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Trade and Interregional Inequality*

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Abstract

We study the effect of international trade and freeness of trade on interregional inequality within countries. We estimate a model derived from a structural economic geography approach where interregional inequality depends on weighted trade shares and trade costs and where we can derive an aggregate freeness of trade measure. These measures are instrumented based on constructed trade shares and trade costs fitted from a gravity model of bilateral trade, which covers 208 countries for the period 1948–2006. We analyze a cross country data set of regional inequality within countries, which covers 110 countries (1569 sub-national regions) for the year 2005, and a panel data set, which covers 56 countries (835 sub-national regions) for the period 1980–2009. IV and dynamic panel regressions show that trade increases interregional inequality within countries but an increase in freeness of trade is probably neutral. Because the latter is an indicator for integration in the world markets, we conclude that more integration neutralizes the negative interregional distribution effects of the increase in trade.

JEL classification: R10

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1 Introduction

For a long time economists have been working on the effect of trade on inequality within countries. Most of this research is on intra-country wage inequality (overview in Pavcnik, 2013) but since the advent of the New Economic Geography spatial effects (review by Brühlhart, 2011), intra-group inequality (e.g. Egger and Kreickemeier, 2012), and interregional inequality (e.g. Brühlhart et al., 2012) aroused interest of scholars. We pick up this latter issue and study whether international openness contributes to interregional income inequality within countries.

A first glance at data reveals that openness and inequality are correlated in a number of countries. Take India and Bolivia as examples. While the per capita GDP of the poorest federal state in India, Bihar, was 24% of the richest state, Delhi, in 1980, its relative income decreased to 13% in 2005. In Bolivia, our second example, the income of the poorest department, Potosí, was 43% of that of the richest department, Santa Cruz, in 1988, but the relative performance of Potosí decreased to 29% in 2009. A potential cause of this development is international trade. Both countries have significantly increased their international trade integration. In India, the ratio of sum of exports and imports to GDP, i.e. the trade to GDP ratio, increased from 15.6% in 1980 to 41.2% in 2005, while trade in Bolivia increased from 41.9% in 1988 to 64.% of the GDP in 2009. This positive correlation between the trade-to-GDP ratio and interregional inequality gives a first hint at a link between both variables.

A high level of regional inequality is an issue of major concern because it may cause serious trouble. There is evidence that regional inequality is a breeding ground for separatist movements and a major determinant of internal conflict, such as civil war (e.g. Østby, 2009, Buhaug et al., 2012, Lessmann, 2013). Further, evidence suggests that interregional inequality determines about one third of interpersonal inequality (Yemtsov, 2005, Elbers et al., 2005). In light of these findings, it is important to understand the determinants of regional inequality.

In this paper we ask whether international trade and increasing openness to trade is one of these determinants. We examine this issue for a huge number of countries and derive our empirical model from a structural economic geography approach.

The theoretical literature is ambiguous concerning the direction of the effects (Brühlhart, 2011). In the traditional trade theory trade increases regional inequality if the initially poorer regions of a country gain relatively less from the opening to the world market and vice versa (Wood, 2002,

Anderson, 2005)¹. In models of the new economic geography the effect depends on other conditioning factors such as trade costs (Krugman and Livas Elizondo, 1996, Paluzie, 2001, Behrens et al., 2006), the initial level of inequality (Alonso Villar, 1999) the initial country size (Zhang and Zhang, 2010), or the strength of the market crowding effect (Brühlhart et al., 2004, Crozet and Koenig-Soubeyran, 2004).

While theory does not provide clear signs most empirical studies focusing on single countries provide evidence in favor of a positive link between trade and interregional inequality (e.g. Chiquiar, 2008 on Mexico, Zhang and Zhang, 2003, on China, Brühlhart et al., 2013, on Austria²)

There are also studies on a cross-section or panel of countries usually with a rather limited number of countries due to the scarcity of data. These studies are very heterogeneous. For instance, Egger et al. (2005) find evidence that trade raises interregional inequality in a panel of eight CEEC countries (central and eastern European countries) over 1991–1999. In contrast, Milanovic (2005) finds no significant coefficient for the five most populated countries in the period 1978–2000. Petrakos et al. (2005) examine the effect of growth and integration on interregional inequality in eight European countries from 1981–1997. They found that integration, measured as intra EU trade to GDP, raises inequality in France and Spain, declines inequality in the Netherlands and Portugal and is insignificant for Greece, Italy, and the UK.

Barrios and Strobl (2009) examine a panel of the EU 15 countries for 1970–2000. They find evidence that the coefficient of the real openness measure is positively significant providing evidence that real trade openness raises interregional inequality in the EU15. Eventually, Rodríguez-Pose (2012) studies an unbalanced panel of 28 countries for 1980–2005 and provides evidence that only interaction terms of trade with development and ‘coincidence’ measures are statistically significant, while the coefficient of the trade to GDP ratio is insignificant.³

This literature left several open issues: (i) the size of the cross-country data base is usually very small and also biased in favor of industrial countries and hardly consider developing countries, hence there might be a selection bias; (ii) except for a few studies (e.g. Barrios and Strobl, 2009, Brühlhart et al., 2013) most empirical studies are not based on sound theoretical models; (iii)

¹Other channels are migration (Haaparanta, 1998, evidence by Chiquiar, 2008) the distribution of factor ownership (e.g. Anderson, 2005), or the willingness to redistribute via taxes and transfers (Rodrik and van Ypersele, 2001).

²See also Chiquiar (2008), González Rivas (2007), Hanson (1997, 1998), Sanchez-Reaza and Rodríguez-Pose (2002, 2005) on Mexico; Kanbur and Zhang (2005) on China, Pernia and Quising (2003) for the Philippines, Breau and Rigby (2010) on Canada, and Volpe (2010) for Brazil.

³There is another study of Rodríguez-Pose and Gill (2006) using an unbalanced panel for eight countries in 1970–2000. They, however, only use a graphical representation of the trade content index.

most empirical studies use the trade to GDP ratio as proxy for openness and, thus, do not consider integration based on trade agreements etc.

We are dealing with these three shortcomings in the following. There are two recently published cross-country data bases which we are gratefully to be able to work with. Gennaioli et al. (2013) provide a cross-section sample on regional income data for 110 countries with 1569 sub-national regions for the year 2005, while Lessmann's (2011) panel data base comprises 56 countries with 835 sub-national regions for the period 1980–2009. Therefore we consider a considerably higher number of countries than any study on that topic before, hence, avoid the selection bias present in other studies and provide much more general evidence. Our main inequality measure is the population-weighted coefficient of variation of regional income but we also consider alternative measures in the robustness checks.

Our regression models derive from a structural new economic geography model based on Pflüger (2004). In that way, we reconcile the empirical approaches with the respective theories, not yet done for a cross-country study in that context.

Because the Gennaioli et al. data are restricted to 2005, the endogeneity bias cannot be attenuated by instrumenting with lags or past changes as done in the panel studies referred to. Nonetheless, it is by far the largest data base available. To exploit it we carefully address the endogeneity issue.

In our theoretical model trade is endogenously determined by country characteristics and trade costs, which are difficult to measure. Therefore, unobserved heterogeneity and omitted variables might result in an endogeneity bias in linear regressions. We have two strategies to cope with this problem. First, we construct an instrument for the real trade to GDP ratios from an estimated gravity model of bilateral trade (Frankel and Romer, 1999, and Alcalá and Ciccone, 2004). At this, we combine the bilateral trade data for more than 200 countries of Head et al. (2010) with the estimation approaches suggested by Frankel and Romer (1999), Anderson and van Wincoop (2003) and Baier and Bergstrand (2007). Thereby, we augment the gravity equation with some standard determinants of trade following Head et al. (2010) and add country-pair fixed effects in order to deal with multilateral resistances (Anderson and van Wincoop, 2003). Then we use the constructed trade shares in the IV estimates as instrument for the trade to GDP ratio in the cross-section estimates. Then we switch to the second data base, that provides a panel of countries (Lessmann 2011). First, we carry out cross-section estimates to evaluate whether a selection bias

is present in comparison with the huge data base of Gennaioli et al. Eventually, we carry out a panel analysis of this data. To reduce endogeneity we first use our constructed instrument that varies across time and then perform dynamic panel regressions using a system gmm estimator a la Arellano-Bover/Blundell-Bond.

While the literature predominantly uses the trade to GDP ratio, we apply further measures for openness. The trade to GDP ratio is usually used as proxy for outside market potential though it does not explicitly consider the freeness of trade of the trading partners one of the central ingredients of the external market potential in the theory. Consequently, we propose and use an aggregate freeness of trade index based on bilateral openness where bilateral openness is calculated according to Head and Ries (2001). The freeness of trade measure focuses on integration in the world market and, thus, implicitly considers regional free trade agreements etc. Since trade and openness might be endogenous as will free trade agreements, membership in the OECD etc., we instrument both measures. We derive the instruments by performing a gravity type regression, and build an aggregate openness index as well as the instrument for that for each country. Eventually, we also apply the ‘degree of openness’-measure of Arrabias et al. (2009) in the robustness checks. Because this measure is endogenous we use it only in the system GMM approach but not in the cross-section estimates.

We find evidence that trade raises interregional inequality. The point estimate implies that an increase in the trade to GDP ratio by ten percentage points is on average associated with an increase in regional inequality by approx. 2%. A variety of robustness checks including semi-parametric estimates confirms our findings. Nonetheless, this finding implies that more trade increases interregional inequality. In contrast, we cannot identify a significant coefficient of freeness of trade in the panel regressions though it is significant in the IV cross-section estimates. This hints at the relevance of integration. The higher integration in the world markets the less less harmful is more trade to interregional inequality.

The reminder of the paper is organized as follows: Section ?? presents the simple New Economic Geography model and derives our regression equation. Section ?? presents our econometric analysis. At this, we first discuss our measure of regional inequality (section ??), present our empirical approach (section ??), and developed our instrument of trade shares (section ??). Subsequently we present our main results from cross-section and panel regressions. Then we provide different robustness tests, including alternative measures of regional inequality as dependent vari-

able, semi-parametric regression results and different interaction variables. Section ?? summarizes our findings and concludes.

2 Theory

2.1 A simple model

Since interregional inequality might depend on spatial allocation of industry and households, a model that accounts for this link is required. Therefore, we derive the empirical model as well as the gravity approach from a model in the tradition of the New Economic Geography (Krugman, 1991). In particular, we adopt the two-region model of Pflüger (2004) and adjust it to our purpose. We use this model because it is able to handle all kinds of spatial allocation of industry and population and, thus, is better suited than models featuring only full dispersion or full agglomeration. Despite that it is easy to use though it preserves almost all features of the standard core-periphery model (Krugman, 1991).

There are two countries i and j where country i is called ‘*Home*’. We focus on *Home* that consists of S regions with indices r or s . Though we assume full symmetry between both countries, we simplify equations by considering the other country, called ‘*Foreign*’ as a black box. It is straightforward how to extend the model to account for the internal structure of *Foreign*. There are two types of goods: (i) a homogenous tradable good, Z , produced with constant returns to scale, a unit demand of the only input labor and zero trade costs, and (ii) a mass of varieties of a monopolistic good produced with one unit of skilled labor per variety as fix input and c units of labor per output as variable input. We normalize the wage to unity and due to the construction of the homogeneous good sector, the price of these goods is also unity. In the following we focus on *Home* and simplify notations by dropping the index i when we look at country i ’s regions indexed r or s . Aggregate variables of *Home* or *Foreign* are indexed by i .

Each country is endowed with a fixed supply of skilled labor or entrepreneurs, K_i , and each region with a fixed amount of other types of labor, L_r , simply called ‘labor’. Regional skilled labor is endogenous on account of migration. Regional population is given by $P_r = L_r + K_r$.

Each household in a region consumes the local good Z_r and varieties, m of the aggregate monopolistic good, M_r . Upper level utility is represented by the quasi-linear utility function

(Pflüger, 2004) and subutility by an Spence-Dixit-Stiglitz utility function with love for variety, thus,

$$U_r = Z_r + \alpha_r \ln M_r \quad M_r = \left(n_r m_{rr}^{\frac{\sigma-1}{\sigma}} + n_s m_{sr}^{\frac{\sigma-1}{\sigma}} + n_j m_{jr}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \quad (1)$$

where α denotes expenditures on M , m_{sr} is the demand for a variety produced in region s and σ is the elasticity of substitution that also represents the price elasticity of demand. n_r is the mass of varieties produced in region r , n_i the mass produced in *Home* and a mass $n_j = N - n_i$ is produced abroad. The budget constraint is $G_r = Z_r + Q_r M_r$, where G_r denotes household income and Q_r is the perfect price index for monopolistic goods.

Transport of monopolistic goods is subject to Iceberg transportation costs. Following Behrens et al. (2007) ‘transportation costs’ refer to intra-country transportation cost and ‘trade costs’ to international costs. Transportation costs between regions, Ψ , are assumed to be symmetric and $\Psi > 1$ per unit of a variety. We assume that trade costs are symmetric for imports and exports, that there is no distinction concerning the region of destination or origin in *Foreign* but that they might be different among regions of country i . $T_r > 1$ represents the trade costs of *Home*’s region r to *Foreign*.

Demand functions for the varieties are

$$m_{rr} = \alpha_r \frac{Q_r^{\sigma-1}}{q^\sigma}, \quad m_{sr} = \alpha_r \frac{Q_r^{\sigma-1}}{\Psi^\sigma q^\sigma}, \quad m_{jr} = \alpha_r \frac{Q_r^{\sigma-1}}{T_r^\sigma q^\sigma}, \quad (2)$$

In the monopolistic sector a mass of goods is produced by identical firms with increasing returns to scale giving rise to Chamberlains monopolistic competition. The mass of firms n_r is equal to the mass of entrepreneurs K_r and we can use n instead of K below. λ_r determines the share of region r on all firms of country i . Since firms are identical we drop the indices of firms and regions. Further, $\lambda_r = n_r/n_i$ and $\mu_i = n_i/N$ denote regional shares and the national number of firms and country i ’s share on the world number of firms, respectively. Because we consider a mass of firm, profit maximization implies that the mill price is a mark-up on marginal costs, i.e.

$$q = \frac{(\sigma - 1)}{\sigma} c. \quad (3)$$

Accordingly, the perfect price indices are

$$Q_r = Nq [\mu_i (\lambda_r + \psi \lambda_s) + \phi_r \mu_j]^{\frac{1}{1-\sigma}}, \quad Q_j = Nq \left(\mu_i \sum_s \phi_s \lambda_s + \mu_j \right)^{\frac{1}{1-\sigma}}, \quad (4)$$

where $\psi \equiv \Psi^{1-\sigma} \in [0, 1]$ is the index of internal integration while $\phi_r \equiv T_r^{1-\sigma} \in [0, 1]$ represents trade freeness between *Home's* region r and *Foreign*.

On account of zero profits operating profits, R , equal fixed costs, i.e. $R = (q - c)x$. Hence, a firm's scale is $x = (\sigma - 1)(R/c)$ and its cost function is $\sigma R = R + cx$ implying $\sigma R = qx$. Clearing of the market of a variety implies that revenue equals the value of sales to all regions, i.e.

$$\sigma R = qx_r = P_r q m_{rr} + q P_s \Psi m_{rs} + P_j T_r m_{rj}. \quad (5)$$

After substituting (??), and (??) into (??) we see that the factor income in manufacturing is a function of the nominal market access (MA) of the region. The latter is the sum over local market access, interregional market access and international market access, thus⁴

$$\sigma R_r = \underbrace{P_r \alpha_r \left(\frac{Q_r}{q} \right)^{\sigma-1}}_{\text{local MA}} + \underbrace{\psi P_s \alpha_s \left(\frac{Q_s}{q} \right)^{\sigma-1}}_{\text{interregional MA}} + \underbrace{\phi_r P_j \alpha_j \left(\frac{Q_j}{q} \right)^{\sigma-1}}_{\text{international MA}}. \quad (6)$$

This is region's income from manufacturing. Full regional income requires to add labor employed in homogeneous tradables⁵. In the following we derive differences in per capita income. Because the extension to income from the homogeneous good sector is straightforward we focus only on income from manufacturing.

In addition there is some kind of dynamics in the model because λ is endogenous. Entrepreneurs move into the region offering them the higher real reward, i.e. the higher indirect utility. Therefore λ depends on all parameters of the model.

⁴The core periphery model of Krugman (1991) as well as other NEG approaches produce the same general pattern of this equation. Therefore, the following holds for all that kind of models.

⁵Redding and Venables (2004) solve for marginal costs that are included in q above. Then marginal costs, or factor income, depend on the real market access divided by σ . Our solution refers to zero profits. Then σR represents rewards from skilled and unskilled labor in manufacturing. Then $(\sigma - 1)R$ is equivalent to wages paid to the variable factor. For this reason, it is not necessary to solve for q and the RHS represents the real market access.

2.2 Income inequality

Equation (??) is the basis for the whole econometric analysis. We use this equation in several ways. First, we rewrite the equation to determine inequality depending on different definitions of trade openness.

The standard approach to get a link between market access and trade openness is to assume that the trade to GDP ratio is a proxy for international market access divided by Ricardian profits (e.g. Redding and Venables, 2004). This, however, is not fully consistent with the a typical NEG model, e.g. the model we use. Market access in (??) refers to exports. To consider imports we have to extend this equation. Second, freeness of trade or ‘*phiness*’, i.e. ϕ , is an important determinant of regional income. It is, thus, much more natural to use ‘*phiness*’ as measure of openness in these models. Rearranging (??) will show, how freeness of trade determines interregional inequality. A further problem arises, when we switch to a world with more than two countries. Than bilateral openness has to be extended to a multilateral openness measure. The following exercise will provide an idea how such an multilateral ‘*phiness*’ has to look like. Later on we can also derive a gravity equation to estimate and construct the instruments for both openness measures.

2.2.1 Inequality measures using the trade to GDP ratio

For the time being we assume that workers are equally distributed across regions and technologies are identical. Since we, further assume constant marginal productivity of labor, income differences across regions depend on Ricardian profits. We define per capita income of region r as $y_r = (n_r \sigma R_r) / P_r$ and y_i as *Home*’s average income p.c. Next, to simplify matters we define local market access, A_{rr} , market access of r in s , A_{rs} , and international market access, i.e. exports E_r to all countries. These are

$$A_{rr} \equiv n_r P_r \alpha_r \left(\frac{Q_r}{q} \right)^{\sigma-1}, \quad A_{rs} \equiv \Psi_{rs} n_r P_s \alpha_s \left(\frac{Q_s}{q} \right)^{\sigma-1}, \quad E_r \equiv n_r T_{rj} P_j \alpha_j \left(\frac{Q_j}{q} \right)^{\sigma-1}. \quad (7)$$

We use these definitions to rewrite the region's expenditure for varieties as well as (??), thus, giving us the two accounting equations for the use of income and the use of production⁶

$$Y_r = A_{rr} + A_{sr} + I_r \quad Y_r = A_{rr} + A_{rs} + E_r.$$

Adding up and dividing by P_r implies

$$y_r = \frac{A_{rr}}{P_i p_r} + \frac{1}{2} \left(\frac{A_{rs} + A_{sr}}{P_i p_r} \right) + \frac{1}{2} \frac{I_r + E_r}{P_i p_r}, \quad (8)$$

where p_r is the region r 's share in *Home*'s population. Aggregating over all regions gives the countries per capita income y_i

$$y_i = \frac{A_{rr} + A_{ss}}{P_i} + \frac{A_{rs} + A_{sr}}{P_i} + \frac{1}{2} \frac{I_i + E_i}{P_i}. \quad (9)$$

A region's relative deviation in per capita income from the average is then

$$\frac{y_r - y_i}{y_i} = \left(\frac{e_{A_r}}{p_r} - 1 \right) + \frac{1}{2p_r} [(e_{I_r} - p_r e_{I_i}) + (e_{E_r} + p_r e_{E_i} - 2e_{A_r} e_{E_r} + p_r)] T_i, \quad (10)$$

where I represents imports and E denotes exports. e_{I_r} and e_{E_r} are region r 's import and export shares on the country's aggregate trade $I_i + E_i$, respectively, e_{I_i} and e_{E_i} are shares of imports and exports to trade of country i , and T_i is the trade to GDP ratio of the country. Further, we used the definitions for absorption, the regions share in absorption and the link between exports and absorption given by

$$A_i \equiv A_{rr} + A_{ss} + A_{rs} + A_{sr}, \quad e_{A_r} \equiv \frac{A_{rr} + \frac{1}{2}A_{rs} + \frac{1}{2}A_{sr}}{A_i}, \quad \frac{A_i}{Y_i} = \frac{Y_i - E_i}{Y_i}.$$

Equation (??) states that a region's relative income depends on two components. The first term is a measure of intra-country openness. If the regions share on all intra-country trade in relation to its population share is larger than that of the average region, the region is relatively rich. In this case it trades more within itself or with other regions implying gains from intracountry trade.

⁶As we have shown above, we can use nominal export values due to the link between Ricardian profits and factor income. This is in contrast to the approach used in Egger et al. (2005), Redding and Venables (2004) or Head and Mayer (2006) who use real exports.

In addition the markup on prices, and, thus, income depends on the tightness of competition in that region. The second term is the weighted trade to GDP ratio of the country, where the weights depend on the deviation of regions' shares of imports and exports from the country shares.

This implies the econometric model

$$I_{it} = a_i + b_{1kt}\mathbf{Z}_{ikt} + b_2\mathbf{X}_{iht} + b_3T_{it} + b_4\mathbf{X}_{iht} \times T_{it} + d_t + \varepsilon_i, \quad (11)$$

where I_{it} is a measure for interregional inequality in country i at time t , \mathbf{Z}_{ikt} are exogenous control variables, T_{it} is the trade to GDP ratio, \mathbf{X}_{ikt} are other control variables that interact with this measure and represent the weights in (??), d_t are time effects, a_i are country fixed effects, and e_{it} is the error term. In the specifications that use the cross-section data set, we estimate a similar model, which, of course, has no fixed effects and no time dimension.

2.2.2 Inequality measure using the freeness of trade

In our model, freeness of trade enters all parts of the inequality equation (??) and, thus, is an important determinant of interregional inequality. Despite that “phi-ness” (Baldwin et al., 2005) it is not used in the empirical studies on interregional inequality.⁷

We substitute the price indices (??) into the equation for operating profits (??) and divide by P_r to get

$$y_r = N^\sigma \mu_i \frac{\lambda_r}{p_r} \left(\frac{p_r \alpha}{\Delta_r} + \psi \frac{p_s \alpha}{\Delta_s} + \phi_{rj} \frac{P_i \alpha_j}{P_i \Delta_j} \right), \quad (12)$$

where

$$\Delta_r \equiv \mu_i (\lambda_r + \psi \lambda_s) + \phi_{rj} \mu_j, \quad \Delta_j \equiv \mu_i \sum_s \phi_s \lambda_s + \mu_j,$$

are terms inversely related to the price indices. A countries income per capita is given by aggregating (??) and dividing by P_i

$$y_i = N^\sigma \mu_i \sum_s \lambda_s \left(\frac{p_s \alpha}{\Delta_s} + \psi \frac{p_k \alpha}{\Delta_k} + \phi_{sj} \frac{P_j \alpha_j}{P_i \Delta_j} \right). \quad (13)$$

⁷Combes et al. (2005) provide an example for the empirical use of bilateral freeness of trade in a study on another topic.

Manipulating the difference, eventually yields (see Appendix)

$$\frac{y_r - y_i}{y_i} = \left(\frac{e_{E_r}}{p_r} - \frac{e_{A_r}}{p_r} \right) \frac{E_i}{Y_i} = N^\sigma \left(\frac{\lambda_r}{p_r} - \frac{\frac{\lambda_r p_r}{\Delta_r} + \psi \frac{\lambda_s p_s}{\Delta_s p_r}}{(1 + \psi) \sum_s \frac{\lambda_s p_s}{\Delta_s}} \right) \Phi_i, \quad (14)$$

where γ_i is the ratio of *Home*'s GDP to the aggregate GDP of all destination countries. Further, we assume that the ratio of region r 's trade costs to the country's trade cost is constant across all destination countries. We now have a measure for aggregate freeness of trade of *Home*:

$$\Phi_i = \sum_j \frac{\gamma_j}{\gamma_i} \frac{\mu_i \phi_{ij}}{\mu_i \phi_{ij} + \mu_j}, \quad (15)$$

where γ_j is the ratio of country j 's GDP to the aggregate GDP of all destination countries and ϕ_{ij} are symmetric bilateral trade costs between countries i and j . Interregional differences in the income depend now on the weighted aggregate freeness of trade where the weight refers to the regional freeness of trade, the regions population share and the region production share to the country's absorption.

We can formulate the econometric model

$$I_{it} = a_i + b_{1kt} Z_{ikt} + b_2 \Phi_{it} + d_t \epsilon_i, \quad (16)$$

where $a = N^\sigma$, Z_{ikt} is a vector of controls for the term in square brackets in (??) and Φ is the overall freeness of trade of country i defined in ?? and I_i is the logarithm of the income distribution measure.

Unfortunately, bilateral trade openness also enters the price indices (??) and determines λ . For this reason we have to test linearity and also consider interaction terms below.

3 Empirical Analysis

3.1 Data and Variables

3.1.1 Interregional inequality

Below we measure regional inequality (I) by the population weighted coefficient of variation of the regional GDP per capita as calculated by

$$I_{it} := \frac{1}{\bar{y}_{it}} \left[\sum_{r=1}^S p_{rit} (y_{rit} - \bar{y}_{it})^2 \right]^{1/2}. \quad (17)$$

where \bar{y}_{it} is country i 's average GDP p.c. in period t , y_{rit} is the per capita income of region r in country i , p_{rit} is the share of the country's total population in region r , and n is the number of spatial units. This measure has frequently been used in economic geography, and was introduced by Williamson (1965) (see Lessmann, 2013, for detailed descriptions of the data). The measure is mean-independent, independent of the sizes and the number of spatial units, and it satisfies the Pigou–Dalton transfer principle, which states that a transfer from rich to poor regions should reduce the inequality measure (see Dalton, 1920, Pigou, 1912, and Sen, 1973, for details).

We use two different data sets to calculate the measures of regional inequality. First, we refer to Lessmann (2011), who has collected a panel data set of regional inequality. It covers 56 countries (835 sub-national regions) for the period 1980–2009. Second, we use the regional data provided by Gennaioli et al. (2013). This cross-section data set covers 110 countries (1569 sub-national regions) for the year 2005. Both data sources have their strengths and weaknesses. The data provided by Gennaioli et al. (2013) covers more countries, in particular less developed countries, which brings more variation to the cross-section. But this data set has no panel structure, which is the advantage of Lessmann (2011). Therefore, we decided to use both data sets and to compare the results.

The territorial level, at which the regional income is measured, differs slightly between Lessmann (2011) and Gennaioli et al. (2013). While Lessmann (2011) concentrates on NUTS2 regions for European countries or state/province level data otherwise, Gennaioli et al. (2013) focuses on the sub-national level with the highest political authority. Therefore, the regions are more heterogeneous in terms of size in the data set of Gennaioli et al. (2013). Another small difference is the

measure of regional income: while Lessmann (2011) uses the regional per capita GDP, Gennaioli et al. (2013) also include regional wage data and data on household income where GDP data is not available. The correlation between the inequality measures based on the different data sources is with 0.7724 fairly high.

3.1.2 Openness measures

T_i is the trade to GDP ratio (e.g. Redding and Venables, 2004). We measure it by the sum of exports and imports to GDP of country i in purchasing power parities (see Alcalá and Ciccone, 2004). The actual trade shares come from the World Development Indicators Series while the trade-to-GDP ratio is provided by *Penn World Tables 7.1* (Heston et al., 2012).

Because interregional inequality might affect this trade to GDP ratio, for instance by enforcing protection, it might be endogenous. To handle this issue we apply IV estimates. We build our instrument for the trade to GDP ratio, \hat{T}_i , by applying a gravity approach to bilateral trade and aggregating predicted trade. We use the data by Head et al. (2010), who refer to the International Monetary Fund's *Direction of Trade Statistics* (DOTS).

When we use the second approach, the major problem is likely endogeneity of trade openness. Therefore, we follow the same procedure described above. Though we have an exact measure of trade openness, we do not have data on the number of firms. Further, bilateral freeness of trade depends on imports and exports and, thus, endogeneity issues are similar to those in the case of the trade to GDP ratio. For this reason we instrument Φ_i by an proxy calculated from the estimates of bilateral trade freeness in a gravity approach. Because the GDP is the weight in the measure and because this might be endogenous, we use population shares to approximate the weights in the constructed freeness index.

We calculate bilateral trade openness following Head and Ries (2001) according to

$$\phi_{ij} = \sqrt{\frac{I_{ji}}{Y_i - E_{ij}} \frac{I_{ij}}{Y_j - E_{ji}}} \quad (18)$$

The correlation among both measures is 0.3679. **Figure ??** provides a scatterplott of trade to GDP and freeness of trade showing that larger countries, e.g. USA, China, Germany tend to have a higher freeness measure in comparison to their trade to GDP ratio.

Eventually, we use the openness measure based on exports to standardized GDP provided by

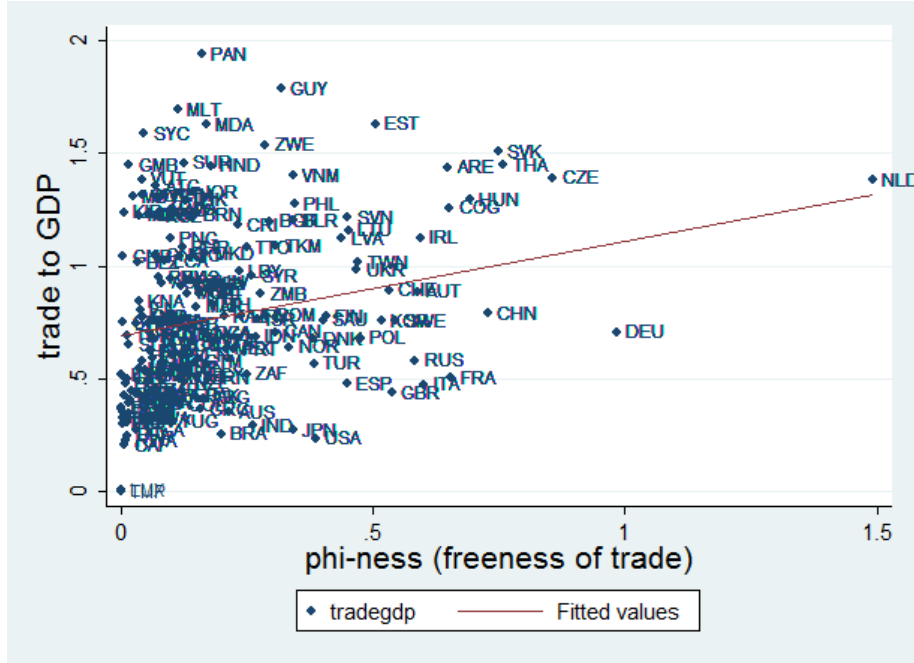


Figure 1: Trade to GDP ratio versus trade freeness ('phi-ness')

Arrabias et al. (2009) as third measure of openness. Due to endogeneity we use this measure only in the system gmm estimates. The correlation among these measures is displayed in **Table ??**

	T_i	Φ_i	DO_i
T_i	1.0000		
Φ_i	0.3024	1.0000	
DO_i	0.4860	0.3309	1.0000

DO_i degree of openness á la Arrabias et al. (2009)
observations 489589

Table 1: Correlation of openness measures

3.1.3 Weights and interregional accessibility

As theory shows, see (??) and (??), interregional allocation matters, too. It determines the weights in the trade to GDP ratio as well as the nonlinearity in the freeness of trade, shown in the price indices in local and interregional market access. As discussed above we approximate this through interaction terms in the econometric specification, see (??) and (??), and also by applying semi-parametric estimates.

Due to the lack of data on interregional accessibility, the number of firms, interregional trade,

and trade between regions and other countries, we have to choose proxies for the internal structure of a country. We use the degree of urbanization as proxy for the distribution of agglomeration effects, firms and population and the share of agriculture as proxy for the importance of industry that determines the agglomeration-periphery pattern. As third alternative measure, we use the road density –measured by road km to country size – that refers to infrastructure and, indirectly, to accessibility within the country.⁸ These controls are also used as proxies for interregional and local market access if required.

In the cross-section estimations, we control for the number of sub-national units within countries (in logs), country size (ln of area in square kilometers), and an fraction of these two variables to control for average unit size. These are also used as proxis for the internal structure of a country and also control for political economy effects (e.g. Lessmann ,2011).

3.2 Other controls

To account for Kuznets-curve effects (see above), we control for income by the per capita GDP and its square. Following Rodríguez-Pose (2012) and Lessmann (2011), we, further, control for policy issues: government size (measured by the expenditure to GDP ratio), a federal dummy, and EU membership. There is a quite large literature on the effect of decentralization on regional inequality, which shows that federal countries have lower regional inequalities, in particular if high income countries are considered (e.g., Rodríguez-Pose and Ezcurra, 2010 and Lessmann, 2012). The EU membership dummy and the government size measure should proxy for redistributive politics within countries, performed by international donors or the national government.

3.3 Constructing the instrument for trade shares

We derive the gravity equation for the bilateral trade-to-GDP ratio from our model giving us

$$\ln \frac{I_{ji} + E_{ij}}{Y_j} = \beta_0 + \beta_1 \ln Y_j + \beta_2 \ln Y_i + \beta_3 \ln \phi_{ij} + \beta_4 \ln \left(\frac{Q_j^{\sigma-1}}{\Pi_i} + \frac{P_i^{\sigma-1}}{\Pi_j} \right) + \varepsilon. \quad (19)$$

Bilateral trade between country i and country j depends on both countries' income, Y_i , Y_j , on trade openness between both countries, ϕ_{ij} plus two terms describing the relative attractiveness

⁸At this, we deviate from Rodríguez-Pose (2012), who uses a joint index of rail and road density. Since data on rail ways are lacking for many countries, we decided to focus on roads solely.

of the destination country in comparison to the Rest of the World and the relative market access to all countries. The latter is the multilateral resistance (ML) term Π of the country of origin. It has to be considered when estimating bilateral trade (Anderson and van Wincoop, 2003)⁹.

When estimating a gravity equation five problems arise: (1) there might be endogeneity of the GDP (Frankel and Romer, 1999) and (2) endogeneity of trade cost controls such as free trade agreements (e.g. Baier and Bergstrom, 2007). (3) one has to take care of multilateral resistance terms, (4) a huge number of zero trade flows are present in the data, and (5) there will be unobserved heterogeneity across countries.

Even though endogeneity of GDP might not be a huge problem because the GDP depends on net exports which is only a small contributor to GDP (e.g. Baier and Bergstrom, 2007), we follow Frankel and Romer (1999). However, we need a time-varying instrument of trade flows and, hence, extend their approach according to Head et al. (2010). We use population of the countries and other time invariant geographic variables, e.g. distance and access to the sea, instead of the endogenous GDP.

To consider the multilateral resistance term (Anderson and van Wincoop, 2003) we follow Feenstra (2004) and include country-pair fixed effects. These dummy variables capture all time-invariant factors that are country-pair specific (e.g. distance, common language, etc.)¹⁰. In doing so we also deal with endogeneity of trade openness variables that affect trade such as regional trade agreements (see Baier and Bergstrand, 2004). We further use distance and the interaction term of time and distance as additional proxies for trade openness.

Trade costs and a country's price index depend also on some intracountry variables such as the degree of agglomeration. However, because interregional inequality also depends on the degree of agglomeration and intracountry trade costs, controls that are used as proxy for those variables are not used in the gravity equation. Otherwise the instrument would become closely correlated with interregional inequality. Instead we use bilateral country-pair fixed effects to allow for a basic level of such effects.

Further we control for exogenous changes in transport costs by an interaction term of distance and time and for the importance of common institutional settings by considering an interaction term of the common legislative tradition with population size and, alternatively, an interaction

⁹A similar expression has been provided by Helpman and Krugman (1985) and Helpman (1987).

¹⁰Cheng and Wall (1999) and Egger and Pfaffermayr (2003) have shown that neglecting these country-pair fixed effects causes an estimation bias.

term of the dummy of common language with the population size. This refers to market access costs and to exogenous restrictions due to institutional settings¹¹.

Our final bilateral gravity model has the following form

$$\begin{aligned} \ln\left(\frac{\tau_{ijt}}{GDP_{it}}\right) = & \alpha_{ij} + \beta_1 \ln POP_{it} + \beta_2 \ln POP_{jt} \\ & + \beta_4 (Comlang_{ij} * \ln POP_{jt}) + \beta_3 (Comlang_{ij} * \ln POP_{it}) \\ & + \beta_5 (Time_t * Distance) + \mu_t + \epsilon_{ijt} \end{aligned} \quad (20)$$

where τ_{ijt} is bilateral trade between countries i and j at time t measured as exports plus imports, GDP_{it} is the income of country i at time t and $Comlang_{ij}$ represents common language that is used to account for close historical and cultural links between countries. Thereby, we concentrate on bilateral trade-to-GDP ratios (trade shares) following the approach of Frankel and Romer (1999), not on exports as Head et al. (2010).

Country size is considered by including the natural logarithm of the population size of country i and j ($POP_{i,j}$). Finally, α_{ij} are country pair fixed effects, μ_t are time fixed effects, and ϵ_{ijt} is the error term. Note that time invariant trade determinants, such as the country size measured by the surface area, are not included in the empirical model, since the country pair fixed effects, are perfectly correlated with these variables.

3.3.1 Results

We use the same data set as Head et al. (2010).¹² The original data source of the trade data is the International Monetary Fund's *Direction of Trade Statistics* (DOTS). The final data set covers the 1948–2006 period and contains trade data of 208 countries.

The main estimation results of the gravity model are reported in Table ??¹³.

Column (1) of **Table ??** displays the independent variable, column (2) the estimated coefficients, column (3) the robust standard errors, and column (4) the significant levels. The regression is based on 714,343 observations of 28,621 trade pairs (208 countries).

¹¹One might think of extractive versus inclusive institutions as suggested by Acemoglu and Robinson (2000) and Acemoglu et al. (2002).

¹² The data set can be downloaded at <http://www.cepii.fr>

¹³We used many other specifications including the idea of a common law or a shared history instead of common language. We also applied a Poisson pseudo-maximum likelihood estimation with bilateral fixed effects to account for the large number of zeros (e.g. Santos Silva and Tenreiro, 2011). Two account for dyadic FE in that approach we applied xtpqml written by T. Simcoe

Table 2: The bilateral trade equation

VARIABLES	(1) logflow_GDP	(2) phiness
logpop_o	0.0732* (0.0390)	-0.161*** (0.0372)
logpop_d	0.0375 (0.0363)	-0.409 (0.0372)
comlangXlogpop_o	0.0542 (0.0746)	
comlangXlopop_d	-0.191** (0.0753)	
tdummy_dist	-0.00581*** (0.000470)	-0.00563*** (0.000475)
Constant	-5.214*** (0.248)	-4.440*** (0.259)
Observations	714,343	489,724
R-squared	0.013	0.031
Number of countrypair	28,621	24,287
F	48.39	77.24

Notes: The dependent variable in (1) is $\ln(\tau_{ijt}/GDP_{it})$.

Notes: The dependent variable in (2) is Φ_i .

Robust standard errors in parentheses.

***, **, and * indicate significance at 1%, 5%, and 10%.

Country pair fixed effects and time effects are not reported due to space limitations.

The figures in column (1) provide evidence that trade openness is increasing in the population size of country i , while there is no significant unconditional effect of the size of country j . Concerning the interaction variables, only the interaction of the population in country j and the border dummy is significant with a positive coefficient. Thus, the population size of trade partner countries j has only an effect in neighboring countries, not in general.

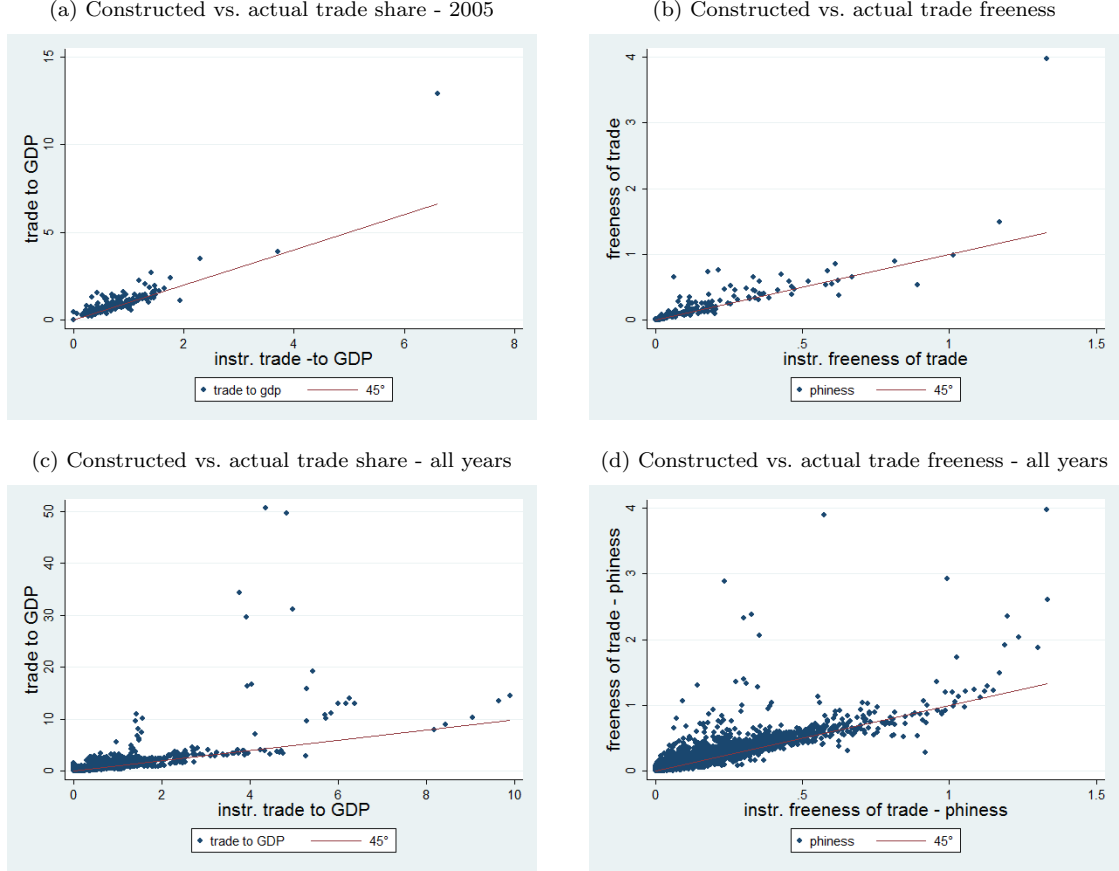
Concerning trade freeness, column(2) show that trade freeness of a country declines with its population and with distance, while size of the destination country is insignificant.

The estimated coefficients are then used to make linear predictions of the bilateral trade flows. Note that we use the full data set for this exercise, not only those countries, which are included in the data base used below. If we calculate the pairwise correlation between predicted bilateral trade and the dependent variable, $\ln(\tau_{ijt}/GDP_{it})$, we get a high correlation of 0.9060. This is however, a correlation between logarithms at the country pair level, which is not the variable that we use in the main part of the paper. The correlation between bilateral trade freeness, that is estimated

with the same data and almost the same approach, and the predicted trade freeness is 0.7643.

Figure ?? shows the relationship between constructed openness measures \hat{T}_{it} and $\hat{\Phi}$, and actual openness measures, T_{it} as reported by the World Development Indicators Series and Φ as calculated from the World Development Indicator Series. Panel (a) and (b) displays it for the year 2005 and panels (c) and (d) for the whole time period considered.

Figure 2: Constructed versus actual openness measures



The correlation between the constructed trade shares and actual trade shares is quite high with a correlation coefficient of 0.7797. In the case of trade freeness the correlation is 0.8504. The figures also include the bisecting line, which indicates where actual and fitted openness measures are equal.

3.4 IV regressions: cross country results

In the following, we present the results of instrumental variable regressions using the cross-section data set. At this, the trade share is treated as endogenous, and the constructed trade shares from the gravity model as used as instruments. In the cross-section analysis, we refer to the data set constructed based on the regional incomes used in Gennaioli et al. (2013) who compile the data for the year 2005. The final sample consists of 105 countries. Table ?? presents the results of the second-stage regressions on the Gennaioli et al.+(2013) data.¹⁴

Throughout, the coefficient of the trade variable is significantly positive¹⁵. The point estimate implies that an increase in the trade to GDP ratio by ten percentage points is associated with an increase in regional inequalities by approx. 2%. The regressions also imply that country size plays a role. In line with Lessmann (2011) we find evidence of an inverted u-relationship between development and regional inequalities. The effects of urbanization and infrastructure are not significant, but it is quite suggestive that the regression coefficients are negative. The share of agriculture is also not significantly related to regional inequality as well as the political variables government size, federal dummy, and the EU dummy.

Table ?? presents the cross-section results concerning the trade freeness measure with the Gennaioli et al. (2013) data. The coefficient of the freeness measure is always positive but changes between significance and insignificance. The findings is much less robust. This has clear implications on policy as discussed below.

Cross-section results for the data base provided by Lessmann (2011) provide about the same results. Therefore, we do not present these but switch to panel regressions instead.

3.5 IV regressions with panel data

A second source of a potential endogeneity bias in our regression analysis is unobserved heterogeneity between countries. There may be an infinite number of unobserved variables, which could render our relationship between trade and inequality endogenous. These omitted variables can be

¹⁴ Because OLS is very sensitive to outliers we apply MM-estimators as suggested by Yohai (1987) in the non-IV estimates. We applied mmregress of Verardi and Croux (2009) to identify outliers with vertical and bad leverage and a robust estimator (robreg, see Jann 2010). As a robustness check we carried out IV estimates without outliers. But this did not change the findings.

¹⁵ In all IV estimates the first round results provide a Kleinfelder-Paap Wald statistic (widstat) that is always above 16 indicating that the instruments are not weak (see Stock and Yogo, 2005, for critical values). Further tests on endogeneity and underidentification (idstat) have the right signs, too

Table 3: Cross section with trade to GDP, Gennaioli-Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	IV0	IV1	IV2	IV3	IV4	IV5	IV9	IV10	RobR2
	covw	covw	covw	covw	covw	covw	covw	covw	covw
tradegdp	-0.0192 (0.0557)	0.209*** (0.0798)	0.229*** (0.0843)	0.199** (0.0862)	0.226*** (0.0856)	0.242*** (0.0904)	0.204** (0.0879)	0.211** (0.0941)	0.0899** (0.0422)
loggdppc	0.131 (0.162)	0.0167 (0.131)	0.0595 (0.156)	0.198* (0.113)	0.0573 (0.156)	0.142 (0.202)	0.120 (0.190)	0.0682 (0.189)	0.198* (0.113)
loggdppc2	-0.0104 (0.00984)	-0.0034 (0.00800)	-0.0052 (0.00907)	-0.0129* (0.00684)	-0.005 (0.00910)	-0.0094 (0.0111)	-0.009 (0.0110)	-0.0046 (0.0113)	-0.0136** (0.00663)
urban			-0.0014 (0.0015)	-0.0019 (0.0014)	-0.0015 (0.0015)	-0.0015 (0.0015)	-0.0017 (0.0016)	-0.0019 (0.0016)	-0.00053 (0.0012)
roaddens				-5.55e-05 (0.0002)					
popdens					-2.09e-05 (5.35e-05)				
agri						0.0024 (0.0038)			
govsize							-0.00087 (0.0022)	-0.00035 (0.0022)	
oecd								-0.0704 (0.0643)	
Observations	105	105	105	83	105	103	83	83	105
R-squared	0.088	0.304	0.304	0.329	0.306	0.293	0.387	0.390	
F	6.097	10.89	9.098	7.493	7.959	7.447	9.129	7.964	.
rss	3.460	2.640	2.641	1.589	2.634	2.636	1.883	1.874	.
idstat	20.36	10.61	11.32	9.239	11.06	12.11	9.131	8.408	.
idp	6.41e-06	0.0011	0.0008	0.0024	0.00089	0.0005	0.0025	0.0037	.
widstat	133.5	28.37	41.07	57.74	39.41	35.90	36.17	33.65	.

Constant, logunits, logarea, logarea/logunits

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4: Cross section with trade freeness, Gennaioli-Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	IVS0	IVS1	IV2	IV3	IV4	IV5	IV9	IV10	RobR2
	covw	covw	covw	covw	covw	covw	covw	covw	covw
phiness	0.0977 (0.0718)	0.0971* (0.0558)	0.103* (0.0584)	0.126 (0.108)	0.151*** (0.0584)	0.0985 (0.0618)	0.0970 (0.0600)	0.106* (0.0613)	0.0950*** (0.0271)
loggdppc	0.138 (0.160)	0.109 (0.137)	0.169 (0.171)	0.315*** (0.106)	0.161 (0.167)	0.144 (0.219)	0.210 (0.207)	0.165 (0.206)	0.262*** (0.101)
loggdppc2	-0.0115 (0.0099)	-0.00968 (0.0085)	-0.0124 (0.0101)	-0.0202*** (0.0063)	-0.0120 (0.0098)	-0.0112 (0.0124)	-0.0151 (0.0121)	-0.0112 (0.0123)	-0.0181*** (0.00600)
urban			-0.0017 (0.0014)	-0.0022 (0.0015)	-0.0018 (0.0014)	-0.0017 (0.0015)	-0.002 (0.0016)	-0.0023 (0.0016)	-0.0009 (0.00094)
roaddens				-0.00030 (0.0004)					
popdens					-0.0001** (5.29e-05)				
agri						-0.0010 (0.0032)			
govsize							-0.0002 (0.0019)	0.0003 (0.0018)	
oecd								-0.0666 (0.0669)	
Observations	105	105	105	83	105	103	83	83	105
R-squared	0.115	0.296	0.308	0.345	0.331	0.302	0.399	0.406	
F	5.909	8.853	7.229	6.796	7.215	5.918	8.452	7.433	.
rss	3.357	2.673	2.625	1.552	2.540	2.603	1.847	1.826	.
idstat	5.712	6.227	6.525	7.881	6.685	6.663	6.641	6.099	.
idp	0.0168	0.0126	0.0106	0.0050	0.0097	0.0098	0.010	0.0135	.
widstat	35.43	37.58	38.00	52.21	34.61	36.61	34.63	30.79	.

Constant, logunits, logarea, logarea/logunits

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

a serious source of bias in our estimated parameters. In our empirical investigation it is very likely that an omitted variable bias occurs, since regional inequalities are affected by several geographic and historical patterns we cannot measure satisfactorily. Using panel data, we can control for unobserved factors by including country fixed effects and time fixed effects.

We estimate four different specifications. The first model is a pooled robust regression with time fixed effects, the second is a two-way fixed effect approach, the third approach is a panel IV approach with the constructed openness measures as instrument and the last approach is a system GMM model (Arellano and Bover, 1995, and Blundell and Bond, 1998). The system gmm estimator was designed for small-T large-N panels, which is true for our data set. Note that we only consider the time varying control variables in the panel regressions. The measure of regional inequality comes from Lessmann (2011) and covers the period 1980–2009. We use 5-year averaged data to take care of the gaps in the data.¹⁶ **Table ??** reports the results considering the trade to GDP ratio and **Table ??** those for the freeness of trade measure.

In these estimates we find a significantly positive coefficient of trade. The standard tests suggest in all IV specifications that trade to GDP is endogenous and that our instruments are not weak. The findings are confirmed for other controls, too (see Table ?? in the appendix). To sum up, the panel regressions support the findings from the cross-section analysis: trade increases interregional inequality within countries.

However, when we control for EU membership the coefficient becomes insignificant. This indicates that integration might offset the negative impact of trade on interregional inequality. Therefore we use freeness of trade that is our measure of market access to examine the impact of integration. The estimates do not provide significant coefficients of freeness of trade except for the pooled regression. This is ambiguous evidence that an increase in freeness of trade, i.e. an increase in integration in the world markets, tends to be neutral with respect to interregional inequality.

3.6 Robustness tests

We performed many different robustness tests, some of them are presented below. We first, test for nonlinearities by applying semiparametric estimates. The Hardle and Mammen (1993) statistics suggest that the linear model can be used because the null hypothesis that both models are not different cannot be rejected (p-values between 0.17 and 0.74). Then we consider different inequality

¹⁶Period 1: 1980–1984, period 2: 1985–1989, ..., period 6: 2005–2009.

Table 5: Regional inequality and trade (panel, Lessmann (2011) data)

VARIABLES	(1) Pool2 covw	(2) Pool3 covw	(3) FE2 covw	(4) FE3 covw	(5) PanIV2 covw	(6) PanIV3 covw	(7) SyGMM2 covw	(8) SyGMM3 covw	(9) SyGMM4 covw
tradegdp	0.136*** (0.0325)	0.237*** (0.0532)	0.139** (0.0537)	0.117** (0.0516)	0.385*** (0.100)	0.381*** (0.102)	0.0345** (0.0147)	0.108*** (0.0360)	0.0388** (0.0169)
loggdppc	0.187*** (0.0707)	0.309* (0.179)	0.209 (0.135)	0.265** (0.121)	0.241** (0.107)	0.264** (0.108)	0.0086 (0.0468)	-0.186 (0.141)	-0.0639 (0.0593)
loggdppc2	-0.0147*** (0.0042)	-0.0209* (0.0109)	-0.0116 (0.0079)	-0.0150* (0.008)	-0.0172** (0.0073)	-0.0186** (0.0073)	-0.0013 (0.003)	0.0094 (0.0076)	0.0022 (0.0032)
urban		-0.00062 (0.00104)		-0.00409* (0.0026)		-0.0018 (0.0023)		0.0031*** (0.0011)	0.0013 (0.0008)
roaddens		-7.86e-05 (0.0002)						-0.000211** (9.01e-05)	
popdensity									-2.91e-05 (1.96e-05)
L.covw							0.941***	1.001***	0.922***
Observations	200	75	200	200	194	194	149	63	146
r2	0.823	0.779	0.468	0.497	0.271	0.282			
ar1p							0.0402	.	0.0697
ar2p							0.235	.	0.297

Panel; time dummies, logunits, logarea logunits/logarea, constant dropped

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Panel - freeness

VARIABLES	(1) Pool2 covw	(2) Pool3 covw	(3) FE2 covw	(4) FE3 covw	(5) PanIV2 covw	(6) PanIV3 covw	(7) SyGMM2 covw	(8) SyGMM3 covw	(9) SyGMM4 covw
phiness	0.0855*** (0.0289)	0.134*** (0.0365)	0.0594 (0.0602)	0.0103 (0.0918)	0.0624 (0.126)	0.0369 (0.234)	-0.0012 (0.0192)	-0.0014 (0.0220)	0.0120 (0.0226)
loggdppc	0.318*** (0.0694)	0.179 (0.359)	0.259* (0.133)	-0.0159 (0.308)	0.260** (0.102)	0.0457 (0.612)	0.0422 (0.0527)	0.0423 (0.0896)	0.0144 (0.0573)
loggdppc2	-0.0217*** (0.00400)	-0.0149 (0.0194)	-0.0143 (0.0088)	0.0061 (0.0234)	-0.0144* (0.008)	0.0016 (0.0445)	-0.0036 (0.0032)	-0.0035 (0.0048)	-0.0021 (0.0033)
urban	-0.0009 (0.0006)	0.0008 (0.0017)	-0.0057* (0.0029)	-0.0034 (0.0036)	-0.0057*** (0.0018)	-0.0035 (0.005)	0.0004 (0.0007)	0.0012 (0.0014)	0.0007 (0.0007)
roaddens		-0.0002 (0.0003)		-0.00015 (0.0003)		-0.00016 (0.0007)		-4.51e-05 (4.33e-05)	
popdens									-2.21e-05* (1.19e-05)
L.covw							0.903*** (0.0421)	0.975*** (0.0459)	0.902*** (0.0406)
Observations	194	73	194	73	194	73	144	61	141
r2_w	0.771	0.759	0.472	0.356	0.472	0.350			
F			5.140	15242			227.1	258.8	228.4
ar1p							0.0198	.	0.0267
ar1							-2.331	.	-2.216
ar2p							0.259	.	0.306
ar2							-1.129	.	-1.023

Constant, time dummies, logarea, logunits logarea/logunits

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

measures. Using the Gini coefficient does not affect the findings, while many results are insignificant when using the pure coefficient of variation. We also find that a third openness measure (Arrabias et al. 2009) does not deviate from our panel outcomes concerning the trade to gdp ratio.

Further, we examine interaction terms. This is important because theory suggests that interaction terms are important. Unfortunately, in many cases the coefficients of the interaction term and the control variable that is used in the interaction term are almost of the same size and of opposite sign. Because the correlation of both has the same direction and size and since the variance inflation factors are very high, the interaction estimates seem so suffer under high multicollinearity. Because this inflates standard errors, significances are lower. In some cases, the coefficient of trade to GDP or freeness of trade turn to insignificance. For instance, when we control for OECD membership nothing changes. But when we control for OECD membership and interaction terms between that and the openness measures the coefficient of the openness measures becomes insignificant. The estimates concerning interaction terms provide evidence that trade to GDP matters on average, but that the strength of the effect depends on the interaction variable. Concerning trade openness the outcome is much less conclusive. When we consider interaction terms we see that we cannot generally conclude that freeness of trade raises inequality. If we consider urbanization as indicator for the internal structure, significance vanishes while it is confirmed when we use population density instead in the cross-section analysis.

Finally, we consider endogeneity of the GDP variable and carry out estimates with lagged GDP. Further estimates we do not present are robust non-IV regressions that are close to the IV estimates presented above.

4 Summary and Conclusions

This paper studies the impact of international openness on regional inequalities within countries. We derive two measures for international openness from a simple New Economic Geography model. One is the usually used trade to GDP ratio. Our derivations provides a rational why nonlinearities and interaction terms might determine the effect of trade on interregional inequality. The other is an aggregate freeness of trade measure giving us a rule for aggregating bilateral freeness of trade (ϕ -ness) to construct a country's freeness of trade measure. Again we see, that interaction terms that depend on the internal structure of countries has to be considered.

Further, we use two recent data sets on sub-national regions of countries, which allow us to calculate (time-varying) measures of regional inequality for a wide range of countries including many developing countries. Up to 106 countries are considered in our cross-section data set; our panel data set consists of 54 countries for the period 1980–2009.

In empirical part we used our constructed proxies as instruments. The IV regressions suggest a positive and significant effect of trade as well as of freeness of trade on regional inequality for the cross-section of countries. The point estimate implies that an increase in the trade to GDP ratio by ten percentage points is associated with an increase in regional inequalities by approx. 2%. Our findings for the trade to GDP ratio is confirmed for the panel of countries, where we apply dynamic panel data models. In the dynamic approach we also use an export based measure of openness (see Arrabias et al., 2009) that provides the same results. In contrast, the panel approaches did provide only insignificant coefficients of freeness of trade.

What do we learn from this study? If countries increase trade interregional inequalities increase. This outcome is fairly robust. Consequently, we have a classical trade-off between efficiency and distribution: while incomes rises in response to increased trade, inequalities rise, too.

On the other hand, an increase in freeness of trade that we interpret as indicator for integration seems to explain differences in interregional inequality across countries but its change seems to be neutral on interregional inequality within countries. herefore, one tentative conclusion from our study is, that more integration into the world market is likely to dampen or even fully neutralize the negative effect of increased trade.

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Table 7: System GMM - trade to GDP - constructed instrument not used

SysGMM. - trade-to-GDP - constructed instrument not used							
VARIABLES	(1) SysGMMT2 covw	(2) SysGMMT3 covw	(3) SysGMMT4 covw	(4) SysGMMT6 covw	(5) SysGMMT7 covw	(6) SysGMMT8 covw	(7) SysGMMT9 covw
L.covw	0.941*** (0.0760)	1.001*** (0.0741)	0.922*** (0.0611)	0.992*** (0.0642)	0.992*** (0.0642)	1.042*** (0.0804)	0.963*** (0.0746)
trade_gdp	0.0345** (0.0147)	0.108*** (0.0360)	0.0388** (0.0169)	0.0295* (0.0175)	0.0295* (0.0175)	0.0358* (0.0212)	0.0190 (0.0158)
logdppcc	0.00855 (0.0468)	-0.186 (0.141)	-0.0639 (0.0593)	0.0123 (0.0710)	0.0123 (0.0710)	0.0117 (0.0947)	-0.0498 (0.0818)
logdppcc2	-0.00132 (0.00302)	0.00940 (0.00755)	0.00224 (0.00321)	-0.00171 (0.00409)	-0.00171 (0.00409)	-0.000794 (0.00497)	0.00148 (0.00444)
urban		0.00306*** (0.00113)	0.00134 (0.000838)	0.000373 (0.000795)	0.000373 (0.000795)	-0.000155 (0.00143)	0.00105 (0.00112)
roaddens		-0.000211** (9.01e-05)					
popdens			-2.91e-05 (1.96e-05)				
govsize				-0.000226 (0.000630)	-0.000226 (0.000630)	-0.000217 (0.000725)	-0.00234*** (0.000901)
oecd						-0.0236 (0.0361)	
eu							0.0586** (0.0257)
Constant	0.0350 (0.159)	0.635 (0.611)	0.313 (0.243)	0.00155 (0.258)	0.00155 (0.258)	-0.0378 (0.364)	0.308 (0.327)
Observations	149	63	146	96	96	96	96
Number of ccode	52	44	52	48	48	48	48
ar1p	0.0402	.	0.0697	0.640	0.640	0.797	0.720
ar1	-2.052	.	-1.814	-0.467	-0.467	-0.257	-0.358
sig2	0.000349	0.000215	0.000312	0.000358	0.000358	0.000389	0.000328
hansenp	0.244	0.508	0.932	0.586	0.586	0.600	0.558
hansen_df	31	17	49	38	38	37	37
sargan	207.7	116.2	241.5	199.5	199.5	184.3	179.1
ar2p	0.235	.	0.297	0.623	0.623	0.880	0.238
ar2	-1.188	.	-1.042	0.492	0.492	0.151	1.180
Robust standard errors in parentheses							
*** p<0.01, ** p<0.05, * p<0.1							
Panel, time dummies dropped							

Table 8: System GMM - freeness of trade - Lessmann

VARIABLES	No constructed instrument							
	(1) SysGMMP1 covw	(2) SysGMMP2 covw	(3) SysGMMP3 covw	(4) SysGMMP4 covw	(5) SysGMMP5 covw	(6) SysGMMP6 covw	(7) SysGMMP7 covw	(8) SysGMMP8 covw
L.covw	0.984*** (0.0841)	0.903*** (0.0421)	1.458*** (0.160)	1.374*** (0.116)	0.907*** (0.0449)	0.955*** (0.0615)	0.972*** (0.0599)	0.979*** (0.0569)
phiness	-0.00871 (0.0186)	-0.00115 (0.0192)	-0.0133 (0.0177)	-0.00442 (0.0147)	-0.00536 (0.0163)	-0.00699 (0.0157)	-0.00524 (0.0165)	-0.023*** (0.0167)
loggdppc	0.0425 (0.0507)	0.0422 (0.0527)	0.0249 (0.0587)	-0.0623 (0.0381)	-0.0465 (0.0583)	0.0379 (0.0679)	0.0369 (0.0708)	-0.067*** (0.0757)
loggdppc2	-0.00303 (0.00339)	-0.00357 (0.00315)	-0.00136 (0.00326)	0.00313 (0.00231)	0.000863 (0.00335)	-0.00326 (0.00396)	-0.00308 (0.00392)	0.0026*** (0.0043)
urban		0.000420 (0.000659)	-0.000261 (0.000725)	0.000353 (0.000337)	-8.60e-05 (0.000745)	0.000131 (0.000970)	9.25e-05 (0.000998)	0.0011*** (0.0010)
L2.covw			-0.429*** (0.152)	-0.411*** (0.122)				
roaddens			-9.50e-06 (5.15e-05)					
popdens				-1.05e-05 (1.15e-05)				
agri					-0.00394** (0.00160)			
govsize						0.000219 (0.000658)	0.000248 (0.000613)	-0.00238*** (0.0010)
oecd							-0.00293 (0.0271)	
eu								0.0776*** (0.0286)
Constant	-0.111 (0.164)	-0.0685 (0.194)	-0.0971 (0.240)	0.302** (0.139)	0.420 (0.259)	-0.0566 (0.252)	-0.0656 (0.277)	0.381*** (0.302)
Observations	144	144	50	91	141	94	94	94
Number of ccode	51	51	36	38	50	47	47	47
ar2	-1.127	-1.129	.	0.141	-1.285	0.585	0.551	1.333
ar2p	0.260	0.259	.	0.888	0.199	0.559	0.582	0.183
ar1	-2.219	-2.331	.	-1.709	-2.370	-1.053	-0.953	-0.765
ar1p	0.0265	0.0198	.	0.0875	0.0178	0.292	0.340	0.444

time dummies

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1