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Regional Manufacturing Wages: Dancing to the Tune of Trade Shocks

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Abstract
Firms generally choose to locate their production where profits are maximized. As costs affect profits, trade-offs between two marginal costs – employees' wages and transport costs – may be important for decisions regarding location. Wages tend to be greater in industrial centres and decrease as transport costs increase. Trade shocks might impact regional wage disparities by making foreign markets, for example, relatively more attractive for firms than domestic markets. This paper tests these two hypotheses by using regional Brazilian data. Results corroborate that regions with higher transport costs present lower wages, and that trade shocks affect these regional wage disparities.

Keywords: Economic geography, trade shocks, manufacturing wages

JEL Classifications: F12, F14, R12

1. INTRODUCTION

In order to maximize profits, an important decision that firms face is where to locate their production plants. The New Economic Geography (NEG) is a branch of economic literature that investigates this dilemma. According to this literature, a negative correlation exists between two marginal costs: transport costs; and employees' wages. In other words, when transport costs rise, salaries drop. Proximity to target markets explains this negative association, since firms face lower transport costs to ship their goods to consumers when their production plants are close to the prospective market. Firms located far from their target markets need, therefore, to offer lower wages to their employees in order to compensate the higher transport costs. This trade-off faced by firms promotes regional wage disparities.[1]

This pattern may change, however, after the opening of trade, since the importance of foreign and domestic markets changes. This paper investigates these aspects by testing how demand linkages are important when explaining regional wage disparities. Additionally, it also investigates whether a trade shock is able to influence these inequalities by also trying to measure which reduction in trade costs (exports or imports) appears to be stronger.

Forces of agglomeration and dispersion form the basis for understanding decisions on location, especially after a reduction in trade costs. The main example of the agglomeration force is what Krugman (1980) refers to as the "home market effect". Regarding dispersion forces, the main one evidenced in the literature is the increased competition in the market. When trade costs fall, foreign market tends to increase the importance given to export firms due to more demand for their final goods. Firms importing inputs from abroad may find regions close to the foreign market more attractive because inputs may be cheaper there. For these two types of firms, the importance of the foreign market increases in relation to the domestic market after a reduction in trade costs. Wages in these regions therefore tend to narrow the gap between them and the industrial centers.[2] Inequalities in wages between regions may eventually diminish. Nevertheless,

[1] Actually, the role of transport costs in determining location is older than NEG. Fujita, Krugman and Venables (1999) list some earlier work. Von Thünen's (1826) model is an example. It explains the negative relation between land rent and distance to a city. Other more recent examples are from the Central Place Theory, such as Christaller (1933) and Lösch (1940), in which they examine the relation between economies of scale and transport costs.

[2] Assuming that the industrial center is not close to the foreign market, as highlighted by Henderson, J. V. (1996).

some other firms might not perceive this change in international trade costs the same way. Firms facing higher competition from import goods perceive this decrease in trade costs as a threat to their survival, since foreign products become available at a lower cost. These firms consequently may tend to position themselves even farther from the foreign market.[3] In either case, regional wage disparities may therefore change after a trade shock.

The reason why regional wages might be influenced by a reduction in trade costs can be explained by means of two channels: the fierceness in competition in the goods market; and that in the labor market. On one hand, cheaper imported goods force existing firms within a market to reduce their price; those not competitive enough either close down or locate elsewhere to survive. Therefore, regions close to the foreign market are more affected by this shock; that is, firms lower employees' wages to compete with cheaper imported goods. On the other hand, greater access to the foreign market stimulates firms to hire extra labor in order to expand production. Demand for labor rises and, eventually, so do wages. Regions located close to the foreign market face higher competition in their demand for labor and less efficient firms have two options: either leave the market or locate elsewhere. Regardless of which channels, non-competitive firms have only two options after a reduction in trade costs: either leave the market or relocate. Both attitudes influence regional wages; however, the strength of each dispersion force has not been investigated in the literature. In a trade agreement, these two different channels occur simultaneously. The reduction of trade costs raises competition from imports; likewise, export firms may expand their production, increasing the demand for labor. The result, therefore, might even be neutral since jobless employees from firms facing higher competition from imported goods can be hired by export firms expanding their production.

There are two venues explored by the literature to address how demand linkages can affect regional wage disparities. One part of it investigates those linkages by using transport costs as the main explanatory variable for regional disparities in wages, such as Hanson (1996; 1997) and Brulhart and Koenig (2006). Another more recent and numerous part of the literature, represented by Brakman, Garretsen and Schramm (2004); Mion (2004); Redding and Venables (2004); Hanson (2005); Head and Mayer (2006); Fally, Paillacar and Terra (2008), tests how important market potential is to explain those spatial

[3] Industrial center is an option, but not quite, since these firms were unable to survive there before the reduction of trade costs.

inequalities.[4] Hanson (1996; 1997) investigates the Mexican case by not only exploring how transport costs for Mexican states may explain regional wage disparities, but also by probing whether the North America Free Trade Agreement (NAFTA) had any impact on these regional inequalities. Apart from Hanson (1996; 1997), the remaining papers mentioned earlier do not address whether trade shocks may impact regional wages, including Fally et al (2008), which focuses on Brazil. This paper contributes to this literature by showing not only how both transport costs and market potential can explain regional wage differences in Brazil, but also how trade shocks affect these disparities.

Brazil provides a good example to investigate these phenomena. First, this country had a closed economy until the late 1980s. During the 1990s, it experienced two trade shocks which reduced trade costs: a unilateral liberalization process which diminished the weighted average nominal import tariff from 37.7% in 1988 to 10.2% in 1994; and a dramatic 47% depreciation of the exchange rate in 1999.[5] In addition to these shocks, there was a stabilization plan for hyperinflation in 1994 which has appreciated the Brazilian currency (called the "Real") against others. This was an extra macroeconomic shock in the local economy, which has also impacted the Brazilian economy by providing cheaper imported goods.

These shocks have substantially affected Brazilian trade flows. After the liberalization process and the macroeconomic plan, imports quadrupled from 1985 to 1996, while exports did not even double. As a result, the trade balance dropped from a surplus of US$ 12 billion in 1985 to a deficit of US$ 5.6 billion in 1996. As a consequence of the exchange rate depreciation, the trade balance went from an annual deficit of US$ 6.5 billion, on average, during 1996-98 to a surplus of US$ 33.8 billion in 2004. Meanwhile, exports rose from US$ 50 billion on average during 1996-98 to US$ 96.7 billion in 2004. In terms of location, the Brazilian manufacturing industry was also affected by these two shocks. Sao Paulo State, Brazil's industrial center, reduced its participation in this sector from 52% in 1985 to 43% in 2004. This may indicate that dispersion forces won out against those of agglomeration in Sao Paulo throughout the whole period.

In the Brazilian case, it is feasible to distinguish the effects of reduction and expansion of its economy, which are present at the same time in a trade agreement. After the liberalization and stabilization plan, domestic production faced fierce competition from

[4] These two ways (transport costs and market potential) are not exclusive, but rather the same. In other words, the lower the distance is to markets (which makes the market potential measure higher), the higher the wages.

[5] This is a real depreciation subtracting inflation. The exchange rate, moreover, had not returned to the level recorded before the expansion shock until the last year investigated in this paper.

imports, as they became cheaper in the domestic market. On the other hand, the depreciation of the exchange rate has improved the competitiveness of domestic production since local goods become relatively less expensive than any similar product in the international market. As a consequence, domestic firms have expanded their production regardless of the target market – either domestic market or exports. In geographical terms, it is important to evaluate how the economy reacts in terms of location when it faces more competition (and eventually, it shrinks) as well as when it perceives opportunities to increase production (in other words, when firms decide to expand their production).

Summing up, after the liberalization and macroeconomic shock (contraction shock), less efficient firms facing competition from cheaper imported goods have either since closed down or located somewhere else. Firms importing inputs might have seen an advantage to locate close to the foreign market, but the direct outcome is stronger, as evidenced by Fally et all (2008), and it overcomes all other effects.[6] On the other hand, after the exchange rate depreciation (expansion shock), export firms may also have reallocated their production plants to regions closer to the foreign market, and firms aiming to expand production to attend domestic demand might have relocated closer to the domestic market. Therefore, regional disparities in wages may have undergone changes after each shock.

One way to evaluate these shocks and possibly to explain regional wage disparities is by examining whether the importance given to transport costs or market potential might have changed. This paper contributes to the literature by investigating which shock is more intense and more likely to affect regional wage disparities – whether it is the contraction or expansion shock. Additionally, it is also feasible to address which market, domestic or foreign, is more likely to be affected by which shock. Distinguishing which shock and where (domestic versus foreign market) trade issues have a more prominent impact is important for the literature of international trade and regional economics since forces of agglomeration might undergo a key change after an exogenous shock. Aside from academic interest, these issues are also extremely relevant for policy makers as they become much more aware of the regional consequences of any shock, especially related to trade policy.

The remaining seven sectors of this paper explore these ideas. Section 2 points out the theoretical framework of regional disparities of wages and how they can be influenced by trade shocks. A summary of empirical findings is presented in Section 3. Some

[6] It is relevant to point out that export firms using imported inputs can be benefited by reducing costs of imports. However, this is an indirect effect.

descriptive analyses are made in Section 4. Section 5 outlines the econometric specification to test the hypotheses in this paper, followed by data description in Section 6. Empirical results are shown in Section 7. Finally, the last section presents a conclusion.

2. WHY DO WAGES DIFFER ACROSS REGIONS?

One seminal work in explaining why wages are regionally different is Hicks (1932). His work establishes that wages differ across regions due to two reasons: different costs of living; and amenities. Regions with higher costs of living ought to compensate by offering higher wages. After his work, many different approaches try to explain regional disparities in wages, using a wide range of arguments, which are summarized in the next lines.

The heterogeneity of people's skills is the foundation of the Theory of Human Capital, initialized by Becker (1962), to establish why salaries are different and, therefore, also on a regional scale, as put forward by Willis and Orley (1986). According to this theory, regions containing people with more human capital tend to have higher wages. Human capital, indeed, entails wage disparities, but it does not provide us any further interpretation as to why some regions have better endowments (here represented by human capital). Furthermore, it does not cover labor market demand either as it ignores the existence of firms.

Another part of the literature, called Regional Wage Curve, explains these disparities through different unemployment rates in each region. In other words, the more unemployment one region has, the lower wages are, as explained in Blanchflower and Oswald (1995). This approach takes into consideration not only the aspect of demand, but also the issue of supply in the labor market which eventually culminates into a relationship of unemployment and wages. Although this approach covers the forces in the labor market - a step further from human capital theory - it overlooks important issues. First, why some regions are more prosperous than others, represented here by a lower unemployment rate, is a matter this literature fails to question. Aside from that, it also neglects regional characteristics, for instance amenities, as explanatory variables to explain regional wage disparities in which they have emerged as relevant aspects, as suggested in Rosen (1979) and Roback (1982).

NEG theoretical models present some further contributions to the existing literature described above. Demand for labor is included in NEG models, since the literature described earlier focuses its attention solely on the labor supply. According to NEG literature, firms' decision on location provokes higher nominal wages in some areas. The

key assumption which drives firms to a specific location is an increase of returns to scale. This assumption establishes how agglomeration forces bring about firms' desire to locate close to the market due to consumer demand, as proposed by Krugman (1980) and Krugman (1991), or to forward and backward linkages, as suggested by Venables (1996). Furthering these arguments of agglomeration, Elizondo and Krugman (1995) explain the appearance of metropolises in less-developed countries by stating that a closed economy favors the existence of a domestic industrial center with higher wages. Nevertheless, dispersion forces also exist, and competition among firms is considered the main reason for their decision on a location. Overall, firms locating close to the market tend to raise land costs and, therefore, nominal wages. As a result, regions where agglomeration occurs tend to have higher wages. Consequently, as a region moves away from the market, wages tend to fall. The main reason for this pattern is the increase of transport cost incurred to ship goods to consumers. Firms facing higher transport costs tend to offer lower wages to their employees. Summing up, firms face a trade-off between two marginal costs: wages and transport cost.

Although NEG theory findings are in line with previous approaches, they provide a broader view of this phenomenon since the supply and demand aspects of labor are taken into account by acknowledging the existence of firms and their location behavior. The main contribution from NEG literature in relation to regional wages is, however, how trade may affect these inequalities. Changes in agglomeration and dispersion forces between domestic and foreign markets may influence firms' decisions on location by making some regions more attractive than others. Regional wage disparities, as a consequence, might be influenced by these decisions, strengthening or weakening these inequalities.

According to this literature, trade costs are the main exogenous variable that might affect these forces between the domestic and foreign markets. A reduction of trade costs raises competition with imports for domestic firms and makes regions close to foreign markets even more attractive to export firms.

3. EMPIRICAL EVIDENCE OF NEG MODELS

As mentioned in the introduction, several papers have addressed whether regional wages can be explained by NEG literature. Two aspects are explored: either by transport cost; or by market potential. Seminal papers include Hanson (1996; 1997), in which he investigated the Mexican case by using transport cost measures. Mexico is a good example to investigate these phenomena because it had a closed economy before signing the North

American Free Trade Agreement (NAFTA) with the US and Canada in 1985. It is therefore feasible to explore not only whether wages are negatively related to transport to markets, but also whether a trade agreement may change these regional inequalities. NAFTA has weakened the importance of Mexico City, the industrial center of that country, and increased the agglomeration forces in regions close to the border with the US. The reduction of trade costs made the foreign market (the US) more appealing for many Mexican firms. Due to this market effect, firms located close to the border have expanded, while others relocated their production plant to these regions. This expansion in production in regions close to the foreign market may have increased competition in the labor market for employees, therefore raising wages. On the other hand, the fierce competition from imported goods may lead firms to locate not so close to the border with the US. Therefore, regional disparities in Mexico might have changed due to this trade shock.

Hanson's results reinforce that transport costs for industrial centers or for the foreign market are important when determining regional differences in manufacturing wages, bearing out the assumption of increasing returns to scale from theoretical models. No evidence is found, however, in either paper when examining whether the trade shock (NAFTA) has influenced regional wage disparities. His explanations on failing to find regional effects include the short period (3 years) after this trade agreement was signed. Nevertheless, the geographical unit used (state level) is also questionable.

Brulhart and Koenig (2006) provide another example of the literature on using transport costs to explain regional wages disparities. They evaluate how important access to the European Union market and to the domestic market is for wages disparities in some eastern European countries. Their results do not corroborate NEG predictions, since no robust result related to distance is found.

Another recent approach is to use Market Potential instead of distances. Several papers have explored this channel using different measures of market potential and econometric specifications. However, a challenging and substantial difference is how to instrument this endogenous variable. Mion (2004), for example, evaluates whether market linkages are able to explain the spatial distribution of earnings in Italy. For instruments, he uses the spatial lag of his explanatory variables. Brakman et al (2004) evaluate the same issue by using data from German districts. For instruments, they use the size of districts, the size of the population of each district and the population density. Using data from US counties, Hanson (2005) investigates whether regional demand linkages are associated with wages. Hanson's instruments are related to the population in each county. Redding and

Venables (2004) use cross-country data to investigate the same issue: whether demand linkage is able to explain regional wages. As instruments, they use distance to markets represented by New York, Brussels and Tokyo. Head and Mayer (2006) utilize regional data from the EU to explain how employment and wages are associated to market potential. To tackle the issue of endogeneity, they use not only the distance to Brussels as instruments, but also a distance calculated by the centrality of Europe (named "EU centrality") as well as "global centrality" measured by the distance to every inhabited place in the world. Although all these papers have different approaches to understanding how demand linkages are related to wages, their findings support the idea that market potential is important in explaining those regional disparities, regardless of which instrument is used.

Regarding Brazil, two papers on regional wage inequalities are worth mentioning. Azzoni and Servo (2002) investigate whether regional wage disparities in Brazil may be explained by different human-capital endowments. Their paper confirmed this hypothesis by finding human capital as one of the main important features to explain regional wages in Brazil; however, the geographical location also plays an important role. Similar to those presented earlier from NEG literature, Fally et al (2008) test whether demand linkages are correlated to Brazilian wage disparities taking into consideration individuals' and firms' characteristics. Different from previous NEG empirical studies, the authors also identify which access (that of the market or of suppliers) is more prominent to review these wage disparities. Their results suggest not only that demand linkages are important when explaining regional disparities, but also that market access seems to be more relevant than supplier access.

Aside from Hanson (1996; 1997), I am not aware of any other paper investigating whether trade shocks may have influenced regional disparities. This current paper addresses not only these NEG hypotheses, but also whether the reduction of trade costs may be relevant to changing the strength of agglomeration and dispersion forces.

4. BRAZILIAN REGIONAL WAGES: A DESCRIPTIVE ANALYSIS

Some descriptive analyses on relevant variables provide some insights before applying any econometric analysis. The key variable is the ratio of salaries in one region over salaries in the industrial center, which, in Brazil, is represented by the Sao Paulo metropolitan area.[7] A

[7] The regional unit used is the microregion. The justification on why this geographical scale is given in Section 3.5.

summary of this ratio is shown in Table 1, which organizes the information into three periods: Before Shock; After Contraction Shock; After Expansion Shock.

Table 1: Descriptive Analysis of Regional Salaries

Descriptive Summary	Before Shock	After Contraction Shock	After Expansion Shock
Wages in region i / Wages SP	**1985**	**1996-1998**	**1999-2004**
Average	0.44	0.41	0.40
Standard Deviation	0.24	0.23	0.23
Minimum Year-Average	0.10	0.08	0.11
Maximum Year-Average	1.86	1.74	1.76
Number of years available	1	3	6
Number of observations	371	1207	2568
Average of obs. per year	371	402	428

Source: Annual Manufacturing Report (*Pesquisa Industrial Annual – PIA*).

First, the number of observations increases over time, which represents more regions entering into the sample due to the increased number of firms in each locality after the establishment of new firms and/or the enlargement of existing smaller ones.[8] Around 57 microregions (10% of total) have "gained" manufacturing sector plants over the period analyzed, 31 after the contraction shock and 26 after the expansion shock. This result suggests that some sectors might have decided to locate to other areas where salaries are lower due to dispersion forces mentioned earlier.

Looking at these descriptive statistics, it is not clear whether these trade shocks had any impact on how manufacturing wages are regionally distributed. There is a small reduction of the average regional salary over the period analyzed. Additionally, the maximum value declines throughout the whole period analyzed, as well. Other descriptive statistics, such as minimum and standard deviation, present no substantial differences. Overall, it is difficult to grasp insights from these non-spatial measures, which lead us towards a more regional investigation into this variable at a later stage.

Table 2 shows a summary of distances, either to the industrial center, or to the foreign market, which are represented by the nearest port in this case.[9] Regions are closer, on average, to the foreign market (nearest port) than to the industrial center (Sao Paulo).

[8] According to the source, all manufacturing plants with over 30 employees are included in the data. Therefore, the inclusion of more regions shows that either firms have become larger over the years in regions with no previous record, or new firms have established themselves in those regions. Firms with fewer than 30 workers are not included in the dataset.

[9] Most Brazilian International trade is carried out by maritime transport. More details are available in Section 3.5.

This can be partially explained by the calculation of these distances, since distance to the foreign market is created by the nearest port, but there is only one industrial center. Nevertheless, most of the microregions are located closer to the coast, which explains the other part.

Table 2: Descriptive Analysis of Distance to Markets

Distance (in km)	SP	Port	After Suape	After Sepetiba	After Pecem
Average	1,291	427	398	396	393
Standard Deviation	832	295	303	303	304
Minimum	14	22	22	22	22
Maximum	3,317	1,418	1,418	1,418	1,418
Regions changed after infrastructure improvements (137)			64	36	37

Regarding transport costs for foreign markets, during this period three ports were inaugurated and/or vastly expanded with the aim of improving foreign market access – one in the Southeast (Sepetiba in 1998) and two in the Northeast (Suape in 1998, and Pecem in 2002). Such modifications in the port system make the distance to the foreign market vary over time. Since these port improvements, the average minimum distance to the foreign market has consistently reduced (from 427 km to 393 km). Moreover, 137 microregions have become closer to the nearest port since these improvements.[10]

For an overview of the geographical change, some maps are shown to visualize how these trade shocks have affected regional wages in Brazil. Two exercises are carried out. First, an average of the ratio of salaries from 1996 to 1998 is compared to wages in 1985 in an effort to investigate the contraction shock. If changes were greater than a certain limit, then these particular regions have become more similar (or less, if it is negative) to the industrial center.

Three different percentage limits are used for this purpose: 1%, 5% and 10%.[11] Nevertheless, interpretations remained identical regardless of the percentage limit used. For more clarity, maps showed in this paper only use 5% as a limit.[12] In all maps presented, regions are classified as "A" if they have become more similar to Sao Paulo, "B" if they have not shown a significant change, and "C" if they have become less similar to the

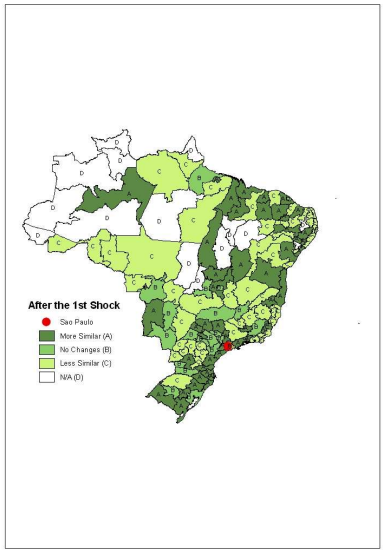
[10]

[11] Changes in the market potential measurement are only marginally different; therefore, it is not shown here. On average, regions have closed the gap by 3% overall. Considering the 95% confidence interval of the difference, the lower bound limit is -4% and the upper 11% in the contraction shock, while 0% and 6% in the expansion.

[12] Maps using 1% and 10% are available from the author on request.

industrial center. There are some regions where information is not available either before and/or after, which are denominated as "D". Figure 1 shows how manufacturing wages on a mesoregional scale have changed after the first liberalization shock.[13]

Figure 1: Map after Shock of the Decline



Numerically, nearly the same number of regions has become more (48) and less (53) similar to the industrial center. However, proportionally, regions in the South have benefited more than any other part of Brazil,[14] especially along the Parana and Santa Catarina coast, which includes some other important manufacturing regions in Brazil.[15] One explanation as to why the South has been more affected is the Mercosur, a regional trade agreement signed by Brazil, Argentina, Uruguay and Paraguay, which started at the beginning of the 1990s. Another geographical pattern is that regions on the coast seem to have benefited the most, while regions in the countryside had the opposite experience. Only 21 regions do not present any substantial difference after the first trade shock. These regions do not show any particular geographical pattern. In summary, these results suggest that regions along the coast, and particularly in the south, are those which show a certain degree of catching up to the industrial center, while countryside regions not.

Figure 2 shows the same analysis, but for the expansion shock: exchange rate devaluation. For this investigation, the average of salaries from 1999 to 2004 is compared

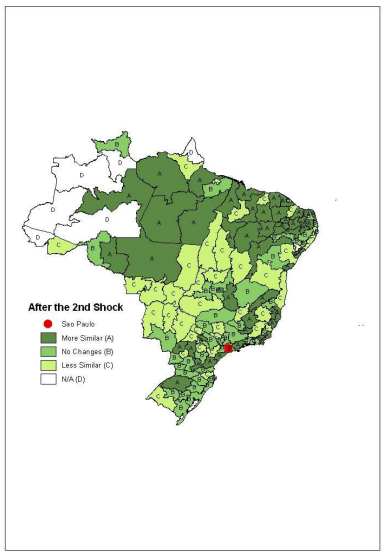
[13] For better visualization, mesoregion scale is used instead. A detailed discussion on the geographical unit is carried out in Section 3.5.

[14] One explanation as to why the South has been more affected is the Mercosur trade bloc, which started at the beginning of the 1990s.

[15] These are: the Curitiba metropolitan region in Parana, and the Itajai Valle in Santa Catarina.

to salaries from 1996 to 1998. The group classification remains the same as before. After the exchange rate depreciation, more regions have narrowed the gap to the industrial center (49), compared to those which have increased (37). Another different feature from the liberalization process is a greater number of regions (44, more than double the 21 recorded after the contraction shock) which have not shown any substantial difference.[16] These figures suggest, in general terms, that the contraction shock seems to have impacted more regions (101) than the second shock (86), but leading them to a much more unequal distribution of wages across Brazil. Nevertheless, the negative impact appears to happen much more in the liberalization process than in the exchange rate depreciation.

Figure 2: Map after Expansion Shock



Proportionally, northern regions seem to have caught up with the industrial center when compared to other parts of Brazil after the expansion shock. Some metropolitan areas have also benefited from both shocks, such as the Curitiba metropolitan area in the South, while others only benefited after the expansion shock, such as the Salvador metropolitan area in the North. Nevertheless, the gap between Sao Paulo and other regions from the Southeast has also reduced. One common feature of the liberalization process is the fact that coastal regions seem to benefit more than countryside regions, where the gap to Sao Paulo has mostly increased.

These outcomes present some insights. Coastal regions, regardless of whether it is after the contraction shock or the expansion shock, tend to have become much more similar to the industrial center than regions in the countryside. This suggests port regions, or those

[16] Similar patterns occur if 10% is used instead. Using this threshold, 21 become 44 after the shock of the decline, and 44 becomes 74 after the expansion shock.

close to ports, are the most affected by any trade shock, as most Brazilian international trade is carried out via maritime transport. Differences are, however, distinguishable between the North and South. While southern regions closed the gap after liberalization, northern regions did so after the exchange rate depreciation.

5. EMPIRICAL STRATEGY: MEASURING HOW GEOGRAPHY MATTERS AND WHETHER TRADE SHOCKS IMPACT REGIONAL WAGE DISPARITIES

As previously mentioned, Brazil has experienced some economic shocks: a liberalization process in the early nineties, a macroeconomic stabilization plan in 1994 and the exchange rate depreciation at the end of the 1990s. An empirical strategy ought to have the capacity to explore not only the NEG literature by showing how demand linkages are able to explain regional wages inequalities, but also whether these trade shocks have impacted these disparities. And, if so, it should show which was more effective.

Testing whether demand linkages can explain regional wages is done by including transport costs or market potential as explanatory variables.[17] The initial approach is to estimate with transport costs, then use market potential. One crucial concern, when using market potential, resides in the fact that it is an endogenous variable and needs to be instrumented. The key issue of this empirical strategy is to detect whether trade shocks have affected these disparities, or not. This is done by trying to evaluate whether the importance of the variable investigated has been reinforced, or not, over the years after the shock. In other words, I test whether the slope of transport costs or market potential has changed over time.

As discussed earlier, differences in regional manufacturing wages may be explained by transport costs. Equation (1) presents the econometric specification to capture how it explains these disparities.

(1)

$$\ln(W_{it}/W_{ct}) = \beta_0 + \beta_1 \ln(IC_{it}) + \beta_2 \ln(PORT_{it}) + \delta_t\theta \ln(IC_{it}) + \delta_t\lambda \ln(PORT_{it}) + \gamma_t\varphi \ln(IC_{it}) + \gamma_t\rho \ln(PORT_{it}) + \alpha_k \ln(Control_{kit}) + \varepsilon_{it}$$

where W_{it} is the average nominal wage per worker for region i at time t; W_{ct} is the average nominal wage per worker from the industrial center in Brazil, the Sao Paulo

[17] Not jointly since they are almost the same measure

Metropolitan Area[18], at time *t*; IC_{it} is the unit of transport cost from region *i* to industrial center at time *t*; $PORT_{it}$ is the unit of transport costs from region *i* to the closest port at time *t*; $Control_{kit}$ is the control variable *k* from region *i* at time *t*; δ_t is a dummy variable which takes a value one if year *t* falls after the contraction shock; γ_t is a dummy variable which takes a value one if year *t* falls after the exchange rate depreciation; ε_{it} is the error term, which is discussed later; the remaining terms are parameters to be estimated.

According to the theory, a negative estimated value of β_1 and β_2 is expected since an increase in transport costs reduces the value of (W_{it} / W_{ct}), which means that the salaries in a region far from the industrial center or from the nearest port become lower in relation to the market. In summary, parameters β_1 and β_2 test the following hypothesis:

a) If β_1 and/or β_2 are significantly negative, transport costs matter for difference in regional wages;
b) If β_1 and/or β_2 are not significant, transport costs are irrelevant to understand regional wage disparities.

If β_1 and/or β_2 change after a trade shock, then liberalization and/or exchange rate depreciation have regionally impacted the Brazilian economy. In order to test this, it is possible to check whether Equation (1) is stable over time, which is equivalent to test that θ and λ are equal to zero for the contraction shock and φ and ρ for the expansion shock.

To examine which channel of the dispersion force (increase in competition) is higher in the Brazilian case, this can be seen by comparing the coefficients in the domestic market after the contraction shock (θ) with the other coefficients after the expansion shock (φ) and coefficients in the foreign market after the contraction shock (λ) with similar coefficients after the expansion shock (ρ). If $|\theta| > |\varphi|$ and $|\lambda| > |\rho|$, then competition with a new product (imported good) has influenced the reduction of wage disparities more than competition in the labor market.

Not only do demand linkages design regional disparities as discussed previously; regions with highly skilled people tend to have higher wages, as stated in human capital theory. Three measures are used to control this issue: years of schooling, human capital and

[18] This is the Sao Paulo microregion and not the state or the city of Sao Paulo.

productivity. The second uses the standard measure of human capital[19], while the first is derived by the average number of years spent in school. Productivity, measured by value added per employee, is also used to control labor quality in regions. In order to provide some exogeneity of this variable, human capital measure is lagged in time. However, people may argue that this variable is still endogenous, since this sort of variable changes slowly over time. It is then relevant to find a suitable instrument for this endogenous variable. First, human capital is measured by a combination of education and work experience. Therefore, education is only a fraction of human capital and sometimes not sufficient to get a job, since some vacancies ask for either work experience or specific technical skills. Moreover, it seems that illiteracy rates in a region may only affect wages through human capital and not through any other measure. If that is the true, this feature satisfies the exclusion restriction of instruments. Additionally, Brazil has a substantial proportion of illiterate people in its population, despite reducing it since the 1950s where approximately half the populace was illiterate. According to the last Brazilian Census in 2000, around 13.6% of inhabitants over 15 years of age are still unable to read or write. Moreover, these figures vary substantially in geographical terms, where some regions have already eradicated illiteracy, while others present illiteracy rates much higher than the national level. These figures represent how illiteracy is important in Brazilian society and how they might be relevant in regional aspects. Apart from those arguments, the exogenous nature of the illiteracy rate is strengthened by the Brazilian context. There is a trade-off experienced by some low-income Brazilian families: either enrolling their children in school; or asking them to contribute to the family budget during the time they would normally be at school. These families represent a large share of Brazil's illiterate inhabitants. Therefore, the reverse causality of income over illiteracy may not apply, since some (yet not all) of these families may increase their income by not allowing their children to learn how to read and write. To substantiate this, regional wages regressed in human capital measurements, and the latter is instrumented by the percentage of illiterate people in each region, since illiteracy may impact regional wages only via human capital measurements, therefore satisfying exclusion restriction needed for an instrument.

Regions are not homogeneous in terms of industrial share, while, in some, the economy relies more on the service sector; in others, manufacturing may play an important role. Therefore, the relevance of the manufacturing industry in each locality ought to be

[19] This includes schooling and work experience. More details on how this human capital was measured can be found at www.ipeadata.gov.br.

taken into account as some regions might have higher wages due to some manufacturing firms offering better remuneration. Three measures are utilized for this purpose: the share of manufacturing in the GDP of regions; the share of employment in manufacturing; and, last but not least, the percentage of the number of manufacturing firms. The first uses the ratio of the value added in the manufacturing sector over regional GDP, while the second shows the share of employment in manufacturing among the total urban population. The latter is calculated by showing the percentage of firms in each region over the total Brazilian manufacturing sector.[20]

Brazil experienced a dispute between states to attract manufacturing plants in the 1990s, referred to as the "Fiscal War", where states offered tax exemption and other subsidies to achieve this goal as confirmed by Rodriguez-Pose and Arbix (2001). Therefore, it is important to control for this government intervention. Two channels are explored. One uses the percentage of expenditure in regional development and the manufacturing industry over the total budget of each state. The other assumes there is an exogenous state effect to attract manufacturing plants. Then, state-fixed effects are utilized to explain this policy intervention.

As discussed above, infrastructure improvements to the foreign market were made via government spending in three ports, and these ought to be included in this estimation process. Two ports in the North, Pecem (CE) and Suape (PE), were basically inaugurated for international trade during the period investigated in this paper, since figures on imports and exports appear only after a certain year[21]. Another port in the South, Sepetiba (RJ), was largely expanded from 1998 onwards. The volume of international trade in this port doubled from 1997 to 1998. It also substantially increased every year after that. By 2004, the amount of imports plus exports was 12 times higher when compared to 1997 figures. Thus, the distance to the nearest port is measured by including these infrastructure changes, where these three ports were included as an option only after major changes were brought about by government expenditure.

A panel-data approach using regions as individual units is essential for this study, as it controls any time invariant characteristics in the regions. Fixed effects ought to be used for this purpose, but they present a different pattern in comparison to Hanson (1997). This author mentions three exogenous amenities which are captured by fixed effects in the

[20] Since the dependent variable is related to the industrial center, all these controls are also measured in relation to Sao Paulo for estimation purpose.

[21] Pecem (CE) after 2003, and Suape (PE) after 1998.

Mexican case: (i) exogenous natural-resource supplies; (ii) exogenous levels of amenities; and (iii) location bias in government spending or tax policies. Although the first two are also exogenous in the Brazilian case, the latter cannot be considered fixed for this country, as stated in the last two paragraphs. The error term has a specific form based on the fixed-effect approach displayed in Equation (2).

(2) $$\varepsilon_{it} = c_i + v_t + \eta_{it}$$

where c_i is the fixed effect for region *i*, v_t is the fixed effect for year *t*, and η_{it} is an i.i.d. term with mean zero and finite variance σ^2.

Estimation by fixed-effects presents a problem. The transport costs used in Equation (1) do not vary over time, but rather within regions, since it is the distance from a region to the industrial center or to a port. The distance to the foreign market is solved by the introduction of improvements in infrastructure (inauguration of ports), as stated previously. The remaining problem is the distance to the industrial center. First differencing the data would eliminate the distance variables from the regression. One way to overcome this issue is by multiplying the importance of the distance to the industrial center in the economy over the years. The share of the industrial center in the Brazilian economy's GDP is used as a measure of "importance". Since the relevance of the industrial center is not static over time, the independent variable becomes time-variant.[22] A fixed-effect approach becomes feasible after this modification.[23]

As mentioned earlier, another approach to detect demand linkages is how well market potential can explain regional wage disparities. In order to probe these transport cost results, estimation using measurements of market potential may provide further evidence. First, it is important to define what domestic and foreign market potential is and how they are calculated. For the former, the GDP from each microregion is used to construct the domestic market potential and is calculated by using formula 3.

(3) $$IM_{it} = \sum_j \left(GDP_{jt} \Big/ DIST_{ij} \right)$$

where IM_{it} is the domestic market potential of region *i* at time *t*; GDP_{jt} is the GDP of microregion *j* at time *t*; $DIST_{ij}$ is the distance between regions *i* and *j*;

[22]

[23] Actually it seems to have lost share, as suggested in the introduction.
Random effects are also used in order to use state fixed effect to capture the government incentives.

The foreign market potential is created by using data from the international trade in Brazilian ports.[24] The export volumes added to the import value of each port give us the foreign market of each port region. Additionally, foreign market potential is measured via a similar expression for domestic market potential by using the distances between regions and ports. Formula 4 shows how it is calculated.

$$EM_{it} = \sum_{j} \left[\left(X_{jt} + M_{jt} \right) \Big/ DIST_{ij} \right] \quad (4)$$

where EM_{it} is the foreign market potential of region i at time t; X_{jt} is the total exports of port j at time t; M_{jt} is the total imports of port j at time t; $DIST_{ij}$ is the distance of region i and port j;

Instead of utilizing distance to the industrial center or ports, market potential measurements (domestic and foreign) of each region are employed as an alternative in an econometric specification. Equation (5) shows the new econometric equation.

(5)
$$\ln(W_{it}/W_{ct}) = \beta_0 + \beta_1 \ln(IM_{it}) + \beta_2 \ln(EM_{it}) + \delta_t \theta \ln(IM_{it}) + \delta_t \lambda \ln(EM_{it}) + \gamma_t \varphi \ln(IM_{it}) + \gamma_t \rho \ln(EM_{it}) + \alpha_k \ln(Control_{kit}) + \varepsilon_{it}$$

where W_{it} is the average nominal wage per worker for region i at time t; W_{ct} is the average nominal wage per worker from the industrial center in Brazil, the Sao Paulo Metropolitan Area, at time t; IM_{it} is the domestic market potential of region i at time t, as defined before; EM_{it} is the foreign market potential of region i at time t, as defined before; $Control_{kit}$ is the control variable k from region i at time t; δ_t is a dummy variable which takes the value of one if the year t falls after the contraction shock; γ_t is a dummy variable which takes the value of one if the year t falls after the exchange rate depreciation; ε_{it} is the error term; the remaining terms are parameters to be estimated.

Regarding the issues discussed in the previous econometric specification, most of them remained practically the same, but now fixed effects can be used because market potential is not constant over time. Another feature, however, should be examined here with care. Market potential, regardless of whether domestic or foreign, is endogenous in this econometric specification. Endogeneity of regressors leads to biased estimates of the parameters, and instruments are therefore required. Instruments should be able to have an

[24] The next section provides an explanation on why using only port.

effect on dependent variables only through endogenous variables in order to satisfy their two main conditions: correlated to the endogenous variable; and orthogonal to the error term.

The Brazilian government provides long-term loans through its development bank, known as the BNDES. There are different reasons defining which projects should be financially supported by BNDES loans, especially in geographical terms. Two of the most important reasons are either economic or policy. Some greenfield projects, for example, need to be implemented in regions where economies of scale are crucial for the project's profitability. Therefore, such a project should be implemented in one of the most developed regions of the Brazilian territory; otherwise, this project is not financially viable. In these projects, wealthy regions are benefited by such financial support and economic reason prevails. On the other hand, some projects are designed to promote development in poor regions. One example might be investments into infrastructure in less developed regions in which the goal is to boost the local economy. For these projects, loans are driven by policy, and they favor poor regions within the Brazilian territory.

Summing up, BNDES loans do not have, therefore, a single pattern in which disbursements should be regionally allocated, since they depend on distinctive projects received by the bank. Moreover, rich and poor regions might be benefited idiosyncratically throughout the years. Just to exemplify, the richest state in Brazil (Sao Paulo) received only 0.8% of disbursements over its GDP between 1991 and 1999, while in one poor state (Sergipe) the same ratio was 2.0% over the same period. On the other hand, during the same period, another poor state (Piaui) received only 0.5% of disbursements over its GDP, while another rich state (Santa Catarina) showed 1.7% of the same ratio. Looking at these figures, it is safe to conclude that because the BNDES has different objectives for its loans, they do not have, for example, any economic or policy pattern. In this respect, it seems that the BNDES' disbursements would appear to be plausible instruments, but some further precautions might be appropriate in order to tackle each endogenous variable, that is, the domestic and foreign market potentials.

The BNDES has different types of loans; some for exports and others aimed at the domestic market. Since there are two endogenous market potentials, one domestic, another foreign, loans are split up according to each market. All export-oriented loans are used to instrument foreign market potential; others types of loans serve as instruments for domestic market potential.

In order to influence dependent variable only through endogenous variable, some additional precautions are taken. First, disbursements are lagged in time in order to provide some time for the projects to be fully implemented. As exports loans last one year, disbursements are lagged one year. On the other hand, disbursements for the domestic market last for 5 years on average, and then they are lagged for the same period. This lag time helps to avoid any excess in demand for labor due to exogenous increase of investments, since the labor market might clear after the implementation of the project due to the attraction of migrants, for example. Second, all values are at a state level, not at microregion level as wages and market potentials are. Due to this more aggregated regional unit, any government intervention affects all different microregions in the same state evenly. Then, any microregion in each state benefits from government support, especially those closer to where investments are made. Third, the BNDES' disbursements are divided up according to each region's GDP or exports, which makes them even more exogenous and probably only related to market potential and not to regional wages.

Gathering this information, these bank disbursements over each region's GDP or exports might be feasible instruments, since the BNDES' loans may only impact wages through GDP, which is the basis of the market potential measurement. If that is true, these government interventions might be able to satisfy the exclusion restriction, one of the conditions that an instrument should be respected.

It is not possible to control all possible variables that might be correlated with the BNDES' disbursements and regional wages. Furthermore, this empirical approach might capture the effect of the BNDES' disbursements on regional wages, but by working through other different channels. In order to tackle these problems, other variables used in previous papers are performed as additional instruments for the same purpose: to instrument market potentials. Brakman et al (2004) and Hanson (2005) use population as instrument for market potential. Therefore, the share of urban population lagged in time represents a (size) measurement which might be related to nominal wages only through market potential in this research, since manufacturing jobs are generally available in urban areas. Distance measurements are exogenous characteristics enabling them to become an instrument, but they might be related to wages. If this is true, distances to markets are not the ideal instruments, since they may fail the exclusion restriction. However, distances to economic centers have been used as instruments in previous studies, such as Head and Mayer (2006), as well as Redding and Venables (2004). Indeed, Head and Mayer (2006)

tried two other measurements of distance which are considered more exogenous[25], but no real difference is found in their paper. Hence, these additional measurements appear to be the most common instruments used in the literature for market potential measurements. Moreover, expanding the set of instruments may lead to more efficient estimation and enable this research to perform over-identification tests.

Summing up, domestic and foreign market potential are used to explain regional wages, and those endogenous variables are instrumented by the BNDES' disbursements over GDP or exports (depending on the market potential) jointly with the urban share of the population lagged in time and distances to domestic and foreign markets in each region. The main reason for choosing those variables is that they might affect regional wages only through market potential, satisfying the exclusion restriction which is one crucial condition for their validation. Nevertheless, these instruments should meet these criteria through statistic tests, which are supportive, not conclusive.

6. DATA DESCRIPTION

One major issue is to define which geographical unit could better capture these effects. Even though Hanson (1997) analyzed this effect using data from Mexican states, he argues that more disaggregated data, for example separated per city, would be more suitable for this investigation. His justification to use state-level data lies in the fact that manufacturing employment is concentrated in one single city in each Mexican state. Although this could be the case in Mexico, this is not the Brazilian case. There are many important cities within states which cannot be neglected by pooling all of them together in one single unit (states). One aspect to be considered in selecting a geographical scale is whether a political division represents an economic one. Regional disparities within any larger, politically-established scale cannot be captured by such data, for example, at a state level. Therefore, movement to poor regions in the same geographical unit is not able to be captured by data within such a geographical scale. On the other hand, geographical scale ought to be economically meaningful.

Apart from the political division into states and cities, the Brazilian Institute of Statistics and Geography (*Instituto Brasileiro de Geografia e Estatística* – IBGE, henceforth) has two other geographical classifications: mesoregions; and microregions.[26]

[25]

[26] These distances are named as "EU centrality" and "global centrality".

These two classifications use the social and economical linkages to evaluate which cities are more connected, but they respect the political division (states and cities). Thus, they are nested classifications between states and cities.

The former divides the territory into 137 parts, and the latter, into 558. City-level data are not the most appropriate for this period for two reasons. First, more than 1,000 districts were transformed into cities by emancipating themselves in the nineties. Another issue resides in the fact that municipality-level splits functional areas, which ought to be treated jointly. Considering these issues, microregion division seems to be the most suitable spatial scale for the investigation proposed in this paper.

The main data are taken from IBGE. Two types of publications are used: Annual Industry Research (*Pesquisa Industrial Anual* – PIA) from 1996 until 2004; and the Industrial Census from 1985. The former has annual information from all establishments of over 30 employees, while the latter has information from all manufacturing firms. However, only firms above the threshold of PIA are used for analysis in order to keep the same sample characteristics from both publications.

The investigated variable is wages, which are measured by the total remuneration divided by the number of employees in each microregion. In other words, the average wage per worker at each location. Transport cost is calculated by the distance between the main city in a microregion and the industrial center in the domestic market (Sao Paulo), and between the microregion and the foreign market.

The Mexican case has a particular geographical location, since it shares a common border with its most important trade partner (the US). This facilitates any study of trade geographical impact in this particular country. Brazil's international trade is evenly distributed around all parts of the globe. The highest percentage does not exceed 30% over the whole period. The UK has a similar pattern; moreover, a great part of its international trade is by maritime transport. Overman and Winters (2006) tackle this problem by using the distance to the ports as a proxy of distance to the international market in the UK case. Brazil has a large number of ports along its extensive coastline, but the main 14 Brazilian ports represent more than 60% of total international trade.[27] These ports are selected according to Goebel (2002) and Lacerda (2004) based on their historical data and capacity. Only the minimum distance to ports is used in this paper, and the average distance has been neglected, since the former more adequately represents foreign market access than the latter. Consider one simple example to understand why: imagine a region as a straight line with two ports at each end. The average distance to the foreign market does not present any

[27] There are four ports in the Southeast (Santos-SP, Rio de Janeiro-RJ, Sepetiba-RJ and Vitória-ES), four in the South (Paranaguá-PR, São Francisco do Sul-SC, Itajaí-SC and Rio Grande-RS), four in the Northeast (Salvador-BA, Fortaleza-CE, Suape-PE and Pecém-CE) and two in the North (Belém-PA and Manaus-AM).

difference for all random points selected in this region (along the line), since the mean distance to a port is the same for all of them. It is clear, however, that the port regions (the ends) have better access to the foreign market than any region along the line. The minimum distance to a port is thus the best proxy for foreign market access. The distance is given by the Great Circle Formula, using the latitude and longitude of each location (city and/or port).

As stated previously, demand linkage can be explained by market potential. Domestic market potential is calculated by using GDP measures created by IBGE and the Applied Economic Research Institute (*Instituto de Pesquisa Economica Aplicada* – IPEA, henceforth). The external market potential is created by utilizing total trade (imports plus exports) at all ports mentioned before, sourced by the Trade Secretary. The distance to construct these measures is calculated by the Great Circle Formula.

Regarding human capital measures, different sources are used. Human capital, in a strict sense, is calculated by IPEA using education and work experience.[28] Education is derived by the average number of years spent in school for any citizen beyond 25 years of age presented in IBGE's Brazilian Census, which is the same source for illiteracy in adults over 25 years of age. Productivity of each region is measured by dividing value-added by number of employees, sourced by PIA.

For controlling manufacturing importance, most of the measures originated from PIA, while the remaining come from IPEA. The source of states' expenditure, which is utilized to capture subsidies for manufacturing, is the National Treasury.

7. RESULTS

For simplicity, results shown in this paper take into consideration only one measure of labor quality (human capital) and one measure of manufacturing importance at each location (percentage of manufacturing's value-added in each region's GDP).[29] Both measurements of government regional policies, percentage of subsidies and state dummies, are presented here.[30] Since human capital is endogenous, the percentage of illiterate people is used as it may affect regional wages only through human capital, as explained

[28]

[29] For more details see www.ipeadata.gov.br.

Outcomes with other different measurements, such as productivity, years of schooling for labor quality, share of employment and number of manufacturing firms for manufacturing regions importance present similar results to those shown in this paper. Complete results are available from the author on request.

[30]

Parameters estimated for state dummies are not shown. Whenever subsidy parameters estimated are not included in any column, it means that state dummies are used instead. However, state dummies cannot be used with fixed-effects for obvious reasons.

previously.[31] Period effects are included to capture any time change which is not related to the phenomenon investigated. Last, but not least, errors are robustly estimated.

Table 3 provides the first results using Equation (1), and it is structured as follows. The first six columns (i to vi) present results with time-invariant distance to industrial centers, while the last four columns (vii to x) use the distance to the industrial centre weighted by its importance. The first column in each method (i, iv and ix) presents results with no trade effect. Columns ii, v, vii and x use state government expenditure to control for subsidies.[32] Those remaining (iii, vi and viii) show results using state dummies instead.[33]

Table 3: Distance as Explanatory Variable– Equation (1)

Panel A: Regression Results										
Dependent Variable	IV			IV Random Effects					IV Fixed Effects	
Wi,t / Wsp,t	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
Dist. SP	-0.11	-0.11	-0.05	-0.13	-0.12	-0.08	-0.14	-0.11	0.02	-0.29
	(0.013)***	(0.036)***	(0.022)**	(0.024)***	(0.026)***	(0.034)**	(0.025)***	(0.038)**	(0.06)	(0.055)***
SP Cont. Shock		0.00	-0.03		-0.01	-0.02	-0.01	-0.02		0.02
		(0.04)	(0.02)		(0.01)	(0.01)	(0.01)	(0.01)		(0.011)**
SP Exp. Shock		-0.01	-0.01		0.00	0.00	-0.01	-0.01		0.02
		(0.04)	(0.02)		(0.01)	(0.01)	(0.01)	(0.01)		(0.011)*
Dist. Port	0.04	0.07	0.02	0.02	0.06	0.04	0.06	0.04	0.02	0.05
	(0.009)***	(0.023)***	(0.02)	(0.011)**	(0.014)***	(0.014)***	(0.014)***	(0.014)***	(0.013)*	(0.015)***
Port Cont. Shock		-0.03	-0.04		-0.04	-0.04	-0.04	-0.04		-0.01
		(0.03)	(0.018)**		(0.011)***	(0.011)***	(0.011)***	(0.011)***		(0,01)
Port Exp. Shock		-0.03	-0.04		-0.05	-0.05	-0.05	-0.05		-0,03
		-0,02	(0.017)***		(0.010)***	(0.010)***	(0.010)***	(0.010)***		(0.008)***
Human Capital	0,37	0,37	0,17	0,29	0,29	0,17	0,28	0,17	0,11	0,14
	(0.030)***	(0.030)***	(0.013)***	(0.048)***	(0.045)***	(0.027)***	(0.043)***	(0.026)***	-0,15	-0,10
Subsidies	-0,05	-0,05		-0,02	-0,02		-0,02		-0,01	-0,01
	(0.007)***	(0.007)***		(0.006)***	(0.006)**		(0.006)***		-0,01	(0.006)*
Manuf. VA / GDP	0,09	0,09	0,13	0,08	0,08	0,09	0,08	0,09	0,09	0,08
	(0.008)***	(0.008)***	(0.007)***	(0.006)***	(0.006)***	(0.006)***	(0.006)***	(0.006)***	(0.006)***	(0.006)***
Period Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effect	No	No	Yes	No	No	Yes	No	Yes	No	No
Obs.	4.145	4.145	4.145	4.145	4.145	4.145	4.145	4.145	4.145	4.145
R-squared	0,23	0,23	0,52	0,38	0,38	0,51	0,39	0,51	0,30	0,43
Panel B: First Stage Results										
Instrument	Illiteracy	illiteracy	illiteracy	illiteracy	illiteracy	illiteracy	illiteracy	illiteracy	illiteracy	Illiteracy
FS R-sq.	0.09	0.09	0.27	0.19	0.19	0.19	0.19	0.19	0.16	0.17
FS F-stat	388	388	1,520	35	35	35	35	35	225	278

[31] As the dependent variable is measured in relation to Sao Paulo; then, human capital measurements used here are also divided by the Sao Paulo figures.

[32] Hausman tests are performed between vii and x. Results reject the hypothesis that both estimations provide similar parameters estimated. Therefore, fixed effects present more robust results.

[33] In all these columns, human capital measurements are instrumented by the illiteracy rate.

(a) Robust standard errors in parentheses; (b) * significant at 10%; ** significant at 5%; *** significant at 1%.

Regarding rows, panel A presents estimation results, while panel B shows First Stage information, where the first row presents which instrument is used, the second reports R-squared, and the last, F-statistic. It is not possible to show any over-identification test, since the IV approach is just identified.[34]

It is important to observe some facts before interpreting the results. Illiteracy seems to substantially explain human capital measurements, since R-squared is over 0.15 in most first stage results. The F-statistic also shows that this variable is statistically significant in explaining human capital. Therefore, there is some evidence that illiteracy might be a valid instrument.

Regarding interpreting control outcomes, human capital plays an important role in explaining differences in wages, since most estimation results show the expected (positive) significant sign.[35] The importance of manufacturing in each microregion also presents a positive and significant sign, which strengthens our results by controlling how relevant this sector is at each location.

The other control variable, subsidies, does not show consistent outcomes. First, it seems that it has a negative impact, contrary to what is expected. Regions with higher subsidies to industry in their budget, thus, have lower wages. This finding is consistent with Sousa (2002), who also found that states with higher subsidies did not attract more manufacturing production, but contrary to Volpe (2004). When state dummies are included, the majority does not present significant results, showing that any time invariant state characteristic is not important when explaining differences in regional manufacturing salaries. This result in subsidies shows that more work should be done to address the question of to what extent the Fiscal War has really played a role in the location of the manufacturing sector in Brazil.[36]

Concerning transport cost, it is clear that distance to the industrial centre plays a relevant role in explaining regional wages in Brazil, since it has the expected sign showing that transport costs really matter. The transport cost measurement to the foreign market, however, presents the opposite. The farther a region is from the foreign market, the higher wages are, as it presents a positive significant sign. The domestic market thus appears to

[34]

[35] Over-identification tests are presented when using Market Potential later in this paper.

[36] Outcomes with education and productivity present similar results, as well as not instrumenting human capital. Complete results are available from the author on request

Another part of Brazil where manufacturing receive government intervention is Manaus Metropolitan Area as designed by the Manaus Free Trade Zone. Creating a dummy for this metropolitan region captures this effect, but it cannot be used in fixed effect approach. Nevertheless, results using RE and OLS do not show any difference.

determine the regional distribution of salaries in Brazil, but the foreign market seems to explain the other way around.

By analyzing how trade shocks have impacted these disparities, it is possible to point out the increased importance of the foreign market and the opposite for the domestic market, as shown in lines Sao Paulo or Port after contraction and expansion shocks. However, robustness differs. The distance to the industrial centre becomes less important after both trade shocks, only in the FE approach. On the other hand, transport costs to ports show more robust results, regardless which method is used. However, the distance to the foreign market is only affected after the expansion shock when the FE approach is used. Despite these differences, such findings suggest that in a closed economy (1985 in this example) transport costs to the domestic market shape how manufacturing wages are regionally distributed. After opening to trade, the distance to the foreign market tends to increase in importance when explaining regional wage inequalities compared to the domestic market since the distance to the domestic market after either shock has a significant positive sign in the FE approach, while the distance to the foreign market has a significant negative one in most cases. These effects allow me to set out why regions in the South (after liberalization) and in the North (after exchange rate depreciation) have narrowed the gap to the industrial centre, as indicated in the map from Section 4.

Previously, Hanson (1997) found no evidence that NAFTA affected Mexican regional wage disparities, which is explained in the paper by the short period considered after the trade agreement. It is important to notice another issue: the geographical unit, which is at a state level in Hanson (1997). A more detailed geographical unit and time lag after a trade shock illuminate these effects on regional wage disparities as the outcomes of this paper highlight. These findings contribute to rule out the idea that the reduction in trade costs has no impact on regional disparities.

Other interpretations can be made from these results, especially by comparing which shock is more prominent and at which transport cost. Initially, it is not possible to come to a definitive answer in comparing the strength of each shock, since 2SLS and IVRE do not show any difference between estimated parameters. However, the expansion shock presents a positive and significant result in the FE by analyzing distance to ports, while the contraction shock is not significant. On the other hand, the distance to the domestic market might be affected equally after both shocks, since it is not possible to conclude which was stronger. Last, but not least, transport costs to foreign market seem to present more robust results compared to the domestic market. Therefore, some conclusions might emerge from

this result. First, the expansion shock might have a more effective impact than the contraction shock, but only in transport costs to the foreign market. Second, transport costs to the domestic market could be affected by any shock. Indeed, similar results are found when not instrumenting human capital. Although there are some suggestions on shock strength and on which market is more affected, it is not possible to come to a single conclusion.

One might argue that transport costs may not perfectly explain this demand linkage, since Sao Paulo or any port regions do not fully shape the Brazilian geographical economy. There are many other regional economic centers and/or regions close to ports, for example, which could have been affected by these demand linkages. As mentioned previously, it is possible to investigate it further by using market potential measurements, both domestic and foreign. Although it solves this shortcoming, this new approach shows others. These market potential measurements are endogenous, and specific instruments are required. As stated earlier, population size and distances coupled with government support are used for this purpose, since they may affect regional wages only through market potential measurements. Therefore, Equation (5) is estimated to fill the gap that transport costs are not able to.[37]

Table 4 presents these results: panel A is responsible for showing parameter outcomes, panel B for some first stage information, and panel C for the over-identification test.[38] In the former panel, the first two columns present OLS results, the first with no trade shock, and the second using government expenditures. The next three columns show results using two-stage least squares (2SLS): the first with no trade shock considered, the second using government expenditures, and third using state dummies. Random effect outcomes are presented from (vi) to (viii), following the same structure from 2SLS, which means (vi) no trade effect, (vii) government expenditures, and (viii) state dummies.[39] The last two columns show fixed effect results using government expenditures only, with and without trade shock.[40] In panel B, rows are organized as follows: the last four rows report R-

[37]

[38] Just as a reminder, now the expected sign is the opposite, since larger markets present higher wages.

As for transport cost results, this table presents only some of the outcomes for simplicity. Complete results are available from the author on request. In all columns, market potential and human capital measurements are instrumented by the earlier mentioned variables, which are distance, population, government support and illiteracy.

[39]

Not only are human capital measurements divided by Sao Paulo figures in this specification, but also both market potential measurements (domestic and foreign).

[40]

Hausman's test is also performed with outcomes from column v and viii. The null hypothesis is also rejected. Therefore, fixed effects present more robust results.

squared of each endogenous variable, while the others mention which instrument is utilized in each column. Panel C presents the over-identification tests of each method used.

Table 4: Panel Data Approach to Equation (5)

Panel A: Regression Results										
Dependent Variable	OLS		2SLS			IV Random Effects			IV Fixed Effects	
Wi,t / Wsp,t	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
Int. Mkt Pot.	-0.03	-0.02	-0.75	0,11	0.06	-1.23	0.23	0.17	-1.55	-0.59
	(0.018)*	(0.05)	(0.175)***	(0.043)**	(0.027)**	(2.40)	(0.124)*	(0.083)**	(1.25)	(0.60)
Int. Mkt Pot. Cont. Shock		-0.02		-0.12	-0.06		-0.29	-0.24		-0.18
		(0.06)		(0.047)**	(0.031)**		(0.19)	(0.12)**		(0.09)*
Int. Mkt Pot. Exp. Shock		-0.01		-0.12	-0.06		-0.24	-0,19		-0,37
		(0.06)		(0.048)**	(0.031)**		(0.14)	(0.092)**		(0.089)***
Ext. Mkt Pot.	0.25	0.21	1.02	-0.12	-0.06	1.74	-0.26	-0,195	-0.13	-0,14
	(0.015)***	(0.045)***	(0.154)***	(0.046)***	(0.028)**	(1.55)	(0.136)*	(0,09)**	(0.153)	(0.15)
Ext. Mkt Pot. Cont. Shock		0.03		0.14	0.08		0.37	0.30		0.16
		(0.05)		(0.052)***	(0.032)**		(0.209)*	(0.137)**		(0.09)*
Ext. Mkt Pot.l Exp. Shock		0.04		0.13	0.07		0.29	0.24		0.35
		(0.05)		(0.05)***	(0.032)**		(0.157)*	(0.104)**		(0.085)***
Human Capital	0.10	0.10	0.02	0.12	0.09	-0.24	0.09	0.06	0.23	-0.27
	(0.006)***	(0.006)***	(0.06)	(0.038)***	(0.026)***	(0.34)	(0.12)	(0.05)***	(0.19)	(0.11)**
Subsidies	-0.06	-0.06	-0,04	-0.02		0.02	0,06		-0.03	-0.01
	(0.006)***	(0.006)***	(0.008)***	(0.03)		(0.03)	(0.04)		(0.012)**	(0.008)*
Manuf. VA over GDP	0.14	0.14	0.13	0.12	0.14	0.10	0.11	011	0.09	0.10
	(0.006)***	(0.006)***	(0.009)***	(0.017)***	(0.012)***	(0.012)***	(0.017)***	(0.012)***	(0.006)***	(0.007)***
Constant	-0.04	-0.21	0.23	-0.11	-0.07	1.04	1.00	1.15	-11.94	-7.67
	(0.10)	(0.22)	(0.248)***	(0.062)*	(0.033)**	(0.209)***	(0.242)***	(0.499)**	7.97	(4.18)*
Period Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effect	No	No	No	No	Yes	No	No	Yes	No	No
Observations	4,145	4,145	4,145	4,145	4,145	4,145	4,145	4,145	4,145	4,145
R-squared	0.47	0.47	0.20	0.45	0.46	0.13	0.20	0.32	0.23	0.19
Panel B: First Stage Results										
Instruments										
Illiteracy	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank's Disburs.	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Pop. Share	-	-	No	Yes	Yes	Yes	Yes	Yes	No	No
Distance	-	-	No	Yes	Yes	No	Yes	Yes	Yes	Yes
R-sq HC	-	-	0.14	0.21	0.35	0.25	0.21	0.21	0.26	0.23
R-sq Int. MP	-	-	0.32	0.77	0.54	0.26	0.79	0.79	0.36	0.40
R-sq Ext. MP	-	-	0.35	0.89	0.82	0.49	0.88	0.88	0.37	0.32
Panel C: Results from over-identification Test										
p-value (Chi-sq)	-	-	0.87	0.06	0.88	0.24	0.80	0.90	0.55	0.12

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Before interpreting results, it is important to analyze first stage results of all IV estimations in this paper. First, the R-square of first stage regressions of all attempts are no less than 0.14, while some present really high values, such as 0.90. On one hand, it indicates that instruments are sufficiently correlated to the endogenous variables, but, on the other, it raises the question to what extent these instruments may meet the exclusion condition. Regarding the orthogonality condition, over-identification tests present p-values which encourage the results. Most outcomes presented for over-identification tests are not able to reject the null hypothesis by using the 10% level of significance. Such over-identification results are, therefore, able to provide some evidence that variables used might be valid instruments. However, it is relevant to bear in mind that these statistics are only supportive, and not a definitive answer to whether they are perfect instruments. Summing up, the IV results presented in this paper are able to satisfy the two most important conditions, which are: orthogonal to the dependent variable; sufficiently correlated to endogenous variables.[41]

First, controls continue to behave as before, with human capital and the share of manufacturing sector being mostly significantly positive and subsidies negative. Regarding domestic demand, there are different results. At OLS, it seems that domestic demand is not able to explain regional disparities in wages. When using the IV approach, either through 2SLS or RE, the domestic market seems to explain these geographical differences. However, results are not corroborated when using the FE approach, as outcomes are not statistically significant. On the other hand, the foreign demand market presents different outcomes. The external market potential seems to be positively correlated to regional wages by not using instruments. When they take place, this correlation becomes negative, yet this

[41] Human capital is instrumented by a measure (illiteracy) which raises the question to whether which one is more or less endogenous. One way on dealing with it is estimating 3.5 not using human capital as a control. Omitted variable creates biased results and instruments are needed to tackle this issue. However, results do not present substantive difference, neither at first stage nor at interpreting trade effects, those outcomes are available from the author on request.

is not corroborated by estimating with the FE. All in all, results seem to corroborate these results using distance as the explanatory variable, but surprisingly not in the most sophisticated model: the FE. One possible explanation is that perhaps Sao Paulo is the main driving force to regional disparities in wages; a result using distance (in this case, in Sao Paulo) is statistically significant using the FE, while the outcome utilizing the domestic market potential (in this case, weighting all economic centers) is not.[42]

Trade shocks present even more consistent results compared to Table 3. Outcomes presented in Table 4 suggest an increased importance of the foreign market, while the domestic market becomes less relevant, even in the FE approach. It is safe to conclude that any shock, contraction or expansion, affects regional wages. Agglomeration forces in domestic markets lessened after a reduction in trade costs, while these in regions close to the foreign market see their importance strengthened.

In terms of which shock has a greater impact, it seems the difference does not seem to be statistically significant considering the standard deviation in the 2SLS and IVRE approaches. The FE approach presents results suggesting that the expansion shock might impact regional disparities more efficiently, but it is not possible to reach this conclusion considering an interval of 95% confidence. Neither is it feasible to come to a definitive answer on which market is more affected by any of these shocks mentioned, since there are no substantial changes between the domestic or foreign market after both shocks.

8. CONCLUSION

This paper uses Brazilian regional data to test the hypothesis that regional manufacturing wages can be explained by demand linkages and, additionally, how trade shocks can affect these disparities. According to the literature, the most common dispersion force on firms deciding on location is competition. Brazil experienced some shocks which have raised the competition effect through trade at different periods by contracting domestic activities first, then expanding them. This paper contributes, therefore, to the literature on evaluating whether these shocks are able to impact regional wage disparities, as well as trying to measure the strength of each shock and which market might be more affected.

First, regional manufacturing wages are not homogeneous throughout Brazil. They seem to be higher closer to the markets corroborating the hypothesis of agglomeration present in NEG models. Results suggest the domestic market shows that the domestic market shapes regional wage disparities, especially the industrial centers. The external

[42] Estimating not instrumenting any endogenous variable show similar results. Complete results are available from the author on request.

market has the reverse outcome: regions far from the foreign market tend to have higher wages. However, results are not as robust for the domestic market.

Economic shocks have, moreover, changed the importance of the domestic and foreign market in explaining regional manufacturing wages. The overall findings show that the domestic market has turned out to be less relevant, while the foreign market has become more important after both shocks. Comparing which one is more effective and which market might be more affected; outcomes are not conclusive. In spatial terms, southern regions of Brazil appear to have closed the gap to the industrial centers more after the contraction shock, while northern regions after the exchange rate depreciation. Moreover, coastal regions seem to have benefited the most from both shocks, while regions located in the countryside have fallen behind.

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