Regional inequalities are large in India and Brazil and represent a development challenge. This article aims to determine whether regional inequalities are linked to a country’s trade openness. An annual indicator of regional inequalities is constructed for India for the period 1980–2004 and for Brazil from 1985–2004. Results from time series regressions show that Brazil’s trade openness contributes to a reduction in regional inequalities. The opposite result is found for India. India’s trade openness is an important factor aggravating income inequality among Indian states. In both countries, inflows of foreign direct investment are found to increase regional inequalities.

KEYWORDS trade openness, regional inequality, India, Brazil, time series regression

I. INTRODUCTION

Regional inequalities are a matter of serious concern in India and in Brazil. Regional inequality is the spatial dimension of inequality within a nation and the difference between the standards of living applying within a country, when some regions are ahead of others. The per capita income is here used to quantify the poverty or the prosperity of a region. For example, in Brazil, in 2000, the per capita GDP of the Southeast region is more than three times that of the North. In India, in 2002, the mean per capita income of the richest state, Punjab, was about four times that of Bihar, the poorest state.

Regional inequality has been rising in India since the 1990s and has now reached a critical level. Currently, one of the major concerns of the
Indian central government is that rising regional inequalities might affect India's political unity. Indian Prime Minister, Manmohan Singh, declared for the Independence Day in 2007:

> We want to bring greater prosperity to the less developed regions of our country, especially the Northeastern region and Jammu and Kashmir. This is our solemn commitment [...] We are investing in better infrastructure and connectivity in the Northeastern States. In Jammu and Kashmir, our long-term development plan is bringing new investment to all the three regions of the State. Grassroots democracy has taken deep roots in the State and the Roundtable discussions have opened new avenues for reconciliation and development.\(^1\)

Regional inequalities have always been large in Brazil. On his election in 2002 and 2006, President Lula da Silva stated that efforts to combat regional inequalities would be one of his priorities. There is a growing consensus among Brazilian political parties that addressing regional inequalities that expose the country to the risk of fragmentation is a major challenge and a priority for Brazil. President Lula da Silva declared in 2006 in a speech after election victory:

> Nevertheless, the frank exposure of our problems showed that there still exist different and profoundly unequal Brazils, and demonstrated the need to act promptly in order to reduce these social and regional inequalities. I want to continue with the work of a government that integrates correct economic policy with a strong social sensibility, and combines efficient administration with appropriate political leadership. A government that continues reducing the inequalities between people and regions.\(^2\)

Both countries underwent trade liberalization in the 1990s. In 1991, India's liberalization program reduced trade barriers. Before 1987, Brazil was one of the most heavily protected economies in the world. Trade liberalization mainly occurred between 1988 and 1995. A strategy of outward orientation led to reductions in tariffs and removal of other trade barriers. An important question for a country is whether its insertion into the global economy will affect regional economic development and thus affect regional inequality. Focusing on trade globalization, this article aims to determine whether or not the evolution of regional inequality in India and Brazil is linked to trade openness.

This study focuses on Brazil and India, two key players in the world's economy, for two reasons. First, they are comparable to a certain extent.

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1. *Source: The Hindu*, national newspaper, August 15, 2007.
2. *Source: http://www.brazil.org.uk/press/speeches-files/20061031.html.*
They are developing countries, at a similar stage of economic development, and both have undergone trade liberalization in the 1990s. They are federal and democratic countries with a continental dimension, the number of their regional units (28 Indian states and 27 Brazilian states) is similar. Large regional inequalities are a threat to their national unity especially because a democratic federalist system implies political flexibility that can concede more autonomy or independence to subnational units.

Secondly, this study is inspired by Milanovic (2005) who finds no impact of trade openness on regional inequality in India, Brazil, Indonesia, China, and the United States. Milanovic’s results are important, stimulating, and surprising, especially as regards India whose regional inequalities have been increasing since the 1990s and because of India’s trade liberalization. The aim is to determine whether the same results are found for India and Brazil using a different methodology from that of Milanovic.

New economic geography models have explored the effects of trade openness on regional inequalities. Krugman and Livas Elizondo (1996) show that trade liberalization reduces spatial inequalities across regions. They consider that there are centripetal forces (economies of scale due to market size) that tend to attract firms, industries, and workers together and centrifugal forces (commuting costs and land rents) that tend to break up such agglomerations. In their theoretical model, they mention, among other factors, the location’s total income as a function of these centripetal and centrifugal forces, which determine industrial location throughout a national territory. Since there is a link between these forces and trade liberalization, trade openness partly determines industrial location.

In their theoretical model, in autarky, firms are concentrated in the central region to be in proximity to the central consumer market and input suppliers. With interregional labor mobility, the centripetal forces are self-reinforcing in autarky, ensuring big agglomerations, big consumer markets, and large regional disparities within the country. When a country opens to international trade, the central market is less important because foreign markets are potential substitutes for domestic consumer markets, and foreign suppliers are potential substitutes for national input suppliers. Consequently, since the central market and the big agglomeration are less attractive, firms relocate to peripheral zones to avoid congestion costs that existed before trade liberalization. The opening to trade may result in a dispersal of some economic activities across the national territory, thus reducing regional inequality.

Fujita, Krugman, and Venables (1999) also suggest that trade integration might reduce regional inequalities in the long run by attracting manufacturing to the less developed regions of a country especially when wages are lower in these remote regions, because of the relative lack of labour mobility in the country.
Paluzie (2001) and Crozet and Koenig-Soubeyran (2004) build theoretical models that predict that trade liberalization can increase regional inequalities within countries. Paluzie (2001) finds that regional inequality rises as international trade in manufacturing increases. Her model’s assumptions are very similar to those of Krugman and Livas Elizondo’s (1996), but, contrary to these, she assumes that agricultural labor is immobile. Dispersed immobile demand is a dispersion force. In consequence, in autarky, concentration is limited because firms are located in the periphery to service this dispersed and immobile rural demand. But when the country opens to international trade, dispersed local demand is replaced by foreign demand, which weakens the dispersion force. Consequently, after trade liberalization, firms agglomerate in a central region to benefit from various advantages (economies of scale, positive externalities). Crozet and Koenig-Soubeyran’s (2004) model shows that the impact of trade liberalization on the agglomeration process and spatial inequalities depends on the specific internal geography of the country. When one of the regions in a country has better and low-cost access to foreign markets, trade liberalization fosters a cumulative agglomeration process in this advantaged region, unless the dispersion force that is competition between firms is very strong. Although anterior to this model, Hanson’s (1997) results illustrate this idea. Using Mexican data on regional manufacturing before and after Mexico’s trade liberalization in 1986, Hanson (1997) finds that Mexico’s trade openness has fostered the formation of new industrial centers in the United States–Mexican border area. In fact, since trade liberalization, industry has relocated from Mexico City to the U.S.–Mexico border.

The new economic geography models differ concerning their predictions: trade openness is likely to reduce or aggravate regional inequalities that are dependent on the type of agglomeration and dispersion forces included, according to the chosen hypotheses.

Empirical studies on trade openness and regional inequality consist of studies of a few countries and, like economic geography models, they lead to contradictory results. Gonzales Rivas (2007) finds that trade liberalization increases regional inequalities in Mexico. She studies the effect of Mexico’s trade openness on economic growth of Mexican states by estimating a growth model where growth rates of Mexican states are regressed, among others, on Mexico’s trade openness in interaction with income level. Empirical results show that Mexico’s trade openness benefits more the Mexican states with higher levels of income, thereby tending to aggravate regional inequalities.

Paluzie, Pons, and Tirado (2004) find that, since 1960 and economic integration in European and international markets, industrial agglomeration and regional inequality have decreased in Spain. They construct several indices of geographical concentration of manufacturing over the studied period and
find that industrial dispersion began at the beginning of the integration of the Spanish economy into the international markets in the 1970s.

Ge (2006) shows that China’s trade liberalization and inflows of foreign direct investment (FDI) are positively correlated to industrial agglomeration in Chinese coastal regions. Ge constructs indices of industrial concentration (the industrial share of each Chinese province in total national output) and explores the determinants of industry location in 1995. Industry location in Chinese provinces is regressed, among other factors, on provinces’ access to foreign markets, which is measured by the proximity to the coast, and on exports and FDI. Estimations show that industries that rely on exports and foreign investment locate in provinces with easy access to foreign markets.

Milanovic (2005) finds no impact of greater trade openness on regional inequality in India, Brazil, Indonesia, China, and the United States. Using panel data analysis in the period 1980–2000, the author regresses Gini and Theil indicators of regional inequalities on trade openness, GDP per capita, inflation rate, and interest rate. The coefficient on the trade openness variable is not significant.

Many studies (Sachs, Bajpai & Ramiah [2002], for instance) have investigated regional inequalities in India but very few have studied the link between India’s trade openness and inequality among its states. Barua and Chakraborty (2010) find that trade openness increases regional inequality in India. Their econometric estimation consists of regressing a Theil index of regional income inequality on trade openness variables. But, unlike this article, control variables are not included in the empirical estimation and the properties (stationarity, unit root) of the time series are not investigated.

Aghion, Burgess, Redding, and Zilibotti (2004) show that India’s 1991 trade liberalization fostered growth only in the most productive Indian industries located in already advantaged states (Karnataka, Andra Pradesh, and Tamil Nadu), thereby tending to increase regional inequalities. They use industry panel data set for the 16 main states of India over the period 1980–97 and show that innovation, productivity, and growth were positively affected by trade openness in industries initially close to the Indian technological frontier and located in the most industrialized states.

Regional inequalities in Brazil have been studied by Ferreira Filho and Horridge (2006), for instance. The authors use a general equilibrium model to examine how trade openness affects poverty in Brazilian states. They find no evidence of a trade effect on poverty.

In conclusion, like new geographic models, recent empirical studies also yield contradictory results on the effect of trade openness on regional inequality: trade openness may aggravate or reduce regional inequalities within a country. Milanovic (2005) finds no effect of trade on regional inequality. So, without empirical case studies, it is impossible to know in advance whether in India or in Brazil trade liberalization will increase or reduce regional inequalities. That is the reason why this article presents a
case study of the impact of international trade on regional inequality using Indian and Brazilian data.

This study uses time series analysis to investigate the effects of trade openness on regional inequalities. First, an annual indicator of regional inequalities is constructed for India between 1980 and 2004 and for Brazil between 1985 and 2004. This calculation indicates how regional inequality evolves over time in both countries. Secondly, this indicator, which is a proxy of regional inequalities, is explained through time series regressions by trade openness and other determinants of regional inequalities such as the inflows of FDI. The unit root tests and cointegration techniques are used to avoid spurious regressions.

The main empirical results are:

1. in Brazil, trade openness contributes to a decline in regional inequalities;
2. in India, more trade openness means more regional inequalities.

Then, possible explanations for these findings are explored, such as the composition of foreign trade. One result is that a shift from exports in agriculture to exports in manufactured products could partly explain the rise of inequality among Indian states. Besides, FDI is found to aggravate regional inequalities in both countries.

This article aims to contribute to literature in several dimensions. First, a case study of national experiences, such as the Indian and Brazilian experiences, can offer a useful complement to literature. Two countries, China and Mexico, feature prominently in empirical approaches on links between trade and regional inequalities (see Rodriguez-Pose [2010] for a review of empirical literature). These studies have found a positive impact of the rise in country’s trade on regional inequality. This current article provides new results for India and Brazil, two important countries in the world. Besides, it shows that unlike in China, Mexico, and India, trade reduces regional inequalities in Brazil.

Secondly, the empirical findings of this article suggest that empirical strategies may influence the results and that time series regressions and cointegration techniques could be favored over others. Indeed, the results obtained from time series regressions are different from those of Milanovic’s (2005). The empirical methods are different, which could explain the difference in outcomes. As detailed previously, Milanovic (2005) investigates the evolution of regional inequalities across China, India, the United States, Indonesia, and Brazil using panel data during the period 1980–2000.

The results of fixed effects panel analyses point to an absence of a causal relationship between trade openness and regional inequalities. This absence of a causal relationship could be due to the fact that in some countries (such as Brazil), trade reduces regional inequalities and that in some other countries (like in India), trade increases regional inequalities. Using panel
analyses including different countries could hide the specific effect of trade on regional inequalities in each country and the opposite effects of trade on inequality will cancel each other out in panel analyses, thus providing potentially misleading results. In consequence, case studies and thus time series regressions could be the preferred strategy to address the link between regional inequality and trade.

Barua and Chakraborty’s (2010) results show that trade openness increases regional inequality in India. A Theil index of regional inequality is regressed on trade openness variables. However, control variables are not included in the empirical estimation and the stationarity of the variables is not tested. Yet this article shows that most of times series in India (trade openness, regional inequality, FDI) are not stationary, which must be taken into account in order to avoid spurious regressions. Besides, control variables such as FDI should be included since it has been found to impact on regional inequality and it is potentially correlated with trade openness.

In conclusion, the contribution of this article is to show that time series regressions might have several advantages over panel data analyses to explore the causal link between trade and regional inequalities since trade may have opposite effects on regional inequalities depending on the country. The cointegration techniques should be used since most of series, trade openness and regional inequality, are found to be non-stationary and cointegrated.

This article is organized as follows. Section II describes the calculation of the indicator for regional inequality and provides some stylized facts on regional inequality in Brazil and India. Section III presents the econometric methodology used to estimate the impact of trade on regional inequalities. Section IV presents the results obtained for Brazil and India and explores some possible explanations. Section V discusses the results. Section VI offers a conclusion.

II. CONSTRUCTING AN INDICATOR OF REGIONAL INEQUALITY IN BRAZIL AND INDIA

An annual indicator of regional inequality for Brazil and India is calculated over the periods 1985–2004 and 1980–2004, respectively. The Gini index is widely used in inequality literature to measure the extent to which the distribution of income among individuals deviates from a perfectly equal distribution. The Gini coefficient varies between 0 (complete equality) and 1 (complete inequality). There are not much available data on regional inequality. Due to this lack of data, empirical analyses on openness and regional inequality, based on cross-country regressions including a large number of countries, do not exist. Thus, an indicator of regional inequality has to be
constructed for this study. As the Gini index is widely used in inequality literature, it is used here as a measure of the level of inequalities among states. In its calculation, states are considered like units.

The Gini index is calculated as shown in Eq. (1) and measures inequality in per capita income across 19 Indian states for each year between 1980 and 2004 and across 26 Brazilian states for each year between 1985 and 2004. More precisely, Eq. (1) is the formula of the weighted Gini index that weights the states’ per capita GDP based on their respective population proportions. Weighting by population means that states are not counted the same way. In other words, the more populated an Indian state is, the greater the gap between its income and the average income will be taken into account to calculate the Gini index. Per capita income and population data by state and by year are required to construct the Gini coefficient. Per capita income data are not available before 1980 for India, or before 1985 for Brazil, and for neither of the two countries in 2005 and 2006. Thus, the periods studied in this article were determined by the availability of per capita income data at a subnational level.

The weighted Gini index is computed using the usual formula for the Gini coefficient:

$$Gini = \frac{1}{GDP_m} \sum_{i}^{n} \sum_{j>i}^{n} (GDP_j - GDP_i) POP_i \cdot POP_j$$

where \(n\) is the number of Indian states if Gini is calculated for India; \(i\) and \(j\) are Indian states; \(GDP_m\) is the mean of GDP per capita of the 19 Indian states weighted by state population; and \(GDP_i\) is GDP per capita of the \(i\)-th Indian state. Each state’s GDP data are provided in current local currency. Data sources are detailed in Appendix A. \(POP_i\) is the population share of the \(i\)-th state in the total Indian population. The Gini coefficient is calculated based on 19 of 28 Indian states, which are the largest, comprising 98.2% of total Indian population in 2003. The same calculation is repeated for Brazil and the 26 Brazilian states. Calculated Gini coefficients are presented in Table 1.

**Table 1**  Gini Index as an Indicator of the Level of Regional Inequality in India and Brazil

| Year | India | Brazil |
|------|-------|--------|
| 1980 | .160  | .273   |
| 1981 | .172  | .263   |
| 1982 | .163  | .283   |
| 1983 | .164  | .289   |
| 1984 | .164  | .290   |
| 1985 | .165  | .278   |
| 1986 | .164  | .270   |
| 1987 | .171  |        |
| 1988 | .167  |        |
| 1989 | .183  |        |
| 1990 | .177  |        |
| 1991 | .185  |        |
| 1992 | .207  |        |
| 1993 | .217  |        |
| 1994 | .222  |        |
| 1995 | .235  |        |
| 1996 | .230  |        |
| 1997 | .234  |        |
| 1998 | .233  |        |
| 1999 | .238  |        |
| 2000 | .241  |        |
| 2001 | .247  |        |
| 2002 | .255  |        |
| 2003 | .256  |        |
| 1992 | .257  |        |
| 1993 | .257  |        |
| 1994 | .269  |        |
| 1995 | .261  |        |
| 1996 | .267  |        |
| 1997 | .269  |        |
| 1998 | .263  |        |
| 1999 | .261  |        |
| 2000 | .258  |        |
| 2001 | .248  |        |
| 2002 | .238  |        |

*Note: The higher the Gini index, the higher the regional inequality.*
*Source: Calculations by the author.*
FIGURE 1 Trade openness and regional inequality in India (1980–2004) and in Brazil (1985–2004) (color figure available online).

Note: The Gini index was calculated by the author (see Table 1); the higher the index, the higher the regional inequalities. The trade openness ratio is the sum of exports and imports in percentage of GDP.

Figure 1 presents the Gini index of inter-state inequalities in India and India’s trade openness from 1980 to 2004. Trade openness is the sum of exports and imports in percentage of GDP in a given year. Data come from the World Bank’s World Development Indicators (WDI). In the 1980s, trade openness and regional inequality were rather stable. Then, there was a dramatic increase in regional inequalities in the 1991 post-liberalization period: regional inequality and trade openness have risen overall in India during the last 15 years. The correlation coefficient between the Gini index and trade openness is equal to 0.96. In consequence, the studied period (1980–2003) for India includes a period of trade closeness (1980–1990) and
a period of trade openness (1991–2003) that allow the investigation of the effect of a trade policy change on regional inequalities.

The year 2004 indicates an unusual rise in India’s trade openness ratio, which increased from 31% to 40%. This unusual increase will be treated as an outlier. Consequently, this article studies the impact of trade openness over the period 1980–2003. In a country of India’s size, significant regional inequality is not a surprise. However, the evolution of these regional inequalities is of concern. Geographically (see Figure A1 in Appendix B), the most developed group of states (Maharashtra, Goa, and Karnataka) fall in the southern parts of the country and are contiguous, except for the region of the capital New Delhi and Punjab.

Evolution of inter-state inequality in Brazil differs from the Indian experience. Figure 1 also presents the Gini index of inter-state inequalities in Brazil and Brazil’s trade openness from 1985 to 2004. Regional inequality and trade openness in Brazil varied over the period 1985–2004, with alternating periods of ups and downs. There is no noticeable trend between 1985 and 1998. Then, there was an increase in trade openness and a decline in regional inequality after 1997. The correlation coefficient between Gini index and trade openness is $-0.75$. Therefore, the studied period (1985–2004) for Brazil includes a period of low trade openness (1985–1997) and a period of high trade openness (1998–2004). In Brazil, the north and northeast regions are the poorest (see Figure A2 in Appendix B). Per capita GDP of the southeast region is more than three times that of the north.

In conclusion, individual country experiences differ and rough data show that:

1. in India, trade openness might be associated with increasing regional inequalities;
2. in Brazil, trade openness seems to be associated with a decline in regional inequality. However, concomitance of greater trade openness and rising (or decreasing) regional inequalities do not equal causation, and it remains to be demonstrated that trade openness impacts regional inequalities in both countries.

III. METHODOLOGY

The empirical methodology consists in regressing in a time series equation the Gini index of regional inequality on trade openness and other determinants. The next subsection identifies the determinants of regional inequality to be taken into account, and the section “The Empirical Equation” presents the empirical equation used to estimate the impact of trade openness on regional inequalities.
The Determinants of Regional Inequality

The objective of this study is to explore the impact of trade openness on regional inequality. New economic geography models predict that trade openness has an impact on regional inequality. This theoretical prediction is therefore tested empirically by specifying an empirical equation where regional inequalities proxied by the Gini index are regressed on trade openness. Given the small sample size (24 observations for India and 19 for Brazil), it is not possible to include in the empirical equation all the other determinants of regional inequality. However, the exclusion of relevant factors of inequality potentially correlated with trade openness may result in a biased estimation of the impact of the trade openness variable on inequality.

Controlling factors that may drive both trade openness and regional inequality is therefore necessary. Other factors of regional inequality can be omitted from the empirical equation provided they are not correlated with trade openness. Their effect will be included in the error term and their omission will not introduce substantial bias into the estimates of coefficients on the trade openness variables. Here, the methodology consists of reviewing the different factors of regional inequality hypothesized and tested in literature. Then the choice of control variables that are included in the empirical equation is explained.

Many empirical studies have investigated the determinants of regional inequality. Most of these studies are country cases (e.g., China, Indonesia, European countries, etc.). The empirical work on regional inequalities is not facilitated by the absence of a theoretical model deriving the different factors of inequality. So empirical equations exploring determinants of regional inequality are not derived from a theoretical equation but from empirical hypotheses or partially from theoretical models such as new economic geography models in the case of trade openness. Consequently, the inclusion of factors of regional inequality in an empirical equation is often a discretionary choice that might influence the results. In addition, it is not that easy to identify the factors of regional inequality because of countries’ specificities. Some of the factors underlying regional inequalities such as the internal geography or history of the country are intrinsic to the country and depend on the country’s characteristics. Internal geography could impact on regional inequality in the country concerned but not in another one.

Williamson (1965), Lucas (2000), or Petrakos, Rodriguez-Pose, and Rovolis (2005) show that economic development and per capita GDP are associated with regional inequality. Milanovic (2005) regresses Gini indicator of regional inequality on per capita GDP, growth rate, trade openness, interest rate, and inflation rate. Rodriguez-Pose and Gill (2004) show that rising regional inequalities and fiscal decentralization have become established trends in China, India, Mexico, Spain, and the United States. Barrios and Strobl (2009) regress an indicator of regional inequalities on per capita GDP,
trade openness, regional industrial specialization, fiscal decentralization, and European regional policy through structural funds in panel data estimations including 300 European regions. Ge (2006) shows that foreign trade and inflows of foreign direct investment have reinforced regional inequality in China. In addition to these factors, the history of national economic development, the geographic advantages of some regions, and the climate may explain in some countries the level of regional inequality. Fiess and Verner (2003) explain that inequality between the northeast and the south of Brazil goes back centuries. Guha (2007) invokes history and geography to present the historical and cultural advantages of South India.

As this brief review shows, at least ten factors of regional inequalities have been hypothesized and tested in literature. Economic development and per capita GDP, trade openness and FDI, regional industrial specialization, fiscal decentralization, inflation rate and interest rate, regional policy, and history and culture of the country are all potential factors of regional inequalities. In the aforementioned studies, some of these potential factors are found to have no significant impact on regional inequality. They are regional industrial specialization, inflation rate, and interest rate. Consequently, they will not be taken into account in this study. In the following discussion, among the potential factors, those potentially correlated to trade openness will be identified because, due to this correlation, they will have to be included in the empirical equation.

On the one hand, per capita income and economic development of a country are considered potential factors of regional inequality. Williamson (1965) and Lucas (2000) argue that regional inequalities follow an inverted U-shaped curve depending on the country’s per capita income. Regional inequality should first rise before diminishing. In the early stages of the development process, development is expected to be spatially unbalanced.

On the other hand, per capita income might also drive trade openness. Head (2003) argues that higher-income countries trade more in general, because of superior transportation, infrastructure, and lower tariffs, for instance. It could be particularly true in the case of India. Trade liberalization that occurred in 1991 has probably gone hand-in-hand with greater economic development that resulted from the economic liberalization (privatization, deregulation, etc.) that started in 1991 as well. Since per capita income may drive both regional inequality and trade openness, it is included in the empirical equation as a control variable.

Foreign direct investment inflows could be a factor of regional inequality in India and in Brazil. Since the opening of their economy to international trade in the 90s, Brazil and India have experienced an increase in inflows of FDI. FDI is concentrated in both countries in the most developed states, in South India and in the region of São Paulo. Hansen and Rand (2006) show that FDI bring advantages to host regions and that they have a positive effect on economic growth. FDI is also seen as a vehicle for technological spillover.
Performing causality tests among FDI, trade, and growth in India, Dash and Sharma (2011) show that FDI is positively related to growth.

The concentration of FDI in richer Indian and Brazilian states probably aggravates the economic gap between rich and poor areas. In the absence of FDI as a control variable, trade openness could capture the potential impact of FDI on regional inequality since trade and financial liberalizations were concomitant in both countries. Thus, inflows of FDI are included in the empirical equation as a determinant of regional inequalities and are expected to exacerbate them.

Fiscal decentralization and regional policy are hypothesized as potential factors of regional inequality in Rodriguez-Pose and Gill (2004) and Barrios and Strobl (2009), respectively. For instance, transfers from the central government to poorer states should help the backward states and reduce regional inequality. According to Rao and Singh (2001), the decentralization process that occurred in India in concomitance with trade liberalization in the 1990s reinforced the regional inequalities of the country, whereas the transfer system fails to reduce them. Although correlations among trade openness, fiscal decentralization, and subsection regional policy are expected to be low, the impact of decentralization and regional policy on regional inequality will be explored in the section of the article headed “Estimating Vector Error Correction Models: Results for India.” Finally, the history and culture of a country are also potential factors of regional inequalities. Indeed any inequality within a country might depend on history, culture, the legal system, and other national institutions. However, over a short time period, such as between 1980 and 2000, these factors of inequality can be considered as constant and can be excluded from a time series regression. Besides, Wei and Wu (2001) argue that studying inequality in a short time period has one advantage. Since some factors of inequality can be considered as constant, the researcher can more easily isolate the influence of current phenomena such as trade openness.

The Empirical Equation
To investigate the impact of trade openness on regional inequalities in India and Brazil, the following time series equation is specified:

\[
\ln Gini_t = a_0 + a_1 \ln Opennesst + a_2 \ln FDI_t + a_3 \ln GDPcapita_t + u_t
\]  

(2)

The dependent variable is the \( Gini_t \) index, which is the measure of regional inequality for a year \( t \) presented in Table 1. The variable \( Opennesst \) is the measure of India’s or Brazil’s trade openness. This is the sum of exports and imports in percentage of GDP in a given year \( t \), which is a common measure of trade openness. The trade openness ratio is presented in Figure 1. The variable \( FDI_t \) is the net inflow of FDI in percentage of the GDP in India or
in Brazil. Data on FDI are presented in Table 2. The variable $GDP_{\text{capita}}$ is India’s or Brazil’s per capita GDP in constant 2000 U.S. dollars and is a control variable for the level of development. For all equations in this article, $t$ denotes the year $t$ and $\ln$ is the log. All data sources are presented in Appendix A. Eq. (2) is estimated from 1980 to 2003 for India and from 1985 to 2004 for Brazil due to availability of data.

The linear form of Eq. (2) and the log-log model (all variables are transformed in log form) imply that the obtained coefficients on explanatory variables are constant elasticities over all values of the data set. For instance, it means that, over the studied period, trade openness is assumed to affect regional inequality in the same way, whatever the values of both variables may be. Unit root tests, cointegration techniques, and error-correction models are used to test the causal relationship between trade openness and regional inequalities. Indeed, direct OLS estimations of Eq. (2) are not appropriate if time series, namely the dependent and explanatory variables, are not stationary.

A non-stationary time series has a time-varying variance or a time-varying mean or both. More precisely, a time series can be non-stationary because of a deterministic trend. In that case, the series is called a Trend Stationary (TS) series. It tends to increase or decrease over time with a predictable trend: the effect of a shock on the series is not permanent. A time series can be non-stationary because of a stochastic trend. In that case, the series is called a Difference Stationary (DS) series, it may increase or decrease over time and the impact of a shock on the series is persistent. For instance, inflows of FDI in Brazil are found to be a TS series. It means that inflows of FDI have a general direction and tend to increase over time between 1985 and 2004, and, if there is a shock to inflows of FDI such as the 1999 Brazilian crisis, this temporary deviation does not change the long-run increase of FDI. India’s trade openness is found to be a DS series: trade openness tends to increase over time and a shock to trade openness, such as a global crisis or a devaluation, may change the long-run direction of trade openness. TS series can be stationarized by removing the trend and DS series can be stationarized by being in first (or more) difference. A I(1) variable is a DS series whose first difference is stationary.

### TABLE 2 Net Inflows of FDI in Percentage of GDP in India and Brazil, 1980–2003 (Selected Years)

| Year | India     | Brazil    |
|------|-----------|-----------|
| 1980 | 0.04      | 0.65      |
| 1983 | 0.003     | 0.40      |
| 1985 | 0.05      | 0.21      |
| 1987 | 0.08      | 0.29      |
| 1990 | 0.08      | 0.69      |
| 1993 | 0.20      | 2.43      |
| 1995 | 0.60      | 5.45      |
| 1997 | 0.87      | 2.01      |
| 2000 | 0.78      |           |
| 2003 | 0.76      |           |

*Note:* For instance, in 2003, net inflows of FDI account for 2.01% of Brazil’s GDP.

*Source:* World Bank (n.d.).
Eq. (2) is correctly estimated only if all dependent and explanatory variables are stationary. There is a risk of spurious regression when the variables included in a time series equation are non-stationary. For instance, a spurious regression would show a significant relationship between a dependent variable and an explanatory variable only because both variables are TS series that tend to increase over time but in reality the causal relationship between both variables does not exist. In consequence, Augmented Dickey-Fuller (ADF) and Phillips-Perron tests for unit roots have been carried out to determine whether the variables in Eq. (2) are stationary, TS, or DS series. In this article, all series are tested.

Secondly, the Engle-Granger (1987) approach is performed to establish the existence of a cointegration relationship between I(1) variables. For instance, in the case of Brazil, the Gini indicator and trade openness are found to be I(1). The Engle-Granger approach involves the regression of the Gini indicator on trade openness. Then, if the residual predicted from this regression is stationary, the variables are said to be cointegrated. If no variables are cointegrated, Eq. (2) can be estimated with the OLS estimator, after stationarizing all non-stationary variables. But if the dependent variable is cointegrated with one or more explanatory variables, for instance if the Gini indicator and the trade openness variable are cointegrated, an error correction model must be estimated.

IV. EMPIRICAL RESULTS
Results from Error Correction Model Estimations: The Impact of Trade Openness on Regional Inequality in Brazil

First, estimation for Brazil is conducted. Considering Eq. (2), the unit root and time series properties of all series ($\ln Ginit$, $\ln Opennesst$, $\ln FDIt$, and $\ln GDPcapitat$) are investigated using the Augmented Dickey-Fuller and Phillips-Perron unit root tests. For space reasons, the test statistics are not presented in this article but are available upon request. The unit root test results indicate that the time series $\ln Ginit$, $\ln Opennesst$, and $\ln GDPcapitat$ are DS series, I(1), integrated of order one. The series $\ln FDIt$ is a TS, which is with a time trend. Having confirmed the existence of unit root for three time series, the next step involves conducting the Engle-Granger two-step cointegration method. The aim is to determine whether the series $\ln Openness$ and $\ln GDPcapita$ are cointegrated with $\ln Gini$. Results from the Engle-Granger method support the hypothesis of cointegration among trade and regional inequality ($\ln Gini$ and $\ln Openness$), which means that

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3 Two I(1) time series (Xt and Yt) are cointegrated if the series of residuals collected from the regression of the dependent variable Yt on the explanatory variable Xt is stationary.
there exists a long-run relationship between trade and regional inequality. The variables $\ln Gini_t$ and $\ln GDP_{capita_t}$ are not cointegrated.

Since regional inequality and trade are cointegrated in Granger’s sense (Granger 1988), the use of the error correction model (ECM) procedure is appropriate. If two variables are cointegrated, then the relationship between the two can be expressed as ECM of the following form:

$$D.\ln Gini_t = a_0 + a_1 \text{ residual}_{t-1} + a_2 D.\ln Openness_t + \ln X_t \beta + u_t$$ (3)

$D.$ denotes I(1) variables stationarized in first-difference. $D.$ is the differencing operator so that $D.\ln Gini_t$ is equal to $\ln Gini_t - \ln Gini_{t-1}$. The variable $\text{ residual}_{t-1}$ is the series of lagged residuals collected from the regression of the cointegrated variables—namely the variable $\ln Gini_t$ on the explanatory variable $\ln Openness_t$. $\ln X_t$ are any exogenous stationary variables, which in this case are GDP per capita and inflows of FDI, both stationarized. The variable $\ln FDI_t$ is stationarized by removing the trend. The ECM of Eq. (3) says that changes in trade openness, inflows of FDI, and per capita GDP cause regional inequality to change. The estimation of Eq. (3) is presented in column 2 of Table 3. Column 1 presents the long-term

| TABLE 3 | Estimation of Error Correction Models Using OLS Estimator and Estimation of the Impact of Trade Openness on Regional Inequality in Brazil, 1985–2004 |
|---------------------------------|---------------------------------|---------------------------------|
| $\text{lnGini}_t$ | $D.\ln Gini_t$ |  |
| $\ln Openness_t$ | $-.19$ | $-.11$ |
| $D.\ln Openness_t$ | $(-.029)^{***}$ | $(-.064)^{*}$ |
| (Export + import to GDP) | | |
| $D.\ln GDP_{capita_t}$ | $-.22$ | $(-.273)$ |
| $\ln FDI_t$ | $0.02$ | $(-.010)^{*}$ |
| (Inflows of FDI) | | |
| $\text{ residual}_{t-1}$ | $-.69$ | $(-.215)^{***}$ |
| Constant | $-.76$ | $-.00$ |
| | $(-.087)^{***}$ | $(-.007)$ |
| Observations | 20 | 19 |
| $R^2$ | 0.70 | 0.53 |
| Breusch-Pagan test, Prob. $> \chi^2_2$ | 0.74 | 0.31 |
| Durbin-Watson d-statistic | 1.64 | 1.91 |

Notes: Standard errors in parentheses; $^{***}$, $^{**}$, and $^*$ represent statistical significance at the 1%, 5%, and 10% levels, respectively. The Breusch-Pagan test indicates that there is no heteroskedasticity. The Durbin-Watson test shows that there is no autocorrelation. The Theil coefficient is another indicator of regional inequality. Similar results are found for openness and FDI when the Theil index is used as the dependent variable (instead of Gini).
relationships between the cointegrated \textit{lnGini} and \textit{lnOpenness}. The Breusch-Pagan test is used to test for heteroskedasticity. Results show that none of the regressions of this study suffers from heteroskedasticity. The Durbin-Watson and Breusch-Godfrey tests are used to test for autocorrelation in the residuals.\footnote{The Durbin-Watson test finds no autocorrelation in the estimations of Tables 3 and 4. The Breusch-Godfrey test that must be used in estimations with lagged dependent variables among the explanatory variables finds autocorrelation in all estimations of Tables A1, A2, and A3, excepted in column 3 of Table A2. According to Keele and Kelly (2006), OLS estimation does relatively well when autocorrelation is low, inferior to 0.50 in absolute value. The degree of autocorrelation, $\phi$, is calculated and reported for each estimation of Tables A1, A2, and A3. Results show that autocorrelation is low in Table A2 and shouldn’t affect the results on India. Autocorrelation is higher for Brazil. Nevertheless, OLS estimation in column 4 of Table A3 reports a autocorrelation equal to 0.51, just at the limit. This estimation confirms the results on Brazil and reports a significant and negative coefficient on the trade openness variable.}

The error correction model estimates long- and short-term effects of trade openness on regional inequality. In column 2 of Table 3, the trade openness variable $D.lnOpenness$, yields a negative ($-0.11$) and significant coefficient, which measures the immediate effect (over one year) of a change in Brazil’s trade openness on Brazil’s regional inequality: a rise in Brazil’s trade openness at year $t$ immediately reduces regional inequality in Brazil, which is the short-term effect.

More precisely, a one unit increase in the variable trade openness in log produces a 0.11 decrease in the Gini indicator of regional inequality, in log form. In addition to that, regional inequality and trade openness are cointegrated, which means that they share a long-run relationship, with an error-correction mechanism: a change in Brazil’s trade openness has an effect on Brazil’s regional inequality that lasts longer than one year. In column 1, the coefficient on trade openness that is an elasticity is equal to $-0.19$: if trade openness, the ratio of exports and imports to GDP, increases by 1%, the Gini indicator decreases by 0.19%. The coefficient on the lagged residual term is equal to $-0.69$ in column 2 of Table 3. The interpretation is the following: increases in Brazil’s trade openness will cause deviations from the long-run relationship between regional inequality and trade openness, causing regional inequality to be too high. Regional inequality will then decrease to correct this disequilibrium, with 69% of the remaining deviation correction in each subsequent time period. In other words and according to calculations, the effect of a change in trade openness at $t-1$ on regional inequality lasts four years, until $t+3$, which is the long-term effect.

To sum up, empirical results show that opening of the Brazilian economy to the foreign market appears to have reduced regional inequality in Brazil. This result contradicts that of Milanovic (2005), who finds that greater
trade openness has no impact on regional inequality in Brazil and four other countries, but, as it has been explained previously, this difference in outcomes could be due to the use of different empirical strategies.

In the estimation of the ECM in column 2 of Table 3, the coefficient on the FDI variable is significant and positive, equal to +0.02, which indicates that FDI reinforces regional inequality in Brazil. This result was expected. Since the opening of its economy in the 1990s, Brazil has experienced a great increase in inflows of FDI, most of which has been concentrated in richer regions such as São Paulo or Rio Grande do Sul in South Brazil. According to Bacen (Foreign Capital Census of the Brazilian Central Bank), the southeast region concentrated in Brazil 91% of all assets of foreign-controlled firms in 1995. FDI probably favors the growth rate of rich host states, thereby tending to increase regional inequality in Brazil.

Ge (2006) finds a similar result for China, showing that FDI reinforces industrial agglomeration, especially in coastal regions that have the best access to foreign markets. The coefficient on the variable $D.\ln GDP_{\text{capita}}$ is not significant, which indicates that there is not an instantaneous causality between economic development and regional inequality in Brazil.

Results from Error Correction Model Estimations: The Impact of Trade Openness on Regional Inequality in India

The same econometric methodology was used for India and results are reported in Table 4. The series $\ln G_{\text{init}}$, $\ln \text{Openness}_t$, $\ln \text{FDI}_t$, and $\ln GDP_{\text{capita}}$ are found to be integrated of order 1 and are thus I(1) variables. The series $\ln \text{Openness}$ and $\ln \text{FDI}$ are cointegrated with $\ln G_{\text{ini}}$.

If trade openness and the inflows of FDI are cointegrated with the Gini variable, then the relationships among the three can be expressed as ECM in the following form:

$$D.\ln G_{\text{ini}} = a_0 + a_1 \text{ residual}_{t-1} + a_2 D.\ln \text{Openness}_t + a_3 D.\ln \text{FDI}_t$$

$$+ a_4 D.\ln GDP_{\text{capita}} + u_t \quad (4)$$

The variable residual$_{t-1}$ is the series of lagged residuals collected from the regression of the variable $\ln G_{\text{ini}}$ on the variables $\ln \text{Openness}_t$ and $\ln \text{FDI}_t$ since these three variables are cointegrated. The estimation of Eq. (4) is presented in column 2 of Table 4. Column 1 presents the long-term relationships among cointegrated $\ln G_{\text{ini}}$, $\ln \text{Openness}_t$, and $\ln \text{FDI}_t$.

The coefficient on the trade openness variable $D.\ln \text{Openness}_t$ is positive (+ 0.40) and highly significant: a one unit increase in the variable trade openness in log produces a 0.40 increase in the Gini indicator in log, which

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6 Source: Banco Central do Brazil, http://www.bcb.gov.br/rex/censo1995/ingl/980527/hics0400.asp.
TABLE 4 Estimation of Error Correction Models Using OLS Estimator and Estimation of the Impact of Trade Openness on Regional Inequality in India, 1980–2003

| Dependent Variable: Regional Inequality in India, Gini Index | \( \ln Gini_t \) (1) | \( D.\ln Gini_t \) (2) |
|---|---|---|
| \( \ln Opneness_t \) | .40*** | \( .40 \)*** |
| \( \ln FDI_t \) | .04*** | \( .04 \)*** |
| \( D.\ln Opneness_t \) (Export + import to GDP) | (.107)*** | \(.107 \)*** |
| \( D.\ln GDPcapita_t \) | .24 | (.333) |
| \( D.\ln FDI_t \) (Inflows of FDI) | (.007)*** | (.007)*** |
| residual\(_{t-1}\) | \(-.71\)*** | \(-.71\)*** |
| Constant | \(-2.74\)*** | \(-2.74\)*** |
| Observations | 24 | 23 |
| R\(^2\) | 0.96 | 0.59 |
| Breusch-Pagan test, Prob. > chi2 | 0.28 | 0.68 |
| Durbin-Watson d-statistic | 1.07** | 2.00 |

Notes: Standard errors in parentheses; ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. The Breusch-Pagan test indicates that there is no heteroskedasticity problem. The Durbin-Watson test finds no autocorrelation. The Theil coefficient is another potential indicator of regional inequality. Similar results are found for openness and FDI when the Theil index is used as the dependent variable (instead of Gini).

is the short-term and immediate effect of trade on inequality. In column 1 of Table 4, the coefficient on trade openness is equal to +0.40: if India’s trade openness increases by 1%, the Gini index of regional inequality increases by 0.40%. The coefficient on the lagged residual term is equal to −0.71 in column 2 of Table 4, which allows to calculate the long-term effect. If trade openness increases in India, the impact of openness on regional inequality will last three years according to the calculations. Opening of the national economy to the foreign market appears to aggravate regional inequality in India. This result is in line with Barua and Chakraborty (2010) whose empirical results show that trade openness increases regional inequality in India over the same period but contradicts that of Milanovic’s (2005), who finds that greater trade openness has no impact on regional inequality in India.

As stated in the introduction, new economic geography models differ concerning their predictions on the impact of trade on regional inequalities. The empirical results provide a good illustration of this indecisiveness since Brazil’s trade openness is found to contribute to a reduction of inequality
among Brazilian states whereas India’s trade openness is found to contribute to a rise of regional inequality.

In columns 1 and 2 of Table 4, the coefficients on the FDI variables are significant and positive, equal to +0.04 and +0.03, respectively, which indicates that FDI reinforces regional inequality in India. Since the opening of its economy in 1991, India, like Brazil, has experienced an increase in inflows of FDI, most of which has been concentrated in richer regions in South India. According to FDI data from the Indian Ministry of Commerce\(^7\), the top five states that received high levels of FDI between 1991 and 2004 are also the richest states. In terms of the destination of FDI flows over this period (1991–2004), Maharashtra (18% of total FDI inflows) and New Delhi (12%) top the list, followed by Karnataka (8%), Tamil Nadu (8%), and Gujarat (6%). Nunnenkamp and Stracke (2008), who study FDI’s growth effects in India, also find that FDI is likely to increase India’s regional inequality because FDI concentrated in already advanced regions strongly stimulates their economic growth. In column 2, the coefficient on the variable \(D.\ln\text{GDPcapita}\) is not significant, which indicates that there is not an instantaneous causality between economic development and regional inequality in India.

Robustness Checks on the Link between Trade Openness and Regional Inequality: Estimating Vector Error Correction Models

The aim is to check the robustness of results on the trade openness variable, which is the main interest of the article. A way to test robustness is to estimate a vector autoregression (VAR) model or a vector error correction model (VECM). The VAR suggests that the current (time t) observation of regional inequality depends on its own lags as well as on the lags of each other variable in the equation (trade openness, inflows of FDI, and GDP per capita). All variables are included in the VAR equation after being stationarized. For both countries, the optimal lag length is 2 according to the AIC criterion. The cointegration between variables is taken into account by including an error term as in the ECM. The VECM can be expressed by the following form for Brazil:

\[
D.\ln\text{Gini}_t = a_0 + a_1\text{residual}_{t-1} + a_2 D.\ln\text{Gini}_{t-1} + a_3 D.\ln\text{Gini}_{t-2} \\
+ a_4 D.\ln\text{Openness}_{t-1} + a_5 D.\ln\text{Openness}_{t-2} + a_6 \ln\text{FDI}_{t-1} \\
+ a_7 \ln\text{FDI}_{t-2} + a_8 D.\ln\text{GDPcapita}_{t-1} + a_9 D.\ln\text{GDPcapita}_{t-2} + u_t
\]

\(^7\) Source: http://www.indiabudget.nic.in/es2003-04/chapt2004/chap76.pdf.
Estimating Vector Error Correction Models: Results for Brazil

Estimations of VECM models are presented in Table A1. In column 1, Eq. (5) is estimated. The coefficients on the lagged values of trade openness are significant and negative (−0.16 and −0.15). This means that lagged values of Brazil’s trade openness are useful in forecasting regional inequality in Brazil. More trade openness means less regional inequality in the future, which confirms the results from the ECM estimation in the previous subsection. It is possible to provide a concrete interpretation of this result. The coefficient on the openness variable is equal to −0.16. Assuming that the Gini index in Brazil is equal to 0.26 at year 2000, if Brazil’s trade openness increased from 20% of GDP to 25% of GDP from year 1999 to year 2000, then the Gini index should decrease from 0.26 in 2000 to 0.249 in 2001, which is rather important. In column 2 of Table A1, the dependent variable is Brazil’s trade openness. The lagged values of $D.lnGini$ (regional inequality) and the error correction term are not significant, which indicates that regional inequality in Brazil does not Granger-cause Brazil’s trade openness. In other words, there is probably one-way causality from trade openness to regional inequality, but not the reverse.

Estimating Vector Error Correction Models: Results for India

Column 1 of Table A2 presents the estimation for India. Regional inequality is the dependent variable. Coefficients on the lagged values of trade openness are significant and positive (+0.49 and +0.33), which confirms the results from the ECM regression. Lagged values of India’s trade openness are useful in forecasting income inequalities among Indian states: more trade openness means more regional inequalities in the future. More precisely, the coefficient on the openness variable is equal to +0.49. Assuming that the Gini index in India is equal to 0.24 at year 2000 and that India’s trade openness increased from 25% of GDP to 30% of GDP (see Figure 1, Table 1) from year 1999 to year 2000, then the Gini index should increase from 0.24 in 2000 to 0.262 in 2001, all things being equal. In reality, the Gini index increased from 0.24 in 2000 to 0.247 in 2001, which means that other factors are reducing regional inequalities in India, thereby reducing the effect of India’s trade openness on inequality.

In column 2 of Table A2, trade openness is the dependent variable. The lagged values of $D.lnGini$ and the error correction term are not significant: inequality among Indian states does not seem to Granger-cause India’s trade openness. There is one-way causality from trade openness to regional inequality in India, but the reverse is not true. In conclusion, the VECM estimations confirm the results from the ECM estimations. Trade openness reduces regional inequality in Brazil and aggravates regional inequality in India.

The previous analysis assumes that the evolution of regional inequalities is influenced by trade openness, inflows of FDI, and national economic
development. However, another possible determinant of regional inequalities is fiscal decentralization. Rodriguez-Pose and Gill (2004) show that rising regional inequalities and decentralization have become established trends since the 1980s in China, India, Mexico, Spain, and the United States. In the 1990s, India favored a greater redistribution of authority to subnational levels. According to Rodriguez-Pose and Gill (2004) and Rao and Singh (2001), decentralization of expenditures disadvantaged the poorer Indian states whose public investments cannot compete with the richer states. Poorer states have become unable to provide the necessary infrastructure and services to attract investments.

To control for the impact of decentralization on inequalities, lagged values of decentralization variables are included in the VECM estimation for India in column 3 of Table A2. Data come from the World Bank’s *Country Database on Fiscal Decentralization*. Regarding India, data are available from 1980 to 1999. In column 3, the subnational share of public expenditures, in total public expenditures, which is a proxy of decentralization, is included. This indicator fell from 72.8% in 1980 to 67.7% in 1989. In the 1990s, decentralization increased, up to 73.2% in 1999. The series is I(1) and is included after being stationarized. The coefficient on the decentralization variable lagged at two periods is positive (+1.47) and significant, which indicates that more decentralization of expenditures means more regional inequalities in India.

Furthermore, trade openness still has a significant impact on regional inequality after including the decentralization variable. The role of intergovernmental transfers in regional inequality, as a proxy of regional policy, is now examined. A variable of vertical imbalance *Transfers*, namely intergovernmental transfers, as a share of subnational expenditures is included in column 4 of Table A2. It measures the degree to which subnational governments rely on central government revenues to support their subnational expenditures. The share of transfers from central government in subnational expenditures decreased in India from 44.3% in 1980 to 31.3% in 1999. This time series is I(1) and is included after being stationarized. More transfers probably reduce the level of regional inequality by helping poorer states. Consequently, a negative coefficient is expected on the variable Transfers. But the coefficients on the variables, equal to 0.07 and 0.21, are not significant while trade openness keeps its positive impact on regional inequalities. This analysis was not conducted for Brazil because of a lack of data over the full period 1985–2003. The World Bank’s *Country Database on Fiscal Decentralization* provides data only until 1998.

The Role of Composition of Trade in Regional Inequalities

In a new economic geography model, Paluzie (2001) shows that opening to manufacturing trade increases regional inequalities. She assumes immobility
The Impact of Trade Openness on Regional Inequality

in the agricultural sector: labor forces and agricultural inputs are tied to the land. The agricultural population is dispersed throughout the national territory, which encourages firms and industries, in a closed economy, to also spread out in order to service local demand. When the country opens to international trade, local demand can be replaced by foreign demand and, thus, industrial firms leave agricultural regions to agglomerate and benefit from the advantages of concentration. Furthermore, an increase in manufacturing exports in relation to agricultural exports will favor the manufacturing region at the expenses of agricultural regions.

Rodriguez-Pose and Gill (2006) provide a similar analysis and argue that changes in trade composition can impact regional inequality. When agricultural exports decrease in relation to manufacturing exports, regional inequalities increase. The idea is that agriculture is tied to the land and is (more or less) equally distributed throughout the national territory, whereas manufacturing can be subject to agglomerative forces and become concentrated in one region. Agricultural exports are favorable to the whole country, while manufacturing exports are directly favorable only to the industrial center. If manufacturing exports develop at the expense of agricultural exports, trade favors one region and contributes to a rise of regional inequality. Rodriguez-Pose and Gill (2006) find a correlation between the composition of trade and regional inequalities for eight countries (Brazil, China, Germany, India, Italy, Mexico, Spain, United States), but they examine correlation without controlling for other factors of regional inequality.

India and Brazil do not export the same products and the composition of their exports has been following a different evolution since the 1980s. Mayer and Wood (2001) examine the commodity composition of the exports of South Asian countries. Regarding India, they find that in 1990 the share of manufactures in total Indian exports is high and equal to 71.7% and that the share of skill-intensive goods in Indian manufactured exports is equal to 41.3%. Their results also show that India exports a smaller share of manufactures than predicted from India’s human and natural resources. The share of manufactures in total exports should be equal to 83%, suggesting that India could export more and more manufactured products in the future. As regards Brazil, Wood and Mayer (2001) suggest that some Latin American countries such as Brazil are land-abundant with educated labor, which explains why they may have a comparative advantage in processed primary products.

Data from the World Trade Organization’s (WTO) database are used to build ratios of manufacturing to agricultural exports for both countries. Unlike Brazil, India exports more and more manufactured products compared to agricultural products. The ratios of manufacturing to agricultural exports are presented in Table 5. India’s ratio increased from 1.77 in 1980 to 3.57 in 1990 and rose to 6.04 in 2003. In Brazil, this ratio has barely changed
TABLE 5 Ratio of Manufacturing to Agricultural Exports for India, 1980–2003, and Brazil, 1985–2003 (Selected Years)

|       | 1980 | 1985 | 1990 | 1995 | 2000 | 2003 |
|-------|------|------|------|------|------|------|
| India | 1.77 | 2.06 | 3.57 | 3.42 | 5.28 | 6.04 |
| Brazil| 1.10 | 1.65 | 1.56 | 2.05 | 1.53 |      |

Source: Author’s calculation based on WTO data. The ratio is equal to (exports of manufactured products)/(exports of agricultural products). The higher the ratio, the more the country exports manufactured products in relation to agricultural products.

since it was equal to 1.10 in 1985, 1.56 in 1995, and 1.53 in 2003. Indeed, many agricultural products (coffee, sugar, orange juice) are exported from Brazil. Consequently, one can expect exports to aggravate regional inequality in the case of India but not in the case of Brazil.

The index of the manufacturing to agricultural export ratio is now included in the VECM for both countries in Table A3 in Appendix B. The higher the ratio, the more important manufacturing exports are in relation to agricultural exports. In column 1 of Table A3, the ratio is included for India. The ratio is a TS series and is stationarized. The coefficient on the lagged value of the ratio is positive but not significant, equal to +0.03. However, in column 2, the manufacturing exports in percentage of GDP yields a positive (+0.25) and significant coefficient: an increase in manufacturing exports increases inequality among Indian states. Indeed, in India, industries are mainly located in the developed states of the South (Maharashtra and Karnataka). In the 1990s, manufacturing exports increased significantly in relation to agricultural exports, thereby favoring manufacturing zones at the expense of agricultural states. For Brazil, the ratio is a stationary series and is included in column 3 of Table A3. The coefficients are negative (equal to −.02) and, as expected, not significant.

V. DISCUSSION

Empirical results show that trade openness aggravates inequality among Indian states. An initial explanation is that an increase in manufacturing exports in relation to agricultural exports has reinforced this inequality. However, there may be additional mechanisms linking trade openness and regional inequality in India. Brazil’s trade openness is found to have reduced regional inequality. The regression fails to establish a link between composition of exports and regional inequality. Links between Brazil’s trade openness and regional inequalities remain to be found. This section discusses some hypotheses on how trade openness might impact regional inequalities in both countries.
Why Does India’s Trade Openness Increase Inequality among States?

Crozet and Koenig-Soubeyran (2004) build a theoretical model that predicts that trade liberalization can increase regional inequalities depending upon the national geography. Trade liberalization fosters agglomeration of economic activities in the border region that has the best and lowest-cost access to foreign markets, thereby creating inequalities between this region and the remote areas. The purpose is now to determine whether such a scenario occurred in India after the liberalization of trade in 1991.

In India, the coastal and southern states clearly have better access to foreign markets than the landlocked northern states. The southern states have good seaports and an active coastline. For instance, in the 2000s, Visakhapatnam (in Andra Pradesh, first Indian port in terms of tons of cargo handled), Chennai (in Tamil Nadu, third-ranked port), New Mangalore Port (in Karnataka, tenth-ranked port), Tuticorin Port (in Tamil Nadu, eleventh-ranked port), and Cochin (sixth-ranked) are some of the country’s largest ports (Indian Ports Association 2007).

Industries located in coastal South India can satisfy both the international market and the internal market. After the 1991 trade liberalization, coastal regions may have been advantaged compared to the interior. However, is there any evidence of an agglomeration process in South India after trade liberalization? Thanks to the Indian Ministry of Statistics, which provides data on state domestic product for each year, it is possible to calculate that, in 1990, South India (formed by Maharashtra, Karnataka, Kerala, Tamil Nadu, and Andra Pradesh) represented 32% of the Indian population and produced 29% of the total national output. In 2003, the same states represented 30% of the Indian population and produced 42% of the total national output. Their share in Indian output increased sharply in the 1990s during the liberalization process and they have become prominent in manufacturing goods.

Jayanth (2007) reports that Indian firms, from Reliance Industries and Tatas, to the Mittals and Mahindras, which located in the past in the northern parts of the country, have been moving into New Delhi or into South India since 1991. Okada and Siddharthan (2007) demonstrate that Indian industrial hubs have emerged since 1991 and are now concentrated in three clustered regions: the region of the capital, New Delhi, in Mumbai-Pune in the state of Maharashtra, and in Chennai-Bangalore in the states of Karnataka and Tamil Nadu. The proposition here is that Indian coastal states have the best access to foreign markets, due to the country’s specific geographical features, and that an agglomeration process occurred in South India after trade liberalization, thereby aggravating inequalities between South and North India.

Another channel linking international trade and regional inequality could be that of economic growth. The most recent studies on trade openness and growth such as the work of Calderon, Loayza, and Schmidt-Hebbel
(2004) show that the growth effect is almost null for countries with low levels of per capita income and positive for countries with a good level of development. From this point of view, the richer states in South India and New Delhi would benefit from India’s trade openness because of their good level of development and the lagging regions of North India would not, thereby tending to increase regional inequalities.

Why Does Brazil’s Trade Openness Reduce Inequality among States?

A possible explanation, inspired from Krugman and Livas Elizondo’s (1996) model, would be that Brazil’s trade openness has fostered dispersion of economic activities from São Paulo to peripheral regions. Their model shows that trade liberalization may reduce spatial inequalities. In the model, repellent forces are congestion costs, pollution, insecurity, and high land costs. These forces encourage firms to move to peripheral regions. The agglomerating force is proximity to large consumer markets, workers, and input suppliers. In autarky, workers follow firms and centripetal forces are self-reinforcing, ensuring big agglomerations. When a country opens to international trade, consumers and input suppliers are partly replaced by exports and imports, respectively, and the attraction of the economic center is weakened. Then, there is a dispersal of manufacturing firms throughout the national territory because of congestion forces.

Brazil opened to international trade in the 1990s. Is there any evidence of a dispersal of firms over the same period? Regional inequality in Brazil is mainly due to concentration of production in one region, the state of São Paulo. This region enjoys a large consumer market, an educated workforce, and easy access to foreign markets, which are all favorable to concentration. Industries are concentrated in the Southeast. However, there are congestion costs. São Paulo is one of the most expensive places to live in Brazil. The cost of land, traffic congestion, delays, accidents, and environmental problems are important (Jacobi 2001). There are many local conflicts with polluting industries. Trade unions are also stronger than those of the periphery. The peripheral region (Amazonia, Northeast, and South) provides a smaller domestic market, but has advantages compared to São Paulo: low wages, lower production costs, and more space (Tendler 2001). Moreover, the peripheral states provide tax exemptions or subsidies in order to attract firms. The coastal northeast region has better access to European and North American markets thanks to its international ports and airports and the south of the country has the closest access to Mercosur countries.

Saboia (2001) and Gutberlet (2005) argue that the Brazilian development trend has been towards industrial decentralization since the beginning of the 1990s. The Annual Survey of Mining and Manufacturing Industry conducted by Instituto Brasileiro de Geografia e Estatística (IBGE) in 2003, also confirms that there has been a change in Brazilian industrial localization.
patterns and a reversal of industrial polarization. The region of São Paulo has experienced a downward trend in terms of industrial production since São Paulo’s industrial production accounted for about 53% of the nation’s industrial output in 1990 and only 40% in 2004. There has been a rise of new industries and production lines in other regions. Rodrigues (2002) also confirms the trend towards decentralization of investments away from São Paulo and the extension of production towards the south and the northeast. Some firms have moved from the state of São Paulo in other states. It seems that an industrial dispersion has occurred in Brazil in conjunction with Brazil’s trade liberalization.

Comments and Policy Suggestions
Empirical results show that India’s trade openness has contributed to increasing regional inequalities in the country. This finding has important policy implications for India since rising regional inequalities might affect the unity of the Indian federation. The World Bank Development Report (2009) states that spatial inequalities recede as a country develops and suggests that reducing regional inequalities is not necessarily an economic priority. However, for all countries and policy makers, regional inequalities are an issue of national concern since inequality among regions can affect immediately and irreversibly the political stability of a country. Rising regional inequalities are all the more worrying in the case of the Indian federation since India is a country with high ethnic and linguistic heterogeneity.

Many Indian states have their own language, culture, and traditions. India has 22 officially recognized languages. Ten Indian states have large populations (between 50 and 200 million inhabitants). With such large populations, they could become sovereign countries, among the largest ones in the world. In a context of a federal system and linguistic heterogeneity, large and rising regional disparities could trigger demands for autonomy by richer states. In India, new territorial disparities resulting from international trade reinforce pre-existing political and cultural divides among Indian states. In addition to that, even if the right to secede is not expressly mentioned in the Indian federal constitution, a federalist system implies political flexibility and allows for arrangements that can concede autonomy and independence to subnational units.

Political conflicts linked to rising regional inequality have emerged in India since the Eleventh Finance Commission in 2000. Kurian (2001) reports that the richest states of South India were clearly against more transfers and an increased tax revenue devolution in favor of the poorest states.

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8 "With development and the passage of time, a country’s economic geography approximates a natural balance that equalizes welfare between urban and rural residents,” Chapter 1, “Density” (World Bank 2009).
The populations of non-Hindi states (South India does not speak Hindi but, instead, regional languages) no longer want to subsidise the Hindi-states of the North. In India, the increasing regional inequalities might lead to economic and political disintegration that would stem from a few rich states seeking greater fiscal autonomy. Besides, regional inequality could lead to more fiscal decentralization and less interregional transfers, which, in turn, could aggravate regional inequalities and so on. Regional inequalities can be considered as an immediate threat to the unity of the federation.

The solution to correcting regional inequality is not India’s closeness to international trade. The role of international trade as an engine of economic growth has been emphasized by academics and empirical papers (e.g., Frankel & Romer 1999; Grossman & Helpman 1991; Sachs & Warner 1995), which means that international trade has growth effects in India. From this point of view, trade openness should be encouraged. The problem is not trade openness but large and rising regional inequality. How to reduce regional inequalities in India is, of course, beyond the scope of this article. Nevertheless, some papers already give some hints.

Aghion et al. (2004) find that India’s trade liberalization favors industries initially close to the Indian technological frontier because they are able to compete internationally. These industries are mainly located in industrialized Indian states (Andhra Pradesh, Karnataka, and Maharashtra). Trade openness also favors industries located in states which have more pro-employer labor institutions (Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Rajasthan, and Tamil Nadu) because pro-employer labor regulations increase productivity and investment. International trade fosters output growth and productivity of these states. As a result, policy makers should focus on policies that encourage the productivity of industries located in the north of the country and the reforms of the local labor laws.

Bandyopadhyay (2011) explores the evolution of incomes across Indian states over 32 years (1965–1997) and finds that a low level of primary education, literacy, road density, and irrigation explain low growth performances in the poorest states such as Bihar, Uttar Pradesh, and Orissa. Trade or financial openness is not taken into account in this study. Not only does a low level of human, social, and transport infrastructures negatively impact economic growth of the poorer Indian states, but it also prevents them from benefiting from international trade. Indeed, a growth effect due to trade openness might be conditioned by some structural characteristics. For instance, international trade constitutes an effective channel for international dissemination of technological progress via imports of high-tech inputs, but Ben-David (2000) argues that foreign trade will not transfer knowledge to regions with low levels of human capital. That is to say, the diffusion of

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9 Growth equations are estimated using panel data, including indicators of infrastructure as explanatory variables.
technologies and thus a positive impact of trade on growth is conditioned by the stock of human capital. The Indian states with a low level of human capital might not benefit from international technology. Transport infrastructure is another channel between trade and growth. Lack of basic infrastructure reduces the productivity of local firms by creating high transaction costs and increasing the cost of moving goods, which in turn reduces their ability to compete internationally. Lehman and Zarzozo (2003) show that, for trade between Mercosur countries and European countries, infrastructure (paved roads, telephone per country, and railroads) in Mercosur countries fosters their international exports.

This suggests that large investments in education and transport infrastructure should be made in India to foster economic growth and international trade of lagged regions. But, in the Indian federal system, the states assume a significant role for these areas involving considerable governmental expenditures (Rao & Singh 2001). In the case of greater decentralization, the financially weaker states, which are also the less developed, will invest less in these areas than rich states, which might trigger a vicious cycle increasing regional inequalities and further decentralization.

According to Rao and Singh (2001) and the empirical results of this article, the decentralization process that occurred in India in concomitance with trade liberalization in the 1990s reinforced the regional inequalities of the country. The policy response should include centralization or more financial transfers to North India to ease investment in human capital and transport infrastructure.

Though this discussion focuses on India and makes policy suggestions based on the Indian experience, the results and policy implications can be used to draw lessons for other countries. To sum up, policy makers must keep in mind that the insertion of a country into the globalization process can have negative consequences such as rising regional inequality. These potentially negative effects must be anticipated or at least addressed as quickly as possible in order to avoid larger problems like intra-national political conflicts.

VI. CONCLUSION

Regional inequalities represent a development challenge in many countries. Globalization is frequently cited as a factor of rising inequalities across regions within a country. The investigation in this article of a causal link between trade openness and regional inequality is based on two country cases, India and Brazil, over the periods 1980–2003 and 1985–2004, respectively.

Empirical evidence from time series analysis shows that Brazil’s trade openness has contributed to the reduction of income inequality across states
and that an explanation is the composition of trade. Brazil exports many agricultural products compared to manufacturing products, which has favored agricultural regions that are not the richest in Brazil.

Regarding India, empirical estimations indicate that greater global integration of the country in international trade has gone hand-in-hand with rising regional inequality. More precisely, this article shows that a rise in India’s exports, combined with a shift from exports in agriculture to exports in manufactured products, could partly explain the rise of inequality among states. Furthermore, the opening of the country to foreign markets in the 1990s may have triggered an agglomeration process in South India, which is the border region with the lowest-cost access to foreign markets.

The persistence of large regional inequalities in India may affect its political unity. Currently, the Indian central government recognizes regional inequalities as a threat to national unity. Political conflicts between developed Indian states and the center have become more acute since 2000. Some southern states no longer want to subsidize the states of the North. Consequently, the richest states demand more fiscal autonomy. Results also indicate that foreign direct investment aggravates regional inequality in India and Brazil due to their concentration in richer states. This article shows that the effect of trade openness on regional inequalities depends on the country studied and its composition of trade.

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APPENDIX A: DATA SOURCES

India

India is a country consisting of 28 states in 2004. The Gini coefficients are calculated with data for the 19 largest states: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Goa, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, and Delhi, comprising 98.2% of total Indian population in 2003.

Annual population data that are needed in the calculation of the Gini index are missing for the other states for some years between 1980 and 2004, which explains that they are not taken into account in the calculation. However, their omission should not have any effect on Gini coefficient. Indeed, the missing states comprise only 1.8% of total Indian population in 2003 (a year for which all data are available). In addition, the formula of the weighted Gini index used in the article weights the states’ per capita GDP based on their respective population proportions. The more populated an Indian state is, the greater the gap between its income and the average income will be taken into account to calculate the Gini index. Consequently, omitting very small states should not affect the value of the Gini coefficient.

To calculate the Gini indicator, one needs GDP per capita at current prices (in local currency) and population data for each state and each year. These data come from the Indian Ministry of Statistics and Programme Implementation. GDP per capita data by state are available only from 1980, which explains why this article studies the evolution of regional inequalities only after this year. Data for the year 2006 were not available. Data for 2005 exist but data were not reported for a few states, which explains why the period studied ends in 2004. India’s exports and imports, net inflows of foreign direct investment (FDI), and GDP per capita come from the World Bank’s World Development Indicators.

Brazil

Brazil is a country divided into 27 states. GDP per capita and population data for each state and each year are provided by the Brazilian institute IBGE (Instituto Brasileiro de Geografia e Estatistica). IBGE provides annual data for the period 1985–2004. Data for 2005 and 2006 were not available. GDP per capita and population data by Brazilian state and for each year are available only from 1985 to 2004, which has limited the period studied in this article. Brazil’s exports and imports, net inflows of foreign direct investment (FDI), and GDP per capita come from the World Bank’s World Development Indicators.
TABLE A1  Estimations of Vector Error Correction Models Using OLS Estimator: Links between Regional Inequality and Trade Openness in Brazil, 1985–2004

| Dependent Variables       | Regional Inequality in Brazil | Brazil’s Trade Openness |
|---------------------------|-------------------------------|-------------------------|
|                           | \( D.\text{lnGini}_{t-1} \) | \( D.\text{lnOpenness}_{t} \) |
| \( \text{residual}_{t-1} \) | .64 (391) | -.66 (615) |
| \( D.\text{lnGini}_{t-1} \) | -.71 (273)** | .20 (1777) |
| \( D.\text{lnGini}_{t-2} \) | -.23 (179) | -1.89 (1231) |
| \( D.\text{lnOpenness}_{t-1} \) | -.16 (073)** | -.05 (.751) |
| \( D.\text{lnOpenness}_{t-2} \) | -.15 (.051)** | .26 (.555) |
| \( D.\text{lnGDP capita}_{t-1} \) | .44 (197)** | -2.37 (1574) |
| \( D.\text{lnGDP capita}_{t-2} \) | -.14 (.198)** | (2.131) |
| \( \text{lnFDI}_{t-1s} \) | .06 (.013)** | .11 (.115) |
| \( \text{lnFDI}_{t-2s} \) | -.04 (.010)** | .04 (.098) |
| Constant                  | -.006 (.004) | .04 (.046) |
| Observations              | 17              | 17               |
| \( R^2 \)                 | 0.88            | 0.55            |
| Breusch-Pagan test, Prob. > chi2 | 0.20 | 0.37 |
| Breusch-Godfrey test \( p \)-value | 0.00 | 0.00 |
| \( \phi \)                | -0.64           | -0.47           |

Notes: Standard errors in parentheses; ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. FDI is stationarized by removing the trend.
TABLE A2  Estimations of Vector Error Correction Models Using OLS Estimator: Links between Regional Inequality and Trade Openness in India, 1980–2003

| Dependent Variables | Regional Inequality in India $D.ln\text{Gini}_t$ | India’s Trade Openness $D.ln\text{Op們ness}_t$ | Regional Inequality in India $D.ln\text{Gini}_t$ |
|---------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
|                     | (1)                                           | (2)                                           | (3)                                           | (4)                                           |
| residual$_{-1}$     | .57                                           | -.48                                          | -.18                                          | -.16                                          |
|                     | (.438)                                        | (.318)                                        | (.490)                                        | (.649)                                        |
| $D.ln\text{Gini}_t$ | -1.07                                         | -.77                                          | -.88                                          | -90                                           |
|                     | (.538)**                                      | (.826)                                        | (.496)                                        | (.690)                                        |
| $D.ln\text{Gini}_t$ | -35                                           | -.54                                          | -.51                                          | -31                                           |
|                     | (.311)                                        | (.515)                                        | (.275)*                                       | (.370)                                        |
| $D.ln\text{Op們ness}_t$ | .49                                          | .51                                           | .33                                           | .55                                           |
|                     | (.235)**                                      | (.396)                                        | (.236)                                        | (.318)                                        |
| $D.ln\text{Op們ness}_t$ | .33                                          | .57                                           | .42                                           | .30                                           |
|                     | (.154)*                                       | (.281)**                                      | (.181)**                                      | (.203)                                        |
| $D.ln\text{GDP capita}_t$ | -1.05                                         | -.48                                          | -.80                                          | -55                                           |
|                     | (.514)*                                       | (.895)                                        | (.603)                                        | (.719)                                        |
| $D.ln\text{GDP capita}_t$ | -1.30                                         | -1.40                                         | -.92                                          | -1.23                                         |
|                     | (.522)**                                      | (.906)                                        | (.474)*                                       | (.606)*                                       |
| $D.ln\text{FDI}_t$  | .005                                          | -.02                                          | .009                                          | .003                                          |
|                     | (.014)                                        | (.019)                                        | (.013)                                        | (.016)                                        |
| $D.ln\text{FDI}_t$  | .01                                           | .01                                           | .02                                           | .006                                          |
|                     | (.010)                                        | (.017)                                        | (.009)                                        | (.012)                                        |
| Decentralization$_{-1}$ of expenditures | - .23                                         |                                   |                                   |                                   |
|                     |                               | (.608)                                        |                                   |                                   |
| Decentralization$_{-2}$ of expenditures | 1.47                                           |                                   |                                   |                                   |
|                     |                               | (.518)**                                      |                                   |                                   |
| Transfers$_{-1}$    | .09                                           | .08                                           | .08                                           | .08                                           |
|                     | (.029)**                                      | (.050)*                                       | (.028)**                                      | (.036)**                                      |
| Observations        | 21                                            | 21                                            | 18                                            | 18                                            |
| R$^2$               | 0.57                                          | 0.55                                          | 0.83                                          | 0.69                                          |
| Breusch-Pagan test, Prob. > chi2 | 0.28                                           | 0.71                                          | 0.97                                          | 0.49                                          |
| Breusch-Godfrey test p-value | 0.00                                           | 0.02                                          | 0.94                                          | 0.00                                          |
| $\phi$              | -0.43                                         | 0                                             | 0                                             | -0.55                                         |

Notes: Standard errors in parentheses; ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. For India, FDI is stationarized in first-difference.
TABLE A3  Estimations of Vector Error Correction Models Using OLS Estimator: Breakdown of Exports as a Determinant of Regional Inequality in India from 1980–2003 and in Brazil from 1985–2004

|                      | Regional Inequality in India | Regional Inequality in Brazil |
|----------------------|------------------------------|-------------------------------|
|                      | (1)                          | (2)                          |
|                      | (3)                          | (4)                          |
| residual_{t-1}       | .86                          | .45                          | .36                          | .33                          |
|                      | (.463)*                      | (.381)                       | (.343)                       | (.335)                       |
| D.lnGini_{t-1}       | −1.34                        | −.85                         | −.73                         | −.76                         |
|                      | (.586)**                      | (.475)**                     | (.318)*                      | (.295)**                     |
| D.lnGini_{t-2}       | −.45                         | −.16                         | −.26                         | −.28                         |
|                      | (.334)                       | (.277)                       | (.210)                       | (.189)                       |
| D.lnOpenness_{t-1}   | .45                          | .13                          | −.14                         | −.23                         |
|                      | (.234)*                      | (.244)                       | (.093)                       | (.100)**                     |
| D.lnOpenness_{t-2}   | .30                          | .35                          | −.13                         | −.18                         |
|                      | (.146)*                      | (.161)**                     | (.070)*                      | (.078)*                      |
| lnFDI_{t-1}          | .01                          | −.003                        | .06                          | .06                          |
|                      | (.014)                       | (.012)                       | (.017)**                     | (.014)**                     |
| lnFDI_{t-2}          | .01                          | .02                          | −.04                         | −.04                         |
|                      | (.009)                       | (.009)**                     | (.012)**                     | (.011)**                     |
| D.lnGDP capita_{t-1} | −1.19                        | −.87                         | .49                          | .43                          |
|                      | (.490)**                     | (.439)**                     | (.240)*                      | (.207)**                     |
| D.lnGDP capita_{t-2} | −1.10                        | −.87                         | −.48                         | −.44                         |
|                      | (.556)*                      | (.477)**                     | (.312)                       | (.245)                       |
| (Manuf. exports/agricultural exports)_{t-1} | .05                          | −.02                         | .06                          | .06                          |
|                      | (.021)                       | (.080)                       | (.099)**                     | (.057)                       |
| (Manuf. exports/agricultural exports)_{t-2} | .005                         | −.02                         | .01                          | .01                          |
|                      | (.024)                       | (.080)                       | (.099)**                     | (.057)                       |
| Constant             | .10                          | .07                          | .01                          | −.006                        |
|                      | (.030)**                     | (.026)**                     | (.063)                       | (.005)                       |
| Observations         | 21                           | 21                           | 17                           | 17                           |
| R^2                  | .69                          | .75                          | .88                          | .91                          |
| Breus-Pagan test, Prob. > chi2 | 0.38                      | 0.14                         | 0.46                         | 0.89                         |
| Breus-Godfrey test p-value | 0.00                      | 0.00                         | 0.00                         | 0.00                         |
| φ                    | −0.55                        | −0.58                        | −0.66                        | −0.51                        |

Notes: Standard errors in parentheses; ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. For India, FDI is stationarized in first-difference and for Brazil by removing the trend.
FIGURE A1 Regional inequality in India: per capita income of Indian states in 2001.

*Source:* Map belonging to the author. Per capita income is in PPP current dollars.
FIGURE A2 Regional inequality in Brazil: per capita income of Brazilian states in 2001.

Source: Map belonging to the author. Per capita income is in PPP current dollars.