Trade and Productivity

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Abstract: We estimate the effect of international trade on average labor productivity at the country level. Our empirical approach relies on summary measures of trade that, we argue, are preferable on both theoretical and empirical grounds to the one conventionally used. In contrast to the marginally significant and non-robust effects of trade on productivity found previously, our estimates are highly significant and robust even when we include institutional quality and geographic factors in the empirical analysis. We also examine the channels through which trade and institutional quality affect average labor productivity. Our finding is that trade works through labor efficiency, while institutional quality works through physical and human capital accumulation. We conclude with an exploratory analysis of the role of trade policies for average labor productivity. (JEL F43, O40)

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1 Introduction

Theories about international trade increasing aggregate productivity at the country level are nearly as old as economics. But how large is this effect empirically? Answering this question is difficult because any particular summary measure of trade is likely to miss some aspects of how trading activities affect countries' productivity. Moreover, while international trade may increase aggregate productivity, the reverse also seems likely. Empirical work therefore has to make sure to identify the effect of trade on productivity instead of the other way round.

The summary measure of international trade nearly always used in empirical work is nominal imports plus exports relative to nominal GDP, usually referred to as *openness*. For recent examples see Coe and Helpman (1995), Ades and Glaeser (1999), Gustavsson, Hansson, and Lundberg (1999), Alesina, Spolaore and Wacziarg (2000), Dinopoulos and Thompson (2000), and Miller and Upadhyay (2000). Openness is also the measure of trade used in Frankel and Romer's (1999) innovative work on the *causal* effect of trade on average labor productivity at the country level. The idea underlying their empirical approach is that trade is partly determined by (geographic) characteristics of countries that are unrelated to productivity. These characteristics should therefore allow for estimation of the causal effect of trade on productivity using an instrumental-variables approach. They implement this idea empirically for a large set of countries in 1985 and find a positive, but rather imprecisely estimated, effect of trade on average labor productivity. According to their estimate, the effect of trade on productivity is just significant at the 5-percent level (see also Frankel and Rose (2002)). Further research using the same approach by Irwin and Tervio (2000) has shown, however, that trade no longer affects average labor productivity significantly once countries' distance to the equator is included in the empirical analysis. This result suggests that the positive effect of trade on countries' average labor productivity found by Frankel and Romer may be driven by spatially correlated omitted variables.

We argue that estimates of international trade's effect on average labor productivity at the country level in the existing literature give a misleading picture of the true productivity-gains caused by trade because of the summary measure of trade used in the empirical analysis. Summarizing trade using nominal imports plus exports relative to nominal GDP (openness) has drawbacks for empirical cross-country productivity analysis that are easily explained. Suppose that international trade increases productivity but that the implied productivity-gains are greater in the tradable goods sector (e.g. manufacturing) than in the non-tradable goods sector (e.g. services).

Will countries that are more productive because of trade have higher values of openness? Not necessarily, because the relatively greater productivity-gains in the tradable goods sector lead to a rise in the relative price of non-tradable goods, which may decrease openness when the demand for non-tradable goods is inelastic. We show this formally in a model where productivity-gains from international trade arise due to increasing returns to specialization (Helpman (1981), Krugman (1981), Ethier (1982)).

This problem with the conventionally used summary measure of international trade motivates our two simple alternatives, which we refer to as *real openness* and *tradable GDP openness* respectively. Real openness is defined as imports plus exports in exchange rate US$ relative to GDP in purchasing-power-parity US$ (PPP GDP). Using real openness instead of openness as a summary measure of trade eliminates the distortions due to cross-country differences in the relative price of non-tradable goods. Tradable GDP openness is defined as nominal imports plus exports divided by the nominal value of production in the tradable goods sector. Using tradable GDP openness instead of openness therefore eliminates cross-country differences in the value of non-tradable goods from the summary measure of trade.

Ultimately, choosing the best summary measure of international trade for cross-country productivity analysis is an empirical issue. We show that both real openness and (our proxy of) tradable GDP openness are capable of explaining a greater amount of the variation in cross-country productivity than openness (with real openness performing somewhat better than tradable GDP openness). This result, combined with our theoretical work, leads us to stress real openness and (our proxy of) tradable GDP openness in our investigation of international trade's effect on countries' average labor productivity (PPP GDP per worker).

Our empirical analysis takes into account the key role of institutions for average labor productivity as well as for income per capita found by Hall and Jones (1999) and Acemoglu, Johnson, and Robinson (2001) respectively. Acemoglu, Johnson, and Robinson estimate the effect of expropriation risk on income per capita in former colonies, while Hall and Jones consider the effect of a more broadly defined index of institutional quality (including expropriation risk) on average labor productivity for a larger set of countries. Both use an instrumental-variables approach to address measurement error and reverse causation. We adapt their approach in order to estimate how international trade affects average labor productivity or income per capita for a given level of institutional quality or expropriation risk. Our empirical work also incorporates geographic factors that may affect average labor productivity (distance from the equator included in the analysis of Irwin and Tervio (2000) for example).

The result of our empirical analysis is that the effect of international trade—measured either using real openness or (our proxy of) tradable GDP openness—on average labor productivity and income per capita at the country level is highly significant and extremely robust to the inclusion of institutional quality, expropriation risk, and geography controls. For example, using the largest possible sample of countries in 1985, we find that the instrumental-variables estimate of the elasticity of average labor productivity with respect to real openness is 1.44 with a standard error of 0.19 when we do not include any controls for institutional quality and geography in the empirical analysis. International trade is therefore a statistically significant determinant of productivity at the 0.001-percent level. The estimate implies that an increase of real openness taking a country from the 30th percentile to the median value doubles productivity; an increase of real openness taking a country from the 20th percentile to the median value almost triples productivity; and an increase of real openness taking a country from the 10th to the 90th percentile increases average labor productivity by a factor of ten.[1] When institutional quality and geography controls (distance from the equator and continent dummies) are included in the empirical analysis, we find that a 1-percent increase in real openness raises average labor productivity by 1.45 percent with a standard error of 0.35. Hence, the estimated elasticity of average labor productivity with respect to real openness hardly changes with the inclusion of institutional quality and geography controls. The standard error increases however. Still, trade remains a statistically significant determinant of productivity at the 0.02-percent level. Similarly, the instrumental-variables estimate of the elasticity of average labor productivity with respect to (our proxy of) tradable GDP openness is 1.89 with a standard error of 0.38 when we do not include any controls for institutional quality and geography in the empirical analysis. International trade is therefore a statistically significant determinant of productivity at the 0.01-percent level. When institutional quality and the statistically significant geography controls are included in the empirical analysis, we find that a 1-percent increase of (our proxy of) tradable GDP openness raises average labor productivity by 1.66 percent with a standard error of 0.53. Hence, the estimated elasticity of average labor productivity with respect to tradable GDP openness also changes little and remains highly significant when institutional quality and geography controls are included in the empirical analysis.

We also include the size of countries' workforce in the empirical analysis to allow for aggregate scale effects conditional on international trade. Our results suggest that aggregate scale effects are economically and statistically significant. For example, when we use real openness as a measure of international trade, we find an elasticity of countries' average labor productivity with respect to their workforce of around 0.3 with a standard error of around 0.1. Using (our proxy of) tradable GDP openness as a measure of international trade yields similar estimates for aggregate

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[1] A more precise version of the first statement for example (given that real openness is endogenous) would be that a change in exogenous variables taking real openness from the 30th percentile to the median value doubles productivity. And even this statement may require further qualification because part of the variability of real openness may be due to measurement error. We will return to this issue below.

scale effects conditional on international trade. These findings confirm the aggregate scale effects found in Frankel and Romer (1999) and Frankel and Rose (2002) among others.

To determine the channels through which international trade and institutional quality affect average labor productivity at the country level, we also estimate the effect of trade and institutional quality on the (physical) capital-output ratio, the average level of human capital, and labor efficiency. Our findings indicate that trade is a significant determinant of labor efficiency but not of the capital-output ratio or the average level of human capital. Institutional quality, on the other hand, is a significant determinant of the capital-output ratio and the average level of human capital but not of labor efficiency.

Our theoretical criticism of openness as a summary measure of international trade in cross-country productivity analysis rests on the hypothesis that trade raises the relative price of non-tradable goods at the country level. This in turn raises the price level (compared to some benchmark country). We test for these links by estimating the relationship between countries' international trade and their relative price of non-tradable goods as well as their price level. Our empirical findings confirm that international trade has a positive, statistically significant effect on the relative price of non-tradable goods as well as on the price level.

We conclude our empirical work on the link between international trade and average labor productivity with an *exploratory* analysis of the effect of trade policies on trade and productivity. The analysis leads us to the tentative conclusion that policies favorable for trade may be an effective tool for increasing productivity.

The remainder of this paper is structured in the following way. Section 2 explains the potential theoretical drawbacks of openness as a summary measure of trade in empirical cross-country productivity analysis. Our analysis is based on a simple trade model with tradable and non-tradable goods and increasing returns due to specialization. Section 3 contains the equations to be estimated and details on the instrumental-variables approach. Section 4 discusses the data and the quality of the instruments. Section 5 presents the results on the effects of international trade and institutional quality on average labor productivity in 1985 and 1990 using three broad samples, as well as on income per capita in 1995 using a sample of former colonies. The section also contains our estimates of the impact of international trade on the price level and the relative price of non-tradable goods at the country level, and our results on the effect of international trade and institutional quality on the capital-output ratio, the average level of human capital, and labor efficiency**.** Section 6 concludes with our exploratory analysis of the causal effect of trade policies on real openness and average labor productivity at the country level.

2 Increasing Returns to Specialization, International Trade, and Productivity

The potential drawbacks of the ratio of nominal imports plus exports to nominal GDP as a summary measure of trade in empirical work on cross-country productivity can be *illustrated* using a simple static, small open economies model with increasing returns to specialization in the spirit of Helpman (1981), Krugman (1981), and Ethier (1982). The key element of the argument is that international trade ends up affecting total factor productivity in the tradable goods sector more strongly than in the non-tradable goods sector.

Suppose that each country can potentially produce a unit measure of commodities indexed by $i \in [0,1]$. Commodities $i \in [0,t]$, $0 < t < 1$, are tradable goods (e.g. manufacturing goods), while the remaining fraction $1-t$ of commodities are non-tradable goods (e.g. services). The measure of tradable goods produced in country c is denoted by d_c. As the measure of tradable goods produced domestically decreases, countries are said to have become *more specialized*.

Firms in tradable goods sectors $i \in [0,t]$ are assumed to be able to produce output y using labor l according to the following constant-returns-to-scale production function

$$y = B_c g(d_c, l_c) l \,, \qquad (1)$$

where B_c is a productivity parameter specific to country c and l_c is aggregate employment in country c. The (continuously differentiable) function $g(\bullet)$ allows us to capture increasing returns due to specialization as well as increasing returns to the aggregate scale of production. Increasing returns to specialization is defined as marginal labor productivity in tradable goods production increasing as the range of tradable goods produced domestically *decreases*, $g_1(d_c, l_c) < 0$ (subscripts 1,2 denote partial derivatives with respect to the first and the second argument respectively). Increasing returns to the aggregate scale of production is defined as marginal labor productivity in tradable goods production increasing with aggregate employment, $g_2(d_c, l_c) > 0$. We assume increasing returns to specialization and to the aggregate scale of production throughout our analysis. [2]

Suppose that increasing returns (captured by $g(\bullet)$) are limited to tradable goods. Non-tradable goods $i \in (t,1]$ are produced according to the constant-returns-to-scale production function

$$s = B_c l \,. \qquad (2)$$

The assumption that increasing returns are completely absent in the production of non-tradable goods is made for simplicity only. Our argument goes through as long as increasing returns are weaker in the production of non-tradable goods than in the production of tradable goods.

Households are assumed to supply an aggregate amount of labor L_c inelastically. Their preferences over consumption goods are given by

$$U = \left(\beta^{\frac{1}{\varepsilon}} \left(\min(x_i : i \in [0,t]) \right)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta)^{\frac{1}{\varepsilon}} \left(\min(s_i : i \in (t,1]) \right)^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{3}$$

where x_i denotes consumption of the different tradable goods and s_i consumption of the different non-tradable goods; $\varepsilon > 0$ captures the elasticity of substitution between tradable and non-tradable goods and $0 < \beta < 1$ is a distribution parameter. We assume perfect complementarity among tradable goods and among non-tradable goods respectively because the elasticity of substitution within these groups of commodities plays no role for our argument. The elasticity of substitution between tradable goods and non-tradable goods is crucial for our analysis however. We assume throughout that $\varepsilon < 1$ and hence that the demand for non-tradable goods is inelastic.

Goods and labor markets are assumed to be perfectly competitive. The price of all tradable goods in international markets is taken to be identical and normalized to unity. In equilibrium, the relative price of different non-tradable goods (relative to tradable goods) produced in the same country is identical. Across countries, the relative price of non-tradable goods varies endogenously. The relative price of non-tradable goods produced in country c is denoted by ρ_c.

The fact that both different tradable goods and different non-tradable goods enter preferences in a perfectly complementary way implies that households in country c consume the same amount of each tradable good and of each non-tradable good. These quantities are denoted by x_c and s_c respectively. Household preferences also imply that the demand for non-tradable goods in country c relative to the demand for tradable goods is equal to

$$\frac{s_c}{x_c} = \frac{\theta t}{1-t} \rho_c^{-\varepsilon}, \tag{4}$$

where $\theta \equiv (1-\beta) t^{\varepsilon-1} / \beta (1-t)^{\varepsilon-1}$.

In equilibrium, trade of each country with the rest of the world must be balanced. Hence, the total value of (tradable goods) imports $(t-d_c)x_c$ must be equal to the total value of (tradable goods) exports. For simplicity we concentrate on symmetric equilibria where countries produce the same quantity y_c of all tradable goods that they export. Denoting the variety of tradable goods that are exported by e_c, $e_c \leq d_c$, yields that the total value of (tradable goods) exports can be written as $e_c(y_c - x_c)$. Balanced trade $(t-d_c)x_c = e_c(y_c - x_c)$ therefore implies that the value of aggregate

[2] Rauch and Weinhold (1999) present evidence on the link between specialization in production and productivity growth for 39 less developed countries.

consumption of tradable goods tx_c is equal to the value of aggregate production of tradable goods $e_c y_c + (d_c - e_c)x_c$,

$$tx_c = e_c y_c + (d_c - e_c)x_c . \tag{5}$$

Wages in the tradable goods sector and in the non-tradable goods sector are equalized in labor market equilibrium. Combined with the assumption that increasing returns are limited to the production of tradable goods, this yields that the equilibrium relative price of non-tradable goods ρ_c reflects the productivity of labor in the tradable goods sector relative to the non-tradable goods sector,

$$\rho_c = g(d_c, L_c) , \tag{6}$$

where we use that aggregate employment l_c is equal to aggregate labor supply L_c in equilibrium. Non-tradable goods are therefore relatively more expensive in countries where the production of tradable goods is relatively more efficient. This yields a link between countries' degree of specialization and their relative price of non-tradable goods that is key to our criticism of openness as a summary measure of trade.

Wage-equalization, balanced trade, and the relative demand for non-tradable goods combined with market clearing and the production functions for tradable goods and non-tradable goods imply that

$$B_c g(d_c, L_c) l_{cT} = (1-t)\theta^{-1} \rho_c^{\varepsilon} s_c = \theta^{-1} g(d_c, L_c)^{\varepsilon} B_c (L_c - l_{cT}) \ , \tag{7}$$

where l_{cT} and $L_c - l_{cT}$ denote the aggregate amount of labor used in the production of tradable goods and non-tradable goods respectively. Simplifying yields the aggregate amount of labor employed in the tradable goods sector as a function of aggregate equilibrium employment and the measure of tradable goods produced domestically d_c,

$$l_{cT} = \frac{L_c}{1 + \theta g(d_c, L_c)^{1-\varepsilon}} . \tag{8}$$

Purchasing power parity (PPP) GDP in the model is defined as

$$Y_{PPP,c} \equiv e_c y_c + (d_c - e_c)x_c + (1-t)\rho s_c , \tag{9}$$

where ρ is the relative price of non-tradable goods in the *benchmark* country. This definition combined with the production functions for tradable goods and non-tradable goods yields that

$$Y_{PPP,c} = B_c g(d_c, L_c) l_{cT} + \rho B_c (L_c - l_{cT}) . \tag{10}$$

Combining PPP GDP with the allocation of labor across sectors implies that PPP average labor productivity can be written as a function of aggregate employment and the measure of tradable goods produced domestically,

$$\frac{Y_{PPP,c}}{L_c} = B_c \frac{g(d_c, L_c) + \rho\theta g(d_c, L_c)^{1-\varepsilon}}{1 + \theta g(d_c, L_c)^{1-\varepsilon}} \quad . \tag{11}$$

Differentiating (11), making use of our maintained hypothesis $\varepsilon < 1$, yields that PPP average labor productivity increases with aggregate employment and decreases with the measure of tradable goods produced domestically (increases with the degree of specialization).

2.1 International Trade and Productivity

The model implies that international trade increases countries' PPP average labor productivity by allowing them to consume all the different types of tradable goods while specializing in the production of a subset only. But will this effect of trade on productivity lead to productivity being a monotonically increasing function of openness? We show that this is not necessarily the case because of the effect of specialization on the relative price of non-tradable goods. The relationship between real openness and average labor productivity is, however, strictly increasing. Moreover, we show that the relationship between imports plus exports relative to domestic tradable goods production (tradable GDP openness) and average labor productivity is also strictly increasing.

Openness

GDP is defined as $Y_c \equiv e_c y_c + (d_c - e_c)x_c + (1-t)\rho_c s_c$ in our model. Openness therefore corresponds to

$$Open_c \equiv 2\frac{(t-d_c)x_c}{e_c y_c + (d_c - e_c)x_c + \rho_c(1-t)s_c} = 2\frac{(t-d_c)x_c}{tx_c + (1-t)\rho_c s_c} = 2\frac{1-d_c/t}{1+\theta g(d_c, L_c)^{1-\varepsilon}} \tag{12}$$

where the first equality makes use of (5) and the second equality makes use of (4) and (6).

To see that the model may imply a non-monotonic relationship between openness and PPP average labor productivity, suppose that specialization economies are strong in the sense that $g(d_c, L_c) \to \infty$ as $d_c \to 0$ for all $L_c > 0$ (this assumption is not necessary for the argument but simplifies the exposition). In this case, *Open* tends to zero as the economy becomes more and more specialized (holding aggregate employment constant), i.e. as $d_c \to 0$. Clearly, *Open* is also equal to zero when the economy produces all tradable goods domestically and does not specialize at all, $d_c = t$. Continuity of *Open* as a function of the degree of specialization therefore implies that all levels of openness between zero and the maximum value correspond to at least two different degrees of specialization. Countries with different degrees of specialization (and the same level of aggregate employment) may therefore have the same level of *Open*. This implies that countries with the same level of exogenous productivity, aggregate employment, and openness may have different PPP average labor productivity. The result that *Open* is equal to zero if the country is not specialized at all and if the country is extremely specialized also yields that *Open* must at some point decrease as the economy becomes more specialized (holding aggregate employment constant). An increase in openness may therefore be associated with a decrease in PPP average labor productivity.[3]

It is straightforward to show that if $\varepsilon < 1$ then the relationship between PPP average labor productivity and openness (given aggregate employment) is non-monotonic for many different specifications of the increasing returns function $g(d,L)$ even if productivity in tradable goods production does *not* tend to infinity as the economy becomes more and more specialized. To get a better understanding of this result, it is useful to first establish that the value of imports plus exports relative to the value of tradable goods production is *always* increasing in the degree of specialization. To see this suppose first that the value of tradable goods production increases by one percent because of an increase in exogenous productivity. This increases the demand for imports by one percent because consumers spread the resulting increase in income evenly across all tradable goods. Hence, the value of imports and exports increases exactly by one percent (because of balanced trade) and the value of imports plus exports relative to the value of tradable goods production remains unchanged. Now suppose that the value of tradable goods production increases by one percent because of higher total factor productivity due to the economy having become more specialized. Clearly, in this case the demand for imports increases by more than one percent because, in addition to consumers spreading the increase in income evenly across all tradable goods, increased specialization implies that the country starts importing goods that used to be produced domestically. Recall that *Open* is equal to the value of imports and exports divided by GDP, which in turn is equal to the value of tradable goods production plus the value of non-tradable goods production. The fact that the value of imports plus exports relative to the value of tradable goods production is *always* increasing in the degree of specialization therefore implies immediately that *Open* is always increasing in the degree of specialization if the value of non-tradable goods production increases at a rate smaller or equal than the value of tradable goods production. Hence, for *Open* to fall with the degree of specialization it is necessary for the value of non-tradable goods production $(1-t)s_c\rho_c$ to increase at a faster rate than the value of tradable goods production $e_cy_c+(d_c-e_c)x_c=tx_c$ with increased specialization. Rewriting (4) as $(1-t)s_c\rho_c=\theta\rho_c^{1-\varepsilon}(tx_c)$, yields that this requires the relative price of non-tradable goods to increase and the elasticity of substitution between tradable and non-tradable goods to be strictly smaller than unity. These two conditions are very intuitive of course. First, if the relative price of non-tradable goods does not change, the total value of non-tradable goods production increases at exactly the same rate as income because preferences are assumed to be homothetic (like in almost all of trade theory). Second, if the relative price of non-tradable goods increases with specialization but the elasticity of substitution between tradable and non-tradable goods is greater or equal than

[3] For example, suppose that $g(d,L)=(L/d)^{\gamma}$ as well as $L=1$, $\gamma=2$, $\varepsilon=0.5$, and $t=0.5$. Then (12) implies that *Open* is a hump-shaped function of d with a maximum value (reached at $d=0.22$) equal to 0.45.

unity, the total value of non-tradable goods consumed increases at a rate smaller or equal than the value of production. (The explanation of why *Open* tends to zero as the economy approaches complete specialization when $g(d_c, L_c) \to \infty$ as $d_c \to 0$ is that, in this case, inelastic demand for non-tradable goods implies that the value of non-tradable goods consumption relative to the value of tradable goods consumption tends to infinity as the economy approaches complete specialization, while the value of exports relative to the value of tradable goods production tends to unity. Hence, *Open*, which can be written as $2\times(\text{exports/tradables production})/$ $(1+(\text{non-tradables consumption/tradables consumption}))$ tends to zero as the economy approaches complete specialization.)

Real Openness

Real openness in our model corresponds to

$$ROpen_c \equiv 2\frac{(t-d_c)x_c}{e_c y_c + (d_c - e_c)x_c + \rho(1-t)s_c} = 2\frac{1-d_c/t}{1+\theta\rho g(d_c, L_c)^{-\varepsilon}}, \tag{13}$$

where ρ is the relative price of non-tradable goods in the benchmark country (first introduced in (10)) and we are making use of (4), (5), and (6). Hence, the degree of specialization is strictly increasing in real openness (and vice versa). To see that (13) implies that PPP productivity is increasing in both real openness and aggregate employment, notice that relative productivity in the tradable goods sector (relative to the non-tradable goods sector) g_c can be written as an increasing function of both real openness and aggregate employment

$$g_c = h(ROpen_c, L_c), \tag{14}$$

$h_1(\,) > 0,\ h_2(\,) > 0$. This can be seen formally by implicitly differentiating (13), making use of $g_c = g(d_c, L_c)$. Combined with the result in (11) that PPP average labor productivity is increasing in the relative productivity of the tradable goods sector, (14) yields that PPP average labor productivity can be written as a strictly increasing function of real openness, aggregate employment, and the country-specific productivity parameter B_c,

$$\frac{Y_{PPP,c}}{L_c} = B_c f(ROpen_c, L_c), \tag{15}$$

$f_1(\,) > 0, f_2(\,) > 0$.

Tradable GDP Openness

The third concept of openness considered in this paper is *tradable GDP openness* ($TROpen$) defined as the value of imports plus exports relative to domestic tradable goods production

$$TROpen_c \equiv 2\frac{(t-d_c)x_c}{e_c y_c + (d_c - e_c)x_c} = 2(1-d_c/t)\,, \tag{16}$$

where we are making used of (5). It follows from (16) that $TROpen$, like *ROpen*, is strictly increasing in the degree of specialization. Hence, PPP average labor productivity can be written as a strictly increasing function of tradable GDP openness, aggregate employment, and the country-specific productivity parameter.[4]

2.2 International Trade and the Prices

Our theoretical criticism of openness as a summary measure of international trade in cross-country productivity analysis rests on the hypothesis that the relative price of non-tradable goods is increasing in the degree of specialization and hence in real openness as well as in tradable GDP openness (see (6), (14), and (16)). We now show that this link implies that the price level of countries (relative to the benchmark) is increasing in real openness as well as in tradable GDP openness.

The price level in our model is

$$P_c \equiv \frac{Y_c}{Y_{PPP,c}} = \frac{e_c y_c + (d_c - e_c)x_c + (1-t)\rho_c s_c}{e_c y_c + (d_c - e_c)x_c + (1-t)\rho s_c} = \frac{1+\theta\rho_c^{1-\varepsilon}}{1+\theta\rho\rho_c^{-\varepsilon}}\,, \tag{17}$$

where the last equality makes use of (4) and (5). Hence, the price level is increasing in the relative price of non-tradable goods. Combined with (6), (14), and (16), this yields that the price level is an increasing function of real openness or tradable GDP openness and aggregate equilibrium employment,

$$P_c = k(ITrade_c, L_c)\,, \tag{18}$$

where $k_1(\ ) > 0,\ k_2(\ ) > 0$ and $ITrade = ROpen, TROpen$.

We test for the link between real openness and (our proxy of) tradable GDP openness on the one hand and the relative price of non-tradable goods and the price level on the other hand empirically. It is interesting to note that our theoretical work does not imply that the price level is increasing in openness, as the possible non-monotonicity between the degree of specialization and openness stemming from (12) translates into a non-monotonicity between openness and the price level.

[4] We are very grateful to a referee for pointing this out and also for suggesting an empirical proxy for *TROpen*.

3 Estimation

Our empirical work is based on three main estimating equations. The first equation relates average labor productivity (and income per capita) across countries to international trade and institutional quality using openness as well as real openness and tradable GDP openness as alternative summary measures of the intensity with which countries trade. The second estimating equation relates openness as well as real openness and tradable GDP openness to the price level and the relative price of non-tradable goods across countries. The third equation relates international trade and institutional quality to capital-output ratios, average levels of human capital, and levels of labor efficiency in order to determine the channels through which trade and institutional quality affect average labor productivity.

3.1 International Trade and Productivity

The equation that we use to estimate the effect of international trade, the aggregate scale of production, and institutional quality on countries' average labor productivity (PPP GDP per worker) is

$$\log\left(\frac{PPP\ GDP_c}{Workforce_c}\right) = a_0 + a_1 ITrade_c + a_2 \log Workforce_c + a_3 \log Area_c + a_4 IQual_c + a_5 X_c + u_c \tag{19}$$

where *ITrade* stands for measures of the intensity with which country c trades with the rest of the world, *Workforce* denotes the size of the country's work force, *Area* refers to the land area of the country in square kilometers, *IQual* stands for the quality of the country's institutions, and X denotes a set of geographic control variables. The variation in average labor productivity not captured by our empirical analysis is summarized by u, and $a_0, \ldots, a_5$ denote the parameters to be estimated.

The choice between different measures of the intensity with which countries trade is ultimately an empirical question. Equation (19) is therefore estimated using three different, already mentioned measures for *ITrade*:

1. *Open*, defined as nominal imports plus exports divided by nominal GDP. This is the measure used in existing empirical research. Because theory is inconclusive on how *Open* is supposed to enter the estimating equation, we also try log*Open*. The main difference between the two specifications is that the specification with log*Open* assumes that a 1-point increase in *Open* has larger effects on average labor productivity in countries that start from lower levels of openness.

2. Because of the theoretical drawbacks of *Open* discussed in the previous section, we consider imports plus exports in exchange rate US$ divided by GDP in PPP US$ (*ROpen*) and log*ROpen* as alternative measures of *ITrade*.
3. We also use a measure of openness that is meant to approximate what we earlier referred to as tradable GDP openness ($TROpen$). The proxy we use is nominal imports plus exports divided by nominal GDP in manufacturing and agriculture or, equivalently, *Open* divided by the share of GDP produced in manufacturing and agriculture. This proxy is referred to as *PTROpen*. Although not ideal, *PTROpen* does eliminate the bulk of non-tradable goods and should therefore be a useful alternative for determining whether the theoretical drawbacks of *Open* discussed earlier are empirically relevant. We also try log*PTROpen* for the same reasons as log*Open*.

Area is included in the estimating equation to facilitate comparisons with the work of Frankel and Romer (1999). See Frankel and Romer as well as Frankel and Rose (2002) for theories that imply that average labor productivity depends on the land area of countries. (Like Frankel and Romer, we usually find that area is a statistically insignificant determinant of productivity however.)

IQual is measured using indices of bureaucratic quality, law and order, and property-rights protection developed by *Political Risk Services*. These indices have previously been used by Knack and Keefer (1995) and Hall and Jones (1999) in their empirical investigations of the effect of institutional quality on economic growth and the level of productivity at the country level.

The geography controls (X) used in the estimating equation are countries' distance from the equator and continent dummies. These variables are included to account for spatially correlated omitted determinants of productivity.

Our empirical analysis of the role of international trade in former colonies follows Acemoglu, Johnson, and Robinson (2001) and estimates (19) with income per capita (instead of average labor productivity) on the left-hand side and an indicator of expropriation risk instead of institutional quality on the right-hand side.

We refer to (19) without institutional quality and geography controls as the *baseline* trade specification.

The parameters in (19) cannot be estimated consistently using ordinary least squares because countries' trade intensity, workforce, and institutional quality are endogenous and measured with error. Our estimation strategy therefore relies on instrumental variables. The instruments are constructed following Frankel and Romer (1999) as well as Hall and Jones (1999) and Acemoglu, Johnson, and Robinson (2001).

To determine the causal effect of international trade on average labor productivity across countries, Frankel and Romer (1999) use a two-step approach to construct an instrument for their measure of trade intensity (openness). The first step consists of estimating a gravity equation for bilateral trade shares that uses countries' geographic characteristics and population only as explanatory variables (i.e. the estimating equation does *not* include measures of productivity or income). The second step of the approach aggregates bilateral trade shares predicted by the gravity equation to obtain a predicted value for countries' trade intensity. This value is then used as an instrument for openness. We use the same approach to construct instruments for our measures of trade intensity.

The gravity equation estimated to obtain geography-predicted bilateral trade shares is

$$
\begin{aligned}
&\log\left(\frac{\tau_{ij}}{PPP\ GDP_i}\right) = \alpha_0 + \alpha_1 \log Dist_{ij} + \alpha_2 \log Pop_i \\
&+\alpha_3 \log Area_i + \alpha_4 \log Pop_j + \alpha_5 \log Area_j \\
&+\alpha_6 (Ldl_i + Ldl_j) + \alpha_7 Cb_{ij} + \alpha_8 Cb_{ij} \log Dist_{ij} \\
&+\alpha_9 Cb_{ij} \log Pop_i + \alpha_{10} Cb_{ij} \log Area_i \\
&+\alpha_{11} Cb_{ij} \log Pop_j + \alpha_{12} Cb_{ij} \log Area_i \\
&+\alpha_{13} Cb_{ij} (Ldl_i + Ldl_j) + v_{ij}
\end{aligned}
\tag{20}
$$

where τ_{ij} denotes exports of country i to country j plus exports from j to i; $Dist_{ij}$ is the distance between the two countries; Pop_i, Pop_j denote the population of the two countries; $Area_i, Area_j$ denote the area of the two countries; Ldl_i, Ldl_j are dummies indicating whether countries i, j are landlocked; Cb_{ij} is a dummy indicating whether or not the two countries have a common border; and v_{ij} summarizes the variation in bilateral trade shares no captured by our empirical approach.[5] The common border dummy is included by itself in the regression as well as interacted with other explanatory variables to capture trade between neighboring countries more accurately. The ordinary least-squares estimates of the coefficients in (20) can be used to determine the predicted value of the bilateral trade share for all countries for which there is data on the right-hand-side variables (even if we do not have any bilateral trade data for those countries).

Predicted bilateral trade shares are then aggregated to obtain the predicted value of aggregate imports plus exports relative to PPP GDP for each country

$$
TFit_i \equiv \sum_j \exp\left(\text{Predicted Value of } \log\left(\frac{\tau_{ij}}{PPP\ GDP_i}\right) \text{ using (20)}\right). \tag{21}
$$

The sum includes all countries for which data on the right-hand-side variables in (20) are available. We use both the variable *TFit* (which we refer to as the fitted trade intensity or geography-predicted trade) and the variable log*TFit* as instruments when estimating (19). We also try fitted trade intensities based on gravity equations without population and area respectively as instruments in our empirical analysis.

Additional instruments to estimate the effect of trade and institutional quality on average labor productivity and income per capita come from the work of Hall and Jones (1999) and Acemoglu, Johnson, and Robinson (2001). Hall and Jones estimate the effect of social infrastructure—defined as a weighted average of what we call institutional quality and the Sachs-Warner (1995) policy-measure of openness averaged over a certain period of time—on productivity across countries. They address the reverse causality problem by using the fraction of the population speaking English at birth, the fraction of the population speaking one of the five primary European languages (including English) at birth, the distance from the equator, and the Frankel-Romer fitted trade intensity as instruments. Hall and Jones argue, based on historical considerations, that the first three variables are correlated with past European influence and therefore with the transmission of the (growth-enhancing) European institutional framework. They check the validity of distance from the equator as an instrument by testing the hypothesis that distance from the equator does *not* affect productivity directly once social infrastructure is accounted for and find that this hypothesis cannot be rejected at conventional significance levels. We find that distance from the equator does not affect average labor productivity in a statistically significant way once institutional quality and trade are included in the empirical analysis.

Acemoglu, Johnson, and Robinson (2001) estimate the effect of expropriation risk between 1985 and 1995 on 1995 income per capita in a sample of former colonies using settler mortality between the 18^{th} and 19^{th} century as an instrument for expropriation risk.[6] They demonstrate that historic settler mortality explains a considerable amount of the variation in average expropriation risk 1985-1995 across former colonies and argue that this correlation arises because the implementation of European, growth-enhancing institutions was more likely when conditions for long-term European settlements were favorable. Following their argument, we use settler mortality as one of the instruments when estimating the effect of international trade on 1995 income per capita for a given level of expropriation risk.

Other instruments used to estimate (19) are the geography controls included as right-hand-side variables, land area, and population.

3.2 International Trade and Prices

The relationship between the price level and real openness as well as aggregate employment is estimated using the following equation

$$\log P_c = b_0 + b_1 \log ROpen_c + b_2 \log Workforce_c + b_3 Z_c + v_c, \qquad (22)$$

[5] Distance is calculated as the great-circle distance between countries' principal cities.

[6] Interestingly, their empirical analysis validates the use of distance from the equator as an instrument in the work of Hall and Jones (1999).

where v summarizes the variation in the log price level not captured by our empirical analysis, and $b_0,\ldots,b_3$ denote the parameters to be estimated. Z_c contains the usual geographic controls as well as a variable (z_c) that captures cross-country differences in log-productivity not explained by increasing returns to specialization or aggregate employment: $z_c \equiv \log(Y_{PPP,c}/L_c) - \hat{a}_1 \log ROpen_c - \hat{a}_2 \log Workforce_c$, where $\hat{a}_1, \hat{a}_2$ are estimates of the effect of $\log ROpen$ and $\log Workforce$ on log-productivity obtained using (19). This variable is considered as a control to account for cross-country productivity-differences not explained by increasing returns affecting the price level through the Balassa-Samuelson effect.[7] Equation (22) is estimated using instrumental variables, with the geography controls included among the right-hand-side variables, the fitted trade intensities, the Hall-Jones language variables, and population as instruments.

We also estimate (22) with (our proxy of) tradable GDP openness instead of real openness since our theoretical work predicts that tradable GDP openness and real openness can be used interchangeably. Moreover, we estimate a version of (22) with openness instead of real openness on the right-hand side.

The link between countries' price level and their real openness or tradable GDP openness, as well as their workforce, that we test for using (22) arises through the relative price of non-tradable goods. We therefore estimate the effect of either log*ROpen* or log*PTROpen*, combined with $\log Workforce$, on the relative price of non-tradable goods across countries. This is done by estimating equation (22) with the log of the relative price of non-tradable goods across countries (instead of the price level) on the left-hand side. Although this equation is a more direct test of our hypothesis than (22), it has two potential drawbacks. First, the number of countries with data on the relative price of non-tradables is limited. Second, the classification of goods into tradables and non-tradables is debatable.

3.3 International Trade, Capital, and Labor Efficiency

We are also interested in whether trade affects average labor productivity mostly through physical capital, human capital, or labor efficiency once institutional quality is taken into account. This issue is analyzed following the approach of Hall and Jones (1999), who in turn follow David (1977) and Klenow and Rodriguez-Clare (1997). The starting point of the approach is the constant-returns-to-scale Cobb-Douglas aggregate production function $Y = K^{\alpha}(AhL)^{1-\alpha}$, where Y denotes aggregate output, K aggregate capital, L aggregate employment, h average human capital, and

[7] The Balassa-Samuelson hypothesis states that cross-country differences in productivity are positively correlated with cross-country differences in the price level because cross-country productivity differences in the manufacturing sector are greater than in the services sector (see Heston, Nuxoll, and Summers (1994) and Rogoff (1996) for empirical work on the Balassa-Samuelson effect).

A labor efficiency.[8] In this formulation, α and $1-\alpha$ capture only the effects of production factors on output that are internalized by firms; external effects of the production factors on output are included in labor efficiency. This production function implies that average labor productivity can be written as the product of labor efficiency, the (physical) capital-output ratio raised to the power $\alpha/(1-\alpha)$, and the average level of human capital,

$$\frac{Y_c}{L_c} = A_c \left(\frac{K_c}{Y_c} \right)^{\frac{\alpha}{1-\alpha}} h_c . \tag{23}$$

We analyze how international trade and institutional quality affect the three components of average labor productivity on the right-hand side of (23). This is done by using the log of each component as the left-hand-side variable in (22) (instead of average labor productivity).

4 Data and Quality of the Instruments

The data on PPP GDP per worker, the number of workers, population, openness, and the price level are from the *Penn World Tables*, Mark 5.6 (PWT).[9] Real openness is obtained by multiplying the PWT variable *Openness*, which is defined as *Open* in this paper, with the PWT variable *Price Level GDP*, which is defined as *P* in this paper. The shares of GDP produced in manufacturing and agriculture necessary to obtain our proxy of tradable GDP openness are taken from the *World Bank*'s *World Development Indicators* (2001).

The different measures for openness (*Open*, *ROpen*, and *PTROpen*) are highly correlated. For example, the simple correlation coefficient between *Open* and *ROpen* for the largest possible sample in 1985 is 0.86, and the simple correlation coefficient between *Open* and *TROpen* is 0.84. The 10 countries with the highest value of *Open* are (in this order): Singapore, Luxembourg, Hong Kong, Bahrain, Belize, St. Lucia, Malta, Lesotho, St. Vincent and Grenada, and Belgium. The 10 countries with the highest value of *ROpen* are (in this order): Singapore, Bahrain, Luxembourg, Hong Kong, Puerto Rico, Belgium, Bahamas, St. Lucia, and Kuwait. The 10 countries with the highest value of *TROpen* are (in this order): Singapore, Hong Kong, Luxembourg, Seychelles, St. Lucia, Djibouti, Belgium, Barbados, Bahrain, and Belize. Evidently, there is considerable overlap. Among the bottom-10 countries there is a similar amount of overlap. For example, 6 of the bottom-10 *Open* countries are also among the bottom-10 *ROpen* countries (exactly the same

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[8] Our terminology does not follow Hall and Jones, who refer to A as productivity, because this could generate confusion with what we call average labor productivity. We do not refer to A as labor-augmenting technology because A will also capture institutional quality and increasing returns to specialization as well as to aggregate employment in our empirical analysis

[9] This is a revised version of Summers and Heston (1991). The data are available online at http://PWT.econ.upenn.edu. The number of workers is obtained by dividing the PWT variable *Real GDP Per Capita* by the PWT variable *Real GDP Per Worker* and multiplying the result by the PWT variable *Population*.

number as in the top-10). There are some countries whose position in the ranking changes considerably however. For example, the US goes from being the 147th country from the top in the *Open* ranking to the 111th country from the top in the *ROpen* ranking. Lesotho, on the other hand goes from 9th place in the *Open* ranking to 90th place in the *ROpen* ranking. The simple correlation coefficient between *Open* and *ROpen* for the largest possible sample in 1990 is 0.56 and hence considerably lower than in 1985 and only 4 of the bottom-10 *ROpen* (top-10 *ROpen*) countries are among the bottom-10 *Open* (top-10 *Open*) countries. (It should be noted at the outset that our instrumental-variables strategy implies that the results of estimating (19) with, for example, *Open* or *ROpen* as alternative measures of international trade may differ considerably even if these two variables are highly correlated.)

The price indices for non-tradable and tradable goods across countries relative to the US are taken from Heston, Summers, Aten and Nuxoll (1995) and Aten (1997). They define the relative price of non-tradables (*NT*) and tradables (*T*) as

$$P_{ci} = \frac{\sum_k p_{ck} q_{ck}}{\sum_k p_{USk} q_{ck}}, \quad i = T, NT \tag{24}$$

where p_{ck} is the price of good *k* in country *c* and q_{ck} the quantity consumed. These indices are available for 64 countries. The data used to calculate these indices refers to 94 tradable and 42 non-tradable items in 1985 and come from the *International Comparison Project* (ICP) benchmark.[10]

We employ four different samples in our empirical work. The first two samples include all countries for which the relevant data are available for 1985 and 1990. We focus on 1985 and 1990 because these are benchmark years of the PWT. The third sample consists of the 1985 98-country sample used by Mankiw, Romer, and Weil (1992) and Frankel and Romer (1999). The fourth sample is the group of former colonies in Acemoglu, Johnson, and Robinson (2001). In this last case, we use (their data on) PPP income per capita in 1995 on the left-hand side of the estimating equation in (19).[11] Moreover, we use 1995 population from the *World Development Indicators* (2001) instead of workforce on the right-hand side of the estimating equation because the currently available version of the PWT contains data only up to 1992.

Our measure of institutional quality is created following Hall and Jones (1999). They construct a measure of institutional quality using data from the *International Country Risk Guide*

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[10] We are very grateful to a referee for directing us to the benchmark data. The data are available online at http://PWT.econ.upenn.edu. It important to note that tradable goods in this definition are goods that while in principle tradable might not actually be traded (because of tariff or non-tariff barriers for example).

[11] The source of their data is the *World Development Indicators.*

concentrating, like Knack and Keefer (1995), on five of the twenty-four categories provided.[12] Two of the five categories relate to the role of governments in providing services and protecting against private diversion: bureaucratic quality and law and order. The three remaining categories relate to the role of governments in diversion: corruption, risk of expropriation, and government repudiation of contracts. Our index of institutional quality, which we refer to as *IQual*, consists of an equally weighted average of these five measures standardized to lie between zero (worst institutional quality) and unity (highest quality).[13] We also tried the type of economic organization as classified by *Freedom House* (Finn (1994)) as a measure of institutional quality, but do not present these results as they turned out to be very similar to those obtained using *IQual*.[14] The data on institutional quality are not available for all countries, which implies that smaller samples have to be used whenever this variable is included in the analysis.[15]

The data on average expropriation risk between 1985 and 1995 in former colonies is taken from Acemoglu, Johnson, and Robinson (2001). Their measure of expropriation risk is the *International Country Risk Guide* index of protection against expropriation of private foreign investment and ranges from one (highest risk) to ten (lowest risk).

The data used to construct the continent dummies are taken from Rand McNally (1993). Countries' distance from the equator is measured as the absolute value of their latitude and is taken from Hall and Jones (1999), which is also the source for the two language-spoken-at-birth instruments.[16]

The bilateral trade data to obtain the instrument for *ITrade* is taken from different *Yearbook* issues of the *Direction of Trade Statistics* published by the *International Monetary Fund*. These

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[12] The *International Country Risk Guide* is produced by *Political Risk Services* and the methodology is explained in Coplin et al. (1996). The data are available online at http://www.countrydata.com.

[13] *IQual* corresponds to the index of government anti-diversion policies (*GADP*) in Hall and Jones. One reason why Hall and Jones use social infrastructure instead of *GADP* is that the overidentifying restrictions are rejected for the model where *GADP* is taken as the *only* determinant of productivity, but not for the model where social infrastructure is taken as the only determinant of productivity. We find that the overidentifying restrictions can never be rejected at conventional significance levels when *IQual* is combined with *ITrade* or continent dummies (or both).

[14] The empirical results provide somewhat more support for the importance of trade and somewhat less support for the role of institutional quality in determining productivity when we use the *Freedom House* index instead of *IQual*.

[15] For 1985, there are data on 150 countries for the specification without institutional quality and on 137 countries once institutional quality is added. For 1990, there are data on 115 countries for the specification without institutional quality and on 110 countries once institutional quality is added. For the 98-country sample in 1985, we only lose one observation by including institutional quality in the specification.

[16] The calculations are based on the latitude of the center of countries' most populated region.

statistics contain 7928 non-zero observations on bilateral trade for the 1985 150-country sample and 10569 observations for the 1990 115-country sample.[17]

The three components on the right-hand side of (23) are calculated following the approach of Hall and Jones (1999). They calculate average levels of human capital at the country level by combining the data on average schooling in Barro and Lee (1993) and Mincerian estimates of the individual return to schooling in countries with different average levels of education.[18] Formally, their estimate of average human capital in country c is $h_c = \exp(\phi(S_c))$, where S_c is average schooling in the country and $\phi(\bullet)$ is a piecewise linear function capturing estimated Mincerian returns.[19] Aggregate capital K_c across countries is calculated with the investment data in the PWT according to the perpetual inventory method. Hall and Jones calculate capital-output ratios and average labor productivity using a measure of output Y_c that subtracts mining output (which includes oil and gas) from PPP GDP given in the PWT. To obtain $(K_c / Y_c)^{\alpha/(1-\alpha)}$, they use data on (physical) capital-income shares to calibrate α at a value of $1/3$. Finally, the efficiency of labor across countries A_c is obtained by combining the values of α, h_c, and $(K_c / Y_c)^{\alpha/(1-\alpha)}$ with data on average labor productivity and (23). We follow exactly the same approach as Hall and Jones but use the updated average schooling data in Barro and Lee (2000) instead of the 1993 data. The relevant data are available for 101 countries in 1985.[20]

Table 1 (all tables are in the Appendix) gives detailed measures of the quality of the gravity-equation instruments for *ITrade* in the different samples used, concentrating on three measures of *ITrade* that will turn out to work best: *Open*, log*ROpen*, and log*PTROpen*.[21] Each column gives the following statistics:

- R^2(1), which is the R^2 of the least-squares regression of the measure of *ITrade* heading the column (*Open,* log*ROpen* or log*PTROpen*) on *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit*, and the geography controls whenever it says so in the third row from the bottom.
- R^2(2), which is the R^2 of the least-squares regression of the measure of *ITrade* heading the column on all the variables listed above except *TFit* and log*TFit*.
- (R^2(1)-R^2(2))/R^2(2), which is the proportional increase of the R^2 due to the inclusion of the fitted trade intensities *TFit* and log*TFit* among the explanatory variables.
- The P-value of the hypothesis that *TFit*, log*TFit* can be excluded from the equation.

[17] For comparisons, Frankel and Romer (1999) work with 3969 observations on bilateral trade for 1985 (they do not have data for 1990).
[18] See also Bils and Klenow (2000).
[19] For the first four years of schooling, Hall and Jones assume a return of 13.4 percent per year. For the next four years, 10.1 percent per year. Starting with the eighth year, the assumed return is 6.8 percent per year.
[20] We concentrate on 1985 because the sample of countries is greater for 1985 than for 1990 (because of missing values on education and physical capital for 1990).
[21] The simple correlation between our fitted (log) trade shares and actual (log) trade shares in 1985 and 1990 varies between 0.60 and 0.73.

For example, according to the top entry in column (1), *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit* explain 54.4 percent of the variation of *Open* across 150 countries in 1985. The third entry from the top in column (1) indicates that the increase in the explanatory power associated with the inclusion of *TFit* and log*TFit* is 12.9 percent. And according to the fourth entry from the top in column (1), the hypothesis that *TFit* and log*TFit* do not affect *Open* can be rejected at the 0.001-percent significance level. The top entry in column (2) indicates that geography controls (*GeoControls*, which are dummies for four of the five continents—the regression includes a constant—and distance from the equator) add very little to the prediction of *Open* relative to the specification in column (1). According to the third entry from the top in column (2), the inclusion of geography controls reduces the increase in the explanatory power associated with the inclusion of *TFit* and log*TFit* from 12.9 percent to 6 percent.

One of the interesting patterns in Table 1 is that according to the R^2 criterion the instruments tend to work somewhat better for *Open* and log*PTROpen* than for log*ROpen*. The additional explanatory power of *TFit* and log*TFit* once the other instruments have been included in the regression tends to be somewhat better for log*ROpen* than for *Open* however, with the results for log*PTROpen* in-between. The overall message of Table 1 is that the instruments work well for predicting a substantial amount of *ITrade*.[22]

The Hall-Jones European/English language-spoken-at-birth instruments also help in explaining countries' trade intensity. For example, for the largest possible sample in 1985, the two language instruments are a (jointly) significant determinant of log*ROpen* at the 2-percent level when added to the specification in column (4) of Table 1, raising the R^2 by 2.5 percentage points (not in the table). For the 1990-sample, the two instruments are a significant determinant of log*ROpen* at the 8-percent level when added to the specification in column (14) of Table 1, raising the R^2 by 3 percentage points (not in the table). Hence, the increase in R^2 due to the language instruments is more than half of the increase produced by the fitted trade intensities for 1985 and more than one-third of the increase produced by the fitted trade intensities for 1990. The explanatory power of the Hall-Jones language instruments for real openness may capture that past European influence led to a favorable environment for trade or that historical ties between European countries and former colonies translate into policies to encourage trade between them.

The explanatory power of the four Hall-Jones instruments for our measure of institutional quality is analyzed in Table 2, which contains the results of regressing *IQual* on the instruments using least squares. The table shows that the instruments combined explain a large part of the variation in institutional quality across countries. For example, column (6) indicates that for the

[22] For comparison, the instruments used by Frankel and Romer (1999) produce about half of the $(R^2(1)\text{-}R^2(2))/ R^2(2)$ in the case where geography controls are included and imply P-values of the exclusion restriction for *TFit* and log*TFit* between 0.07 and 0.04.

1990-sample the R^2 of the regression of *IQual* on the four instruments is 0.62. According to column (7), the R^2 of the regression remains quite high even if distance from the equator is omitted. Furthermore, comparing column (8) with column (10) yields that the instruments have considerable additional explanatory power when added to the continent dummies. Columns (1) to (5) repeat the analysis for the largest possible sample in 1985. The results for the 98-country sample in 1985 (not in the table) are very similar.

The explanatory power of historic settler mortality for average expropriation risk 1985 to 1995 in former colonies is documented in detail in Acemoglu, Johnson, and Robinson (2001). They show that regressing expropriation risk on the log of historic settler mortality yields an R^2 of 0.25. Interestingly, settler mortality remains a highly significant determinant of expropriation risk even if continent dummies for Africa and Asia are included in the analysis (while the dummies turn out to be insignificant).

5 Results

We start out with the effect of international trade on average labor productivity and prices, which we see as the main results of our empirical analysis. Then we check the robustness of these results and turn to the effect of international trade on the capital-output ratio, the average level of human capital, and labor efficiency.

Main Results

We first present the empirical results on the effect of the different measures of international trade on average labor productivity and then turn to the effect on the price level and on the relative price of non-tradable goods.

5.1.A International Trade and Productivity

The results using the different measures of international trade in the baseline trade specification are presented first. Then we turn to the results when institutional quality and geography controls are included in the empirical analysis.

Baseline Specification

Table 3 summarizes the results of the baseline trade specification (i.e. (19) using *ITrade*, log*Workforce*, and log*Area* only as right-hand-side variables) for each of the proposed measures of *ITrade* and the three samples with data on average labor productivity. For example, column (1) contains the results for the largest possible sample in 1985 (consisting of 150 countries), using *Open* as a measure of trade intensity. The estimation method employed is the generalized method of moments (GMM) with robust standard errors. Instruments used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, and log*TFit*. Calculation of the standard errors takes into account that the last two instruments are estimated (the details of the necessary adjustments are explained in Frankel and

Romer (1999)).[23] The three bottom rows of the table contain the R^2 of the regression, the generalized R^2 of the regression, as well as the P-value of the test of the (three) overidentifying restrictions. Notice that the R^2 is sometimes negative. It is well known that this is a possibility with instrumental-variables estimation. This is one of the reasons why the R^2 is neither a useful measure of how well the regression "fits" the data nor a valid criterion for model selection when there are endogenous right-hand-side variables. To select among models in this case, it is necessary to use the generalized R^2, which is a measure of explanatory power for models with endogenous right-hand-side variables (Pesaran and Smith (1994)). The generalized R^2 is obtained as the R^2 of the least-squares regression once the endogenous right-hand-side variables in the baseline specification are replaced by their predicted values using all instruments. Table 3 indicates that, according to the generalized R^2 criterion, the baseline trade specification with log*ROpen* as a measure of *ITrade* does better than the model with *Open*, with the results for log*PTROpen* in-between. For example, comparing the baseline trade specification with log*ROpen* to the one with *Open* as a measure of *ITrade* yields an improvement in the generalized R^2 of around 20 percent for the two 1985 samples and 56 percent for the 1990 sample. The P-values of the test of overidentifying restrictions indicate that none of the models can be rejected at the 10-percent level with the two 1985 samples. With the 1990 sample, however, all models except the one using log*ROpen* as a measure of the intensity with which countries trade can be rejected at the 5-percent level.[24] The ranking of models according to the generalized R^2 criterion that emerges from the baseline trade specification prevails when we include geographic and institutional control variables in the empirical analysis.

The explanatory power of the different models suggests that *Open* works better than log*Open* as a measure of *ITrade* in cross-country productivity analysis and that log*ROpen* and log*PTROpen* work better than *ROpen* and *PTROpen* respectively. Our empirical work therefore concentrates on the specifications with openness and the log of real openness as well as the log of (our proxy of) tradable GDP openness as a measure of *ITrade* in (19).

Openness and Productivity

Table 4 contains the results on the effect of openness on average labor productivity. Estimation is based on (19) with *Open* as a measure of *ITrade*. The estimation method employed is GMM with robust standard errors. Column (1) is the baseline trade specification for the largest possible sample in 1985 (which consists of 150 countries). It can be seen that the effect of *Open* on

[23] We are grateful to David Romer for providing the program to make these adjustments.
[24] We do not use (our proxy of) tradable GDP openness as a measure of *ITrade* when working with the 1990 sample because the share of GDP in agriculture and manufacturing is not available for many countries, resulting in much fewer observation than those available to estimate the specification with real openness.

productivity is large. The point estimate indicates that increasing *Open* by one percentage point increases productivity by 4.13 percent. The 95-percent confidence interval of this effect is between 1.7 and 6.5 percent, and the hypothesis that *Open* is not a determinant of productivity can be rejected at the 0.1-percent significance level. This finding contrasts with the result of Frankel and Romer (1999) who, using the same sample, estimate the effect of *Open* to be less than half of our estimate (1.96) and just significant at the 5-percent level. (The results using the specification, data, and estimation technique of Frankel and Romer are summarized in Table 5.) There are three reasons for this discrepancy: (1) we use more data to construct fitted trade intensities, resulting in better instruments; (2) we use a more efficient estimation method (Frankel and Romer's estimation method is just identified two-stage least-squares with non-robust standard errors); (3) we instrument for *Workforce* using population. When the Hall-Jones language variables are included among the instruments, the effect of *Open* on productivity falls to 2.14 with a standard error of 0.61 (not in the table).

Column (2) estimates (19) including geography controls (continent dummies and distance from the equator) but not institutional quality as right-hand-side control variables. The point estimate on *Open* drops to 1.78, less than half of the estimate in the baseline trade specification, but *Open* remains statistically significant at the 1-percent level.[25] The effect of the workforce on productivity becomes insignificant at the 10-percent level however. This is inconsistent with theories implying aggregate scale effects conditional on international trade. When the Hall-Jones language variables are included among the instruments, the effect of *Open* on productivity falls to 1.59 with a standard error of 0.57 (not in the table).

Column (3) estimates (19) excluding geography controls but including *IQual*, the measure of institutional quality constructed following Hall and Jones (1999), as a right-hand-side control variable. (The results of estimating the specification with institutional quality only, using GMM with robust standard errors, are contained in Table 6.[26]) In this case, only institutional quality is a significant determinant of productivity and has the "right" sign (notice that the largest possible 1985 sample now consists of 137 countries only). *Open* and the aggregate scale of production enter with the "wrong" sign and are statistically insignificant. The two variables remain insignificant as

[25] This contrasts with the non-robustness of openness as a determinant of productivity in Irwin and Tervio (2000). Our findings differ from those in Irwin and Tervio for the same reasons they differ from those in Frankel and Romer.

[26] We find that the effect of institutional quality on average labor productivity is quite similar to the effect of social infrastructure found by Hall and Jones (1999). Columns (3), (6), and (9) in Table 6 indicate that the hypothesis that distance from the equator is a significant determinant of average labor productivity once institutional quality is accounted for can be rejected at conventional significance levels. Furthermore, the table also indicates that the effect of institutional quality on average labor productivity is robust to the inclusion of continental dummies.

determinants of average labor productivity in column (4) where both geography controls and institutional quality are included in the analysis. The result that, once *IQual* is included in the estimating equation, trade and the aggregate scale of production become insignificant determinants of productivity is not driven by the reduction in sample size from 150 to 137 countries when institutional quality is included in the analysis. Estimating the baseline trade specification using only countries for which data on institutional quality is available yields results (not in the table) that are similar to those of the 150-country sample. For example, the coefficient on *Open* is 4.33 with a standard error of 1.15, which is similar to the result in column (1). Including geography controls reduces this estimate to 1.77 with a standard error of 0.83, which is similar to the result in column (2).

The finding that international trade and scale become insignificant as determinants of average labor productivity once institutional quality is added to the estimating equation persists for the other two average-labor-productivity samples used. Columns (7) and (8) contain the results for the 98-country sample in 1985 and columns (11) and (12) for the largest possible sample in 1990. And columns (13) to (15) demonstrate that *Open* remains insignificant in the three samples even if we exclude all geography controls that are insignificant at the 10-percent level from the empirical analysis.

Real Openness and Productivity

Table 7 contains the results on the effect of real openness on average labor productivity. Estimation is based on (19) with log*ROpen* as a measure of *ITrade*. The estimation method employed is GMM with robust standard errors. Column (1) gives the result of the baseline trade specification. The point estimate of the elasticity of productivity with respect to *ROpen* is 1.44 and very precisely estimated. This estimate implies that an increase of real openness that takes a country from the median value (31 percent) to the 60th percentile (39 percent) increases productivity by 39 percent. The standard error of the estimate implies that the 95-percent confidence interval of this effect is from 29 to 49 percent. An increase of real openness that takes a country from the 30th percentile (19 percent) to the median value increases productivity by 102 percent, with a 95-percent confidence interval from 68 to 143 percent. And an increase of real openness that takes a country from the 30th percentile to the 70th percentile (51 percent) increases productivity by 314 percent, with a 95-percent confidence interval from 184 to 503 percent.[27]

[27] It might be useful to compare our point estimate of the effect of trade on productivity in column (1) of Table 7 with the estimate in Frankel and Romer (1999). This can be done using the identity $ROpen \equiv Open * P$, where P is the price level**.** The identity implies that an increase in *Open* from 70 percent (the average value in 1985) to 80 percent raises average labor productivity by 21 percent when holding the price level constant (in our theoretical model the price level is endogenous of course). The magnitude of this effect is similar to the one implied by the estimate of

When the Hall-Jones language variables are included among the instruments, the effect of log*ROpen* on productivity increases to 1.61 with a standard error of 0.17 (not in the table). Hence, the productivity-gains of international trade are estimated very precisely in the baseline trade specification when real openness is used as a summary measure.

Column (2) estimates (19) including geography controls (continent dummies and distance from the equator) but not institutional quality as right-hand-side control variables. The point estimate of the effect of trade on average labor productivity remains basically unchanged and is significant at the 0.1-percent level. Furthermore, the inclusion of geography controls in the empirical analysis does not alter the effect of aggregate employment on productivity. When the Hall-Jones language variables are included among the instruments, the effect of log*ROpen* on productivity is 1.34 with a standard error of 0.19 (not in the table).

Column (3) estimates (19) including institutional quality, in addition to all geography controls, as a right-hand-side control variable. Both the estimate of the effect of trade on productivity and its standard error change little compared to column (2). Comparing column (3) with the baseline trade specification in column (1) yields that the point estimates of the effect of both log*ROpen* and the aggregate scale of production remain basically unchanged. The standard errors increase but both variables remain highly significant determinants of average labor productivity. Columns (4) and (5) exclude the insignificant geography controls from the specification. Not surprisingly, the effect of trade and the aggregate scale of production on productivity change little. Institutional quality becomes a statistically significant determinant of productivity however. These results, combined with our finding that the historic forces captured by the Hall-Jones language instruments affect not only institutional quality but also trade intensities, imply that countries fortunate enough to have history and geography work together saw productivity increased by international trade as well as by the quality of institutions.

Columns (6) to (10) and columns (11) to (15) present the results on the effect of real openness on average labor productivity for the 98-country sample in 1985 and for the largest possible sample in 1990 respectively. The results for the largest possible sample in 1990 echo those for the largest possible sample in 1985. For example, the results of the baseline trade specification in column (11) and of the specification with all geography controls and *IQual* in column (13) are similar as far as the effect of trade and the aggregate scale of production on productivity are concerned. Again, standard errors increase as more controls are added, but log*ROpen* and aggregate employment remain highly significant determinants of average labor productivity even in the most complete specification. The results for the Mankiw, Romer, and Weil (1992) 98-

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Frankel and Romer. But our (log) specification yields that the effect of *Open* on productivity is greater (smaller) than their estimate for countries with levels of *Open* below (above) average.

country sample in 1985 indicate that trade and the aggregate scale of production are significant determinants of productivity once insignificant geography controls are excluded from the empirical analysis. Overall, the results indicate that, in contrast to *Open*, log*ROpen* is a significant determinant of productivity irrespectively of the control variables included in the analysis and the sample used.[28]

The results obtained so far do not clarify to what extent the robustness of log*ROpen* compared to *Open* as a measure of international trade is driven by the different functional form (the logarithm) or by the use of real openness instead of openness. Table 8 looks at this question in detail by estimating (19) using log*Open* and *ROpen* respectively as measures of *ITrade*. Columns (1) to (3) show that log*Open* is not a statistically significant determinant of productivity at the 5-percent level even if geography controls that are not statistically significant at the 10-percent level are excluded from the analysis. If we include all geography controls, log*Open* is not a statistically significant determinant of productivity at the 10-percent level (not in the table). Hence, the very high level of statistical significance of log*ROpen* as a measure of trade cannot be explained by the different functional form only. Moreover, the results in columns (4) to (6) indicate that *ROpen* holds up much better (it is always significant at the 10-percent level) than *Open* (which is always highly insignificant) as a determinant of productivity when controls for geography and institutional quality are included in the analysis.

Real Openness, Tradable Goods Prices, and Purely Quantity-Based Measures of Trade Intensity

The main point of using real openness instead of openness in cross-country productivity analysis is to eliminate cross-country differences in the relative price of non-tradable goods that may make openness a misleading measure of the trade intensity. Cross-country variations in the prices of tradable goods, if any, would however still be captured by real openness. It is therefore interesting to ask under what conditions using log*ROpen* in cross-country productivity analysis is *asymptotically equivalent* to using a purely quantity-based measure of the trade intensity. With asymptotically equivalent we mean that coefficient estimates emerging from our cross-country productivity analysis with trade intensity measured using log*ROpen* are asymptotically identical to

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[28] Sometimes the effect of international trade on productivity at the country level is estimated assuming that trade policy is exogenous. Re-estimating the specification in column (3) using the Sachs and Warner (1995) measure of tariff and non-tariff barriers (which is discussed in more detail in Section 6) averaged over 1960-1985 as an instrument for log*ROpen* (instead of geography-predicted trade) yields a coefficient of 0.83 with a standard error of 0.52 (a P-value of 0.12). Once the insignificant geography controls are eliminated, the coefficient becomes 0.71 with a standard error of 0.37 (a P-value of 0.06). Repeating this exercise with *Open* as a measure of trade yields significantly negative effects of trade on average labor productivity.

(i.e. have the same probability limit as) coefficient estimates that would be obtained by using the following purely quantity-based measure of trade intensity

$$\log ROpen_c^{US} \equiv \log\left(\frac{p^{US} * EX_c + p^{US} * IM_c}{PPP\ GDP_c}\right), \tag{25}$$

where EX_c and IM_c are vectors of dimension $G \times 1$, where G is the number of goods that are imported or exported by some country in the world, with positive entries of EX_c (IM_c) denoting goods that are exported (imported) by country *c*. p^{US} is the corresponding US-price vector of dimension $1 \times G$. All imports and exports are therefore valued at US prices and differences in trade intensities reflect differences in quantities traded and produced only. To explore under what conditions using log*ROpen* is asymptotically equivalent to using the purely quantity-based measure of the trade intensity in (25) notice that log*ROpen* can be written as

$$\begin{aligned} &\log ROpen_c \\ &\equiv \log \frac{p_c^{EX(fob)} * EX_c + p_c^{IM(cif)} * IM_c}{PPP\ GDP_c} \\ &= \log\left(\frac{p_c^{EX(fob)} * EX_c + p_c^{IM(cif)} * IM_c}{p^{US} * EX_c + p^{US} * IM_c}\right) + \log\left(\frac{p^{US} * EX_c + p^{US} * IM_c}{PPP\ GDP_c}\right) \\ &\equiv \log PIX_c^{US} + \log ROpen_c^{US}. \end{aligned} \tag{26}$$

The first line makes explicit that in the data exports are valued free on board (f.o.b) while imports are valued including insurance and freight (c.i.f.) (positive entries of the $1 \times G$-vector $p_c^{EX(fob)}$ ($p_c^{IM(cif)}$) correspond to the f.o.b. (c.i.f.) prices of goods that are exported (imported) by country *c*). The decomposition of real openness in the third line makes clear that using log*ROpen* in our empirical (instrumental-variables) analysis is asymptotically equivalent to using the purely quantity-based measure in (25) if variations in the price index of imports and exports $\log PIX_c^{US}$ are independent of the instruments used.

Theoretically, there seems to be no good reason to suspect that the instruments used affect the relative price index of imports and exports $\log PIX_c^{US}$ systematically. For example, while it is true that transport costs (which are one of the determinants of our instruments for trade) between the US and Africa raise the c.i.f. price of African imports from the US, thereby raising the African price index of imports and exports, the same transport costs raise the US price of African exports, thereby lowering the African price index of imports and exports. And there seems to be no reason to believe that one of these two effects dominates. Another theoretical reason why we do not expect the effect of the instruments on $\log PIX^{US}$ to be systematic is that countries that have relatively high c.i.f. prices of imports because of high transport costs are likely to have relatively low f.o.b. prices of exports. For example, transport costs imply that US products have higher c.i.f. prices in Thailand than in Mexico and at the same time that products exported from Thailand to the US must have lower f.o.b. prices to be competitive with the same exports from Mexico to the US.

Still, it would be useful to test the hypothesis that the price index of imports and exports is independent of the instruments used empirically. Unfortunately, this hypothesis is not directly testable because there is no data on the price index of imports and exports. It is however possible to test a related hypothesis, namely that the price index of tradable goods across countries defined in (24) is independent of the instruments used. The reason why these two hypotheses should be related is that the c.i.f. price of imports and the f.o.b. price of exports should be related to the domestic prices of these goods.[29] Regressing $\log P_{cT}$ (for the 64 countries for which data are available in 1985) on all our instruments using least squares with robust standard errors yields that each instruments is highly insignificant. The P-value of each exclusion hypothesis is never below 51 percent. The joint exclusion hypothesis has a P-value of 11 percent and we can therefore reject the hypothesis that our instruments have a significant effect on the relative price of tradables at the 10 percent level. Hence, departures from the law of one price for tradable goods are not systematically related to our instruments.

Another way to see whether cross-country differences in tradable goods prices affect our empirical results is to use $\log(ROpen_c / P_{cT})$ as a proxy for the quantity-based measure of the trade intensity $\log ROpen_c^{US}$ and estimate (19) using this new proxy. This can be done for a sample of 61 countries in 1985 (we loose 3 of the countries with data on the price index of tradable goods because of a lack of data on institutional quality). Estimating (19) for this sample using GMM with the usual instruments and $\log ROpen_c$ as a measure of trade intensity yields an estimate of 0.41 with a standard error of 0.15 for the effect of trade on productivity once we exclude geography controls that are insignificant at the 10-percent level from the empirical analysis. Re-estimating the equation using the new proxy $\log(ROpen_c / P_{cT})$ yields an estimate of 0.43 with a standard error of 0.18 for the effect of trade on productivity. Hence, our estimate of the effect of trade on average

[29] The two hypotheses are related but not equivalent. In particular, it is straightforward to think of reasons why cross-country differences in tradable goods prices may be related to our instruments although the price index of imports and exports is not. For example, if richer countries have higher sales taxes, the domestic price of imports will be higher than in poorer countries even if c.i.f. prices are identical. Hence, our instruments could be related to tradable goods prices.

labor productivity is basically unaffected by the adjustment for differences in tradable goods prices.

Tradable GDP Openness and Productivity

Table 9 contains the results regarding the effect of (our proxy of) tradable GDP openness on average labor productivity. Estimation is based on (19) using GMM with the usual instruments and log*PTROpen* and *PTROpen* as measures of *ITrade*. The estimate of the elasticity of average labor productivity with respect to (our proxy of) tradable GDP openness is 1.89 when we do not include any controls for institutional quality and geography in the empirical analysis (not in the table). Column (1) shows that log*PTROpen* remains a significant determinant of average labor productivity at the 5-percent level when we control for institutional quality and for geography. Column (2) eliminates the insignificant geography controls, which implies that log*PTROpen* becomes highly significant. Columns (3) and (4) demonstrate that *PTROpen* is also a significant determinant of average labor productivity at the 5-percent level even when we control for institutional quality and for geography.

Assessing Measurement Error

Part of the variability of both real openness and (our proxy of) tradable GDP openness is due to measurement error. This is not a problem for consistent estimation because it seems reasonable to assume that measurement error is independent of the instruments used in the empirical analysis.[30] Measurement error does however raise the question of how to properly assess how well differences in trade intensity explain differences in average labor productivity because the variability in the observed trade intensity exceeds the variability of the "true" trade intensity. For example, the statement made earlier that our estimates of real openness' effect on average labor productivity imply that an increase of real openness taking a country from the 30th percentile to the median value doubles productivity must be taken with caution because of measurement error in real openness.

There is a simple way to assess the importance of measurement error in the log of real openness if we are willing to assume that both log*ROpen* and log*PTROpen* measure the same "true" openness with error and that the two errors are independent. In this case it is well known that the regression coefficient when regressing log*PTROpen* on log*ROpen* using least squares is a consistent estimate of the measurement error of log*ROpen* defined as the variance of "true" openness divided by the variance of log*ROpen* (e.g. Krueger and Lindahl (2001)). This regression yields a coefficient of 0.91 with a standard error of 0.04, which suggests that measurement error is

[30] The generalized R^2 criterion also remains valid in the presence of measurement error if the measurement error is independent of the instruments used in the empirical analysis.

not too large. But this analysis must be taken with caution because of the very stringent underlying assumption.

Least-Squares Results

Table 10 contains the results of estimating (19) using least squares. It can be seen that both real openness and (our proxy of) tradable GDP openness have a positive effect on average labor productivity, while openness turns out to be statistically insignificant. The least-squares estimates in the table differ substantially from the instrumental-variables estimates discussed earlier. For example, the least-squares effects of log*ROpen* and log*PTROpen* on average labor productivity is lower than the instrumental-variables estimates in Tables 7 and 9. There are several possible explanations for this discrepancy as the three main regressors, trade intensity, size of the workforce, and institutional quality, are measured with error and endogenous. For example, the discrepancy could be explained by measurement error in the trade intensity (although the argument just above suggests that this alone is not sufficient to explain the discrepancy). A definite explanation of the discrepancy is difficult because the bias depends in a complicated way on the interaction between the three possible sources of measurement error and endogeneity bias.

5.1.B International Trade and Prices

Table 11 summarizes the results of estimating (22) for the largest possible sample in 1985. The estimation method employed is GMM with robust standard errors and the usual instruments. The control variable z_c is calculated as $\log(Y_{PPP,c} / Workforce_c) - 1.45 \log ROpen_c - 0.3 \log Workforce_c$ using the estimates of the effect of real openness and aggregate employment on productivity in column (3) of Table 7. It can be seen from column (1) of Table 11 that the effect of real openness and aggregate employment on the price level is positive and highly significant in the specification with real openness and aggregate employment only. The addition of geography controls (distance from the equator and four continent dummies) in column (2) does not change this result. And real openness continues to have a positive, highly significant effect on the price level even when the variable capturing productivity differences not explained by increasing returns to specialization and aggregate employment (z_c) is added to the estimating equation in columns (3) and (4). According to the most general specification in column (4), real openness is significant at the 1-percent level and workforce at the 5-percent level. Productivity differences not explained by increasing returns are also a significant determinant of the price level. (Real openness remains a significant determinant of the price level when institutional quality is used instead of z; institutional quality is insignificant however (not in the table).) The results for the 98-country sample in 1985 and the largest possible sample in 1990 (not in the table) show even stronger effects of real openness and aggregate employment on the price level.[31]

Columns (5) to (8) contain the results of estimating (22) for the largest possible sample in 1985 after replacing real openness by (our proxy of) tradable GDP openness. The control variable z_c' is calculated as $\log(Y_{PPP,c}/Workforce_c) - 2.22\log PTROpen_c - 0.39\log Workforce_c - 0.18\log Area_c$ using the estimates of the effect of (our proxy of) tradable GDP openness and aggregate employment on average labor productivity in column (1) of Table 9 (z_c' is included for the same reasons we include z_c in the specification with real openness). The results show that (our proxy of) tradable GDP openness also has a significant positive effect on the price level.

Columns (9) to (12) differ from (1) to (4) in two respects. First, openness is used instead of real openness on the right-hand side of the estimating equation. Second, given our finding that openness and aggregate employment are insignificant determinants of productivity in column (4) of Table 4, we include average labor productivity without any adjustments for increasing returns to specialization and aggregate employment as an additional control variable. The results indicate that neither openness nor aggregate employment is a statistically significant determinant of the price level at the 5-percent level when we include geography controls and that both variables are highly insignificant when average labor productivity is included as a control variable.

Table 12 summarizes the results of estimating (22) using the relative price of non-tradable goods (logP_{NT}) and the price of non-tradable goods relative to tradable goods (log(P_{NT}/P_T)) as left-hand-side variables (these price indices are defined in (24)).The estimation method employed is GMM with the usual instruments (and robust standard errors). Columns (1) to (3) show that log*ROpen* and log*Workforce* are highly significant determinants of logP_{NT}, and columns (5) and (6) show that they are also significant determinants of log(P_{NT}/P_T) (the effect of real openness on log(P_{NT}/P_T) is significant at the 10-percent level in column (5) where all geography controls are included and becomes highly significant in column (6) where we are excluding geography controls that are insignificant at the 10-percent level). Columns (4) and (7) demonstrate the same results for (our proxy of) tradable GDP openness.

5.2 Robustness and Alternative Specifications

We first check the robustness of our results and then analyze important alternative specifications.

Robustness

Table 13 uses the largest possible sample in 1985 and the 1990 sample to see whether log*ROpen* holds up as a determinant of average labor productivity even when we include *Open* into the

[31] The effect of real openness and aggregate employment on the price level remains positive and highly significant when we include average labor productivity instead of z in the estimating equation.

empirical analysis. The estimation method employed is GMM with robust standard errors and the usual instruments. It can be seen that real openness remains highly significant in both cases while openness is statistically insignificant at the 10-percent level (and has the “wrong” sign).[32]

We also check the robustness of our results by eliminating Luxembourg, Hong-Kong, and Singapore, three countries with extremely high (real) openness, from the empirical analysis (not in the table). This does not affect the results at all. For example, estimating (19) for the largest possible sample in 1985 (134 countries) with GMM and the usual instruments yields a coefficient on log*ROpen* of 1.45 with a standard error of 0.36 and a coefficient on log*Workforce* of 0.34 with a standard error of 0.16 (basically identical to the results in Table 7). Estimating (19) for the largest possible sample in 1990 (107 countries) yields a coefficient on log*ROpen* of 1.16 with a standard error of 0.37 and a coefficient on log*Workforce* of 0.31 with a standard error of 0.14 (again basically identical to the results in Table 7).

As another robustness check (not in the table) we estimate (19) with GMM and the usual instruments separately for the most productive 80 countries and the least productive 80 countries in 1985 (this yields some overlap as the largest possible sample consists of 137 countries but ensures that the two samples are sufficiently large). For the 80 least productive countries, the coefficient on log*ROpen* is 1.72 with a standard error of 0.64 and the coefficient on log*Workforce* is 0.58 with a standard error of 0.27. These estimates remain basically unchanged but become somewhat more precise when we eliminate the geography controls that are insignificant at the 10-percent level. For the 80 most productive countries, the coefficient on log*ROpen* is 0.91 with a standard error of 0.36 and the coefficient on log*Workforce* is 0.1 with a standard error of 0.1. When we eliminate the geography controls that are insignificant at the 10-percent level, the coefficient on log*ROpen* becomes 1.02 with a standard error of 0.24 and the coefficient on log*Workforce* becomes 0.13 with a standard error of 0.06.[33]

Table 14 contains the results of estimating (19) for 1985 with GMM and the usual instruments, allowing the effect of log*ROpen* and log*Workforce* on average labor productivity to differ between countries on a particular continent and countries not on the continent. For example, column (1) allows the effect of real openness and workforce to differ depending on whether the country is in Africa or not. And columns (2), (3), and (4) repeat the same exercise for Asia, America, and Europe respectively. (The (dummy) variable *D* takes the value of 1 if the country is on the continent heading the column and the value of 0 otherwise.) The results in column (1) indicate that the effect of log*ROpen* is somewhat larger for African countries than non-African countries but the

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[32] For the 98-country sample in 1985, *Open* turns out to be significant but continues to have the “wrong” sign.

[33] Splitting the full sample into non-overlapping samples of 68/69 countries yields the same pattern of results but larger standard errors.

difference is not statistically significant (the point estimate of the difference is –1.43 with a standard error of 1.11). The effect of log*Workforce* is also somewhat larger for African countries than non-African countries but again the difference is not statistically significant (the point estimate of the difference is –0.26 with a standard error of 0.31). The results in columns (2) to (4) indicate that the differences between the effect of log*ROpen* and log*Workforce* on average labor productivity in Asian, American, and European countries and non-Asian, non-American, and non-European countries respectively are also statistically insignificant. Column (5) contains the results of estimating (19) for African countries only. The difference between columns (1) and (5) is that the latter specification estimates Africa-specific effects for all the right-hand-side variables in equation (19). Still, the effects of log*ROpen* and log*Workforce* on average labor productivity are very similar.

Figure 1 contains a partial scatter plot of the variation in the log of average labor productivity not explained by workforce, area, institutional quality, and geography controls, $\log(Y_{PPP}/Workforce) - \left(\hat{a}_0 + \hat{a}_2 \log Workforce + \hat{a}_3 \log Area + \hat{a}_4 IQual + \hat{a}_5 X_c\right)$, with the coefficient estimates $\hat{a}_0, \hat{a}_2, .., \hat{a}_5$ taken from column (3) of Table 7, against the value of log*ROpen* predicted by the instruments. The data is for the largest possible sample in 1985 (137 countries). This plot is useful for identifying countries that maybe potentially influential "outliers." It can be seen from the plot that there seem to be no outliers.

As a final robustness check (not in the tables) we estimate (19) for the largest possible sample in 1985 with GMM using log*ROpen* as a measure of *ITrade* but constructing the fitted trade intensities with gravity equations that eliminate either population or area as explanatory variables for bilateral trade shares (following Frankel and Romer (1999)). The results changed very little compared to Table 7.

Results Without Instrumenting for Institutional Quality

In a recent paper, Frankel and Rose (2002) argue that *Open* remains a significant determinant of 1990 per capita GDP even if institutional quality is included in the empirical analysis. Their specification differs from ours in four main ways. First, they use an additional explanatory variable for bilateral trade intensities (our equation (20)). The variable is whether the two countries considered speak the same language or not. Second, they use population instead of workforce in their empirical analysis. Third, they analyze the effect of openness on GDP per capita instead of GDP per worker. Fourth, and most importantly, they assume that institutional quality is exogenous and measured without error. Table 15 compares their empirical analysis using our data with the results obtained using real openness. The year considered is 1990 and the left-hand-side variable is per capita output. Column (1) reproduces the Frankel and Rose specification (in particular, institutional quality is used as a right-hand-side variable *and* as an instrument). It can be seen that *Open* is significant at the 5-percent level in this case. Column (2) re-estimates the equation treating institutional quality as an endogenous, mismeasured variable and using the Hall-Jones European/English language-spoken-at-birth variables as instruments. *Open* now becomes statistically insignificant. This suggests that *Open* is significant in the Frankel and Rose specification because the error in measuring institutional quality biases the effect of institutional quality downward and hence the effect of *Open* upwards when institutional quality is not instrumented for (in fact, the effect of institutional quality is almost 70 percent larger in the case institutional quality is instrumented for). Columns (3) to (6) document that the same pattern of results holds when we include geography controls in the analysis. For example, it can be seen from column (4) that *Open* is significant if institutional quality is assumed to be exogenous and measured without error even if all geography controls are included in the analysis. And column (5) demonstrates that *Open* becomes insignificant if institutional quality is instrumented using the Hall-Jones language-spoken-at-birth variables (notice that the effect of institutional quality in column (5) is more than twice the effect in column (4)). Column (6) demonstrates that this result prevails even if we only include the significant geography controls in the empirical analysis (the P-value of the exclusion hypothesis for *Open* is 0.13, which implies that openness is insignificant at the 10-percent level). Columns (7) and (8) show that log*ROpen* is a highly significant determinant of per capita output even if institutional quality is instrumented for with the Hall-Jones language variables (the results differ from those in Table 7 because common language is used as a determinant of bilateral trade, because per capita output is used instead of average labor productivity, and because population is used instead of workforce). The difference between columns (7) and (8) is that the former includes all geography controls while the latter eliminates geography controls that are insignificant at the 10-percent level. Column (9) adds the geography controls used by Frankel and Rose as right-hand-side variables (in addition to the continent dummies and the distance from the equator used throughout). The Frankel-Rose geography controls are a dummy that is unity for countries with a significant fraction of their land-area inside the tropics (*Tropical*) as well as dummies for Sub-Saharan, East Asian, and Latin-American countries. It can be seen that real openness remains significant. Column (10) eliminates all the geography controls that are insignificant at the 10-percent level. Real openness is now highly significant.

Real Openness and Income per Capita in Former Colonies

Table 16 analyzes the effect of trade measured by real openness on income per capita in the Acemoglu, Johnson, and Robinson (2001) sample of former colonies. The left-hand-side variable of the estimating equation is income per capita in 1995 and the right-hand-side variables considered are real openness, the aggregate scale of production measured by population (because of a lack of 1995 data on workforce in the currently available PWT), area, expropriation risk, institutional quality, and geography controls. The estimation method is GMM with robust standard errors.

Column (1) analyzes the effect of average expropriation risk 1985-95 (*ExprR*) only on income per capita, reproducing the result in Acemoglu, Johnson, and Robinson using their sample of former colonies with the exception of Vietnam (because of missing trade data in the PWT). The instrument used is the log of historic settler mortality. Columns (2) and (3) demonstrate that the large effect of expropriation risk on income per capita is robust to the inclusion of (statistically significant) continent dummies for Africa and Asia and that distance from the equator is not a significant determinant of income per capita (once expropriation risk is accounted for). The instruments used are the log of historic settler mortality and the geography controls used as right-hand-side variables. (Notice that the continent dummies are now defined following Acemoglu, Johnson, and Robinson; the omitted continent is America, and Europe and Oceania are combined as *Other Continent*.)

Columns (4) to (7) in Table 16 include log*ROpen* and the log of 1995 population as right-hand-side variables in the empirical analysis. The data on real openness is for 1985 because the PWT do not contain data for 1995 and because missing data for some former colonies reduces the sample to 54 countries if we use 1990 trade data instead.[34] The instruments used are the log of historic settler mortality, *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit*, and the geography controls used as right-hand-side variables. It can be seen that trade remains a highly significant determinant of income per capita across all specifications. The same result holds when we combine our data with Acemoglu, Johnson, and Robinson's data on expropriation risk and historic settler mortality to estimate the effect of trade and scale on average labor productivity in former colonies in 1985 or 1990 (not in the table). Column (8) differs from (7) in that the Hall-Jones language variables are also used as instruments (when comparing the coefficient on *IQual* with the coefficient on *ExprR* it is important to keep in mind that the former is measured between 0 and 1 while the latter is measured between 1 and 10). International trade and expropriation risk are now both significant determinants of income per capita in this case. Column (9) uses the same instruments as (8) but our measure of institutional quality (based on Hall and Jones) instead of expropriation risk. Both trade and institutional quality turn out to be significant. Finally, column (10) re-estimates (9) without the log of historic settler mortality as an instrument.

5.3 The Effect of Trade on Capital and Labor Efficiency

Table 17 contains the 1985 values, relative to the US, for PPP average labor productivity y_c, average human capital h_c, the capital-output ratio raised to the power $\alpha/(1-\alpha)$, $(K_c/Y_c)^{\alpha/(1-\alpha)}$, and labor efficiency A_c. These values differ from those in Hall and Jones (1999) because we use the revised Barro-Lee average schooling data. For example, labor efficiency in Italy and France is now 4 percent and 20 percent below the US instead of 20 percent and 13 percent above.[35]

Table 18 contains the results of using the logarithm of the three components determining average labor productivity in (23) on the left-hand side of the estimating equation in (19). All specifications include the geography controls that are significant at the 10-percent level. It can be seen that institutional quality is a significant determinant of the capital-output ratio at the 10-percent level and the amount of human capital at the 5-percent level, while both trade and scale are statistically insignificant at the 10-percent level. When it comes to explaining labor efficiency, however, the pattern is reversed. Institutional quality is insignificant but trade and aggregate employment are significant.[36] Hence, the empirical results indicate that institutional quality increases average labor productivity only through human and physical capital accumulation, while trade works only through labor efficiency.[37]

6 Conclusions and Some Tentative Remarks on Trade Policy

Our analysis of the effect of international trade on average labor productivity across countries emphasizes imports plus exports in exchange rate US$ relative to GDP in purchasing-power-parity US$ (real openness) and (our proxy of) nominal imports plus exports relative to the nominal value of production in the tradable goods sector (tradable GDP openness) as summary measures of trade. Using these measures, we find that the causal effect of trade on productivity across countries is large, highly significant, and very robust. For example, our point estimate of the effect of real openness on average labor productivity implies that an increase of real openness taking a country

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[34] The results for the 54-country sample using 1990 trade data are almost identical to those in Table 16 however. In particular, the point estimates are very similar and all the right-hand-side variables that are significant (insignificant) in Table 16 remain so for the 54-country sample.

[35] Hall and Jones' calculations are based on 1988 data, while the calculations in Table 17 are based on 1985 data (because this is the year used in our empirical analysis). Using Barro and Lee (2000), we find basically the same relative values for 1988 (not in the table) than for 1985 however.

[36] It is interesting to note that log*Area* is a significant determinant of the capital-output ratio. This is probably due to larger countries requiring more capital for transportation.

[37] Notice that this analysis is done with 89 countries only as the data available allows us to calculate the capital-output ratio and the amount of human capital for 101 countries only and we loose 12 additional countries because institutional quality is not available. This smaller sample yields very similar results to the full 150-countries sample however when we estimate (19). The GMM estimate (using the usual instruments) of the elasticity of average labor productivity with respect to real openness is 1.29 with a robust standard error of 0.25 and therefore not significantly different from the corresponding estimate in column (3) of Table 7.

from the 20th percentile to the median value triples average labor productivity. We also find that average labor productivity is affected in an economically and statistically significant way by the size of countries' workforce once international trade is taken into account. Regarding the channels through which international trade affects average labor productivity, our findings indicate that trade works through labor efficiency.

The large effect of international trade on average labor productivity raises the question of whether trade policies may be effective in increasing productivity. A thorough investigation of this issue is beyond our scope here, but it may still be worthwhile to conclude with a tentative analysis using on the most common measures of trade policy. Our first measure is based on the Sachs and Warner (1995) indicator of trade policies. According to the Sachs and Warner criterion, a country has "open" trade policies in a given time period if it satisfies all of the following criteria: (1) non-tariff barriers cover less than 40 percent of trade, (2) average tariff rates are less than 40 percent, (3) any black market premium is less than 20 percent (this criterion only applies to the 1970s and 1980s), (4) the country is not classified as socialist by Kornai (1992), and (5) the government does not monopolize major exports. Based on annual information on the Sachs-Warner criterion we calculate the fraction of years countries have had "open" trade policies between 1960 and 1985, which yields a variable between zero and unity (higher values indicating policies that are more favorable for trade) that we refer to as *YsOpen*.

The effect of *YsOpen* on real openness is estimated using the following equation

$$\log ROpen_c = c_0 + c_1 \log TFit_c + c_2 YsOpen_c + c_3 Mining_c + c_4 X_c + u_c, \tag{27}$$

where *TFit* captures real openness explained by geography and population; *Mining* is the fraction of GDP produced in the mining and quarrying sector (taken from Hall and Jones (1999)); X denotes the usual geography controls; u captures the variation in real openness not explained by our empirical approach; and $c_0, \ldots, c_4$ are the parameters to be estimated.

The key issue in estimating (27) is that *YsOpen* is endogenous and measured with error. We therefore require instruments for estimating its effect on real openness consistently. The instruments used are the Hall-Jones European/English language-spoken-at-birth variables and population in 1960. The language instruments capture the possibly favorable attitude towards free market policies in general and international trade in particular associated with past European influence. The population instrument captures that larger countries can benefit from productivity-gains market size even if they are less open, translating into a smaller incentive for adopting policies that are favorable for trade (Alesina, Spolaore, and Wacziarg (2000)). Our identifying hypothesis is that population in 1960 and the Hall-Jones language variables affect real openness only through the right-hand-side variables in (27). The full list of instruments used for estimation is: log*TFit*, log-population in 1960, the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, mining, and all the usual geography controls. (Table 19 gives the results of the least-squares regression of *YsOpen* on all the instruments used. It can be seen that population in 1960 has a significantly negative effect on *YsOpen* between 1960 and 1985, while the Hall-Jones European language variable has a significantly positive effect.) As the number of instruments exceeds the number of right-hand-side variables in the estimating equation, we test the (two) overidentifying restrictions.

Table 20 contains the results of estimating (27) with GMM. Column (1) indicates that geography-predicted trade, policies favorable for trade, and the fraction of GDP produced in the mining and quarrying sector have a positive, highly significant effect on real openness. Moreover, the P-value of the test of overidentifying restrictions indicates that these restrictions cannot be rejected at conventional significance levels. Column (2) includes the population instrument and column (3) includes the Hall-Jones language instruments in (27) to test whether these variables have a direct effect on real openness. The hypothesis that the instruments have a direct effect can in all cases be rejected at conventional significance levels. Columns (4) and (5) give the results of some alternative specifications of (27).

To get a sense for the effect of trade policies on productivity implied by our empirical analysis, notice that the results in Table 20 imply that a 0.1-point increase in *YsOpen* raises real openness by at least 15 percent. Combined with the effect of real openness on productivity estimated in Table 7, this yields that a 0.1-point increase in *YsOpen* implies a 24-percent increase in productivity. An increase in *YsOpen* from zero to unity—which according to the Sachs and Warner criterion corresponds to going from policies least favorable for trade to policies most favorable—implies an eightfold increase in productivity.

Quantifying the stance of trade policies using the Sachs-Warner measure has recently been criticized by Rodriguez and Rodrik (1999) because, according to their empirical analysis, little of the explanatory power of the measure for economic *growth* stems from the non-tariff and tariff barriers criteria. We therefore check the robustness of our results by repeating the analysis substituting *YsOpen* in (27) by a dummy capturing whether countries have been "open" (unity) or "closed" (zero) during the 1970-1989 period according to the non-tariff/tariff criteria of the Sachs and Warner measure only. Using this variable, taken from Rodriguez and Rodrik, reduces our sample to 94 countries. Estimating the effect of the non-tariff/tariff barrier dummy on real openness using the same method and instruments employed for *YsOpen* yields that a change in trade policies from zero to unity raises log*ROpen* by 1.71 with a standard error of 0.41 (not in the table). This estimate is actually somewhat *larger* than the result obtained when quantifying trade policies using *YsOpen* in Table 20. Combined with the effect of real openness on productivity, the estimate implies that going from policies least favorable for trade to policies most favorable increases average labor productivity by a factor of 12.

As a further robustness check, we also estimate (27) using import duties as a percentage of the value of imports in 1984-1985, also taken from Rodriguez and Rodrik, instead of *YsOpen* as a measure of trade policies. In this case our sample is reduced to 92 countries. Estimating the effect of import duties relative to imports on real openness using the same method employed for *YsOpen* yields that a one-point increase in relative import duties reduces *ROpen* by 7 percent with a standard error of 2.4 percent (not in the table). Combined with the effect of real openness on average labor productivity, this yields that a one-point increase in relative import duties reduces productivity by 10 percent. Reducing relative import duties from 27 percent (average of the ten highest relative-import-duties countries) to 0.5 percent (average of the ten lowest relative-import-duties countries) therefore raises productivity by a factor of 14.

Our exploratory empirical analysis therefore suggests that policies favorable for trade may be an effective tool for increasing real openness and consequently productivity.

References

Acemoglu, Daron, Simon Johnson, and James A. Robinson (2001), "The Colonial Origins of Comparative Development: An Empirical Investigation," *American Economic Review*, December, *91*(5), pp. 1369-1401.

Ades, Alberto, and Edward L. Glaeser (1999), "Evidence on Growth, Increasing Returns, and the Extent of the Market," *Quarterly Journal of Economics*, August, *114*(3), pp.1025-45.

Alesina, Alberto, Enrico Spolaore, Romain Wacziarg (2000), "Economic Integration and Political Disintegration," *American Economic Review*, December, *90*(5), pp. 1276-96.

Aten, Bettina (1997), "Does Space Matter? International Comparisons of the Prices of Tradables and Nontradables," *International Regional Science Review*, *20*(1&2), pp. 35-52.

Barro, Robert, and Jongwha Lee (1993), "International Comparisons of Educational Attainment," *Journal of Monetary Economics*, December, *32*(3), pp. 363-94.

Barro, Robert and Jongwha Lee (2000), "International Comparisons of Educational Attainment: Updates and Implications," mimeo, Harvard University, February.

Bils, Mark, and Peter Klenow (2000), "Does Schooling Cause Growth?" *American Economic Review*, December, *90*(5), pp. 1160-83.

Coe, David, and Elhanan Helpman (1995): "International R&D Spillovers," *European Economic Review*, May, *39*(5), pp.859-87.

Coplin, William D., Michael K. O'Leary, and Tom Sealy (1996), *A Business Guide to Political Risk for International Decisions*. Syracuse, Political Risk Services.

David, Paul (1977), "Invention and Accumulation in America' s Economic Growth: A Nineteenth-Century Parable," *Journal of Monetary Economics*, Supplementary series, *6*(0), pp. 176-228.

Dinopoulos, Elias, and Peter Thompson (2000), "Endogenous Growth in a Cross-Section of Countries," *Journal of International Economics*, August, *51*(2), pp. 335-62.

Ethier, Wilfred (1982), "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review*, June, *72*(3), pp. 389-405.

Finn, Hames (ed.) (1994), *Freedom in the World: The Annual Survey of Political Rights and Civil Liberties*, 1993-1994. New York, Freedom House.

Frankel, Jeffrey, and David Romer (1999), "Does Trade Cause Growth?" *American Economic Review*, June, *89*(3), pp. 379-99.

Frankel, Jeffrey A., and Andrew Rose (2002), "An Estimate of the Effect of Common Currencies on Trade and Income," *Quarterly Journal of Economics*, May, *117*(2), pp. 437-466.

Gustavsson, Patrik, Par Hansson, and Lars Lundberg (1999), "Technology, Resource Endowments and International Competitiveness," *European Economic Review*, August, *43*(8), pp. 1501-30.

Hall, Robert, and Charles Jones (1999), "Why do some countries produce more output per worker than others?" *Quarterly Journal of Economics*, February, *114*(1), pp. 83-116.

Helpman, Elhanan (1981), "International Trade in the Presence of Product Differentiation, Economies of Scale, and Monopolistic Competition: A Chamberlin-Heckscher-Ohlin Approach," *Journal of International Economics*, August, *11*(3), pp. 305-40.

Heston, Alan, Daniel Nuxoll, and Robert Summers (1994), "The Differential-Productivity Hypothesis and Purchasing-Power Parities: Some New Evidence," *Review of International Economics*, October, (2)3, pp. 227-243.

Heston, Alan, Robert Summers, Bettina Aten and Daniel Nuxoll (1995), "New Comparisons on the Prices of Tradables and Nontradables," Working Paper 95-3, Center for International Comparisons, University of Pennsylvania.

International Monetary Fund, *Direction of Trade Statistics*. Various years, Washington D.C.

Irwin, Douglas, and Marko Tervio (2000), "Does Trade Raise Income: Evidence from the Twentieth Century," NBER Working Paper No 7745, Cambridge, MA.

Klenow, Peter, and Andres Rodriguez-Clare (1997), "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" In Ben Bernanke and Julio Rotemberg (eds.), *NBER Macroeconomics Annual*. Cambridge, MA, MIT Press.

Knack, Stephen, and Philip Keefer (1995), "Institutions and Economic Performance: Cross-Country Tests Using Alternative Institutional Measures," *Economics and Politics*, November, *7*(3), pp. 207-27.

Kornai, Janos (1992), *The Socialist System: The Political Economy of Communism*, Princeton, Princeton University Press.

Krueger, Alan, and Mikael Lindahl (2001) "Education for Growth: Why and for Whom?" *Journal of Economic Literature*, *39* (4), pp. 1101-1136.

Krugman, Paul (1981), "Intraindustry Specialization and the Gains from Trade," *Journal of Political Economy*, October, *89*(5), pp. 959-73.

Mankiw, Gregory, David Romer and David Weil (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, May, *107*(2), p. 407-37.

Miller, Stephen M., and Mukti P. Upadhyay (2000), "The Effects of Openness, Trade Orientation, and Human Capital on Total Factor Productivity," *Journal of Development Economics*, December, *63*(2), pp. 399-423.

Pesaran, Hashem, and Richard Smith (1994), "A Generalized R^2 Criterion for Regression Models Estimated by the Instrumental Variables Method," *Econometrica*, May, *62*(3), pp. 705-10.

Summers, Robert, and Alan Heston (1991), "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," *Quarterly Journal of Economics*, May, *106*(2), pp. 327-68.

Rauch, James, and Diana Weinhold (1999), "Openness, Specialization, and Productivity Growth in Less Developed Countries," *Canadian Journal of Economics*, *32*, pp. 1009-27.

Rand McNally (1993), *Quick Reference Atlas*, Chicago, Rand McNally.

Rodriguez, Francisco, and Dani Rodrik (1999), "Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence," NBER Working Paper No 7081, Cambridge, MA.

Rogoff, Kenneth (1996), "The Purchasing Power Parity Puzzle," *Journal of Economic Literature*, *34*, June, pp. 647-668.

Sachs, Jeffrey and Andrew Warner (1995), "Economic Reform and the Process of Global Integration," *Brookings Papers on Economic Activity*, 1, pp. 1-95.

World Bank (2001), *World Development Indicators CD-ROM*, Washington D.C.

Appendix

Table 1. The quality of the gravity-equation instruments for trade intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Open	*Open*	log*ROpen*	log*ROpen*	log*PTROpe*n	log*PTROpen*	*Open*
$R^2(1)= R^2$ with all instruments	0.544	0.548	0.508	0.54	0.54	0.58	0.591
$R^2(2)= R^2$ excluding *TFit*/log*TFit*	0.482	0.517	0.377	0.496	0.46	0.54	0.414
$(R^2(1)- R^2(2))/ R^2(2)$	0.129	0.060	0.347	0.089	0.17	0.074	0.428
P-value of excluding *TFit*/log*TFit*	0.000	0.001	0.000	0.001	0.000	0.001	0.000
All *GeoControls* included?	no	yes	no	yes	no	yes	no
Observations	150	150	150	150	134	134	98
Year	1985	1985	1985	1985	1985	1985	1985

	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Open	log*ROpen*	log*ROpen*	*Open*	*Open*	log*ROpen*	log*ROpen*
$R^2(1)$	0.631	0.49	0.573	0.567	0.584	0.559	0.595
$R^2(2)$	0.529	0.285	0.491	0.43	0.492	0.39	0.501
$(R^2(1)- R^2(2))/ R^2(2)$	0.193	0.719	0.197	0.319	0.187	0.433	0.188
P-value of excluding *TFit*/log*TFit*	0.000	0.000	0.001	0.000	0.000	0.000	0.000
All *GeoControls* included?	yes	no	yes	no	yes	no	yes
Observations	98	98	98	115	115	115	115
Year	1985	1985	1985	1990	1990	1990	1990

Notes: Results of regressing the measure of *ITrade* heading the column (*Open*, log*ROpen*, and log*PTROpen*) on *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit*, and the geography controls whenever it says so in the third row from the bottom. The methods used is least squares. $R^2(1)$ is the R^2 of the regression using all the aforementioned variables. $R^2(2)$ is the R^2 of the regression of the measure of *ITrade* on all the instruments used in the previous row except *TFit* and log*TFit*. $(R^2(1)-R^2(2))/R^2(2)$ is the proportional increase in the R^2 associated with the inclusion of *TFit*, log*TFit* among the instruments. The fourth row gives the P-value of the hypothesis that *TFit* and log*TFit* can be excluded from the equation. All regressions include a constant. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator.

Table 2. The quality of the Hall-Jones instruments for institutional quality

		(1)	(2)	(3)	(4)	(5)
EnglL	Est. S.e.	0.11 0.05	0.16 0.07	0.09 0.05	0.12 0.06	
EuroL	Est. S.e.	0.08 0.03	0.11 0.04	0.14 0.04	0.15 0.04	
TFit	Est. S.e.	0.006 0.002	0.14 0.002	0.004 0.002	0.003 0.002	
AbsLati	Est. S.e.	0.65 0.07		0.48 0.1		
All *Continent Dummies* included?		no	no	yes	yes	yes
Observations Year R^2		137 1985 0.54	137 1985 0.25	137 1985 0.59	137 1985 0.52	137 1985 0.43

		(6)	(7)	(8)	(9)	(10)
EnglL	Est. S.e.	0.13 0.05	0.18 0.08	0.08 0.05	0.12 0.06	
EuroL	Est. S.e.	0.07 0.03	0.09 0.04	0.11 0.04	0.115 0.0	
TFit	Est. S.e.	0.005 0.001	0.1 0.01	0.004 0.002	0.004 0.002	
AbsLati	Est. S.e.	0.65 0.06		0.48 0.1		
All *Continent Dummies* included?		no	no	yes	yes	yes
Observations Year R^2		137 1990 0.62	137 1990 0.29	137 1990 0.66	137 1990 0.59	137 1990 0.43

Notes: Results of regressing *IQual* on the variables in the first column of the table using least squares with robust standard errors. The construction of *IQual* is explained in the main text. All regressions include a constant.

Table 3. The baseline trade specification

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Open	log*Open*	*ROpen*	log*ROpen*	*PTROpen*	log*PTROpen*	*Open*
ITrade	Est.	4.13	2.96	3.41	1.44	0.84	1.89	3.19
	S.e.	1.21	0.8	0.59	0.19	0.16	0.38	0.71
log*Workforce*	Est.	0.29	0.48	0.14	0.34	0.11	0.34	0.39
	S.e.	0.14	0.14	0.075	0.068	0.08	0.09	0.12
log*Area*	Est.	0.36	0.14	0.21	0.01	0.27	0.14	0.07
	S.e.	0.12	0.1	0.07	0.05	0.07	0.07	0.12
Year		1985	1985	1985	1985	1985	1985	1985
Observations		150	150	150	150	134	134	98
R^2		neg.	neg.	0.37	0.28	neg.	neg.	neg.
Generalized R^2		0.165	0.15	0.18	0.198	0.175	0.185	0.207
P-value overident. restrictions		0.12	0.25	0.11	0.25	0.17	0.21	0.13

		(8)	(9)	(10)	(11)	(12)	(13)	(14)
		log*Open*	*ROpen*	log*ROpen*	*Open*	log*Open*	*ROpen*	log*ROpen*
ITrade	Est.	1.86	2.73	1.28	2.03	2.44	2.14	1.47
	S.e.	0.52	0.73	0.24	0.68	0.62	0.47	0.23
log*Workforce*	Est.	0.49	0.28	0.41	0.34	0.46	0.27	0.38
	S.e.	0.13	0.092	0.09	0.099	0.12	0.077	0.076
log*Area*	Est.	0.03	0.08	-0.01	0.049	0.12	0.01	0.028
	S.e.	0.1	0.1	0.07	0.11	0.11	0.08	0.066
Year		1985	1985	1985	1990	1990	1990	1990
Observations		98	98	98	115	115	115	115
R^2		neg.	0.13	0.28	neg.	neg.	0.295	0.33
Generalized R^2		0.2	0.233	0.249	0.181	0.166	0.219	0.282
P-value overident. restrictions		0.13	0.19	0.11	0.005	0.048	0.006	0.12

Notes: Results of the baseline trade specification (i.e. (19) without geography and institutional quality controls) using different measures of *ITrade*. The measure of *ITrade* used in each column is the one heading the column. The left-hand-side variable is the log of PPP GDP per worker. The construction of the generalized R^2 is explained in the main text. The estimation method is GMM with robust standard errors. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. Instruments used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit* in all cases. The last row gives the P-value of the test of overidentifying restrictions. All regressions include a constant.

Table 4. The specification using openness as a summary measure of trade intensity

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Open	Est.	4.13	1.78	-0.9	0.43	3.19	1.11	-0.7	0.26	2.03	1.59	-0.8	0.16	0.48	0.38	0.08
	S.e.	1.21	0.86	0.89	0.73	0.71	0.29	0.48	0.28	0.68	1.09	0.53	0.5	0.75	0.27	0.49
log*Workforce*	Est.	0.298	0.12	-0.3	-0.16	0.397	0.18	-0.1	0.033	0.34	0.27	-0.1	-0.01	-0.12	0.04	-0.02
	S.e.	0.139	0.11	0.1	0.12	0.122	0.066	0.08	0.077	0.099	0.11	0.09	0.1	0.1	0.05	0.077
IQual	Est.			8.25	3.55			6.75	2.78			7.03	4.67	3.51	2.71	5.28
	S.e.			1.31	1.16			0.87	0.89			1.03	1.11	0.84	0.66	0.37
log*Area* included?		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Which *GeoControls* included?		none	all	none	all	none	all	none	all	none	all	none	all	*Asia, America, AbsLati*	*America, AbsLati*	*Asia, America*
Year		1985	1985	1985	1985	1985	1985	1985	1985	1990	1990	1990	1990	1985	1985	1990
Observations		150	150	137	137	98	98	97	97	115	115	110	110	137	97	110
R^2		neg.	0.46	neg.	0.67	neg.	0.73	0.38	0.79	neg.	0.57	0.33	0.69	0.65	0.79	0.65
Generalized R^2		0.165	0.571	0.432	0.581	0.133	0.737	0.588	0.741	0.181	0.71[illegible]	0.608	0.732	0.557	0.739	0.718

Notes: Results of estimating (19) using *Open* as a measure of *ITrade*. The left-hand-side variable is the log of PPP GDP per worker. The estimation method is GMM with robust standard errors. Instruments always used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit* and log*TFit*. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. When institutional quality (*IQual*) is included as a right-hand-side variable then the instruments include the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. The construction of *IQual* is explained in the main text. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator. When *GeoControls* are included as right-hand-side variables, they are also used as instruments. The last three columns exclude geographic controls that are not significantly different from zero at the 10-percent level. All regressions include a constant.

Table 5. Effects of openness on productivity using the Frankel and Romer (1999) data and estimation method

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Open	Est.	1.96	0.88	0.95	0.34	-1.44	2.96	3.42	3.36	0.58	-1.18
	S.e.	0.91	0.79	0.7	0.76	0.94	1.34	1.9	1.27	0.86	0.89
log*Workforce*	Est.	0.19	-0.03	-0.02	-0.02	-0.31	0.35	0.34	0.34	0.057	-0.26
	S.e.	0.088	0.09	0.07	0.07	0.11	0.14	0.26	0.16	0.094	0.12
log*Area*	Est.	0.086	0.11	0.11	-0.01	-0.04	0.2	0.29	0.28	-0.02	-0.07
	S.e.	0.097	0.069	0.069	0.07	0.09	0.17	0.17	0.14	0.11	0.11
Africa	Est.		-1.05	-1.22				-1.3	-1.72		
	S.e.		0.29	0.13				0.71	0.24		
Asia	Est.		0.15					-0.93	-1.35		
	S.e.		0.35					0.79	0.42		
America	Est.		0.23					0.52			
	S.e.		0.29					0.84			
Europe	Est.		0.8	0.61				0.37			
	S.e.		0.36	0.19				0.74			
AbsLati	Est.				3.64					4.08	
	S.e.				0.44					0.47	
IQual	Est.					6.74					6.89
	S.e.					1.27					0.98
Year		1985	1985	1985	1985	1985	1985	1985	1985	1985	1985
Observations		150	150	150	150	137	98	98	98	98	97
R^2		neg.	0.51	0.509	0.42	0.15	neg.	0.034	0.052	0.55	0.35

Notes: Results of estimating (19) using *Open* as a measure of *ITrade*. The left-hand-side variable is the log of PPP GDP per worker. The estimation method used for the specifications without institutional quality (*IQual*) is (exactly identified) two-stage least-squares. Instruments used are *TFit*, log*Workforce*, log*Area* and whatever geography controls are included as right-hand-side variables. *TFit* is constructed using the Frankel and Romer data on bilateral trade (with about half of the observations on bilateral trade data used in this paper). Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. The specifications with *IQual* as a right-hand-side variable use as additional instruments the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. The construction of *IQual* is explained in the main text. All regressions include a constant.

Table 6. The institutional quality model

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IQual	Est.	4.07	4.37	3.95	4.22	4.58	4.18	4.49	4.62	4.62
	S.e.	1.06	0.65	0.82	0.61	0.55	0.67	0.74	0.65	0.84
AbsLati	Est.			0.55			0.82			-0.001
	S.e.			0.68			0.64			0.67
AbsLati used as instrument?		no	yes	yes	no	yes	yes	no	yes	yes
All *Continent Dummies* included?		yes	yes	yes	yes	yes	yes	yes	yes	yes
Year		1985	1985	1985	1985	1985	1985	1990	1990	1990
Observations		137	137	137	98	98	97	110	110	110

Notes: The left-hand-side variable is the log of PPP GDP per worker. The right-hand-side variables are listed in the first column. The estimation method is GMM with robust standard errors. Instruments always used are the fraction of the population speaking English at birth, the fraction speaking one of the five principal languages of Europe at birth, and continent dummies. Distance from the equator is used as instrument if indicated. The construction of the measure of institutional quality (*IQual*) is explained in the main text. All regressions include a constant. Continent dummies are (jointly) statistically significant at the 1-percent level in all specifications. It can be seen from columns (3), (6) and (9) that *AbsLati* is not significant when included as a control variable. Hence, the hypothesis that it is a valid instrument cannot be rejected at conventional significance levels. (Like Hall and Jones (1999), we find that the overidentifying restrictions can be rejected at standard significance levels for the model with *IQual* only as a determinant of average labor productivity. The overidentifying restrictions can no longer be rejected when continent dummies are included in the analysis however).

Table 7. The specification using the log of real openness as a summary measure of trade intensity

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
log*ROpen*	Est.	1.44	1.32	1.45	1.33	1.32	1.28	0.81	0.49	0.92	0.91	1.47	1.32	1.18	1.01	0.99
	S.e.	0.19	0.29	0.35	0.29	0.3	0.24	0.17	0.3	0.3	0.29	0.23	0.26	0.39	0.31	0.32
log*Workforce*	Est.	0.34	0.3	0.3	0.26	0.25	0.41	0.23	0.14	0.23	0.21	0.38	0.4	0.34	0.28	0.27
	S.e.	0.068	0.1	0.14	0.11	0.11	0.092	0.068	0.087	0.11	0.1	0.079	0.11	0.17	0.11	0.12
log*Area*	Est.	0.01	0.026	0.039	0.058	0.059	-0.01	-0.01	-0.04	-0.01	-0.01	0.019	-0.04	-0.05	-0.018	-0.017
	S.e.	0.05	0.045	0.14	0.05	0.05	0.074	0.052	0.04	0.05	0.05	0.06	0.061	0.06	0.05	0.05
Africa	Est.		-1.1	-0.57	-0.6	-0.64		-1.03	-0.87	-0.53	-0.58		-1.26	-0.54	-0.47	-0.49
	S.e.		0.25	0.49	0.22	0.22		0.38	0.44	0.2	0.22		0.32	0.5	0.22	0.22
Asia	Est.		-0.45	-0.01				-0.42	-0.31				-0.78	-0.06		
	S.e.		0.3	0.54				0.41	0.45				0.39	0.56		
America	Est.		-0.01	0.65	0.65	0.62		0.18	0.34	0.75	0.71		-0.06	0.68	0.74	0.72
	S.e.		0.24	0.47	0.22	0.22		0.38	0.38	0.2	0.21		0.31	0.44	0.2	0.2
Europe	Est.		-1	-0.55				-0.71	-0.52				-0.97	-0.36		
	S.e.		0.35	0.5				0.39	0.4				0.35	0.46		
AbsLati	Est.		1.96	1.11	0.40			2.68	1.94	1.02			1.78	0.74	0.24	
	S.e.		0.63	0.85	0.67			0.48	0.66	0.70			0.58	0.82	0.63	
IQual	Est.			1.03	1.09	1.4			1.38	1.4	2.25			2.46	2.31	2.55
	S.e.			1.29	0.9	0.66			1.24	1.01	0.71			1.43	1.15	0.74
Year		1985	1985	1985	1985	1985	1985	1985	1985	1985	1985	1990	1990	1990	1990	1990
Observations		150	137	137	137	137	98	97	97	97	97	115	110	110	110	110
R^2		0.27	0.5	0.52	0.55	0.53	0.3	0.81	0.65	0.72	0.68	0.24	0.66	0.67	0.68	0.66
Generalized R^2		0.198	0.611	0.615	0.594	0.572	0.249	0.737	0.755	0.741	0.724	0.282	0.76	0.767	0.757	0.757

Notes: Results of estimating (19) using log*ROpen* as a measure of *ITrade*. The left-hand-side variable is the log of PPP GDP per worker. The estimation method is GMM with robust standard errors. Instruments always used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit* and log*TFit*. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. Instruments also include the geography controls (continents and absolute latitude, *AbsLati*) whenever used as right-hand-side variables. When institutional quality (*IQual*) is included as a right-hand-side variable then the instruments also include the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. The construction of *IQual* is explained in the main text. All regressions include a constant.

Table 8. Specification using the log of openness and real openness as summary measure of trade intensity and excluding insignificant geography control variables

		(1)	(2)	(3)	(4)	(5)	(6)
log*Open*	Est.	2.81	0.83	1.2			
	S.e.	1.58	0.56	0.82			
ROpen	Est.				2.47	0.9	0.95
	S.e.				0.63	0.58	0.58
log*Workforce*	Est.	0.41	0.14	0.23	0.08	0.052	0.1
	S.e.	0.33	0.15	0.17	0.08	0.05	0.08
log*Area*	Est.	0.21	0.03	0.01	0.099	-0.03	-0.04
	S.e.	0.12	0.05	0.07	0.05	0.05	0.04
Africa	Est.	-0.62	-0.63	-0.38	-0.73	-0.57	-0.58
	S.e.	0.4	0.22	0.26	0.22	0.2	0.2
Asia	Est.	1.11					
	S.e.	0.6					
America	Est.		0.71	0.98	0.47	0.56	0.54
	S.e.		0.24	0.33	0.2	0.16	0.17
Europe	Est.						
	S.e.						
AbsLati	Est.						
	S.e.						
IQual	Est.	1.88	3.23	3.71	2.19	3.31	3.55
	S.e.	1.24	0.5	0.64	0.54	0.45	0.57
Year		1985	1985	1990	1985	1985	1990
Observations		137	97	110	137	97	110
R^2		neg.	0.71	0.51	0.47	0.72	0.69

Notes: Results of estimating (19) using log*Open* and *ROpen* respectively as the measure of *ITrade*. The left-hand-side variable is the log of PPP GDP per worker. The estimation method is GMM with robust standard errors. Instruments always used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit* log*TFit*, the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. Instruments also include continent dummies whenever used as right-hand-side variables. The construction of *IQual* is explained in the main text. All regressions include a constant. All specifications excludes geography controls that are not significantly different from zero at the 10-percent level.

Table 9. Specification using (our proxy of) tradable GDP openness as a summary measure of trade

		(1)	(2)	(3)	(4)
PTROpen	Est.			0.41	0.35
	S.e.			0.18	0.16
log*PTROpen*	Est.	2.22	1.66		
	S.e.	0.84	0.53		
log*Workforce*	Est.	0.39	0.25	0.09	0.14
	S.e.	0.23	0.13	0.08	0.07
log*Area*	Est.	0.18	0.15	0.16	0.17
	S.e.	0.08	0.07	0.07	0.07
Africa	Est.	-0.91	-0.73	-0.31	
	S.e.	0.61	0.22	0.36	
Asia	Est.	-0.15		0.58	0.93
	S.e.	0.69		0.44	0.23
America	Est.	0.41	0.58	0.91	1.18
	S.e.	0.59	0.23	0.35	0.11
Europe	Est.	-0.50		0.25	0.52
	S.e.	0.57		0.37	0.19
AbsLati	Est.	1.85		0.37	
	S.e.	1.21		0.86	
IQual	Est.	1.53	0.69	3.2	3.93
	S.e.	2.66	1.16	1.09	0.59
Year		1985	1985	1985	1985
Observations		122	122	122	122
R^2		0.07	0.35	0.59	0.58
Generalized R^2		0.588	0.579	0.58	0.576

Notes: Results of estimating (19) using log*PTROpen* and *PTROpen* respectively as the measure of *ITrade*. The left-hand-side variable is the log of PPP GDP per worker. The estimation method is GMM with robust standard errors. Instruments always used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit* log*TFit*, the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. Instruments also include continent dummies whenever used as right-hand-side variables. The construction of *IQual* is explained in the main text. Columns (2) and (4) exclude geographic controls that are not significantly different from zero at the 10-percent level. All regressions include a constant.

Table 10. Least squares results

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
logROpen	Est.	0.45	0.32	0.41					
	S.e.	0.1	0.1	0.11					
Open	Est.				0.11	0.27	0.22		
	S.e.				0.17	0.18	0.15		
log*PTROpen*	Est.							0.29	
	S.e.							0.11	
PTROpen	Est.								0.11
	S.e.								0.05
log*Workforce*	Est.	-0.03	-0.002	0.07	-0.17	-0.07	-0.03	-0.1	-0.12
	S.e.	0.05	0.06	0.06	0.05	0.06	0.05	0.06	0.08
IQual	Est.	1.45	1.86	1.45	2.19	2.34	2.41	2.15	2.34
	S.e.	0.4	0.46	0.51	0.41	0.44	0.44	0.48	0.47
log*Area* included?		yes	yes	yes	yes	yes	yes	yes	yes
All *GeoControls* included?		yes	yes	yes	yes	yes	yes	yes	yes
Year		1985	1985	1990	1985	1985	1990	1985	1985
Observations		137	97	110	137	97	110	122	122
R^2		0.76	0.82	0.79	0.67	0.71	0.77	0.73	0.72

Notes: Results of estimating (19) using different measures of *ITrade*. The left-hand-side variable is the log of PPP GDP per worker. The estimation method is OLS with robust standard errors. The construction of *IQual* is explained in the main text. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator. All regressions include a constant**.**

Table 11. Real openness, tradable GDP openness, openness, and the price level

		(1) logP	(2) logP	(3) logP	(4) logP	(5) logP	(6) logP	(7) logP	(8) logP
log*ROpen*	Est.	0.39	0.36	0.42	0.55				
	S.e.	0.05	0.06	0.08	0.09				
log*PTROpen*	Est.					0.41	0.32	0.45	0.51
	S.e.					0.1	0.17	0.09	0.14
log*Workforce*	Est.	0.07	0.06	0.07	0.1	0.08	0.06	0.07	0.06
	S.e.	0.02	0.03	0.02	0.03	0.03	0.06	0.03	0.04
z	Est.			0.14	0.22				
	S.e.			0.05	0.06				
z'	Est.							0.01	0.2
	S.e.							0.01	0.1
All *GeoControls* included?		no	yes	no	yes	no	yes	no	yes
Year		1985	1985	1985	1985	1985	1985	1985	1985
Observations		150	150	150	150	134	134	134	134
R^2		0.51	0.53	0.52	0.55	neg.	0.08	0.12	0.31
Generalized R^2		0.18	0.21	0.26	0.28	0.16	0.19	0.22	0.25

		(9) logP	(10) logP	(11) logP	(12) logP
log*Open*	Est.	0.56	0.30	0.13	0.09
	S.e.	0.13	0.18	0.12	0.12
log*Workforce*	Est.	0.1	0.03	0.005	0.001
	S.e.	0.03	0.05	0.03	0.04
log(*Y/L*)	Est.			0.23	0.34
	S.e.			0.05	0.07
All *GeoControls* included?		no	yes	no	yes
Year		1985	1985	1985	1985
Observations		150	150	150	150
R^2		0.22	0.05	0.31	0.37
Generalized R^2		0.089	0.11	0.14	0.15

Notes: Results of estimating (22) in columns (1) to (4). The left hand-side variable is the log of the price level. Columns (5) to (8) estimate (22) after replacing real openness by our (proxy of) tradable GDP openness on the right-hand side. Columns (9) to (12) estimate (22) after replacing real openness by openness on the right-hand side. The estimation method is GMM with robust standard errors. z is defined as $\log(Y_{PPP}/Workforce) - 1.45\log ROpen - 0.3\log Workforce$. z' is defined as $\log(Y_{PPP,c}/Workforce_c) - 2.22\log PTROpen_c - 0.39\log Workforce_c - 0.18\log Area_c$. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator. Instruments always used are *Pop*, log*Pop*, *TFit* log*TFit*, the fraction of the population speaking English at birth, and the fraction of the population speaking one of the five principal languages of Europe at birth. The geographic variables are also used as instruments whenever they are included among the right-hand-side variables. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. All regressions include a constant.

Table 12. Real openness, tradable GDP openness, and the relative price of non-tradable goods

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		$\log P_{NT}$	$\log P_{NT}$	$\log P_{NT}$	$\log P_{NT}$	$\log(P_{NT}/P_T)$	$\log(P_{NT}/P_T)$	$\log(P_{NT}/P_T)$
log*ROpen*	Est.	0.55	0.55	0.49		0.31	0.51	
	S.e.	0.15	0.13	0.14		0.17	0.12	
log*PTROpen*	Est.				0.57			0.27
	S.e.				0.19			0.11
log*Workforce*	Est.	0.1	0.1	0.14	0.08	0.07	0.09	0.01
	S.e.	0.05	0.04	0.04	0.06	0.05	0.04	0.05
log*Area*	Est.	0.04	0.04		0.07	-0.006	0.04	0.03
	S.e.	0.03	0.03		0.04	0.02	0.03	0.03
Africa	Est.	-0.73	-0.76	-0.73	-0.65	-0.25	-0.76	-0.31
	S.e.	0.34	0.16	0.17	0.2	0.29	0.15	0.21
Asia	Est.	-0.49	-0.52	-0.66	-0.52	-0.36	-0.54	-0.36
	S.e.	0.33	0.21	0.19	0.29	0.27	0.22	0.24
America	Est.	0.01			0.09	0.06		0.13
	S.e.	0.18			0.2	0.21		0.22
Europe	Est.	-0.31	-0.52	-0.39	-0.1	-0.18	-0.34	-0.11
	S.e.	0.3	0.21	0.11	0.22	0.28	0.12	0.21
AbsLati	Est.	-0.07			-0.23	0.01		0.13
	S.e.	0.87			0.64	0.59		0.28
z	Est.	-0.01	-0.03	0.003		0.08	-0.03	
	S.e.	0.23	0.09	0.1		0.17	0.1	
z'					-0.02			0.06
					0.2			0.22
Year		1985	1985	1985	1985	1985	1985	1985
Observations		64	64	64	58	64	64	58
R^2		0.69	0.68	0.7	0.71	0.59	0.59	0.51

Notes: Results of estimating (22) using the price of non-tradable goods relative to the US ($\log P_{NT}$) and the price of non-tradable goods relative to tradable goods ($\log(P_{NT}/P_T)$) as left-hand-side variables. Columns (1) to (3) and (5) and (6) estimate (22) using real openness on the right-hand side. Columns (4) and (7) estimate (22) after replacing real openness by our (proxy of) tradable GDP openness on the right-hand side. The estimation method is GMM with robust standard errors. z is defined as $\log(Y_{PPP}/Workforce) - 1.45 \log ROpen - 0.3 \log Workforce$. z' is defined as $\log(Y_{PPP,c}/Workforce_c) - 2.22 \log PTROpen_c - 0.39 \log Workforce_c - 0.18 \log Area_c$. Instruments always used are *Pop*, log*Pop*, *TFit* and log*TFit*. The geographic variables are used as instruments whenever they are included among the right-hand-side variables. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. All regressions include a constant.

Table 13. Specification using log*ROpen* and *Open* simultaneously

		(1)	(2)
log*ROpen*	Est.	1.46	1.55
	S.e.	0.34	0.46
Open	Est.	-1.06	-0.01
	S.e.	0.7	0.01
log*Workforce*	Est.	0.14	0.32
	S.e.	0.14	0.13
log*Area*	Est.	-0.01	-0.09
	S.e.	0.06	0.07
IQual	Est.	2.02	0.47
	S.e.	1.26	1.6
All *GeoControls* included?		yes	yes
Year		1985	1990
Observations		137	110
R^2		0.62	0.54

Notes: Results of estimating (19) using log*ROpen* and *Open* simultaneously as right-hand-side variables. The left-hand-side variable is the log of PPP GDP per worker. The construction of *IQual* is explained in the main text. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator. The estimation method is GMM with robust standard errors. Instruments used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit* log*TFit*, the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, continent dummies and the distance from the equator. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. All regressions include a constant.

Table 14. Allowing effects on GDP per worker to differ by continent

		(1)	(2)	(3)	(4)	(5)
		Africa	Asia	America	Europe	Africa only
$D = 1$	<=>	Africa	Asia	America	Europe	
log*ROpen*	Est.	2.36	1.13	0.87	1.14	1.71
	S.e.	0.89	0.22	0.39	0.54	0.48
(1-*D*)log*ROpen*	Est.	-1.43	0.24	0.59	0.12	
	S.e.	1.11	0.31	0.41	0.65	
log*Workforce*	Est.	0.44	0.19	0.25	0.23	0.48
	S.e.	0.26	0.07	0.11	0.13	0.16
(1-*D*)log*Workforce*	Est.	-0.26	0.1	0.02	-0.03	
	S.e.	0.31	0.07	0.08	0.21	
log*Area*	Est.	-0.03	0.01	0.03	0.06	-0.19
	S.e.	0.06	0.04	0.05	0.06	0.06
GeoControls included?		all	all	all	all	none
IQual	Est.	2.00	0.29	0.84	1.94	1.86
	S.e.	1.34	0.79	0.8	1.16	3.18
Year		1985	1985	1985	1985	1985
Observations		137	137	137	137	49
R^2		0.44	0.61	0.56	0.55	neg.

Notes: Results of estimating (19) using log*ROpen* as the measure of *ITrade* and allowing for effects to differ by continent. The left-hand-side variable is the log of PPP GDP per worker. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator. The (dummy) variable *D* takes the value of 1 if the country is on the continent heading the column and the value of 0 otherwise. Column (1) allows the effect of real openness and workforce to differ depending on whether the country is in Africa or not. And columns (2), (3), and (4) repeat the same exercise for Asia, America, and Europe respectively. Column (5) contains the results of estimating (19) for African countries only. The difference between columns (1) and (5) is that the latter specification estimates Africa-specific effects for all the right-hand-side variables. The estimation method is GMM with robust standard errors. Instruments always used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit*, the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. Columns (1) to (4) also use the four continent dummies and 1-*D* interacted with *Pop*, log*Pop*, *TFit*, and log*TFit* as instruments. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. The construction of *IQual* is explained in the main text. All regressions include a constant.

Table 15. Comparisons with Frankel and Rose (2002)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Open	Est.	0.49	-0.34	0.64	0.78	0.58	0.52				
	S.e.	0.25	0.41	0.21	0.29	0.38	0.35				
log*ROpen*	Est.							0.77	0.73	0.6	0.54
	S.e.							0.2	0.17	0.24	0.15
log*Pop*	Est.	0.07	-0.05	0.08	0.06	0.01	-0.01	0.16	0.16	0.09	0.07
	S.e.	0.043	0.06	0.042	0.05	0.06	0.05	0.07	0.06	0.09	0.05
log*Area*	Est.	-0.014	-0.05								
	S.e.	0.052	0.07								
Africa	Est.				-0.61	-0.014		-0.63	-0.54	0.13	
	S.e.				0.29	0.034		0.38	0.13	0.63	
Asia	Est.				-0.16	0.52	0.35	-0.03		0.59	
	S.e.				0.36	0.38	0.19	0.37		0.57	
America	Est.				0.27	0.73	0.69	0.36	0.46	0.45	
	S.e.				0.29	0.31	0.13	0.32	0.11	0.28	
Europe	Est.				-0.06	0.35		-0.19		0.27	
	S.e.				0.31	0.27		0.32		0.37	
AbsLati	Est.			1.59	1.46	-0.22		0.21		-2.12	-2.04
	S.e.			0.46	0.52	0.67		0.52		0.73	0.53
IQual	Est.	4.19	6.91	3.00	2.49	5.11	5.48	2.55	2.63	3.75	3.23
	S.e.	0.25	0.84	0.46	0.52	0.88	0.3	0.91	0.53	1.58	0.55
Other geography controls included?		no	no	no	no	no	no	no	no	*Tropical*, *Sub-Saharan*, *East Asian*, *Latin*	*Tropical*, *Sub-Saharan*
Year		1990	1990	1990	1990	1990	1990	1990	1990	1990	1990
Observations		110	110	110	110	110	110	110	110	110	110
R^2		0.67	0.51	0.71	0.78	0.75	0.69	0.79	0.77	0.81	0.83
IQual instrumented?		no	yes	no	no	yes	yes	yes	yes	yes	yes

Notes: Results of estimating (19) using *Open* and log*ROpen* as alternative measures of *ITrade*. The left-hand-side variable is the log of PPP GDP per person. The estimation method is GMM with robust standard errors. Instruments always used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit* and log*TFit*. *TFit* and log*TFit* are obtained from the usual bilateral trade equation except that dummies for a common language between trade partners are included as right-hand-side variables. Instruments include geographic variables whenever used as right-hand-side variables. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. The "other" geography controls come from Frankel and Rose (2002) and are dummies for countries with a significant fraction of their land-area inside the tropics as well as dummies for Sub-Saharan, East Asian, and Latin-American countries. The construction of *IQual* is explained in the main text. When *IQual* is instrumented for, the instruments used are the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, and the distance from the equator. Geography controls that are not significantly different from zero at the 10-percent level are excluded in columns (6), (8), and (10). All regressions include a constant.

Table 16. Trade and institutions in former colonies

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log*ROpen*	Est.				1.53	1.48	1.44	1.43	0.83	1.15	1.15
	S.e.				0.29	0.28	0.22	0.25	0.33	0.22	0.22
log*Pop*	Est.				0.44	0.34	0.44	0.35	0.16	0.19	0.20
	S.e.				0.14	0.14	0.14	0.14	0.11	0.1	0.11
log*Area*	Est.				0.03	0.06		0.05	0.03	0.06	0.05
	S.e.				0.06	0.06		0.05	0.04	0.04	0.04
Africa	Est.		-0.55	-0.55	-1.56	-1.42	-1.51	-1.42	-1.12	-1.26	-1.27
	S.e.		0.27	0.33	0.22	0.21	0.2	0.21	0.2	0.16	0.16
Asia	Est.		-0.74	-0.81	-0.98	-0.61	-0.87	-0.59	-0.64	-0.9	-0.72
	S.e.		0.31	0.4	0.28	0.31	0.27	0.31	0.24	0.26	0.26
Other	Est.						0.56	0.56	-0.55	-0.64	-0.66
Continent	S.e.						0.25	0.25	0.23	0.24	0.25
AbsLati	Est.			-1.69		2.56		2.33	1.81	2.1	2.1
	S.e.			1.33		0.72		0.72	0.54	0.53	0.53
IQual										2.33	2.37
										0.72	0.74
ExprR	Est.	0.94	0.82	0.88	0.06	-0.06	0.001	-0.08	0.35		
	S.e.	0.19	0.23	0.39	0.09	0.09	0.1	0.13	0.18		
Year		1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
Observation		63	63	63	63	63	63	63	63	63	63
R^2		0.19	0.44	0.33	0.61	0.66	0.63	0.67	0.76	0.73	0.73

Notes: The left-hand-side variable of the estimating equation is the log of 1995 GDP per capita in PPP US$ taken from Acemoglu, Johnson, and Robinson (2001). The right-hand-side variables are in the leftmost column. The variable *ExprR* is an index of average risk of expropriation 1985-95. The PWT have data on trade only for a subset of former colonies after 1985. The data on *ROpen* are therefore for 1985. Moreover, the PWT lack data on Vietnam, leaving us with 63 of the 64 observations in Acemoglu et al. The estimation method is GMM with robust standard errors. Instruments used are the geography controls whenever used as right-hand-side variables (to make the analysis consistent with Acemoglu et al, we omit America and define *Other Continent* as Europe and Oceania). Moreover:

- Columns (1) to (7) additionally use the following instruments: Log of historic settler mortality taken from Acemoglu et al. (2001), and *Area*, log*Area*, *Pop*, log*Pop*, *TFit* and log*TFit* when population, area, and log*ROpen* are used as right-hand-side variables.
- Column (8) uses the instruments in (7) plus the fraction of the population speaking English at birth and the fraction speaking one of the five principal languages of Europe at birth.
- Column (9) uses the instruments in (8).
- Column (10) uses the instruments in (9) except for the log of historic settler mortality.

Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. The construction of *IQual* is explained in the main text. All regressions include a constant.

Table 17. Countries ranked by their average labor productivity relative to the US in 1985

Country	Relative(y)	Relative(h)	Relative($(K/Y)^{0.5}$)	Relative(A)
U.S.A.	1	1	1	1
CANADA	0.91	0.90	1	1
SWITZERLAND	0.88	0.87	1.17	0.86
AUSTRALIA	0.84	0.88	1.11	0.86
NETHERLANDS	0.84	0.78	1.05	1.02
BELGIUM	0.82	0.77	1.04	1.03
ITALY	0.82	0.79	1.07	0.96
WEST GERMANY	0.82	0.82	1.12	0.89
FRANCE	0.81	0.93	1.09	0.79
NORWAY	0.80	0.79	1.16	0.87
SWEDEN	0.80	0.83	1.03	0.93
NEW ZEALAND	0.78	0.98	1.08	0.74
AUSTRIA	0.72	0.78	1.07	0.86
DENMARK	0.71	0.84	1.06	0.80
. .	. .	. .	. .	. .
U.S.S.R.	0.41	0.84	1.22	0.40
ALGERIA	0.38	0.62	0.95	0.65
TAIWAN	0.37	0.89	0.88	0.47
BARBADOS	0.37	0.95	0.77	0.50
YUGOSLAVIA	0.34	0.91	1.16	0.32
PORTUGAL	0.33	0.72	1.01	0.45
BRAZIL	0.33	0.69	0.87	0.54
REPUBLIC OF KOREA	0.31	0.77	0.90	0.45
URUGUAY	0.31	0.86	0.96	0.37
PANAMA	0.30	0.83	0.90	0.41
FIJI	0.29	0.88	0.92	0.35
MALAYSIA	0.28	0.73	1	0.39
SOUTH AFRICA	0.27	0.75	0.98	0.36
COLOMBIA	0.26	0.69	0.83	0.46
COSTA RICA	0.26	0.75	0.85	0.41

Table 17 continued

Country	Relative(y)	Relative(h)	Relative($(K/Y)^{0.5}$)	Relative(A)
. .	. .	. .	. .	. .
GUINEA-BISS	0.04	0.52	0.86	0.09
MYANMAR	0.04	0.61	0.59	0.11
MOZAMBIQUE	0.04	0.54	0.36	0.20
COMOROS	0.04	0.52	0.86	0.09
ANGOLA	0.04	0.52	0.51	0.14
CENTRAL AFRICAN REPUBLIC	0.04	0.56	0.57	0.12
UGANDA	0.04	0.59	0.37	0.17
CHAD	0.03	0.52	0.36	0.18
ZAIRE	0.03	0.60	0.51	0.11
MALAWI	0.03	0.65	0.69	0.07
NIGER	0.03	0.54	0.69	0.08
BURUNDI	0.03	0.52	0.49	0.12
TANZANIA	0.03	0.52	0.67	0.08
BURKINA FASO	0.03	0.52	0.56	0.10
ETHIOPIA	0.02	0.52	0.45	0.09

Notes: The method of calculation for h, $(K/Y)^{\alpha/(1-\alpha)}$ for $\alpha = 1/3$, and A are explained in the main text; y stands for PPP GDP per worker (Y/L). All values are relative to the US. The table contains data for selected countries only.

Table 18. Effects of trade and institutional quality on the components of productivity

		$\log(K/Y)^{\alpha/(1-\alpha)}$	$\log(H/L)$	$\log A$
log*ROpen*	Est.	-0.03	0.034	1.12
	S.e.	0.08	0.06	0.32
log*Workforce*	Est.	-0.063	0.012	0.29
	S.e.	0.036	0.023	0.11
log*Area*	Est.	0.046	-0.004	-0.04
	S.e.	0.015	0.01	0.04
IQual	Est.	0.71	1.09	0.55
	S.e.	0.39	0.32	1.08
Continent Dummies included?		yes	yes	yes
Year		1985	1985	1985
Observations		89	89	89
R^2		0.39	0.71	0.054

Notes: Results of estimating (19) using the three components on the right-hand side of (23) logged as left-hand-side variables ($\log(K/Y)^{\alpha/(1-\alpha)}$ for $\alpha = 1/3$, $\log(H/L)$, and $\log A$). The measure of *ITrade* used is log*ROpen*. The estimation method is GMM with robust standard errors. Continent dummies included are *Africa*, *America*, and *Asia* (the P-value of the exclusion restriction for *Europe* is 0.52). Instruments used are *Area*, log*Area*, *Pop*, log*Pop*, *TFit*, log*TFit*, the fraction of the population speaking English at birth, the fraction of the population speaking one of the five principal languages of Europe at birth, distance from the equator, and continent dummies included as controls. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. The construction of *IQual* is explained in the main text. All regressions include a constant.

Table 19. The quality of the instruments used to predict trade policies

		(1) *YsOpen*	(2) *YsOpen*
log*TFit*	Est.	0.12	0.017
	S.e.	0.04	0.05
Mining	Est.	-0.23	-0.3
	S.e.	0.3	0.33
log*Pop* in 1960	Est.		-0.05
	S.e.		0.02
EngL	Est.		0.13
	S.e.		0.16
EuroL	Est.		0.24
	S.e.		0.08
All *GeoControls* included?		yes	yes
Observations		130	130
Year		1985	1985
R^2		0.34	0.43

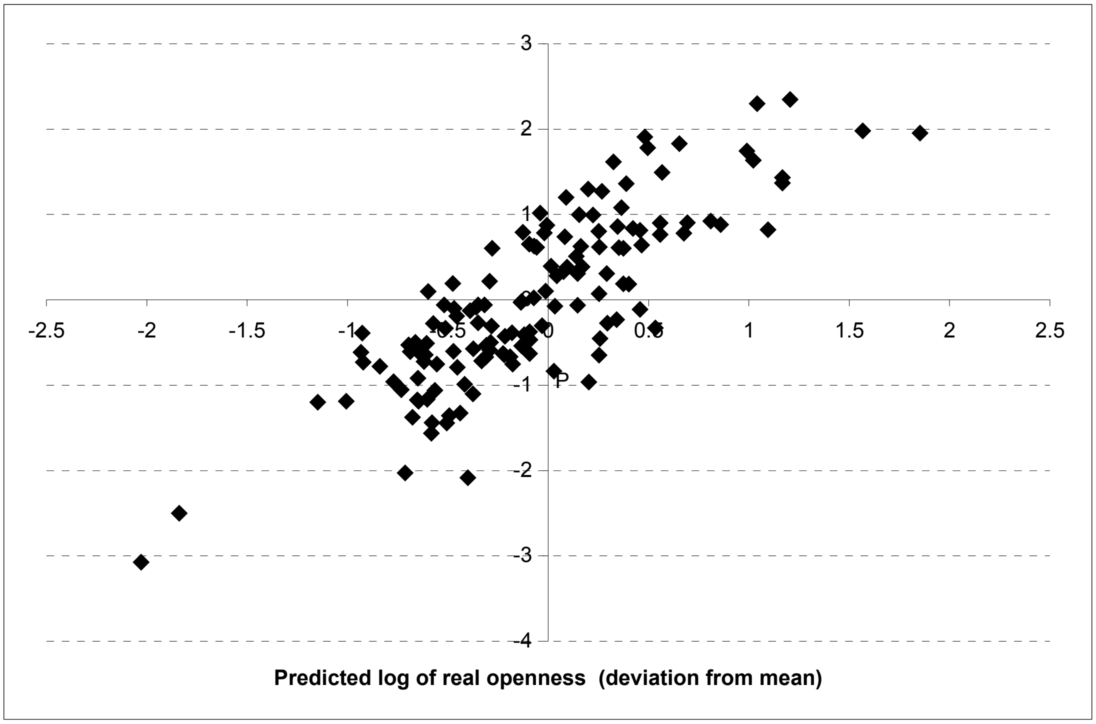
Notes: Results of regressing *YsOpen* on the variables in the first column of the table using least squares with robust standard errors. *YsOpen* is calculated following Sachs and Warner (1995). All regressions include a constant. The results in column (2) indicate that the fraction of the population speaking one of the five primary European languages (including English) at birth (*EuroL*) has a positive effect on *YsOpen*, while the fraction of the population speaking English at birth (*EngL*) is insignificant. Log-population in 1960 affects *YsOpen* between 1960 and 1985 negatively. Comparing columns (1) and (2) yields that the proportional increase in R^2 due to the inclusion of log-population in 1960 and the Hall-Jones European/English language-spoken-at-birth instruments in the regression is 26 percent.

Table 20. The effect of trade policies on the log of real openness

		(1)	(2)	(3)	(4)	(5)
		log*ROpen*	log*ROpen*	log*ROpen*	log*ROpen*	log*ROpen*
log*TFit*	Est.	0.53	0.53	0.53	0.65	0.58
	S.e.	0.1	0.11	0.11	0.11	0.11
YsOpen between 1960 and 1985	Est.	1.55	1.48	1.92	3.24	1.83
	S.e.	0.34	0.35	0.61	0.84	0.73
Mining	Est.	2.96	2.88	2.95	4.13	2.83
	S.e.	0.74	0.7	0.76	1.5	0.67
log*Pop* in 1960	Est.		-0.04			
	S.e.		0.04			
EngL	Est.			0.21		
	S.e.			0.21		
EuroL	Est.			-0.34		
	S.e.			0.27		
log(*Y*/*L*) in 1960	Est.				-0.36	
	S.e.				0.32	
IQual	Est.					-0.53
	S.e.					1.36
All *GeoControls* included?		yes	yes	yes	yes	yes
Observations		130	130	130	130	130
Year		1985	1985	1985	1985	1985
R^2		0.61	0.62	0.35	0.59	0.53
P-value overidentifying restrictions		0.43				

Notes: Results of estimating (27). The left-hand-side variable is the log of real openness. The estimation method is GMM with robust standard errors. *GeoControls* refers to four continent dummies (Oceania is excluded) and distance from the equator. Instruments used are log*TFit*, log-population in 1960, the fraction of the population speaking English at birth (*EngL*), the fraction of the population speaking one of the five principal languages of Europe at birth (*EuroL*), *Mining* and all geography controls. Standard errors in the table take into account that *TFit* and log*TFit* have been estimated. All regressions include a constant. The P-value in column (1) corresponds to the test of the four overidentifying restrictions. Columns (2) and (3) add log-population and the Hall-Jones language variables directly to (27). It can be seen that these variables do not have a significant direct effect on real openness. Columns (4) and (5) add GDP per worker in 1960 and institutional quality to (27) to check the robustness of the effect of *YsOpen* on real openness.

Figure 1. log *ROpen* partial scatter plot for the 137-country sample in 1985



Notes: The vertical axis measures the deviation from the mean of

$$\log(Y_{PPP}/Workforce) - \left(\hat{a}_0 + \hat{a}_2 \log Workforce + \hat{a}_3 \log Area + \hat{a}_4 IQual + \hat{a}_5 X_c\right)$$

(notice that log*ROpen* does not appear in this equation) with the coefficient estimates $\hat{a}_0, \hat{a}_2, .., \hat{a}_5$ taken from column (3) of Table 7. The horizontal axis measures the deviation from the mean of the predicted value of log*ROpen*. The variables used to predict log*ROpen* are all the instruments. The partial scatter plot does not point towards any observations that may be unduly influential. The two observation with the lowest predicted log*ROpen* are China and India and the one with the highest predicted log*ROpen* is Luxembourg.