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Income distribution, factor endowments, and trade openness

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Abstract

This paper studies the empirical links among factor endowments, trade and *personal* income distribution. By using panel data, we show that land and capital intensive countries have a less equal income distribution while skill intensive countries have a more equal income distribution. We also show that the effects of trade openness on inequality depend on factor endowments in a way consistent with several recent case studies but not with the simple Hecksher–Ohlin framework. Our results are robust to the division of the sample according to level of income, the inclusion of different regressors, the use of different measures of trade openness and of relative factor abundance, and tests for possible problems of endogeneity.

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1. Introduction

This paper studies the empirical links among factor endowments, trade, and *personal* income distribution. The motivation is that many developing countries

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have implemented radical trade reforms in recent years; these reforms have changed relative prices, have induced a reallocation of resources, and may have led to the introduction of new production techniques. These changes are quite complex and their final effect on income distribution is theoretically unclear. Our aim is to present the stylized empirical facts on the relations among income distribution, factor endowments, and trade.

Even though the links between personal income distribution and trade are quite important, there have been only a few empirical papers on the topic. Bourguignon and Morisson (1990) present a neoclassical model in which income distribution depends on factor endowments and the degree of openness. They estimate their model by using a cross-country analysis of 36 observations in 1970 and find that factor endowments can explain 60% of the difference in income shares of the bottom decile across countries, but they do not measure the effects of trade, pointing out the problems of definition of openness. In addition, Edwards (1997) examines the relationship between trade and the distribution of income by using a larger sample of countries with time-series observations, which allows him to utilize a different estimation technique. Even though he uses more observations and several measures of openness, he does not find any significant effect of trade on income distribution by looking at the effects of changes in trade openness on changes in inequality.

In addition to these two papers directly related to our topic, there is a growing literature on the effects of trade on wage inequality (see for instance, Wood, 1994, 1996; Borjas and Ramey, 1995; Freeman and Katz, 1995; or Robbins, 1996). Most empirical studies have consistently found that wage dispersion has increased in recent years in the developing countries which opened up to trade and for instance, Katz et al. (1995) find that the shift in relative factor supplies can explain a fair amount of cross-time and cross-country differences in relative wages. While this literature analyzes the wage component of income quite thoroughly, we cannot deduce that an increase of wage inequality leads to an increase of income inequality because official labor income represents only a fraction of total income.

The empirical analysis presented in this work is different from the aforementioned studies in that it uses panel data on factor endowments and the distribution of total income over the 1965–1992 period. The central idea is that income distribution and the impact of trade openness on inequality depend on the country's relative endowments of production factors with respect to the rest of the world.

The work consists on four sections. In Section 2, we start by describing a simple theoretical framework that constitutes the basis for our empirical analysis. Section 3 tests the hypothesis that relative factor endowments explain inequality. Section 4 uses a measure of openness, which we develop in Appendix B, to assess the effects of trade on income distribution, and performs several tests to check for the robustness of our main results. Finally, Section 5 draws the conclusions.

2. A simple framework

This section, which is divided into two parts, focuses on the theoretical relationship among income distribution, the prices of the factors of production, and the distribution of ownership. In the first part, we describe a model of a single closed economy. In the second, we generalize our framework to a world composed of several economies which share the same production function and preferences, but have different endowments. Finally, we discuss the implications of trade on personal income distribution. The framework draws from the model by Bourguignon and Morisson (1990).

2.1. Closed economy

In our closed economy, there are M different factors of production and N individuals. The vector $\boldsymbol{E}$ represents the total endowment of factors of the economy and the vector $\boldsymbol{Q}^c$ represents total output. The production factors are used to produce $\boldsymbol{Q}^c$ goods through the production function $\boldsymbol{F}$:

$$\boldsymbol{Q}^c = \boldsymbol{F}(\boldsymbol{E}), \tag{2.1}$$

where $\boldsymbol{F}$ represents the vector of the production functions.[2] If there is perfect competition in the factor and the final good markets, the price of every factor is equal to its marginal product in every sector where the factor is used:

$$\boldsymbol{P}^c \boldsymbol{F}'(\boldsymbol{E}) = \boldsymbol{W}^c, \tag{2.2}$$

where $\boldsymbol{P}^c$ is the vector of prices of the final goods in the closed economy, $\boldsymbol{F}'(\boldsymbol{E})$ is the vector of the marginal products of factors $\boldsymbol{E}$, and $\boldsymbol{W}^c$ is the vector of factor prices. Additionally, we suppose that there is full employment for all the factors.

The full employment conditions and Eq. (2.2) define the factor prices, $\boldsymbol{W}^c$ given the final good prices, $\boldsymbol{P}^c$, and the relative endowment of the economy, $\boldsymbol{E}$:

$$\boldsymbol{W}^c = \boldsymbol{W}(\boldsymbol{E}, P^c). \tag{2.3}$$

The system is closed by the demands for final goods:

$$\boldsymbol{P}^c = \boldsymbol{P}(\boldsymbol{Q}^c) \tag{2.4}$$

Plugging Eqs. (2.1) and (2.4) into Eq. (2.3), we obtain the factor prices as a function of the endowments:

$$\boldsymbol{W}^c = \boldsymbol{W}(\boldsymbol{E}). \tag{2.5}$$

Factor endowments determine fully the prices of the production factors in the

[2] We assume that the production functions $\boldsymbol{F}$ and the utility functions satisfy the general regularity conditions as described in Varian, 1978.

closed economy. Note that the size of the economy does not determine the relative price of the production factors if the production functions $\boldsymbol{F}$ have constant returns to scale. Moreover, the relative price of a factor is negatively correlated with its abundance under the hypothesis of decreasing returns and no (or low) complementarity between factors. [3]

2.2. Small open economy

In a small open economy, the vector of international prices, $\boldsymbol{P}^*$, determines the internal prices of the tradeable goods. International trade can also determine the factor prices under the following conditions: (a) the economy is sufficiently similar to the rest of the world in terms of endowments; (b) the economy has the same technology as the rest of the world; (c) there are no non-traded goods; (d) there are at least as many goods as factors; (e) the production functions are homogeneous of degree one; (f) there is no factor intensity reversal. If the conditions above are all satisfied, there is factor price equalization and the internal factor prices are determined by the international good prices:

$$\boldsymbol{W}^{\circ} = \boldsymbol{W}(\boldsymbol{P}^*). \tag{2.6}$$

If any of the conditions listed above fails to hold, factor price equalization is not assured and both international good prices and internal factor endowments determine internal factor prices:

$$\boldsymbol{W}^{\circ} = \boldsymbol{W}(\boldsymbol{P}^*, \boldsymbol{E}). \tag{2.7}$$

In an integrated world economy where the endowments of single countries do not differ too much, the international prices are determined by the world relative endowments in the same way as in the closed economy (see Dixit and Norman, 1980):

$$\boldsymbol{P}^* = \boldsymbol{P}^*(\boldsymbol{E}^*). \tag{2.8}$$

Substituting Eq. (2.8) in Eqs. (2.6) and (2.7) yields:

$$\boldsymbol{W}^{\circ} = \boldsymbol{W}^{\circ}(\boldsymbol{E}^*) \text{ and } \boldsymbol{W}^{\circ} = \boldsymbol{W}^{\circ}(\boldsymbol{E}^*, \boldsymbol{E}); \tag{2.9}$$

These equations say that the factor prices are determined by international endowments under the conditions mentioned above and also by internal endowments under more general conditions.

The case illustrated above is just a benchmark and is not realistic because almost no economy in the world has no tariffs. When governments intervene and impose tariffs and other barriers, factor price equalization does not take place; we

[3] Within the context of the recent income distribution literature, Stokey (1996) presents a model in which the complementarity between capital and unskilled labor breaks the positive relationship between factor relative scarcity and its price.

call T the distortion to the international factor prices. Therefore, Eq. (2.9) becomes:

$$\boldsymbol{W}^{o} = \boldsymbol{W}^{o}(T, \boldsymbol{E}^{*}, \boldsymbol{E}). \tag{2.10}$$

2.3. Income distribution

In Section 2.2, we make explicit the determinants of the factor prices, the factor income distribution, and the openness of an economy. The link between factor income distribution and personal income distribution is the ownership structure. Each individual may get her income from several production factors so that the total income of individual i, y_i, is the sum of her income from all sources,

$$y_i = w_1(\boldsymbol{E},\boldsymbol{E}^{*},T)\,E_1\,\omega_{i1} + \cdots + w_j(\boldsymbol{E},\boldsymbol{E}^{*},T)\,E_j\,\omega_{ij} \quad \text{with } i = 1,\ldots,I, \tag{2.11}$$

where E_j is the endowment of the economy of factor j, and ω_{i1} is the share of factor 1 owned by individual i. By construction, $\sum_{i=1}^{I}\omega_{ij} = 1$ for $j = 1,\ldots,J$. w_j represents the payment to factor j. We call $\boldsymbol{\Omega}$ the matrix of coefficients ω_{ij} which describes the ownership structure.

A synthetic indicator of income distribution, such as the Gini coefficient, is a function of the income of the single individuals:

$$\text{gini} \equiv g(\boldsymbol{Y}) = g(\boldsymbol{E},\boldsymbol{E}^{*},T,\boldsymbol{\Omega}). \tag{2.12}$$

Eq. (2.12) is the basis for our empirical investigation. It indicates that personal income distribution depends on the same variables which determine the factor income distribution, and on the structure of ownership $\boldsymbol{\Omega}$. [4]

The matrix $\boldsymbol{\Omega}$ is determined by historic conditions and may differ quite dramatically from country to country. Even though $\boldsymbol{\Omega}$ presents variation across time and countries, we can make one general observation. Some factors of production such as land or capital can be concentrated in the hands of few people because there is no natural upward limit to their accumulation; other factors of production such as skills cannot be concentrated to the same extent because there is a natural upward limit to the amount of education that an individual can accumulate. This observation puts a limit to the variation of $\omega_{ij}E_j$ if the resource j is human capital. Consequently, if an economy is endowed mostly with land and capital, there is no limit to the concentration of wealth. If an economy is endowed mostly with education, the distribution of income is expected to be more egalitarian, keeping constant the other factors.

[4] Note that the computation of the Gini coefficient requires information on the complete structure of ownership $\boldsymbol{\Omega}$. Other synthetic indicators such as the variance–covariance matrix of the factor distribution are theoretically insufficient to calculate the Gini coefficient.

3. Evidence on endowments and income distribution

In this section, we test the empirical evidence for the arguments presented in Section 2.3: that income distribution can be explained by factor endowments and degree of openness.

We start by estimating a specification of Eq. (2.12) which ignores the structure of protection T, and the structure of ownership $\boldsymbol{\Omega}$:

$$\text{gini} = g(\boldsymbol{E},\boldsymbol{E}^*). \tag{3.1}$$

The simplifications implicit in Eq. (3.1) are justified in the two polar cases of a completely closed or completely open economy. [5]

For our dependent variable, the Gini coefficient, we use the data base on income distribution compiled by Deininger and Squire (1996a). The data set consists of Gini coefficients and quintile shares for 108 countries covering the 1947–1994 period. All the observations satisfy three criteria: (a) the observations are taken directly from household surveys, (b) they are representative of the national level, and (c) include all sources of income. The last requirement is very important for our empirical analysis because we want to examine the whole personal distribution of income and not just the wage component. [6]

For our main exogenous variables, we consider three endowments: arable land per capita, skill intensity, and capital per worker. The data on arable land and the stock of capital per worker per country come from the *1995 World Bank Tables*. Endowment in skilled labor is defined as the proportion of population over the age of 25 with higher education, the data is taken from the Barro and Lee (1994) data set. [7] We construct indicators of relative scarcity in the following manner:

$$A_{ift} = \ln\left(\frac{E_{ift}}{E^*_{ft}}\right), \tag{3.2}$$

where f can be arable land, capital or skill intensity, i stands for the country, t is

[5] Bourguignon and Morisson (1990) adopt a similar specification; this allows them to avoid the problems of defining an index of trade openness.

[6] We drop 10 observations from the original data set of 670 Gini coefficients to ensure that within any given country, inequality is measured consistently by using either expenditure or income.

[7] The Barro and Lee (1994) data set contains four different educational categories (no schooling, some primary, some secondary, some higher education). We chose to use just the last category because we want to measure just the most skilled proportion of the population, and because the last category is measured with less error. If we try different categories in the same regression, our results do not change significantly. Putting more categories in the same regression can create problems of multicollinearity because they are highly correlated.

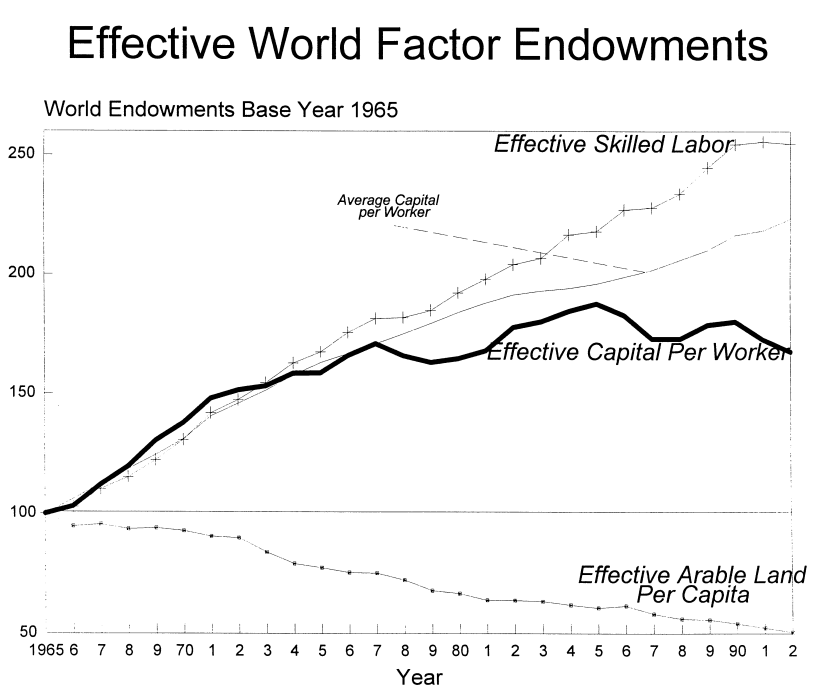

Fig. 1.

the year; E_{ift} represents the per capita endowment of factor f of country i in year t; and E^*_{ft} represents the world per capita effective endowment of factor f at time t, which is computed by weighting every country's endowment by the population and by the degree of openness. Given that this measure can be constructed in several ways, we explore other possibilities in the fifth test of robustness in Section 4.1. [8] We take the logarithm of the ratio between E^*_{ft} and E_{ift} because we want the variable A_{ift} to be unbounded in our estimations and because this definition allows us an easy interpretation of the regression coefficients as semi-elasticity. We weight by the degree of openness to take into account that the endowments of closed countries do not compete in the world markets with other

[8] The formula used to calculate the per capita world effective endowment is: $E^*_{ft} \equiv$ adjusted endowment/adjusted population $= \{\Sigma_i[E_{ift} \times \text{pop}_i \times ((X + M)/\text{Gdp})_i]\}/\{\Sigma_i[\text{pop}_i \times ((X + M)/\text{Gdp})_i]\}$, where pop_i refers to the population of country i, X are exports, and M are imports. The original sources do not always provide information for all the years of the 1965–1992 period for these four variables, which imposes problems for calculating the world averages. To calculate consistent world averages, we interpolate the variables for the years for which there was no information.

factors. So, if a country is totally closed, its endowments will not affect the world average.

Fig. 1 shows the evolution of the world effective endowments from 1965 to 1992. Under this definition, the relative endowment of a country can vary significantly through time depending on the trade policy of other countries, and so its comparative advantage can shift significantly simply because the world effective endowments change. For instance, if instead of considering the world *effective* endowment of capital per worker we simply plot the population weighed average of this factor, it would seem that capital per worker in the world increased steadily (see Fig. 1). However, we find that the *effective* endowment of this factor remained fairly stable after 1978. The reason is that although the rate of accumulation did not decline, five large low-income countries (Bangladesh, China, India, Indonesia and Pakistan) entered into the world economy around that year, and this increased the effective supply of labor in the world (see Wood, 1996, for a similar argument).

Besides factor endowments, other variables explain income distribution. Ideally, we would like to have a satisfactory model explaining inequality, to which we could add the effects of trade. Unfortunately, as noted by Atkinson (1997), such a model is not available and there is no clear indication of which variables should be used.

For many years, empirical studies on inequality have focused on the Kuznets hypothesis of an inverted 'U'-shaped relationship between economic growth and income distribution. Following the Kuznets tradition, we add income per capita and its squared value as control variables in our base specification. [9]

So, the test table equation derived from Eq. (3.1) is:

$$\text{Gini}_{it} = c + \alpha_1 A_{ilt} + \alpha_2 A_{ikt} + \alpha_3 A_{ist} + \alpha_4 \text{Gdppc}_{it} + \alpha_5 \text{Gdppc}_{it}^2 + e_{it}, \tag{3.3}$$

where l stands for arable land per capita, k for capital per worker, s for percentage of population with higher education, and Gdppc is the PPP adjusted GDP per capita taken from the *World Penn Tables 1995*.

By including the latter variables, the size of our sample is reduced to 320 observations for 34 countries for which there is information on income distribution

[9] For recent empirical (lack of) evidence on the Kuznets curve see Bruno et al. (1995) and Deininger and Squire (1996b). Anand and Kanbur (1993) have shown that there are other possible functional forms in which income can enter, different from the one used here. Specifically, they suggest using the inverse of the level of income instead of the squared term to study the relation between the Gini coefficient and the stage of development in the absence of other regressors. We have estimated our regressions with alternative specifications, including the one suggested by those authors, but none of the conclusions on the relationship between factor endowments and income distribution changes.

Table 1
Factor endowment and income distribution

Dependent variable: Gini	
Variable	Coefficient
A_{ilt}	1.29**
A_{ikt}	4.70**
A_{ist}	−1.20*
Gdppc	−0.003**
Gdppc^2	1.31**
Constant	52.26**
R^2	0.27

*Statistically significant at 95% level.
**Statistically significant at 99% level.
The coefficient for Gdppc^2 is multiplied by 1,000,000.

and factor endowments (see Appendix A for the summary statistics of the variables).[10] We do not use fixed effects because many countries have few observations and change in relative endowments is relatively slow; therefore, the major part of cross country variation would be absorbed by the fixed effects. However, we calculate the residuals by using the Huber correction to take into account that the exogenous variables are not independently drawn.

The results of Table 1 are in line with the qualitative hypotheses at the end of Section 2.3: the level of inequality increases when land and physical capital are relatively abundant, but declines when skilled labor is relatively abundant.[11] The proportion of income distribution explained the (R^2 is 0.27) is quite high, given that we use only factor endowments and level of income as explanatory variables. These results are robust to the inclusion of year dummies and to changes in the

[10] The reason why the sample is reduced is that the Barro–Lee data set—from which we obtain the education indicators—does not include information for all the countries for which we have data on inequality. The distribution of the observations by country is as follows: Belgium 4, Canada 20, Chile 4, Colombia 7, Denmark 4, Finland 11, France 5, Germany 6, Greece 3, Guatemala 3, Hong Kong 7, India 17, Iran 5, Ireland 3, Italy 15, Jamaica 5, Japan 20, Korea 11, Mauritius 3, Mexico 4, Netherlands 12, New Zealand 12, Norway 8, Peru 1, Philippines 5, Portugal 3, Spain 8, Sri Lanka 6, Thailand 7, Turkey 3, United Kingdom 26, United States 27, Venezuela 9, and Zambia 2. Overall we have 187 observations for developed countries and 133 for developing ones.

[11] In this specification the relation between income distribution and income per capita follows a 'U'-shaped trend rather than the inverted 'U' suggested by the Kuznets hypothesis. However, when we substitute GDP per capita and the squared value for their logarithms, we do obtain the inverted 'U'. So, the coefficients on income are not robust to different specifications, but this does not affect our results on the coefficients on factor endowments.

definition of A_{ilt}, A_{ikt}, A_{ist}. [12] In an unreported regression, we use directly the absolute endowment E^*_{ft} and E_{ift} instead of our relative endowment indicator A_{ift}; in this case, all the coefficients on land remain significant while all the others lose significance, indicating that only the relative endowments are relevant while the absolute endowments are not important per se.

As mentioned before, Eq. (3.3) is a simplification that does not include variables on the structure of ownership $\mathbf{\Omega}$, or the degree of openness T. The main reason why we do not include variables about $\mathbf{\Omega}$ is that there is no systematic data base on the structure of ownership. However, we have performed another experiment in an unreported regression by including measures of land and education inequality and the level of financial depth as a proxy for the distribution of capital in the regression in Table 1. [13] The three coefficients on factor endowments remain statistically significant at the 90% level; the coefficients on land and education distribution are positive and significant, while the coefficient on financial depth is negative but not significant.

4. Endowments, income distribution, and openness

In this section, we estimate Eq. (2.12) under the hypothesis that the level of trade distortion T enters in the determination of factor prices.

Even though the concept of trade openness is conceptually simple, there is controversy about how to measure it properly. There is no satisfactory direct measure of trade policy because trade protection can take several forms—tariffs, non-tariff barriers, requirements on standards, etc. For this reason, the empirical literature has used mostly outcome-based indices such as the intensity of trade; the main drawback of these indices is that trade intensity is influenced by many other variables, such as geography, economic cycle, and resource endowments. Different authors have corrected the measures of trade openness for these factors, which are independent of the trade policy. We review some commonly used indices in Appendix B.

[12] Instead of taking the logarithm of the ratio of the endowment of the country to the world effective endowment, we have used the absolute difference between them, the logarithmic absolute difference, the absolute difference squared, and the absolute difference divided by the world effective endowments, respectively. Additionally, we have changed the definition of world average by not weighting each country's factors by the share of international trade and used all the definitions mentioned before.

[13] The results from this regression are not reported because the sample size was reduced to only 70 observations due to data limitations. The measure of the distribution of education is the ratio of the labor force over 25 years of age with no education, over the proportion with secondary schooling and higher education; the measure of financial depth is *M*2 over *GDP*, from the *IMF International Financial Statistics, 1995*; the data on the Land Gini index are taken from Li et al. (1996).

In addition to the issues mentioned above, there is an additional problem specific to our exercise. For instance, a country that is well-endowed in land with respect to the world typically has a high volume of trade; therefore, a measure of trade openness which does not control for endowments shows that this country is quite open. Given that relative intensity of land is associated with higher income inequality, as the analysis in Section 3 shows, we could erroneously attribute the high inequality to the openness of the economy. To solve this problem, we have constructed an index of trade openness which controls for the factor endowments (Open). We discuss the construction and properties of our index in Appendix B. We add our measures of trade distortion directly, and interacting with every indicator of resource intensity. The testable specification derived from Eq. (2.12) is:

$$\begin{aligned}\text{Gini}_{it} = c + \alpha_1 A_{ilt} + \alpha_2 A_{ikt} + \alpha_3 A_{ist} + \alpha_4 A_{ilt}\text{Open}_{it} + \alpha_5 A_{ikt}\text{Open}_{it} \\ + \alpha_6 A_{ist}\text{Open}_{it} + \alpha_7 \text{Open}_{it} + \alpha_8 \text{Gdppc}_{it} + \alpha_9 \text{Gdppc}_{it}^2 + e_{it}.\end{aligned} \tag{4.1}$$

Three conclusions can be drawn from Table 2. The first is that the signs and the significance of the resource endowments remain robust to the inclusion of the openness index.

The second conclusion is that the index of trade openness (Open) is positive and significant. This suggests that trade openness is associated with higher inequality keeping constant the factor endowments. This can be due to the fact that more liberal governments have more liberal trade policy and less redistributional policies, so that we observe a positive correlation between inequality and trade openness.

Table 2
Income distribution and trade openness

Dependent variable: Gini	
Variable	Coefficient
A_{ilt}	1.71**
A_{ikt}	17.26**
A_{ist}	−3.63**
$A_{ilt} \times \text{Open}_{it}$	−1.71
$A_{ikt} \times \text{Open}_{it}$	−52.40**
$A_{ist} \times \text{Open}_{it}$	14.95*
Open_{it}	42.69**
Gdppc_{it}	−0.004**
Gdppc_{it}^2	1.50**
Constant	45.05
R^2	0.40

*Statistically significant at 95% level.
**Statistically significant at 99% level.
The coefficient for Gdppc^2 is multiplied by 1,000,000.

The third and most important conclusion is that openness seems to undo the effect of factor endowments on inequality because the coefficients on the interaction between a specific endowment and openness have opposite signs than the coefficient on the endowment itself. This result is opposite to what the simple Hecksher–Ohlin framework would predict. Take the example of a country relatively well-endowed with land. Following the Hecksher–Ohlin framework, we should expect that this country, which has already a bad income distribution as a closed economy, would worsen its income distribution as it opens up because the price of internal land, which is a scarce resource for the world, would go up. Our results indicate that the opposite happens.

There are several theoretical and empirical reasons why this can happen. Theoretically, in a world with more factors of production and specialization, one can not extend the conclusions of the stylized two-factor Hecksher–Ohlin model; therefore, our results cannot be read as a test against the Hecksher–Ohlin model. Empirically, our results confirm from a different perspective what other studies have found. We find that inequality increases in countries that are relatively well-endowed with skills when the economy opens; this result confirms the findings of the empirical literature on wage inequality that trade openness increases the premium for skilled workers. In contrast, inequality decreases in countries that are relatively well-endowed with capital when the economy opens; this result is consistent with the trade literature on political economy, which argues that rents deriving from ownership of capital reduce when the economy opens up (see Krueger, 1974).

4.1. Robustness tests

We perform six tests to check for the robustness of the latter conclusions.

First, our regressions have a potential problem of endogeneity. Factor endowments determine income distribution in the way we have discussed in the theoretical section, but income distribution also determines factor accumulation. In fact, the recent literature on income distribution assumes that inequality determines investment in education and capital accumulation, which are flow variables. [14] Nevertheless, our regressions should not suffer from this endogeneity because the A_{ift} variables are stock variables, which do not depend on present income distribution. To pursue the issue further, we have run our regression instrumenting for the stock of capital and education with financial depth which is well correlated with these variables, and also with lagged variables; the unreported results confirm that our assumptions about the lack of endogeneity are valid.

Second, we check whether the results are robust to other inequality indices given that different inequality measures place greater weight on different sections of the distribution—for instance, the Gini gives more weight to the center. Rather

[14] See Flug et al. (1997).

Table 3
Income distribution and trade openness

Dependent variables					
Variable	Poorest 20%	Quintile 2	Quintile 3	Quintile 4	Richest 20%
A_{ilt}	−0.002**	−0.001	−0.003	−0.001	0.006*
A_{ikt}	−0.041**	−0.419**	−0.030**	−0.014**	0.120**
A_{ist}	0.008	0.003	0.006*	0.008**	−0.029**
$A_{ilt} \times$ Open	−0.001	−0.005*	0.003	−0.001	0.031**
$A_{ikt} \times$ Open	0.106**	0.136**	0.124**	0.062**	−0.441**
$A_{ist} \times$ Open	0.013	−0.011	−0.034*	−0.032**	0.078*
Open	−0.139**	−0.182**	−0.127**	0.062**	0.636**
Gdppc	0.001**	0.098**	0.063**	0.034**	−0.001**
Gdppc^2	−4.37**	−3.56**	−2.060**	−9.500**	1.110**
Constant	0.052**	0.115**	0.161**	0.222**	0.393**
R^2	0.36	0.30	0.42	0.47	0.40

*Statistically significant at 95% level.
**Statistically significant at 99% level.
The coefficient for Gdppc^2 is multiplied by 1,000,000,000.

than choosing another index, we proceed in a more general way and estimate regression (4.1) using the income share of each quintile of the population instead of the Gini index, to find where exactly the changes take place.

Table 3 presents results that provide a clearer view of the relationships. [15] For instance, the negative effect of land is determined by the fact that the income share of the poorest 20% of the population declines with land abundance. In contrast, capital intensity is regressive because it has a significant negative effect on the first four quintiles, while raising the incomes of the richest 20%. Greater skill intensity increases the share of quintiles 3 and 4 (which could roughly be considered the middle classes), while reducing the relative incomes of quintile 5, and leaving the lowest quintiles unchanged.

With regard to the interaction terms, we obtain similar results. The interaction with land is not significant across quintiles, while the interaction of openness with capital reduces the share of the top 20% and improves the position of the other four quintiles. When a skilled labor-intensive economy opens to trade, income inequality rises because the share of quintiles 3 and 4 reduces significantly, the income share of the richest 20% increases, while the poorest 40% is unaffected. The trade openness measure used independently has regressive effects because it

[15] Not all the observations that have a Gini index contain the quintile shares, so the sample is reduced to 260 observations.

reduces the incomes of the poorest 60% of the population, while raising the share of the top quintiles.

The third robustness test is about sample heterogeneity. To check whether factor endowments pick up unobservable differences between developing and developed countries, we split our sample. Table 4 presents the results for the sub sample of developing countries. The coefficients for the restricted sample are not very different from those of the complete sample. An interesting result is that the coefficient for the openness measure itself is negative but not significant, indicating that trade openness has no influence on the distribution of income of developing economies, apart from the effect on the factor prices. This last result is in line with the finding by Edwards (1997).

The forth set of robustness tests consists of the inclusion of different regressors. We introduce year dummies and the inflation rate as variables to account for other macroeconomic fluctuations. We also try different definitions of A_{ilt}, A_{ikt}, A_{ist} as explained in [12]. In all cases, the sign and significance of the coefficients do not change. In addition to structural changes, also short-term fluctuations of macroeconomic activity could affect inequality—for instance, if the most income-elastic sectors use a specific factor more intensively, the demand for such factor may increase more than proportionally along the cycle. In an unreported regression, we have introduced the deviation from the long-term income growth trend to control for cycle-related changes in income distribution; our conclusions do not change.

As already mentioned, there is some controversy about which measure of trade openness is more appropriate, so the fifth robustness test is about the sensitivity to the index of trade openness. Table 5 contains the results of estimating the same

Table 4
Subsample of developing countries

Dependent variable: Gini	
Variable	Coefficient
A_{ilt}	6.42**
A_{ikt}	14.14**
A_{ist}	−5.05**
$A_{ilt} \times$ Open	−12.82**
$A_{ikt} \times$ Open	−43.79**
$A_{ist} \times$ Open	24.46**
Open	−4.03
Gdppc	0.01
Gdppc^2	2.89**
Constant	−50.16**
R^2	0.54

*Statistically significant at 95% level.
**Statistically significant at 99% level.
The coefficient for Gdppc^2 is multiplied by 1,000,000.

Table 5
Inequality and trade with alternative measures of trade openness

Dependent variable: Gini						
Variable	Measure of openness					
	XM	Lee1	Lee2	SATI	PDI	BME
A_{ilt}	2.0**	1.9**	0.7*	1.2**	−216.9**	74.1
A_{ikt}	11.1**	11.9**	15.1**	4.5**	93.0	593.4*
A_{ist}	−3.1**	−3.0**	−2.4*	−1.7**	−5.5	−23.9
$A_{ilt}\times$Open	−7.1**	−7.1**	4.8	110.5**	497.7**	−80.1
$A_{ikt}\times$Open	−49.8**	−58.1**	−49.3**	−76.4**	−208.8	−647.1*
$A_{ist}\times$Open	18.1*	23.7**	13.4	53.8**	15.2	25.3
Open	12.0	13.3	22.1**	−1.5	−148.1**	906.8**
Gdppc	−0.04**	−0.04**	−0.04**	−0.04**	−0.02**	−0.03**
Gdppc^2	1.5**	1.8**	1.8**	1.8**	8.9*	1.3**
Constant	54.1**	53.6**	52.8**	57.6**	−415.2**	−772.7**
R^2	0.44	0.47	0.44	0.47	0.32	0.28
Number of observations	320	280	247	286	75	320

*Statistically significant at 95% level.
**Statistically significant at 99% level.
The coefficient for Gdppc^2 is multiplied by 1,000,000.

regression with six different indices of openness. The definitions of the indices are explained in Appendix B. To make the coefficients comparable, we normalize each index so that they range within the interval [0,1].

Even though the correlation matrix of Table 11 in Appendix B indicates that the measures of openness are loosely correlated, our conclusions regarding the relation between income distribution and factor endowments are quite robust to the choice of index. In most cases, skill intensity is found to be progressive (although the coefficient is not significant when PDI and BME are used, while land and capital intensity worsen the distribution of income (the only exception is found with PDI for the case of land). Regarding the openness measure taken independently, the results vary. When we use XM, Lee1, Lee2, and the black market exchange rate, we find a positive relation, but when the SATI and PDI indices are introduced, the sign of the coefficient changes to negative, indicating that trade openness has a progressive effect on inequality (Table 5). Thus, our conclusion about the effect of openness independently of the influence on factor prices is not robust to the choice of openness indicator.

Among the interaction terms, the combination of trade openness and factor abundance is fairly robust in the case of skill and very robust for capital intensity, while the results for land vary considerably across indices. The macroeconomic variables are also highly robust to the choice of openness indicator.

The last robustness test is about the construction of the world effective endowments, E^*_{ft}. Our primary concern in constructing this variable is to exclude

autarchic countries; for this reason, we compute E^*_{ft} by weighting every country's endowment by the population and by the degree of openness:

$$E^*_{ft} \equiv \frac{\text{adjusted endowment}}{\text{adjusted population}} = \frac{\sum_i \left(E_{ift} \times \text{pop}_i \times \left(\frac{X+M}{\text{Gdp}} \right)_i \right)}{\sum_i \left(\text{pop}_i \times \left(\frac{X+M}{\text{Gdp}} \right)_i \right)} \tag{4.2}$$

where pop_i refers to the population of country i, X are exports, and M are imports. The use of the openness ratio $(X+M)/\text{Gdp}$ as relative weights has the potential problem that countries that have the same relative endowment as the rest of the world should have very little weight because they should trade relatively little. This fact could potentially bias our measure of world effective endowments. Theoretically, the proper way to correct this bias would be to have an accepted measure of openness and to use it as relative weight; unfortunately such a measure is not available, as noted before. To check the empirical evidence of the problem, we use several different measures of trade openness to construct the relative weights. The results do not change significantly showing that the potential bias does not determine our conclusions.

4.2. Significance of the results and regional variations

To check for the economic significance of our results, we calculate the average value of each of the independent variables used in Eq. (4.1), and multiply them by the corresponding regression coefficients from our base regressions. Table 6 presents the results, and the variable means are found in Tables 7 and 8 Appendix A. All the variables with a line above are averages over all the time period.

The results in Table 6, and the average endowments presented in Appendix B allow to characterize regions according to the type of factor with which they are endowed. Industrial countries have more capital and skills than the other regions, but they have relatively less land. Latin America has less land, less capital per worker and less skills than the world average, but factor endowments are close to the world effective endowments. [16] As expected, Africa, followed by the Asian countries, has the lowest endowments of capital and skills. The main difference among these two regions is that Africa is well-endowed with land, while this factor is scarce in Asia. Finally, East Asia has more capital and skills than the world average, but it is not well-endowed with land.

[16] It is interesting to note that in line with the argument by Wood (1996), Latin America does not seem to have a comparative advantage in unskilled labor, as is normally thought, as the skill level and the amount of capital per worker are higher than the average registered in Asia and Africa.

Table 6
Effect of factor endowments and trade openness on income distribution (points of the Gini coefficient)

Variable	Sample of countries				
	Industrial countries	Latin America	Africa	East Asia	Asia[a]
$1.71\times\overline{A_{il}}$	−1.36	−0.94	0.78	−5.97	−2.22
$17.26\times\overline{A_{ik}}$	21.56	−1.95	−32.21	2.79	−15.53
$-3.63\times\overline{A_{is}}$	−3.12	0.53	7.88	−1.26	2.95
$-1.71\times\overline{A_{il}}\times\overline{\text{Open}_i}$	0.35	0.08	−0.61	2.48	0.73
$-52.40\times\overline{A_{ik}}\times\overline{\text{Open}_i}$	−13.20	−1.73	12.52	−2.52	9.80
$14.95\times\overline{A_{is}}\times\overline{\text{Open}_i}$	2.87	−0.19	−6.56	1.76	−1.76
$42.69\times\overline{\text{Open}_i}$	9.01	8.15	9.22	14.26	9.35
$-0.004\times\overline{\text{Gdppc}_i}$	−40.96	−14.24	−4.54	−19.16	−8.02
$1.50\times\overline{\text{Gdppc}_i}^2$	15.90	2.37	0.27	5.31	2.63
Constant	45.05	45.05	45.05	45.05	45.05
Predicted Gini	36.09	37.12	31.81	42.75	42.97
Observed Average Gini	34.20	49.01	45.11	34.82	36.81
Points of Gini due to Trade[b]	−0.98	6.31	14.57	15.99	18.12
Impact of 10% rise in Open[c]	−0.10	0.63	1.46	1.60	1.81

[a] Excludes East Asia.
[b] Estimated by $(-1.71\times\overline{A_{il}}-52.4\times\overline{A_{ik}}+14.95\times\overline{A_{is}}+42.69)\times\overline{\text{Open}_i}$.
[c] Expressed as points of the Gini coefficient. Estimated by simulating an increase in the Openness measure by 10% and recalculating the points of the Gini due to trade.

With regard to the effect of trade on income distribution, we estimate the points of the Gini coefficient that are associated to the Openness measure by adding up the interaction terms in Table 6 and the openness measure taken independently. Then we simulate the impact of increasing the measure of openness by 10% in each region. The main result is that openness has a regressive impact through skills in the regions with the highest skill levels (namely the industrial countries and East Asia), while it seems to be progressive in unskilled labor abundant regions.

We find that trade has practically no impact on the personal income distribution in industrial countries. The reason is that although openness worsens the distribution through its effect on skills, this is totally offset by the progressive impact over capital. In this case, land does not appear to play an important role.

Trade openness also has a negligible effect over income distribution in Latin America. This is in line with the argument that when factor endowments are very similar to the world average, only small changes in relative prices will take place with openness, due to the absence of a comparative advantage.

The impact of trade through skills and capital is very similar in Africa and Asia. In both of these regions, trade has an equalizing effect due to the low levels of skill, but on the other hand it has a regressive impact due to the scarcity of capital. The main difference in these two regions is that openness is regressive in

Asia while it is progressive through its effect in land in land-abundant Africa. In East Asia, trade openness has a progressive effect through the capital endowment, but this is totally offset by the regressive effect on skills and by the fact that the region is land scarce.

5. Conclusions

The objective of this paper is to explore the relation between the distribution of income and trade openness. Our analysis differs from related works in that it uses panel data for a long period (28 years), and that it focuses on the personal distribution of income rather than only on wage inequality.

In the first part, we analyze theoretically the links among income distribution and factor endowments, structure of ownership, and the price of factors. We argue that some factors such as land and capital can be accumulated with no limit by a few individuals, while other factors such as education have limits to how much an individual can accumulate. This introduces natural bounds to the structure of ownership. The factor prices depend on their relative scarcity and on the degree of openness, as the neoclassical theory of trade suggests.

In the empirical section, we first test whether factor endowments and trade openness can explain income distribution. We find that countries endowed with factors that do not have limits to their accumulation (e.g., land and capital) are more unequal. In contrast, countries in which the average skill level is higher than the world effective endowment, have lower inequality. We show that this specification is theoretically valid if there is no impediment to trade.

We then drop the assumption that there are no impediments to free trade, and introduce an index of trade distortion which is based on factor endowments. By using this index, we show that: (a) after controlling for the effect of trade, income distribution remains well explained by relative factor endowments; (b) trade openness reduces inequality in capital-abundant countries; and (c) trade openness increases inequality in skill-abundant countries. Our conclusions are robust to endogeneity tests, to the use of different regressors, to seven different openness measures, and to the division of countries by income.

Finally, we argue that our results are compatible and confirm the findings of several country specific studies; however, a simple version of the Hecksher–Ohlin framework cannot account for our conclusions.

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Table 7
Summary statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Gini	35.76	9.25	17.83	63.18
A_{ilt}	−0.46	1.64	−7.85	4.85
A_{ikt}	0.05	1.33	−4.20	2.31
A_{ist}	0.13	1.01	−3.99	2.07
$A_{ilt} \times$ Open	−0.27	0.75	−6.48	0.50
$A_{ikt} \times$ Open	0.09	0.20	−0.41	0.70
$A_{ist} \times$ Open	0.09	0.20	−0.57	0.51
Open	0.22	0.10	0	1
Gdppc	3842	3971	257	33,946
Gdppc^2	3.05	6.27	66,049	1.15

The statistics for Gdppc^2 is divided by 1,000,000.

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Appendix A. Summary statistics

The summary statistics of the variables are shown in Tables 7 and 8.

Table 8
Variable means by region

Variable	Sample of countries				
	Industrial countries	Latin America	Africa	East Asia	Asia[a]
A_{ilt}	−0.79	−0.55	0.46	−3.49	−1.30
A_{ikt}	1.25	−0.11	−1.87	0.16	−0.90
A_{ist}	0.86	−0.15	−2.17	0.35	−0.81
$A_{ilt} \times$ Open	−0.20	−0.05	0.36	−1.45	−0.43
$A_{ikt} \times$ Open	0.25	0.03	−0.24	0.05	−0.19
$A_{ist} \times$ Open	0.19	−0.01	−0.44	0.12	−0.12
Open	0.21	0.19	0.22	0.33	0.22
Gdppc	9706	3.375	1076	4540	1900
Gdppc^2	10.60	1.58	0.18	3.54	1.75

[a]Excludes East Asia.
The statistics for Gdppc^2 is divided by 1,000,000.

Appendix B. Measures of openness

Even though the concept of trade openness is simple in theory, there is no widely accepted way of measuring it. In the literature, two types of measures of openness have been used: incidence and outcome-based measures. [17]

Incidence-based measures are direct indicators of trade policy, such as the level or dispersion of tariffs. Although these indicators are about the closest one can get to inferring the trade policy of a country, they still have two shortcomings: first, they are imperfect because they cannot capture other types of intervention such as non-tariff barriers; and second, consistent data on tariffs are not available for many countries and for a sufficient number of years.

Outcome-based measures are widely used because they implicitly cover all the sources of distortion and are based on data which are more readily available. The most common of these measures is the trade openness of a country measured as the ratio of exports plus imports over GDP. Other outcome-based measures are obtained from the deviations between actual trade and predicted trade; the predicted values are estimated according to some kind of theoretical framework, such as the Hecksher–Ohlin model or the gravity equations. Therefore, these types of indicator are subject to arbitrariness in the choice of relevant trade theory, and Pritchett (1996) has shown that several outcome-based indices of trade openness are very weakly correlated.

For the purposes of this work, we use seven different indices to test whether our results are sensitive to the use of a particular indicator. Six of them have been used previously in the literature, and we innovate by introducing a new index which is closer to the spirit of our exercise.

The six indexes from the previous literature are as follows.

- *Trade Flows*, measured by (Exports + Imports)/GDP at constant prices denoted XM), obtained directly from the *World Penn Tables 1995*.
- Inverse of the *Black Market Exchange Rate* (BME) obtained from Barro and Lee (1994). This is an indirect measure of trade distortion based on the fact that distorted trade regimes often induce distortions in the exchange rate, which are reflected in the black market premium. Therefore, the inverse of the black market premium is a measure of trade distortions.
- *Price Distortion Index* (PDI) suggested by Dollar (1992), and obtained through the following regression:

$$\text{rprice} = a + \beta_1 \text{Gdppc} + \beta_2 \text{Gdppc}^2 + u, \qquad \text{(B.1)}$$

where rprice is the relative price level (PPP-adjusted real exchange rate) and Gdppc is the PPP-adjusted GDP per capita, both obtained from the *World Penn*

[17] Harrison (1996) and Pritchett (1996) have surveyed the literature on the measurement of trade orientation.

Tables 1995. The measure of trade openness is the residual in the regression. It is based on the idea that deviations from PPP indicate distortion in the trade flow.

• *Measure of Structure Adjusted Trade* (SATI), suggested by Chenery and Syrquin (1986). This indicator measures the deviation of the observed trade composition from the predicted. It is obtained through the following formula:

$$\mathrm{TO} = \mathrm{TB} - \hat{\mathrm{TB}} = \frac{E_{\mathrm{p}} - E_{\mathrm{m}}}{E} - \frac{\hat{E}_{\mathrm{p}} - \hat{E}_{\mathrm{m}}}{\hat{E}}, \tag{B.2}$$

where TB measures trade composition, which is the share of manufacturing exports (E_{m}) over total merchandise exports (E). $\hat{\mathrm{TB}}$ is the expected trade composition, which is obtained from the predicted values of E_{p} (primary sector exports) and E_{m} based on the following regression:

$$E_i = \alpha + \beta_1 \ln \mathrm{Gdppc} + \beta_2 (\ln \mathrm{Gdppc})^2 + \gamma_1 \ln \mathrm{Population} + \gamma_2 (\ln \mathrm{Population})^2 + \mathrm{TD} + u, \tag{B.3}$$

where TD is a time dummy that indicates if the year of observation i is before or after the 1973 oil shock. As argued by Pritchett (1996), one of the drawbacks of this measure is that it does not have a strong theoretical foundation.

• *Lee's measure 1* (Lee1): Following the tradition of outcome-based indices of trade openness, Lee (1993) has proposed two measures that draw on the idea that trade orientation is determined by the geographic characteristics of a country. The first of the measures is based on the following regression: [18]

$$\frac{X + M}{\mathrm{Gdp}} = c + \alpha \ln(\mathrm{area}) + \beta \ln(\mathrm{dist}) + \gamma \ln(1 + \mathrm{bmexch}) + u, \tag{B.4}$$

where area is the size of the country in terms of square miles, dist measures the distance of each country to the major world exporters weighted by bilateral import values in 1985, and bmexch is the black market exchange rate. The source for these three variables is the data set of Barro and Lee (1994). A country's openness is determined by structural features—such as the natural resource endowment proxied by the geographical size and the presence of natural trade barriers measured by the distance variable—and by the trade distortions which are proxied by the black market exchange rate. The measure of trade openness is the residual.

[18] Lee's original regression also includes the logarithm of tariffs, but we were not able to include it in our estimations because we do not have information for this variable for a sufficient number of countries.

• *Lee's measure 2* (Lee2): This is a variation of the previous measure, which does not include the black market premium as an argument:

$$\frac{X+M}{\text{Gdp}} = c + \alpha \ln(\text{area}) + \beta \ln(\text{dist}) + u. \tag{B.5}$$

As already mentioned, both of the variables included in the latter regression are proxies for the natural resource endowment and natural barriers to trade, respectively. We add the share of the primary sector's GDP as indirect measures of natural resource endowment, and we also add the GDP per capita to control for income effects such as intra-industry trade. So, we have estimated to the following specification:

$$\frac{X+M}{\text{Gdp}} = c + \alpha \ln(\text{area}) + \beta \ln(\text{dist}) + \gamma \ln(\text{agdp}) + \delta \ln(\text{Gdppc}) + u, \tag{B.6}$$

where agdp is the share of the primary sector's Gdp. As usual, we take the residuals as indicator of openness.

B.1. Endowment-corrected measure of openness

In this subsection, we develop a new index of trade openness that is in line with our theoretical framework. The indices listed before are based on the deviations of actual from predicted trade. The equations used to predict trade have geographical variables, such as distance or area, and structural variables, such as percentage of income from agriculture; the measure that we construct is based on factor endowments.

Table 9
Trade openness and factor endowments

Dependent variable: trade openness	
Variable	Coefficient
ln(dist)	−12.52**
ln(area)	−6.85**
ln(GDP)	−5.99**
Δ_k^2	0.52**
Δ_l^2	1.47**
Δ_s^2	0.30**
trend	0.79**
Constant	−1346.24**
R^2	0.70

*Statistically significant at 95% level.
**Statistically significant at 99% level.

Table 10
Summary statistics for seven trade indices

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
XM	4349	64.70	43.5	4.9	423.4
Lee1	2551	−2.89e−08	39.8	−48.5	361.6
Lee2	2334	−1.60e−08	37.2	−68.1	332.6
Open	896	3.90	23.3	−44.6	177.2
SATI	3415	0.43	1.2	0.000	14.0
BME	562	1.34	9.7	−92.5	120.6
PDI	4317	−0.07	2.6	−130.0	12.9

Our exercise is similar in spirit to Leamer (1988). Leamer uses several endowments (capital, labor, land, oil, coal, and minerals) and 182 commodity classes in his cross-section analysis to compute the expected trade; he interprets the residuals from this regression as an index of trade intervention. We construct our equation based on the idea that the coefficient of trade openness $((X+M)/Gdp)$ is positively correlated with the difference in the endowments between a country and the rest of the world.

Trade openness is not only a function of factor endowments but also of the geographic distance of a country to other potential trading partners, as well as of the economic size of the country. Therefore, we estimate the following regression:

$$\left(\frac{X+M}{\text{Gdp}}\right)_{it} = c + a_1 \ln(\text{area}_i) + a_2 \ln(\text{Gdppc}_{it}) + a_3 \ln(\text{dist}_{it}) + \beta_1 \Delta^2_{ikt} + \beta_2 \Delta^2_{ilt} + \beta_3 \Delta^2_{ist} + \gamma_1(\text{trend}_t) + u_{it}, \quad \text{(B.7)}$$

where $\ln(\text{area}_i)$ is the logarithm of the size of country i in terms of square miles, $\ln(\text{dist}_i)$ is the average of the distance between country i and its 20 most important trading partners from Lee (1993), and Δ^2_{ift} (with $f=k,l,s$) is the discrepancy between country i's endowment of factor f and world effective endowments; it is defined as $\Delta^2_{ift} \equiv ((E_{ift} - E^*_{ft})/E^*_{ft})^2$ where E_{ift} is the endowment of factor f of country i at time t, and E_{ft} (with $f=k,l,s$) is the world effective endowment of factor f at time t. There are several options in specifying the difference in factor endowments; we opted for the square of the percentage difference because: (a) the percentage ensures that the fact that endowments are trended, does not introduce econometric problems, and (b) the square magnifies the difference at the extreme. [19] We include a time trend to account for the change in transportation costs over time.

[19] We tried different specifications of country i's distance from the effective world endowment: the simple difference between E_{ift} and E^*_{ft}, the absolute difference between E_{ift} and E^*_{ft}. Our conclusions about the relation between trade flows and factor endowments is not sensitive to the different definitions.

Table 11
Correlation matrix between openness measures

	XM	Lee1	Lee2	Open	SATI	PDI	BME
XM	1.00						
Lee1	0.80	1.00					
Lee2	0.67	0.90	1.00				
Open	1.58	0.64	0.60	1.00			
SATI	−0.11	0.06	−0.07	−0.22	1.00		
PDI	0.04	0.09	0.03	−0.17	0.25	1.00	
BME	0.04	0.02	−0.02	0.07	0.04	0.02	1.00

Table 9 presents the results from the panel regression for the years 1965–1992. We use the Huber correction to obtain robust standard errors, which account for the fact that the exogenous variables are grouped by country.

All the variables have the expected sign and significance, showing that the volume of trade is inversely correlated to the size and distance of the country, and positively correlated to the difference between the country's and the world's endowment. We use the residuals from this regression as an indicator of trade openness corrected for the endowments (Open). This measure has the advantage of being directly derived from our theory, and of being available for a considerable time period and for a reasonable number of countries. The main disadvantage of the proposed measure is that it is derived from a regression; therefore, if the regression is misspecified or if there are errors in variables the residuals cannot be taken as a measure of trade openness. Since we could have both problems, we check our results with other measures of openness. [20]

In Tables 10 and 11, we present summary statistics and the correlation matrix of the indices of trade openness we have discussed so far.

Due to the fact that there are significant differences in the way each measure is constructed and in the number of observations available in each case, it is not surprising that there is low correlation among some of the measures (see Table 11). Pritchett (1996) has reached a similar conclusion with some of these indices. It is worth noting that, even though our measure (Open) is based on endowment differences, it is well correlated with Lee1 and Lee2, which are constructed without reference to the factor endowments.

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