christaller (1933) and Lösch (1954), who in a simplified way, infer that in the center of the area there exist a central place, which is the most important center of population. Approximately in the middle of the central place there is the so-called central business district, which usually includes the markets for consumption and investment goods being the most important in that area, and where some goods non existing in any other place of the area can be purchased. Surrounding the central place and at a certain distance, there are usually six important, and similar, population centers, smaller than the central place. Each of these second-order centers is surrounded by approximately six other third-order centers, including markets for basic goods.

We consider for the analysis of the number of journeys the simplest cities system of W. Christaller: A metropolitan area with a central place and six small similar cities around. The Christaller's system assumes monopolistic competition in partial equilibrium with vertical product differentiation in Chamberlin sense. Our preference for this type of differentiation versus the horizontal differentiation from Hotelling (1929) until Fujita and Krugman (1992) is due to reasons of simplicity, and because there are not fall in the generality of this problem. Following this simple model, if population of the central place is PC , and the population of each satellite city is P_i , the number of journeys generated between central place and one satellite city can be expressed according to a gravity model:

$$n_c = \beta.\ PC.P_i\ /\ d^{\alpha} \qquad \{14\}$$

where β and α are constants to be estimated, and (d) is the distance between cities. If we consider that PO is the total area population, then total journeys across the center is:

$$Nc = 6\beta.PC.P_i / d^{\alpha} = (\beta/ d^{\alpha})(PC.PO-(PC)^2) \qquad \{15\}$$

If we assume, for simplicity, that β and α are constant into the area, the transversal journeys generated between satellite cities is:

$$Nt = 6\beta(P_i)^2/d^{\alpha} = (\beta/6d^{\alpha})((PO)^2\text{-}2\ PC.PO + (PC)^2) \qquad \{16\}$$

The total number of journeys generated in the area and expressed in journeys per head will be:

$$Ncs /PO = (Nc + Nt)/PO = (\beta/6d^{\alpha})((PO)^2 + 4\ PC.PO - 5(PC)^2) \qquad \{17\}$$

In the same sense, and remembering that in our model we consider only the road and railways transportation, we can try now to calculate the number of journeys made into a metropolitan area by both transportation systems. Following Thomas (1993), Valdés (1988) and Button et al.(1993) for road transportation, the generation and attraction of traffic by road is a function of cars and trucks stock and the cars / trucks ratio in the area. Considering that the greater part of this traffic is by cars, a possible function of road traffic's generation-attraction is:

$$Nrd = k.(AUT).\phi_1(CAM, AUT/CAM) \qquad \{18\}$$

where (Nrd) is the total number of road journeys, by cars and trucks, into the area, AUT is cars' stock, CAM is trucks' stock, both in circulation, k is a constant and ϕ_1 is a function. The total journeys by road system per head are:

$$Nrd / PO = k(PC / PO)(AUT/ PC).\phi_1(CAM, AUT/CAM) \qquad \{19\}$$

In the same way, following Izquierdo (1982), Oliveros (1983) and Friedlaender et al.(1993) for railways transportation system , the total journeys during a year by train are dependent basically on passenger-kilometer (PASKM) and net ton-kilometer (TNKM) carried and PASKM/TNKM ratio. Passengers-kilometer is defined as the sum of kilometers traveled by each passenger per year. Net ton-kilometer is the sum of kilometers that each ton is carried per year. Considering that the greater part of traffic's volume by railways are freight, a possible function for the volume of traffic is:

$$Nrw = k.(TNKM).\phi_2(PASKM, PASKM / TNKM) \qquad \{20\}$$

where (Nrw) are journeys by railway, passengers and freight, into the area during a year, k is some constant and ϕ_2 is a certain function. The traffic volume per inhabitant will be:

$$Nrw/PO = k(PC/PO)(TNKM / PC).\phi_2(PASKM, PASKM / TNKM) \qquad \{21\}$$

The total number of journeys (Nts) due to the transportation system into the area during a year is Nts = Nrd + N rw. In per capita terms it is expressed:

$$Nts/PO=\lambda(PC/PO)((AUT/PC).\phi_1(CAM,\ AUT/CAM)+(TNKM/PC).\phi_2(PASKM,\ PASKM\ /\ TNKM)). \quad \{22\}$$

where λ is a parameter to be estimated. It can be useful to remember here that the total number of journeys per capita due to the cities system was:

$$Ncs\ /\ PO = (\mu\ /\ d^{\alpha})(PO + 4PC(1-(5/4)(PC/PO))) \quad \{23\}$$

where μ is a constant. Both systems (transportation and cities) provide different variables for explaining the same problem that is the total individual journeys made during a year within an area. Hence, it must exist a certain probability that journeys' explanatory variables will be a composition, probably non linear, of these two systems.

By simplifying explanatory variable names, we will call PCPO to PC/PO; AUTPC to AUT/PC ; AUTCAM to AUT/CAM; PKMTKM to PASKM/TNKM ; and TKMPC to TNKM/PC. With these considerations, total journeys per head can be expressed as a function as follows:

$$N^*/PO = f\ (PO,\ PC,\ PCPO,\ CAM,\ PASKM,\ AUTPC,\ TKMPC,\ AUTCAM,\ PKMTKM) \quad \{24\}$$

If there exists some correlation between the total journeys and the journeys for exchanges between bonds an money, we will have:

$$N\ /\ PO = \varphi(N^*/\ PO) \quad \{25\}$$

but remembering equation (13): V(money velocity) = $2N\ /\ PO = 2\varphi(N^*/\ PO)$, we have the final specification of the income velocity of circulation model as follows:

$$V = F\ (PO,\ PC,\ PCPO,\ CAM,\ PASKM,\ AUTPC,\ TKMPC,\ AUTCAM,\ PKMTKM) \quad \{26\}$$

where income velocity (V) is made dependent on the population of the main city of the concerned country (PC), the country's total population (PO), the ratio of PC to the country's total population (PCPO), the number of road passenger vehicles located into the country divided by population of country's first city (AUTPC), the number of trucks located into the country (CAM), the number of passenger-kilometer transported by railways (PASKM), the passengers-kilometer/ net ton-kilometer railways ratio (PKMTKM), the cars/trucks road ratio (AUTCAM), and the number of net ton-kilometer transported by railways divided by population of country's first city (TKMPC). All the variables are referred to a particular year.

3. EMPIRICAL MODEL

The specification of the theoretical model embody probably a non linear model, but following the standard formulation of panel techniques and again for simplicity, the model which was finally estimated was a linear one such as:

$$V_{it}=\alpha_{it}+\mu_i+B_1(PCPO)_{it}+B_2(PC)_{it}+B_3(PKMTKM)_{it}+B_4(AUTCAM)_{it}+B_5(PASKM)_{it}+ \\ +B_6(AUTPC)_{it} + B_7(PO)_{it} + B_8(CAM)_{it} + B_9\,(TKMPC)_{it} + \xi_{it} \qquad \{30\}$$

where V is the endogenous variable and the rest are the explanatory variables. Although the specification of the model according to Christaller is expected to be applied to metropolitan areas, there exist several difficulties to collect some of the data. Specifically there are not generally M1 data for regions and even less for metropolitan areas. Moreover, the area's surface do not appear into the specification of the theoretical model. In the specification of the model, the central place theory is applied to calculate the total journeys into a metropolitan area, but the total population of one country is basically the addition of the populations of all metropolitan areas in the country. The total number of journeys made into the country are the addition of journeys into each metropolitan area plus the journeys among these areas. Total number of journeys in a country is a linear function of the journeys made into a metropolitan area. These are the reasons to try the application of the model to several countries.

The variables are measured as follows: V is the ratio between GDP at market prices and M1 monetary aggregate, both in national currency units; PC and PO are measured in millions inhabitants; The ratio PCPO is an agglomeration index measured as 100(PC/PO); the ratios AUTCAM and PKMTKM are directly AUT/CAM and PASKM / TNKM, respectively; AUT and CAM are measured in thousands units; PASKM and TNKM are both measured in millions, and AUTPC and TKMPC are directly AUT/PC and TNKM/PC respectively. Velocity (V) and the AUTCAM and PKMTKM are real numbers; the AUTPC ratio is measured in physical quantities divided by physical quantities, and the rest of variables are measured in physical quantities. All variables are hence deflated.

The data set includes yearly variables for 64 countries (19 European, 17 Asian, 14 African, and 14 American), and the period of 14 years (1978 to 1991). All countries of the sample have road and railways transportation system, and only a small group of countries with railways transportation are excluded from the sample because of incomplete data In Figure 1, we can observe some spatial correlation in the endogenous variable, income velocity of circulation, among several countries as say Anselin and Florax (1995). The data are collected basically from several sources, mainly: National Accounts Statistics, Tables 1992. United Nations Statistical Year Book, 37-38-39 issues; United Nations. International Financial Statistics Yearbook, (1994); International Monetary Fund. Statistical Trends in Transport, (1965-1989); E.C.M.T. World Tables, (1991). World Bank and The Europe Year Book, (1989). E.P.L. A group of relevant data are shown in Table 1.

The former model has been estimated using panel data techniques, following the basic references of Hsiao (1986) and Green (1993). This is the way to take advantage when time series data are few and control country specific heterogeneity which states constant over time. We make the estimation using basic panel data techniques, i.e. OLS, between groups, within-groups and GLS. Afterwards, we test the hypotheses embodied amongst these methods. First, we estimate specification (26), although we present in Table 2 the results after dropping the non-significant regressors.

Under the hypothesis of absence of correlation in the residuals, method III provides the best results. This is so, because the Hausman test detects the presence of correlation between the effects and the explanatory variables which make all other set of estimates inconsistent. Under the hypothesis of first order serial correlation in the residuals, we choose model VII because of several reasons: i) the Lagrange multiplier test rejects the homogeneous OLS. ii) the Hausman test rejects the fixed effects or within-groups results in favor of this random effects specification, despite its low predictive capability.

On the other hand, in the specification of the theoretical model appear the distance (d) as a variable that we do not finally consider. However, Fotheringham and O'Kelly (1989) obtain some formulations linking distance and surface. Calling surface (SF), equation (23) above becomes: $Ncs/PO = \alpha\ (PO/SF) + \beta\ (PC/SF) + +\gamma(PC/SF)(PC/PO)$, where α, β and γ are parameters. It is necessary to note that (PO/SF) is the population density which now appears in model' specification. Other new variables which appear in this specification are surface (SF), or also (PC/SF). Mulligan and Sala i Martin (1992) introduce population density in their model as explanatory variable of money demand in the U.S. Surface (SF) is measured in thousands of squared kilometers. Population density is defined by 1000(PO/SF) and called DENSID in our model , and the other new variable called PCSS is defined by 1000(PC/SF). Thus, we add these new variables to our specification. The omitted variables being non-significant are surface (SF) and (PCSS). Population density (DENSID) is significant in some models.

As regards the explanatory variables, all have significant coefficients. Population density appears only in the random effects model, but the rest of regressors are the same in both models and with same sign, positive for PCPO, PC, AUTCAM, and PKMTKM, and negative for PASKM, and AUTPC. Country's surface is non-significant in any relevant model and hence we can, probably, extend the analysis beyond metropolitan areas. Hence the best explanation of income velocity of circulation mean spatial explanatory variables is the VII model of Table 2, where money velocity has linear dependence only with the following seven spatial variables:

$$\begin{aligned}V &= \Phi_o + \Phi_1 PCPO + \Phi_2 PC + \Phi_3 PKMTKM + \Phi_4 AUTCAM + \Phi_5 PASKM + \\ &+ \Phi_6 AUTPC + \Phi_7 DENSID\end{aligned} \qquad \{32\}$$

The second empirical model links the quantity of money in equilibrium and the identical explanatory variables of money velocity. These explanatory variables may be to explain also the quantity money on circulation according to the following model:

$$\begin{aligned}M_{it} = \beta_{it}+\mu_i +A_1(PCPO)_{it}+A_2(PC)_{it}+A_3(PKMTKM)_{it}+A_4(AUTCAM)_{it}+A_5(PASKM)_{it} + \\ +A_6(AUTPC)_{it}+A_7(PO)_{it}+A_8(CAM)_{it}+A_9 (TKMPC)_{it}+A_{10} (DENSID)+\xi_{it}\end{aligned} \qquad \{33\}$$

where M is the quantity of money on circulation in equilibrium and is measured in US dollars in power purchasing parity terms, following the PWT data base developed by Summers and Heston (1991). The correlation among the endogenous variable and spatial explanatory variables is not a spurious one because from equation (12) we have the following specification: M = (b.PO/24.r)V and hence the explanatory variables of V can theoretically to explain M. In this formulation appears the nominal interest rate, but under the hypothesis of Mundell-Fleming model for small economies, we can assume that it is almost constant among economies because them accept the interest rate of rest of the world, which is the interest rate of developed countries, as say in Mundell (1963). The interest rate fluctuations are only variations in the time but not crossection variations. The estimation of this model is reported in Table 3.

We can observe that the best method of estimation is 2SLS (column XIII), with all explanatory variables being significantly different from zero. The spatial explanatory variables of Income Velocity of circulation can also explain the quantity of money in circulation, an hence, the aggregate unit-elastic demand. The estimation of this model show that money (M1) in equilibrium measured in power parity purchasing terms depend of the same spatial variables that income velocity of circulation accord the following equation:

$$Mppp = \Psi_o + \Psi_1 PCPO + \Psi_2 PC + \Psi_3 PKMTKM + \Psi_4 AUTCAM + \Psi_5 PASKM + \\ +\Psi_6 AUTPC + \Psi_7 DENSID \qquad \{34\}$$

According to results in Tables 1 for Velocity, and 2 for Money in equilibrium, we can deduce that PCPO, PC and PKMTKM affect the endogenous variables V and M in same sense, and hence affect the unit-elastic aggregate demand. The another four explanatory variables affect the two endogenous variables in opposite sense. For checking the impact on aggregate demand of these explanatory variables, if we follow the same assumption of unit-elastic aggregate demand, we must estimate the relationship between monetary income, that is the result of multiplying V and M, and all spatial explanatory variables of V and M. The relationship among nominal income and the spatial explanatory variables is not a spurious one, because from equation (12) we obtain the following specification: $I = (b.PO/24.r)V^2$ where I is the nominal income, and r is the nominal interest rate. The considerations on the nominal interest rate are the same that in the estimation of money in equilibrium. The model is not linear but for simplicity we will linearize in order to estimate a classic panel data model. The results of this estimation are shown in Table 4.

The best estimators come from the 2SLS method again, where we assume that the residuals follow a first order autorregressive process (column XXII).This model may be expressed as follow:

$$Monetary = \Omega_o + \Omega PCPO + \Omega PC + \Omega_3 PKMTKM + \Omega_4 AUTCAM + \Omega_5 PASKM + \\ +\Omega_6 AUTPC + \Omega_7 DENSID \qquad \{35\}$$

The results of the estimation of the nominal income indicate that the variables PASKM and AUTPC finally affect the one-elastic aggregate demand in the same sense that PCPO, PC and PKMTKM, and hence all these affect without doubt the aggregate demand. On the other hand, AUTCAM and DENSID affect the unit-elastic aggregate demand in opposite sense.

4. SPATIAL EFFECTS ON MACROECONOMIC EQUILIBRIUM

The spatial effects on real income measured in power parity purchasing (yppp) has been estimated utilizing the same explanatory variables, because the specification of the model coming from the Baumol-Tobin model. The results of estimation are due to within groups method of panel data when the residual autocorrelation is corrected mean a first order autorregressive process. This estimation is the following:

$$\begin{gathered}yppp = \mu_{ij} + \underset{(11.40)}{77.32}(PC) - \underset{(-4.19)}{36.47}(AUTCAM) + \underset{(2.60)}{0.00124}(PASKM) + \underset{(14.36)}{0.1577}(AUTPC) - \\ -\underset{(-3.21)}{0.7681}(DENSID)\end{gathered} \quad \{36\}$$

where μ_{ij} are the fixed effects, and t-ratios are in brackets. In same way, the estimation of real income measured by World Bank method (yreal) is collected in the following expression:

$$\begin{gathered}yreal = \underset{(-1.78)}{-151.94} + \underset{(13.08)}{80.51}(PC) - \underset{(-3.54)}{25.56}(AUTCAM) + \underset{(4.18)}{0.00190}(PASKM) + \\ +\underset{(18.17)}{0.1831}(AUTPC) - \underset{(-4.59)}{1.0152}(DENSID)\end{gathered} \quad \{37\}$$

This estimation are made by the random effects model of panel data technique. Same very evident that the two estimations of real income above mentioned are very similar. The impacts of spatial variables on prices level, considering the seven explanatory variables of income velocity of circulation, have the following form:

$$\begin{gathered}Deflpib = \Gamma_o + \Gamma_1 PCPO + \Gamma_2 PC + \Gamma_3 PKMTKM + \Gamma_4 AUTCAM + \Gamma_5 PASKM + \\ +\Gamma_6 AUTPC + \Gamma_7 DENSID\end{gathered} \quad \{38\}$$

where Deflpib is the indicator of general level price; the estimation of these parameters are due to within groups AR1 model of panel data. The results of estimation are the followings:

$$\begin{gathered}Deflpib = \mu_{ij} + \underset{(2.78)}{0.1739}(PCPO) + \underset{(6.36)}{0.0997}(PC) + \underset{(3.10)}{0.03253}(PKMTKM) - \\ -\underset{(-2.15)}{0.0000025}(PASKM) + \underset{(3.02)}{0.000072}(AUTPC)\end{gathered} \quad \{39\}$$

With all these specifications and estimations we can observer what is the total impact on one-elastic aggregate demand and macroeconomic equilibrium, that is, the impact that spatial explanatory variables of income velocity of circulation cause on prices level and output in equilibrium.

Moreover, may be that some spatial explanatory variables can be influenced by the circular flow of real income. For verify this question we try to estimate the following equations system, for dependence of real income in power parity purchasing:

$$\begin{cases} PCPO = PCPO_o + \alpha(yppp) \\ PC = PC_o + \beta(yppp) \\ PKMTKM = PKMTKM_o + \gamma(yppp) \\ AUTCAM = AUTCAM_o + \delta(yppp) \\ PASKM = PASKM_o + \chi(yppp) \\ AUTPC = AUTPC_o + \nu(yppp) \\ DENSID = DENSID_0 + \omega(yppp) \\ yppp = \varphi_0 + \varphi_1 PCPO + \varphi_2 PC + \varphi_3 PKMTKM + \varphi_4 AUTCAM + \varphi_5 PASKM + \\ +\varphi_6 AUTPC + \varphi_7 DENSID \end{cases} \quad \{40\}$$

where the terms sub ($_0$) are autonomous components not dependents of real income; in the same sense, we estimate the following equations system for real income dependence, when the income is measured by World Bank method:

$$\begin{cases} PCPO = PCPO_O + \lambda(yreal) \\ PC = PC_O + \tau(yreal) \\ PKMTKM = PKMTKM_O + \zeta(yreal) \\ AUTCAM = AUTCAM_O + \eta(yreal) \\ PASKM = PASKM_O + \pi(yreal) \\ AUTPC = AUTPC_O + m(yreal) \\ DENSID = DENSID_O + g(yreal) \\ yreal = \theta_O + \theta_1 PCPO + \theta_2 PC + \theta_3 PKMTKM + \theta_4 AUTCAM + \theta_5 PASKM + \\ +\theta_6 AUTPC + \theta_7 DENSID \end{cases} \tag{41}$$

The results of this two estimations are collected in Tables 5 and 6. And the total impact of spatial variables on macroeconomic equilibrium is shown in Table 7. In this table the endogenous variables are the real income at power parity purchasing (yppp), the real income measured by the World Bank (yreal), the price level (deflpib), monetary income (monetary), and those mentioned above M (mppp) and V (velocid).

There are two type of coefficients in the table, similar to keynesian multipliers, that explain the variations of the endogenous variables when changing the value of some explanatory variable. The first coefficient indicates this variation when the model shows real income dependence (yppp or yreal). This impact is added to the impact caused by the autonomous component of the explanatory variable plus all impacts caused by the explanatory variables after the variation in real income. The generic form of this coefficient is:

$$\frac{\partial(yppp)}{\partial(PCPO_o)} = \frac{\varphi_1}{1-\varphi_1\alpha-\varphi_2\beta-\varphi_3\gamma-\varphi_4\delta-\varphi_5\chi-\varphi_6\nu-\varphi_7\omega} \tag{42}$$

This coefficient means the variation in yppp when change the autonomous component of PCPO, ($PCPO_0$), considering that some spatial explanatory variables of money velocity are dependents of real income (yppp). In same sense, the following multiplier means the variation of velocity when change $PCPO_0$, considering that some spatial variables are real income dependents (yreal):

$$\frac{\partial(VELOCID)}{\partial(PCPO_o)_{yreal}} = \Phi_1 + \frac{\theta_1(\Phi_1\lambda+\Phi_2\tau+\Phi_3\zeta+\Phi_4\eta+\Phi_5\pi+\Phi_6 m+\Phi_7 g)}{1-\theta_1\lambda-\theta_2\tau-\theta_3\zeta-\theta_4\eta-\theta_5\pi-\theta_6 m-\theta_7 g} \tag{43}$$

The second type of coefficient, named by a greek letter, is simply the regression coefficient and indicate the variation on the endogenous variable when the explanatory variable is independent of real income and another explanatory variables. This coefficient reflects only the impact caused by the autonomous component of the explanatory variable, caeteris paribus another explanatory variables and real income. How significant are these coefficients are measured by means of the t-ratios, in brackets in this table 7.

5. **CONCLUDING REMARKS**

In this paper I have specified a model which links the income velocity of circulation and some geographical variables. The model is constructed assuming a unit-elastic aggregate demand function which contains the income velocity of circulation as conventional variable. The central point of the theoretical specification was the Baumol-Tobin model for transaction money demand. The connections with the Spatial Economy come from basically of Christaller's central place theory and some gravity models for the transportation system. The model is estimated using panel data techniques for a sample of 64 countries during 14 years. The best results are obtained in the random effects model making a correction by assuming a first order autorregresive process in the residuals. We have found a positive relationship between the income velocity of circulation and the ratio between central place and total country' population, the ratio between cars and trucks stock in the country, the ratio between passenger-kilometer and net ton-kilometer transported by railways into the country and finally the central place population in absolute terms. We also have found a negative relationship among income velocity of circulation and the passenger-kilometer transported by railways in absolute terms, and the ratio between cars' stock and central place population. The regression coefficients show the variation of the income velocity of circulation when fluctuating each explanatory variable; and hence, the income velocity of circulation increases when increasing the variables whose coefficients are positive, like the ratio between central place and total country's population (PCPO), the ratio between cars and trucks stock (AUTCAM), the ratio between passenger-kilometer and net ton-kilometer transported by railways (PKMTKM), the central place population (PC) and the population's density (DENSID), or when decreasing the explanatory variables whose coefficients are negative, i.e., the passenger-kilometer in absolute terms transported by railways (PASKM) and, the ratio between cars' stock and central place population (AUTPC). The variables PCPO, PC and PKMTKM affect the total aggregate demand in same sense causing fluctuations in output and prices level, that are cause of nominal friction. If the variables DENSID and AUTCAM coming down, or rise the another spatial explanatory variables, then output also rise.

Fluctuations in PCPO and PKMTKM not affect the output. Prices level rise if PASKM come down or the another spatial variables goes up. Fluctuations in DENSID and AUTCAM not affect the prices level. If the spatial explanatory variables are income dependents, impacts on output are the same that if not are income dependents. Moreover in this case, if rise AUTCAM or DENSID, or coming down AUTPC, then prices level come down. Space apparently affect the economic equilibrium and maybe a cause of non neutrality in money market.

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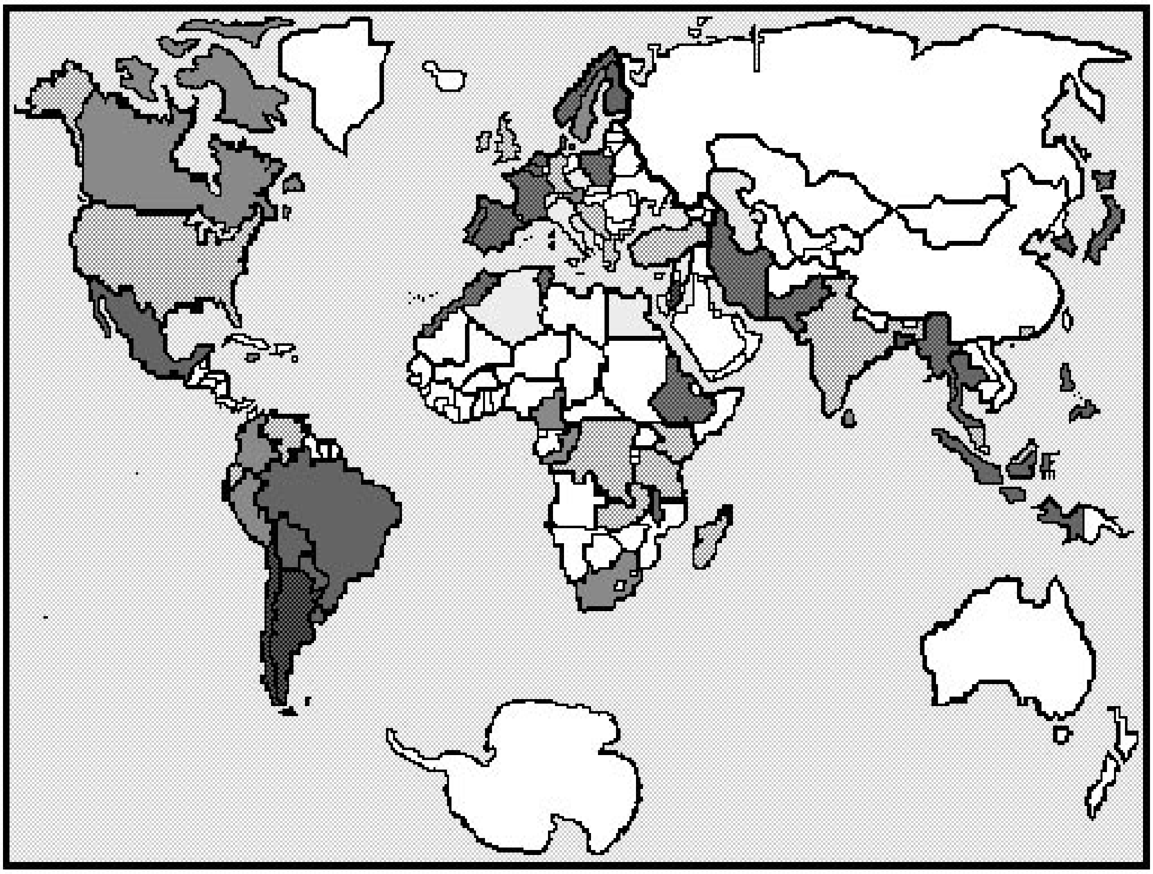
FIGURE 1. Spatial Distribution of Average Money Velocity in the World. Period 1978-91



Av.Velocity: **(1-3)** (yellow) **(3-5)** (red) **(5-7)** (brown) **(7-9)** (orange) **(9-11)** (green-blue) **(11-13)** (green) **(13-19)** (blue) **(Out panel)** (white)

EUROPE

W.Germany 5.7
Austria 7.0
Belgium 4.7
Czechoslovakia 2.5
Denmark 4.2
Spain 3.8
Finland 12.4
France 3.5
Greece 5.7
Netherland 4.6
Ireland 6.9
Italy 2.5
Norway 4.8
Poland 4.0
Portugal 3.1
United Kingdom 5.3
Sweden 8.3
Switzerland 2.8
Yugoslavia 5.0

ASIA

Bangla Desh 10.0
South Korea 10.2
Philippines 12.5
Hong Kong 5.7
India 6.4
Indonesia 9.3
Iran 3.4
Israel 18.7
Japan 3.3
Jordan 2.0
Malaysia 5.1
Myanmar 4.8
Pakistan 3.6
Sri Lanka 7.8
Syria 2.1
Tahiland 10.2
Turkey 6.7

AMERICA

Argentina 15.2
Bolivia 12.3
Brasil 11.0
Canada 7.8
Chile 14.8
Colombia 8.1
Ecuador 6.9
U.S.A. 6.2
Jamaica 7.1
Mexico 12.5
Paraguay 9.9
Peru 8.9
Uruguay 11.1
Venezuela 5.5

AFRICA

Algeria 1.7
South Africa 7.5
Cameroon 7.7
Congo 7.3
Egypt 2.7
Ethiopia 4.0
Kenya 6.7
Madagascar 6.2
Malawi 9.8
Morocco 3.4
Tanzania 4.2
Tunisia 3.5
Zaïre 5.1
Zambia 6.0

TABLE 1. Relevant Data across Countries

Country	**Algeria**	**Cameroon**	**Congo**	**Egypt**	**Ethiopia**	**Kenya**	**Madagasc.**	**Malawi**
Money Unit	dinars	francs	francs	pounds	birr	shillings	francs	kwacha
Averag.Vel.	1.700	7.738	7.300	2.717	4.097	6.723	6.238	9.873
PO-1980	18.67	8.50	1.53	42.13	38.75	16.67	8.78	6.05
PO-1990	25.01	11.83	2.27	52.69	51.69	24.03	11.20	8.29
1st.City	Alger	Douala	Brazzaville	Cairo	Addis Abeba	Nairobi	Tananarive	Blantyre
PC-1980	1.5	0.27	0.48	5.8	1.3	0.81	0.41	0.25
PC-1990	3.0	0.77	0.63	9.0	1.8	1.5	0.67	0.36

Country	**Morocco**	**Tanzania**	**Tunisia**	**Zaïre**	**Zambia**	**SouthAfrica**	**Argentina**	**Bolivia**
Money Unit	dirhams	shillings	dinars	new zaïres	kwacha	rands	pesos	bolivianos
Averag.Vel.	3.416	4.200	3.573	5.190	6.066	7.516	15.272	12.390
PO-1980	20.05	18.58	6.39	26.38	5.56	28.28	28.24	5.60
PO-1990	25.06	25.63	8.07	35.56	8.07	37.96	32.32	7.40
1st.City	Casablanca	Dar es salaa	Tunis	Kinshasa	Lusaka	Johanesburg	BuenosAires	La Paz
PC-1980	2.3	0.85	0.53	2.5	0.61	1.5	9.9	0.81
PC-1990	3.2	1.6	1.1	3.5	0.99	2.3	11.5	1.2

Country	**Brazil**	**Canada**	**Chile**	**Colombia**	**Ecuador**	**U.S.A.**	**Mexico**	**Paraguay**
Money Unit	cruzeiros	can.dollars	pesos	pesos	sucres	US dollars	new pesos	guaranies
Averag.Vel.	11.004	7.876	14.881	8.185	6.904	6.273	12.599	9.981
PO-1980	121.29	24.04	11.14	25.89	8.12	227.76	69.66	3.15
PO-1990	150.37	26.58	13.17	32.99	10.78	249.92	86.15	4.28
1st.City	Sao Paulo	Toronto	Santiago	Bogota	Guayaquil	New York	Mexico DF	Asuncion
PC-1980	6.9	2.9	3.8	4.1	1.0	17.1	8.8	0.70
PC-1990	11.4	3.4	4.3	4.8	1.7	16.2	14.2	0.97

Country	**Peru**	**Uruguay**	**Venezuela**	**Jamaica**	**Bangladesh**	**SouthKorea**	**Philippines**	**India**
Money Unit	new soles	pesos	bolivares	jam.dollars	taka	won	pesos	rupees
Averag.Vel.	8.936	11.145	5.589	7.127	10.031	10.221	12.536	6.410
PO-1980	17.30	2.91	15.02	2.13	88.68	38.12	48.32	675.00
PO-1990	21.55	3.10	19.33	2.41	115.59	42.87	61.48	827.05
1st.City	Lima	Montevideo	Caracas	Kingston	Dacca	Seoul	Manila	Bombay
PC-1980	4.6	1.24	2.9	0.51	3.2	6.5	3.5	7.6
PC-1990	6.2	1.28	3.4	0.64	6.6	10.9	8.4	11.8

Country	**Indonesia**	**Iran**	**Israel**	**Japan**	**Jordan**	**Malaysia**	**Myanmar**	**Pakistan**
Money Unit	rupiah	rials	n.sheqalim	yen	dinars	ringgit	kyats	rupees
Averag.Vel.	9.392	3.452	18.739	3.380	2.028	5.140	4.894	3.616
PO-1980	147.49	39.30	3.88	116.81	2.92	13.70	33.64	82.58
PO-1990	179.30	54.61	4.66	123.54	4.01	17.76	41.67	112.03
1st.City	Yakarta	Teheran	Tel Aviv	Tokyo-Yok	Amman	Kuala Lum.	Rangun	Karachi
PC-1980	6.5	4.7	1.4	11.3	0.85	0.92	2.3	5.0
PC-1990	9.2	6.7	1.8	18.1	1.0	1.7	3.2	7.7

Country	**Sri Lanka**	**Syria**	**Tahiland**	**Hong-Kong**	**Turkey**	**Austria**	**Belgium**	**Czechoslov.**
Money Unit	rupees	pounds	baht	HK dollars	liras	schillings	francs	koruny
Averag.Vel.	7.846	2.109	10.221	5.770	6.705	7.095	4.713	2.500
PO-1980	14.75	8.70	46.72	4.9	44.47	7.55	9.85	15.31
PO-1990	16.99	12.12	56.08	5.9	56.07	7.60	9.84	15.66
1st.City	Colombo	Damasco	Bangkok	Victoria	Istanbul	Wien	Brüxels	Praha
PC-1980	0.58	1.0	4.6	4.5	4.5	1.5	1.0	1.1
PC-1990	0.62	1.8	7.1	5.3	6.6	1.9	0.95	1.2

Country	**Denmark**	**Spain**	**Finland**	**France**	**WGermany**	**Greece**	**Netherland**	**Ireland**
Money Unit	kroner	pesetas	markkaa	francs	deuts.marks	drachmas	guilders	pounds
Averag.Vel.	4.200	3.868	12.413	3.586	5.728	5.784	4.684	6.992
PO-1980	5.12	37.54	4.78	53.88	61.54	9.64	14.14	3.40
PO-1990	5.14	38.96	4.99	56.73	63.23	10.12	14.95	3.50
1st.City	Kϕbenhavn	Madrid	Helsinki	Paris	Hamburg	Atenas-Pireo	Amsterdam	Dublin
PC-1980	1.38	3.1	0.80	8.7	1.6	3.0	0.71	0.86
PC-1990	1.39	3.4	1.0	8.5	1.9	3.4	0.68	0.93

Country	**Italy**	**Norway**	**Poland**	**Portugal**	**U.K.**	**Sweden**	**Switzerland**	**Yugoslavia**
Money Unit	lire	kroner	zlotys	escudos	pounds	kronor	francs	new dinars
Averag.Vel.	2.593	4.891	4.027	3.140	5.375	8.334	2.886	5.058
PO-1980	56.43	4.09	35.58	9.77	56.33	8.31	6.32	22.30
PO-1990	57.66	4.24	38.12	9.87	57.41	8.56	6.71	23.82
1st.City	Roma	Oslo	Warszawa	Lisboa	London	Stockhölm	Zürich	Beograd
PC-1980	2.83	0.64	1.5	1.5	7.6	1.3	0.71	1.4
PC-1990	2.80	0.66	1.7	1.6	6.8	1.6	1.20	1.6

TABLE 2. Empirical Results of Income Velocity of Circulation (1978-1991)

Method:	I	II	III	IV	V	VI	VII
Endog.Var **VELOCID**	**Between**	**OLS**	**Within**	**Random**	**OLS AR1**	**Within AR1**	**Random AR1**
Expl.Var:							
PCPO	0.1552 (3.199)	0.1529 (11.22)	0.1109 (1.797)	0.1293 (3.621)	0.1540 (10.41)	0.1270 (4.896)	0.1283 (5.630)
PC	0.2779 (1.921)	0.2885 (7.202)	0.5763 (4.818)	0.4160 (5.134)	0.2630 (6.234)	0.1145 (1.856)	0.1507 (2.691)
PKMTKM	0.0273 (0.160)	0.0264 (0.588)	-0.207 (-0.38)	-0.397 (-0.07)	0.5558 (1.244)	0.1018 (2.291)	0.0981 (2.289)
AUTCAM	-0.783 (-0.39)	-0.505 (-0.94)	0.3339 (4.020)	0.2120 (2.889)	-0.135 (-0.02)	0.2604 (3.530)	0.2165 (3.241)
PASKM	-0.198 (-1.98)	-0.200 (-7.12)	-0.386 (-3.33)	-0.259 (-3.47)	-0.193 (-6.51)	-0.143 (-2.91)	-0.155 (-3.53)
AUTPC	-0.120 (-0.43)	-0.148 (-1.93)	0.1883 (1.051)	-0.163 (-1.21)	-0.186 (-2.33)	-0.256 (-2.38)	-0.268 (-2.73)
DENSID	0.5242 (1.231)	0.5154 (4.324)	-0.693 (-1.07)	0.2157 (0.667)	0.4967 (3.872)	0.4497 (1.825)	0.4402 (2.093)
Constant	3.8766 (3.307)	3.8123 (11.79)	Fixed Effects	3.1304 (4.222)	6.0706 (27.65)	Fixed Effects	5.9242 (5.688)
Tests:							
R^2	0.2940	0.2630	0.8837	0.0979	0.2484	0.8159	0.2081
R^2-adjusted	0.2008	0.2564	0.8730	0.0145	0.2411	0.7974	
DW			0.7638			2.0636	2.0676
Lagrang.M							2107.0
Hausman				21.508			0.0001

Note: t ratios in brackets.

TABLE 3. Empirical Results of Money in Equilibrium (M1 ppp. 1978-91)

Method	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
Endog var: **MPPP**	**Between**	**OLS**	**Within**	**Random Effects**	**2SLS Panel**	**2SLS AR1**	**OLS AR1**	**Within AR1**	**Random AR1**
Expl var.:									
PCPO	1.07565 (0.92)	1.07 (2.6)	0.0374 (0.025)	0.8177 (0.970)	1.1529 (2.875)	0.8323 (1.85)	0.94 (2.1)	-0.025 (-0.04)	0.2471 (0.473)
PC	12.9693 (3.94)	12.6 (11.)	6.598 (2.018)	7.7081 (3.801)	12.736 (11.24)	12.791 (11.15)	13.0 (10.)	12.257 (8.53)	12.23 (9.289)
PKMTKM	6.34367 (1.65)	5.80 (4.5)	0.7769 (0.623)	1.3014 (1.107)	6.2529 (4.718)	6.5904 (5.619)	5.22 (4.0)	3.3013 (2.98)	3.5153 (3.32)
AUTCAM	-4.8277 (-0.97)	-5.42 (-3.2)	-3.464 (-1.72)	-8.492 (-4.94)	-5.637 (-3.34)	-17.03 (-8.01)	-7.20 (-3.)	-13.62 (-6.90)	-12.508 (-6.804)
PASKM	0.00077 (3.35)	.7E-3 (9.8)	0.00149 (5.531)	0.00116 (6.803)	0.0007 (9.762)	0.0007 (9.157)	.8E-3 (9.3)	0.0008 (8.09)	0.00085 (8.95)
AUTPC	0.03416 (5.33)	0.03 (16.)	0.07837 (15.57)	0.05256 (16.034)	0.0352 (16.11)	0.0414 (19.06)	0.03 (15.)	0.0384 (15.44)	0.03864 (16.71)
DENSID	-0.17479 (-1.79)	-0.17 (-5.0)	-0.2587 (-1.44)	-0.2314 (-2.962)	-0.174 (-5.17)	-0.117 (-2.88)	-0.16 (-4.)	-0.140 (-2.65)	-0.1441 (-3.095)
Constant	-54.8014 (-1.92)	-51.8 (-5.3)	Fixed Effects	-32.462 (-1.761)	-53.27 (-5.43)	-16.77 (-0.86)	-75.9 (-10)	Fixed Effects	-22.68 (-0.82)
Tests:									
R^2	0.705	.689	0.97918	0.57389	0.6916	0.691	.696	0.9466	0.6855
R^2adjusted	0.666	.685	0.97586		0.6871	0.687	.691	0.9367	
DW			0.76321	0.75365	2.0761	1.905		2.8828	2.8869
F.		152.	294.95		153.81	153.8	137.	95.16	
Lagrang.M				1387.93					791.46
Hausman				57.2138					3.3956

Note: t ratios in brackets.

TABLE 4. Empirical Results of Monetary Income. (1978-1991)

Met.Estim:	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	XXV
Var.Endog: **MonetarY**	**Between**	**OLS**	**Within**	**Random Effects**	**2SLS Panel**	**2SLS AR1**	**OLS AR1**	**Within AR1**	**Random AR1**
Var.Expl:									
PCPO	4.20233 (0.71)	4.04 (2.0)	3.339 (0.54)	1.7577 (0.44)	4.3703 (2.17)	4.7071 (2.01)	3.95 (1.7)	1.2436 (0.41)	1.7515 (0.64)
PC	80.1184 (4.77)	79.3 (14.)	38.92 (2.84)	52.42 (5.62)	79.293 (13.9)	70.075 (11.11)	79.9 (12.)	72.121 (9.60)	73.684 (10.75)
PKMTKM	14.3825 (0.73)	13.0 (2.0)	0.479 (0.09)	1.578 (0.31)	14.107 (2.12)	13.238 (2.042)	9.99 (1.5)	4.2232 (0.75)	4.8516 (0.90)
AUTCAM	-41.9646 (-1.66)	-42.0 (-5.0)	-5.582 (-0.66)	-25.59 (-3.44)	-44.47 (-5.26)	-82.59 (-7.20)	-47.1 (-4.9)	-44.337 (-4.54)	-45.099 (-4.96)
PASKM	0.00138 (1.17)	.001 (3.5)	0.0037 (3.28)	0.0028 (3.55)	0.0013 (3.48)	0.0017 (3.896)	.001 (3.4)	0.0019 (3.43)	0.0018 (3.68)
AUTPC	0.18994 (5.82)	0.19 (17.)	0.3188 (15.15)	0.2417 (16.11)	0.1930 (17.6)	0.2182 (18.28)	0.19 (16.)	0.19155 (14.86)	0.1923 (16.17)
DENSID	-0.86011 (-1.73)	-0.85 (-5.0)	-1.0402 (-1.38)	-1.1827 (-3.12)	-0.858 (-5.08)	-0.833 (-3.75)	-0.86 (-4.5)	-0.9276 (-3.31)	-0.9044 (-3.70)
Constant	-209.95 (-1.44)	-203. (-4.1)	Fixed Effects	-171.69 (-1.96)	-203.4 (-4.14)	-61.03 (-0.68)	-272. (-7.4)	Fixed Effects	-179.04 (-1.44)
Tests:									
R^2	0.678	.668	0.9845	0.5613	0.670	0.670	0.66	0.95269	0.6598
R^2-adjusted	0.636	.663	0.9820		0.665	0.665	0.65	0.94386	
DW			0.8884	0.8849	0.321	1.8803		2.93796	2.93418
F.		138.	398.4		139.5	139.5	117.	107.91	
Lagrang.M				1495.11					893.054
Hausman				38.247					0.67049

Note: t- ratios in brackets.

TABLE 5. Regressions of Spatial Variables on Real Income (yppp). (1978-91)

Endog.Var	PCPO	PC	PKMTKM	AUTCAM	PASKM	AUTPC	DENSID
Estimatio Method:	**Within AR1**	**Random AR1**	**2SLS AR1**	**2SLS AR1**	**Random AR1**	**Random AR1**	**Within AR1**
Var.Expl: YPPP	-0.00419 (-5.71)	0.00345 (14.94)	-.0007 (-2.68)	.00042 (2.49)	35.006 (9.22)	2.1090 (13.45)	0.03267 (4.11)
Constant	Fixed Effects	4.6862 (7.23)	2.3969 (4.69)	3.9501 (4.73)	13966. (1.26)	1414.6 (2.73)	Fixed Effects
Tests:							
R^2	0.8826	0.41	0.0014	.0061	0.1443	0.26	0.9518
DW	3.0187	3.085	1.9431	1.909	3.2555	3.27	2.9912
F.	44.99		0.7159	3.000			118.24
Lagrang.M		857.34			936.88	919.65	
Hausman		0.9812			0.0658	0.0320	

Note: t ratios in brackets.

TABLE 6. Regressions of Spatial Variables on Real Income (yreal). (1978-91)

EndogVar	PCPO	PC	PKMTKM	AUTCAM	PASKM	AUTPC	DENSID
Estimatio Method:	**Within AR1**	**Random AR1**	**2SLS AR1**	**Random AR1**	**Random AR1**	**Random AR1**	**Within AR1**
Var.Expl: YREAL	-0.00443 (-6.86)	0.00304 (14.80)	-.2e-3 (-3.62)	0.00053 (2.45)	33.082 (9.91)	2.0786 (15.78)	0.0333 (4.54)
Constant	Fixed Effects	4.8036 (7.02)	1.9797 (3.85)	4.7967 (8.52)	14159. (1.29)	1383.6 (2.81)	Fixed Effects
Tests:							
R^2	0.88	0.36	.90e-4	0.028	0.1514	0.32	0.95
DW	3.0401	3.1793	1.94	2.3515	3.2856	3.3045	3.008
F.	46.83		0.044				117.9
Lagrang.M		900.05		1087.29	942.43	928.71	
Hausman		0.0242		0.07686	0.3117	0.1533	

Note: t ratios in brackets.

TABLE 7. Spatial Variables Impact on Real and Monetary Income, and Prices. Panel (1978-1991).

Exo.Var: Endogen:	PCPO	PC	PKMTKM	AUTCAM	PASKM	AUTPC	DENSID
yppp	$\frac{dYppp}{dPcpo_o}=0$ $\varphi_1=0$	$\frac{dYppp}{dPc_o}=$ $=194.46$ $\varphi_2=77.32$ (11.4)	$\frac{dYppp}{dPkmtkm_o}=0$ $\varphi_3=0$	$\frac{dYppp}{dAutcam_o}=$ $=-91.72$ $\varphi_4=-36.47$ (-4.19)	$\frac{dYppp}{dPaskm_o}=$ $=0.0031$ $\varphi_5=0.00124$ (2.60)	$\frac{dYppp}{dAutpc_o}=$ $=0.3966$ $\varphi_6=0.1577$ (14.36)	$\frac{dYppp}{dDensid_o}=$ $=-1.9318$ $\varphi_7=-0.7681$ (-3.21)
yreal	$\frac{dYreal}{dPcpo_o}=0$ $\theta=0$	$\frac{dYreal}{dPc_o}=$ $=224.09$ $\theta_2=80.51$ (13.08)	$\frac{dYreal}{dPkmtkm_o}=0$ $\theta_3=0$	$\frac{dYreal}{dAutcam_o}=$ $=-71.14$ $\theta_4=-25.56$ (-3.54)	$\frac{dYreal}{dPaskm_o}=$ $=0.0052$ $\theta_5=0.0019$ (4.18)	$\frac{dYreal}{dAutpc_o}=$ $=0.5096$ $\theta_6=0.1831$ (18.17)	$\frac{dYreal}{dDensid_o}=$ $=-2.825$ $\theta_7=-1.0152$ (-4.59)
deflpib	$\left.\frac{dDeflpib}{dPcpo_o}\right\|_{yppp}$ $=0.1739$ $\left.\frac{dDeflpib}{dPcpo_o}\right\|_{yreal}$ $=0.1739$ $\Gamma_1=0.1739$ (2.78)	$\left.\frac{dDeflpib}{dPc_o}\right\|_{yppp}$ $=0.0326$ $\left.\frac{dDeflpib}{dPc_o}\right\|_{yreal}$ $=-0.011$ $\Gamma_2=0.099$ (6.36)	$\left.\frac{dDeflpib}{dPkmtkm_o}\right\|_{yppp}$ $=0.032$ $\left.\frac{dDeflpib}{dPkmtkm_o}\right\|_{yreal}$ $=0.032$ $\Gamma_3=0.032$ (3.10)	$\left.\frac{dDeflpib}{dAutcam_o}\right\|_{yppp}$ $=0.0316$ $\left.\frac{dDeflpib}{dAutcam_o}\right\|_{yreal}$ $=0.0352$ $\Gamma_4=0$	$\left.\frac{dDeflpib}{dPaskm_o}\right\|_{yppp}$ $=-0.0000036$ $\left.\frac{dDeflpib}{dPaskm_o}\right\|_{yreal}$ $=-0.0000051$ $\Gamma_5=-0.0000025$ (-2.15)	$\left.\frac{dDeflpib}{dAutpc_o}\right\|_{yppp}$ $=-0.000064$ $\left.\frac{dDeflpib}{dAutpc_o}\right\|_{yreal}$ $=-0.00018$ $\Gamma_6=0.000072$ (3.02)	$\left.\frac{dDeflpib}{dDensid_o}\right\|_{yppp}$ $=0.00066$ $\left.\frac{dDeflpib}{dDensid_o}\right\|_{yreal}$ $=0.0013$ $\Gamma_7=0$
monetary	$\left.\frac{dMonetary}{dPcpo_o}\right\|_{yppp}$ $=4.3703$ $\left.\frac{dMonetary}{dPcpo_o}\right\|_{yreal}$ $=4.3703$ $\Omega_1=4.3703$ (2.17)	$\left.\frac{dMonetary}{dPc_o}\right\|_{yppp}$ $=205.93$ $\left.\frac{dMonetary}{dPc_o}\right\|_{yreal}$ $=216.16$ $\Omega_2=79.29$ (13.9)	$\left.\frac{dMonetary}{dPkmtkm_o}\right\|_{yppp}$ $=14.107$ $\left.\frac{dMonetary}{dPkmtkm_o}\right\|_{yreal}$ $=14.107$ $\Omega_3=14.07$ (2.12)	$\left.\frac{dMonetary}{dAutcam_o}\right\|_{yppp}$ $=-104.2$ $\left.\frac{dMonetary}{dAutcam_o}\right\|_{yreal}$ $=-87.92$ $\Omega_4=-44.47$ (-5.26)	$\left.\frac{dMonetary}{dPaskm_o}\right\|_{yppp}$ $=0.0033$ $\left.\frac{dMonetary}{dPaskm_o}\right\|_{yreal}$ $=0.0045$ $\Omega_5=0.0013$ (3.48)	$\left.\frac{dMonetary}{dAutpc_o}\right\|_{yppp}$ $=0.45$ $\left.\frac{dMonetary}{dAutpc_o}\right\|_{yreal}$ $=0.50$ $\Omega_6=0.193$ (17.6)	$\left.\frac{dMonetary}{dDensid_o}\right\|_{yppp}$ $=-2.11$ $\left.\frac{dMonetary}{dDensid_o}\right\|_{yreal}$ $=-2.58$ $\Omega_7=-0.858$ (-5.08)
mppp	$\left.\frac{dMppp}{dPcpo_o}\right\|_{yppp}$ $=1.1529$ $\left.\frac{dMppp}{dPcpo_o}\right\|_{yreal}$ $=1.1529$ $\Psi_1=1.1529$ (2.87)	$\left.\frac{dMppp}{dPc_o}\right\|_{yppp}$ $=37.11$ $\left.\frac{dMppp}{dPc_o}\right\|_{yreal}$ $=39.59$ $\Psi_2=12.73$ (11.24)	$\left.\frac{dMppp}{dPkmtkm_o}\right\|_{yppp}$ $=6.25$ $\left.\frac{dMppp}{dPkmtkm_o}\right\|_{yreal}$ $=6.25$ $\Psi_3=6.252$ (4.71)	$\left.\frac{dMppp}{dAutcam_o}\right\|_{yppp}$ $=-17.14$ $\left.\frac{dMppp}{dAutcam_o}\right\|_{yreal}$ $=-5.56$ $\Psi_4=-5.637$ (-3.34)	$\left.\frac{dMppp}{dPaskm_o}\right\|_{yppp}$ $=0.0010$ $\left.\frac{dMppp}{dPaskm_o}\right\|_{yreal}$ $=0.00069$ $\Psi_5=0.0007$ (9.76)	$\left.\frac{dMppp}{dAutpc_o}\right\|_{yppp}$ $=0.084$ $\left.\frac{dMppp}{dAutpc_o}\right\|_{yreal}$ $=0.034$ $\Psi_6=0.035$ (16.11)	$\left.\frac{dMppp}{dDensid_o}\right\|_{yppp}$ $=-0.416$ $\left.\frac{dMppp}{dDensid_o}\right\|_{yreal}$ $=-0.174$ $\Psi_7=-0.174$ (-5.17)
velocid	$\left.\frac{dVelocid}{dPcpo_o}\right\|_{yppp}$ $=0.1683$ $\left.\frac{dVelocid}{dPcpo_o}\right\|_{yreal}$ $=0.1683$ $\Phi_1=0.1683$ (6.41)	$\left.\frac{dVelocid}{dPc_o}\right\|_{yppp}$ $=-0.0082$ $\left.\frac{dVelocid}{dPc_o}\right\|_{yreal}$ $=-0.028$ $\Phi_2=0.2051$ (3.06)	$\left.\frac{dVelocid}{dPkmtkm_o}\right\|_{yppp}$ $=0.1822$ $\left.\frac{dVelocid}{dPkmtkm_o}\right\|_{yreal}$ $=0.1822$ $\Phi_3=0.1822$ (3.45)	$\left.\frac{dVelocid}{dAutcam_o}\right\|_{yppp}$ $=0.549$ $\left.\frac{dVelocid}{dAutcam_o}\right\|_{yreal}$ $=0.523$ $\Phi_4=0.449$ (4.77)	$\left.\frac{dVelocid}{dPaskm_o}\right\|_{yppp}$ $=-0.000017$ $\left.\frac{dVelocid}{dPaskm_o}\right\|_{yreal}$ $=-0.000019$ $\Phi_5=-0.000014$ (-2.93)	$\left.\frac{dVelocid}{dAutpc_o}\right\|_{yppp}$ $=-0.00075$ $\left.\frac{dVelocid}{dAutpc_o}\right\|_{yreal}$ $=-0.00085$ $\Phi_6=-0.000318$ (-2.73)	$\left.\frac{dVelocid}{dDensid_o}\right\|_{yppp}$ $=0.002$ $\left.\frac{dVelocid}{dDensid_o}\right\|_{yreal}$ $=0.0029$ $\Phi_7=0$