**Infrastructure and human capital: a comparison of their effect on regional growth between Mexico and Spain.**

**Very Draft**

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**Summary**

Mainstream economic theory predicts that public investment tends to reduce regional inequalities improving growth of poorer areas. However, recent theoretical contributions suggest a very different impact of public investment. Public investment under a context of trade integration may be widening the gap between rich and poor regions. This paper investigates the influence of public investment on reducing regional inequalities. Using an application to Mexico we test whether public investment is associated with increasing regional inequalities. We estimate ordinary and quantile regressions to explain this feature in different points of the distribution function. Findings suggest that public investment in Mexico amplified rather than reduced regional inequalities. Results from quantile regression show that public investment has a strong positive and significantly effect on increasing regional inequalities, especially in low quantiles, whereas its effects tend to become smoother when ascending in the distribution of regional income.

*Keywords*: regional inequalities, public investment, and quantile regression.

## 1. INTRODUCTION

During the last years regional policies have been largely influenced by a tendency to invest in infrastructure under the logic of its positive impact on regional productivity and its role in reducing regional inequalities. Public investment allocation is theoretically assumed to be guided by increases on productivity, especially in a context of economic integration. As economic integration may lead to unequal gains, benefits may be larger for border regions, and regions with previous advantages from economic agglomeration, namely in Mexico the northern regions and the oil producer regions.

Therefore, investing in poor regions may be seen as a public policy to counteract differentials in economic activity derived form trade intensities. There are strong reasons to argue that public investment may show an inverse effect. Martin (1999) sets a model that shows that improvement in infrastructures reduces the transaction costs inside the poorest region, the reduction in transaction costs allows firm to reduce their location in this poor area what is increasing the regional income gap.

The argument depends on the source of infrastructure considered. Martin and Rogers (1995) distinguish between types of public investment. In particular, they argue that public investment that deals with reduction of transaction costs may be distinguished from a public investment leading to innovation infrastructure. However, innovation infrastructure is subject to the existence of a previous basic infrastructure.

The aim of this paper is to examine the contribution of public investment on reducing regional inequalities. Previous literature is not conclusive in this matter, therefore we examine empirically the effects of public investment in a country, Mexico, that shows a federal structure with well known wide regional differences. We used a database collected from public sources and we describe the implication of our results to the design of public policy aiming to reduce the gap between regions.

The structure of the paper is as follows. Section two deals with the theoretical framework and previous literature on the issue. Section three deals with some explanation of the context of the country chosen to undertake the empirical analysis.

Section four describes the empirical application and section five the results. Finally, some concluding remarks are made.

## 2. THE ROLE OF PUBLIC INVESTMENT ON DISPARITIES

In middle income countries there is an observed pattern to scatter funds among a large number of small projects dispersed through the nation (Hirschman, 1958). One reason for spatial scattering of investment is the political support for the government in all regions of the country. Then, there is an incentive to scatter the investment far and extensive. Another incentive is the belief that economic progress is a force affecting equally all regions. Then, governments are unprepared and unwilling to take decisions about spatial priorities and sequences for investment. Nevertheless, the argument of Hirschman leaves to the criteria of planners when to switch the direction of public investment and this criterion could be manipulated in electoral terms. It also assumes that although disparities will increase in the first phase, the second stage will reduce them.

The time for switching the allocation of investment was modelled by Rahman (1963). The central assumption of his model is that central planning investment is intended to maximise the national rate of growth, also that there are regional demands for an economic process without wide disparities in regional living standards. He finally assumes different rates of productivity of the investment and savings among regions. These findings seem to be reinforced by Intriligator (1964), who found that the optimal allocation of regional investment is very sensitive to the objectives settled by the planner. His model suggests that the maximisation of terminal income leads to switching investment from regions with high growth to regions with high output-capital ratio. It also implies that the maximisation of per capita consumption during the planned period leads to a switching from high output-capital ration regions to high growth regions.

Beyond these findings, Okuno and Yagi (1990) examine those aspects of public investment that tend to balance interregional income equality and efficiency of the economy as a whole. Including private investment in the model, they found that the public investment switch from rural to urban is an optimal policy, while ignoring private

investment the switching is not optimal. They also state that regional income inequality is affected by public investment, showing that this allocation reducing regional output inequality does not always reduce regional income inequality. Martin and Rogers (1995) suggest that public infrastructure may play a role in attracting industries from other regions. They state that there is an increase in local welfare because of the relocation of industry originated in the enhancement of public infrastructure, while there is a decrease in foreign welfare. Furthermore, given the consumption of real resources to improve public infrastructure, the characteristic of a non co-operative equilibrium may be characterised by a sub-optimally high level of domestic infrastructure.

In the same context of economic liberalisation, Martin (1999) remarks that transaction costs exist between regions and also inside regions, being both affected by public infrastructure. Then, the equilibrium location of industries impacts the common rate of innovation because of local technology spillovers. He develops a model in which policies directed to attraction of firms in poorest regions through the improvement of infrastructure may not generate a favourable geography to growth. This is because the presence of local spillovers in industrial concentration leads to lower cost of innovation, and a dispersion of the industry will increase them, affecting the rate of growth in the whole set of regions

## 3. THE MEXICAN MACRO ENVIRONMENT AND RECENT REFORMS

The year 1970 marks the end of the "stabilising development" of 1950s and 1960s, periods in which the closed market grew at rates of 10%, and is also the opening for a period of populism in the Mexican government. During the 1970s and beginning of the 1980s the Mexican economy grew at a rate of 6.7% in real terms and 4% in per capita GDP. Motors of growth during this period can be explained by public investment. This investment was financed with deficit and debt. A good part of this can be attributed to the oil boom, when new oil fields were found and the prices were high in the international market, creating good expectations for the next years.

Long term expectations of high oil prices were the genesis of a considerable external debt to finance public investment. At the beginning of the 1980s oil prices decreased leading to a debt crisis in 1982 and 1985 and international finance organisations closed

credit lines to Mexico. The reschedule of the debt led to an economic adjustment to set conditions for a new period of economic growth and financial solvency.

The economic adjustment implemented during the period 1983-1988 was directed towards two main objectives (Cardenas, 1996). The first was the reduction in the size of the public sector, through the sell of public enterprises, deregulation of markets and cuts in public budgets. The second was the trade liberalisation to open the Mexican economy, decreasing the number of tariff and trade barriers, and specially to become a member of the GATT. A main characteristic of the structural adjustment was the necessity of the government to extract from the society all the resources to transfer as debt payments. These resources were extracted from real wages, using the inflationary tax, leading of course to a drop in real wages during the whole period.

With the government initiated in 1988 a new plan launched a far reaching process of deregulation of economic sectors, privatisation of public enterprises and reductions in budget expenditures leading to a drop in inflation and reductions in the public debt and budget deficit. There was also a new confidence of the international investment due to the restructuring of international debt through the Plan Brady, and the signing of the North America Free Trade Agreement with Canada and the US.

Short-term financial markets made vulnerable external fluctuations. In addition, the decision to continue fighting against inflation with a highly undervalued exchange rate, plus the political instability generated in 1994 led to a interruption of foreign capital flows, halting the financial system and guiding to a devaluation of the peso and the decision to let it to float. International investors withdrew their funds not only from Mexico but also from all Latin America stocks markets, originating the "Tequila effect".

The new government authorities (1994-2000) implemented a new plan with tight fiscal settings, control of inflation, anticipation of debt maturities that immediately restored credibility of international investors in the government policy. If this crisis led to a fall of 6.2% of the GDP in 1995, the new adjustment plan brought an increase of 5.1% of GDP in 1996 (respect to 1995), led essentially by a surge in Mexican exports and investment, mainly in the export oriented sectors (OECD, 1997).

**Table 1**

**Coefficient of Variation of per capita GDP**

| Year | All Regions* | Centre | North | South* |
|---|---|---|---|---|
| 1970 | 0.43 | 0.49 | 0.20 | 0.41 |
| 1980 | 0.38 | 0.49 | 0.20 | 0.42 |
| 1985 | 0.34 | 0.44 | 0.18 | 0.31 |
| 1988 | 0.43 | 0.52 | 0.18 | 0.56 |
| 1993 | 0.47 | 0.62 | 0.17 | 0.70 |
| 1996 | 0.48 | 0.63 | 0.15 | 0.64 |

*Excluding Campeche and Tabasco.

All this macroeconomic issues have implied an effect on regional disparities. To assess to what extent disparities among regions in Mexico have grown we calculated the coefficient of variation of per capita GDP for different years and grouping by geographical zones, as is depicted in table 1. These results show that the disparities of per capita GDP reduced during the period from 1970 to 1985. As we have remarked, 1985 is the year in which Mexico started its trade opening with other countries. The big leap in the income dispersion between states occurred in the period 1985-1988, and since then has remained almost constant. Disparities in the second half of the 1990s are higher than levels in 1970. Northern states have the lower and decreasing disparities, while states in the South show higher disparities of income.

## 4.EMPIRICAL APPLICATION

### 4.1 The empirical Model

The empirical strategy used in this study is based on first analysing the role of public investment (PUBINV) in regional inequalities of income (I). To do so we have included two sets of control variables. First, a variable of initial GDP in order to capture the effect of previous regional differences. The variable employed is the logarithm of 1970 GDP. Second, we use a set of dummy variable to isolate the effect being an oil producer (OIL) such as being a regional in the (NORTH) or in the (CENTRE) of the country. The index for regional inequality in per capita GDP is defined as:

$$I_{it} = (y_{it} - y_t) / S_t \qquad (1)$$

Where i is the state and t the period of time, $y_{it}$ is the per capita GDP for each state in the period t, $y_t$ is the national average of per capita GDP and $S_t$ is the standard deviation of the sample for period t.

The model estimated is the following:

$$I_{ij} = a + b_o PUBINV_{IJ} + b_1 INGDP_{IJ} + b_2 OIL + b_4 NORTH + b_R CENTRE + m_{IJ}$$

(2)

The first coefficient will be informative on the relationship between public investment and regional inequalities. A positive sign is expected according to Martin (1999). Initial GDP is to show as well a positive sign as happens with the catch –up assumption in growth models. Finally, dummy variables may show ambiguous signs. However, we expect a positive sign at least for the OIL regions, as they are more likely to maintain its income due to the production nature.

In ordinary regression models, we cannot distinguish if inequalities are appearing in the whole distribution or are concentrated in some quantiles of the distribution. In order to elucidate about this issue, we estimate a quantile regression model. Quantile regression models are based on the work of Koenket and Basset (1978). These models have been extensively used in labour economics to study wage inequalities (Garcia et al., 1999). We use this method to analyse changes in regional inequalities at different points of the income distribution. Let $(I_{ij}, PUBINV_{ij})$ be a sample of two main explanatory variables for a given period. The relation between these two variables may be formulated as:

$$I_{ij} = b_o PUBINV + m_{0i}$$

(3)

Then the quantile regression can be expressed as:

$$Quant_q (I_{ij} / PUBINV_{ij}) = b_0 PUBINV_q$$

(4)

Where the *Quant* denotes the conditional quantile ($q$) of $I_{ij}$ and the regressor vector $PUBINV_{ij}$ assuming that $Quant_q(U_{oi} / PUBINV_{ij}) = 0$. The estimation results $\hat{Quant}(I_{ij} / PUBINV_{ij}) = \hat{b}_q PUBINV$ indicate how inequality will vary as $q$ increases in the distribution. Therefore the quantile coefficients informs us about the marginal change in the ith conditional quantile due to a marginal change in the jth element of *PUBINV*.

**4.2 The data**

The data used for the Mexican regions was collected from public sources. Data for GDP was gathered from the Instituto Nacional de Estadistica, Geografia e Informatica (INEGI) published every five years, from 1970 to 1996. To calculate per capita GDP we are using population data from the Population Census by INEGI and figures from the Statistical Annexes of the Presidential Address to the Nation many years.

Data on public investment was collected from 1971 to 1996 from the same Statistical Annexes. The dataset was used to calculate the per capita public investment channelled to the region i, as share of the national average of per capita public investment. As we can expect a differentiated effect of public investment according to the region inequality, we determine some dummy variables. Dummy variable for oil states comprises Campeche and Tabasco states, in which during the 1970s there were a high proportion of public resources channelled to discovery an exploitation of new oil fields. There are also dummy variables for the Northern states, including states with border to the US, and a dummy for Centre states comprising all states around Mexico City.

Basic statistics for the variables in the model are presented in Table 2.

**Table 2**

**Basic statistics**

| Variable | Min | Max | Mean | St Dev. |
|---|---|---|---|---|
| Inequality | -1.48 | 4.64 | -2.5E-11 | 0.99 |
| Public investment | 0.26 | 3.98 | 1 | 0.79 |
| Initial GDP | 0.4 | 5.68 | 1 | 0.56 |
| Oil | 0 | 1 | 0.06 | 0.24 |
| North | 0 | 1 | 0.18 | 0.39 |
| Centre | 0 | 1 | 0.16 | 0.36 |

## 5. RESULTS

Table 3 shows results of the model for the Mexican regions with panel data. The first column shows results for OLS regression, while the other columns show outcomes for the quantile regression. In the OLS results there is a positive and significant effect of public investment on regional disparities. This means that the way in which central government allocates public investment has increased disparities between regions in Mexico during this period (1970-96). This could be attributed to two factors. The fist is that during the 1970s Mexico experienced a populist government in which allocation of public investment was made without economic considerations (Bazdresch and Levy, 1991). The second is that as consequence of the recursive economic crises, public investment was cut in order to clear public finances.

**Table 3**

**Estimation results for income inequality (1970-96) in Mexican regions.**

| | | Quantiles | | |
|---|---|---|---|---|
| **Inequality** | **OLS** | **0.25** | **0.5** | **0.75** |
| PUBINV | .180* | .132* | .08* | 0.03 |
| | (0.05) | (0.31) | (0.02) | (0.03) |
| INGDP | 1.232 * | 1.491* | 1.86* | 1.96* |
| | (0.08) | (0.067) | (0.02) | (0.05) |
| OIL | .603* | -0.416* | -0.04 | .56* |
| | (0.17) | (0.07) | (0.05) | (0.11) |
| NORTH | .432* | .280* | .14* | 0.04 |
| | (0.10) | (0.06) | (0.03) | (0.06) |
| CENTRE | .358* | .1671* | 0.05 | 0.08 |
| | (0.11) | (0.69) | (0.04) | (0.07) |
| INTERCEPT | -1.592 * | -1.872* | -1.9* | -1.97* |
| | (-0.08) | (-0.07) | (0.04) | (0.05) |
| Adj $R^2$ | 0.77 | 0.63 | 0.69 | 0.72 |

** Significant at a 5%. *Significant at 1%

Standard errors in parentheses.

Another interesting feature of this regression is the departure income level. Here we have measured this effect using the 1970 per capita GDP. This result confirms the feature that disparities are increasing in this period as table 1 already showed. The explanation of differences may lie on the geographical location of production. Northern and oil producer regions, as well as Mexico City and surrounding areas concentrate the industrial production of the country, effect that is captured through he dummy variables.

However, these results although informative, provide small information on the effects of public investment and other related determinants on income inequality as they may hide differential effects within groups of regions. An alternative way of looking at this issue is using quantile regression analysis, what enables to distinguish those regions situated in the extremes of the inequality distribution such as those situate in the median distribution.

For the lower income group, in the 0.25 quantile, there is a high positive and significant effect of public investment in disparities among regions. This effect is smaller for the median group, and irrelevant for the higher quantile. This means that public investment has had a higher impact on explaining disparities in lower income region than in higher

ones. The initial income level has a positive and significant effect in all quantiles. The dummy for oil states is relevant for the lower and higher quantiles, however the sign is different. This would mean that being an oil state explains a reduction in disparities compared with lower groups, but increases disparities inside the higher income group.

The dummy variable for North states is positive and significant for the lower and middle group, meaning that compared with South states, North states are exerting influence in increasing differences in these groups. The dummy variables for Centre regions is positive and significant for the lower income group, meaning that compared to South states, Centre states are influencing disparities in this lower group.

Then, in all regressions the coefficient for public investment is positive. Moreover, there is a strong effect for the lower quantiles, and no significant for higher quantiles. These results can be interpreted under the light of three ideas. The first is that public investment has had such regressive impact on disparities because during the seventies most of it was allocated primarily to attend the development of the oil industry. Then, in the middles 1980s the government started a plan to cut down public budgets, and the possible positive impact was brushed away.

The second ideas comes from Hirschman (1958), who stated that regional allocation of public investment is the most evident method through which policy influence rates of growth of different parts of a country. He distinguishes three patterns of allocation: dispersal, concentration on growing areas, and promotion of backward regions. In consequence, disparities increase in the first phase, and decrease in the second. However, looking at the evidence, excepting the Northern states with slightly decreasing disparity index, it is difficult to believe that for a period of 26 years public investment has been allocated according to the first phase of Hirschman.

In the third point, according to Martin (1999) investment should be allocated in regions where transaction cost can be reduced due to concentration of industry. Then, investment in poor regions will lead to increase in prices because of dispersion of industry as a decrease in welfare. In a future, the decrease in prices due to concentration will lead to a higher welfare and benefits for poor regions. In line with the regressions, during the period 1970-96, disparities have increased more in low quantile regions, and

then there is no evidence that these regions are benefiting from concentration in other regions.

Although introducing the quantile regression in the analysis of disparities has shown interesting insights, more work has to be done in order to elucidate the effect and direction that disparities are taking place especially to elucidate the time for switching allocation of investment in specific regions.

## CONCLUSIONS

Although some theoretical work has been undertaken to examine forms and times of investment allocation between regions, there is no clear-cut method developed yet. This paper has sought to analyse the influence of public investment in regional income disparities. The quantile regression technique used in this paper permits to go further than a simple decomposition of income inequality in within or between groups. The main advance employing this technique is that we can isolate the impact of public investment on different sets of regions according to the position in the income distribution.

Using data for the Mexican regions and looking to the determinants of regional inequalities we find that inequalities have been fostered during the last twenty years in Mexico. Public investment has not smoothed regional inequalities. Opposite evidence has been found, public investment has been one of major explanations of the income gap between Mexican regions for the period considered. That is, public investment allocated during the period 1970-96 has impacted positively to disparities in general. Results from quantile regression show that public investment has exerted higher positive influence in disparities among regions in the lower quantiles, while for regions in the higher quantiles the evidence is not significant, although still positive coefficients are observed.

One of the explanations of this issue may lie between the ideas of Hirschman (1956) and the recent approach of Martin (1999). The strategy of the allocation of public investment may have followed a set of phases, what explains differences between the north and the south of the Country, such as between oil producers or not. However,

public investment is strongly associated with a rise in regional inequality within less unequal regions. The explanation of this phenomena can be best understood under the Martin (1999) framework. Trade integration tends to reduce transaction costs rather than to reduce innovation costs. This would predict that public investment should increase inequality especially within the regions located in the lowest quintile of the inequality distribution. As empirical result show, public investment has no relevant effects on those regions that are located in the top quintile or the inequality distribution. However, more empirical analysis should be undertaken to provide some insights to this issue.

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