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ABSTRACT

The prevailing view in policy circles is that landlockedness is bad for development because it reduces trade. This paper shows that other channels of transmission are likely to be important and, possibly, quantitatively larger and statistically stronger than the trade channel. One such channel is the quality of institutions. Using a system of structural equations and different estimators, the paper finds that landlockedness negatively affects the quality of institutions, which is in turn a fundamental determinant of per-capita income. By comparison, the evidence in support of the trade channel is surprisingly mild.

JEL classifications: O11, F15, C31.

Keywords: landlocked, income, trade, institutions, system of equations.

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The curse of being landlocked: institutions rather than trade

1. Introduction

This paper presents some new evidence on the development impact of the landlocked geographic status. The prevailing view in policy circles is that being landlocked causes a disadvantage in development because it makes trade more difficult and costly. However, the story might actually be more articulated than that. For one thing, this policy view is predicated on empirical evidence that is more controversial than what appears at first sight. For another, the isolation associated with being landlocked can affect economic development through channels other than international trade integration. In light of these objections, the paper reconsiders the relationship between development and landlockedness from an empirical perspective using a system of equations to assess the relative importance of two different transmission channels: one is trade integration and the other is institutional quality. It turns out that the institutional channel is indeed statistically strong and economically relevant, while the evidence in support of the trade channel is surprisingly mild.

The idea that landlocked countries deserve special attention is rather well consolidated in the profession. For instance, Joyce (2005) shows that the duration of IMF programmes is extended for landlocked countries compared to coastal countries with similar economic and institutional characteristics. More generally, Collier (2008) argues that the landlocked status is one of the four key factors preventing the poorest countries from growing and ripping off the benefits of globalization. The question is then why is landlockedness such a tough development challenge? The conventional answer to this question draws on evidence from gravity models and growth regressions. Gravity models point to a strong negative

effect of landlockedness on bilateral trade flows (see, inter alia, Limao and Venables, 2001; Rose, 2002; Raballand, 2003; Martinez-Zarzoso and Marquez-Ramos, 2005; Coulibaly and Fontagne, 2006)[1] . At the same time, some growth regressions report a positive effect of trade openness (generally measured as the share of international trade in GDP) on the rate of GDP growth (see Frankel and Romer, 1999 and Dollar and Kraay, 2004 for two well-known examples). Combining these two pieces of evidence one can then conclude that landlockedness is bad for growth (and hence development) because it reduces international trade.

There are three possible objections to this conclusion. First, the statistical strength and robustness of the relationship between growth and trade openness is a controversial matter. Levine and Renelt (1992) find that openness to trade is not robustly correlated with growth, but it is correlated with the investment rate (which is in turn a robust determinant of growth). Fernandez et al. (2001) conclude that the number of years an economy has been open to international trade is one of the robust determinants of growth, but the economy's overall degree of outward orientation is not. Similarly, Hoover and Perez (2004), Hendry and Krolzig (2004), and Sala-i-Martin et al. (2004) find growth to be robustly correlated with the years of openness, but not with the international trade share of GDP. Rodrik et al. (2004) show that once institutional quality is controlled for, measures of trade openness are insignificant in income regressions, although trade might be a significant determinant of institutional quality. So, landlockedness might determine trade, but it is unclear whether trade actually matters for growth.

Second, it is even questionable that landlockedness determines trade openess. Consider these simple stylized facts. The dataset which will be used for estimation in this paper

[1] Also relevant here is the evidence that landlockedness significantly increases transport costs (see Radelet and Sachs, 1998 and Arvis et al. 2007)

consists of cross-sectional observations for 150 countries over the period 1970-2005. In a regression of the average trade/GDP share on a constant and a dummy for landlocked countries, the estimated coefficient of the dummy is -1.721 with a standard error of 7.945. That is, the coefficient has the "right" sign, but it is largely insignificant (p-value is above 0.8). If the trade share is log-transformed, then the estimated coefficient of the dummy becomes positive and the associated p-value grows to 0.9. Interestingly, the coefficient of the landlocked dummy is not different from zero (p-value above 0.7) even when trade is measured by the predicted trade shares of Frankel and Romer (1999), which are constructed from a gravity model where landlockedness is strongly significant. Lastly, in a regression of the number of years of trade openness, the coefficient of the landlocked dummy is -0.121, but again it does not pass the zero restriction test at usual confidence level, although the p-value is only marginally larger than 0.1. Hence, the fact that landlockedness significantly reduces bilateral trade flows in gravity models does not automatically imply that it also reduces trade openness.

Third, when landlockedness is directly included on the right hand side of growth or income regressions, results are once again ambiguous. On the one hand, a negative effect of the landlocked status or a positive effect of coastline length on income/growth is reported by Bloom and Sachs (1998), Masters and Sachs (2001), Easterly and Levine (2003), Bloom et al, (2003), and Bosker and Garretsen (2009). On the other hand, Sala-i-Martin et al. (2004) conclude that a landlocked dummy variable is not robustly partially correlated with growth, while Acemoglu et al. (2001) and Rodrik et al. (2004) show that being landlocked does not significantly affect the level of per-capita income after controlling for institutional quality. In a number of other papers (i.e. Acemoglu et al. 2002; Sachs, 2003; Bleaney and Dimico, 2010) the strength and statistical significance of the effect of landlockedness on income or

growth is sensitive to model specification, estimation methodology, and sample selection[2] .

These objections to the prevailing view create scope for further investigation of the development effects of landlockedness. Two distinctive features characterize the analysis in this paper. One is the focus on levels of per-capita income instead of growth rates. As noted by Hall and Jones (1999), levels capture the differences in long-run economic performance that are most directly relevant to welfare. Furthermore, the low persistence of growth rates over time means that cross-country differences in growth rates are mostly transitory and hence that long-run differences in levels are the interesting fact to explain. Finally, results from a growth regression where the dependent variable is measured over a few decades might be misleading: if landlockedness historically depresses growth, but for some reason this negative effect has weakened (or even reversed) in the last few decades, then the growth regression might return a non-significant (or even positive) coefficient that is not representative of the true underlying relationship[3] .

The other distinctive feature of this paper is that it does not restrict landlockedness to affect income only through its effect on trade openness. This is because the landlocked status is likely to impact on determinants of per-capita income other than trade and economic integration. For instance, geographic isolation can influence the degree to which the population is exposed to other cultures, religions, and ideas coming from the rest of the world. It can also affect the pattern of colonization a country was subject to and/or the incidence

[2] See also Henderson et al. (2001) for a survey of earlier research on the impact of landlockedness on economic performance. There are of course several papers that look at the effects of the landlocked status on other economic aspects. For instance, Oshawa and Koshizuka (2003) study the impact of the landlocked status on the extent of fiscal competition among countries. Shatz (2004) looks at how the lack of sea access affects the choice of developing country export bases by US multinationals. Behrens et al. (2006) present a theory of firms' location where landlocked regions are not necessarily at a disadvantage relative to coastal regions.

[3] The use of levels is rather well established in the applied macro-literature now. See for instance, Acemoglu et al. (2001), Rodrik et al. (2004), Glaeser et al. (2004), Nunn (2008), Battacharrya, (2009), Alexeev and Conrad (2009), and Carmignani and Chowdhury (2012).

and recurrence of conflict in country's history. These factors shape cultural values and institutional quality, which are in turn two fundamental determinants of long-term income dynamics[4] . Culture and institutions might then be two other channels linking landlockedness and development. From a methodological perspective, a reduced form, single equation model is inadequate to represent these different transmission channels. Therefore, the paper estimates a system of structural equations. In this system, the trade and institutional channels are explicitly modelled, while the cultural values channel is not, mainly because of difficulties in finding suitable proxies for culture. However, a residual effect of landlockedness on income after controlling for the transmission through institutions and trade is estimated. Any income effect that might operate through the influence of landlockedness on cultural values would be then incorporated into this residual effect.

The rest of the paper is organized as follows. Section 2 explains the modelling strategy. Section 3 presents the results. Section 4 concludes. The Appendix contains the variables definition, the list of data sources, and some summary statistics.

2. Modelling strategy

In the econometric model, landlockedness is allowed to affect per-capita income through its effect on both trade openness and institutional quality. Furthermore, landlockedness is also allowed to have a residual effect on per-capita income after accounting for the transmission via openness and institutions. The set of structural relationships can then be written as follows:

$$y_i = \alpha_0 + \alpha_1 q_i + \alpha_2 t_i + \alpha_3 l_i + \mathbf{a}\mathbf{x}_i' + \varepsilon_i \quad (1)$$

[4] A discussion of the broad effects of landlockedness can be found in Gallup et al (1999) and Faye et al. (2004). The notion of fundamental (or deep) determinants (or causes) of economic performance is surveyed in Rodrik (2002) and Acemoglu (2009, chapter 4).

$$q_i = \beta_0 + \beta_1 l_i + \mathbf{b}\mathbf{z}_i' + \mu_i \tag{2}$$

$$t_i = \gamma_0 + \gamma_1 l_i + \mathbf{c}\mathbf{w}_i' + \upsilon_i \tag{3}$$

where i denotes a generic country in the sample, y, q, and t denote per-capita income, institutional quality, and trade openness respectively, $\mathbf{x}$, $\mathbf{z}$, and $\mathbf{w}$ are set of control variables in each equation, l denotes the landlocked status, ε, μ, and υ are error terms, and $\alpha's$, $\beta's$, $\gamma's$, $\mathbf{a}$, $\mathbf{b}$, and $\mathbf{c}$ are coefficients to be estimated.

Equation (1) draws on the previously mentioned literature on the deep determinants of income. The coefficient α_3 captures the residual effect of landlockedness. This residual effect can arise from the impact of the landlocked status on cultural values and/or some "proximate" determinants of income, such as physical and human capital or technology. The set of controls includes latitude and a dummy variable for oil rich countries. Equation (2) captures the effect of landlockedness on institutional quality (coefficient β_1). The controls are: a set of dummy variables to capture the origin of the legal system, an index of malaria ecology to proxy for the quality of the disease environment, an index of ethnic fragmentation, and the oil rich country dummy variable. The role of legal origins in determining current institutional quality is explored by La Porta et al. (1999). The link between exposure to fatal disease and institutions is proposed by Acemoglu et al. (2001)[5] . The potential harmful effect of ethnic fragmentation on governance is discussed by Easterly and Levine (1997). Finally, Leite and Weidmann (1999), Ross (2001), Isham et al. (2005) and Boschini

[5] In testing their theory, Acemoglu et al. (2001) use the settlers' mortality rate as a determinant of today's institutional quality. These settlers' mortality data are however available for a relatively small group of countries. The malaria ecology index is more widely available and captures the same logic: institutions are likely to be worse in countries whose disease environment discouraged the establishment of European settlements.

et al. (2007) document a negative effect of resource abundance on institutional development. In equation (3), the effect of the landlocked status on trade openness is represented by the coefficient γ_1. The set of controls follows from the argument of Frankel and Romer (1999) and includes two measures of the size of the country (geographic area and total population) and the oil rich country dummy to reflect the greater tendency to trade of oil exporters. The aggregate effect of landlockedness on income is thus given by the term $[\alpha_1\beta_1 + \alpha_2\gamma_1 + \alpha_3]$.

The estimation of this econometric model can proceed in different ways depending on whether (i) the error terms are correlated across equations and (ii) some of the right hand side variables are endogenous. If errors are uncorrelated, then the three equations can be estimated separately by OLS, if the regressors are all exogenous, or 2SLS, if some regressors are endogenous. If instead errors are correlated, then the equations can be jointly estimated as a system by SUR, again if all regressors are exogenous, or 3SLS, if some regressors are potentially endogenous. Which of the four estimators should be applied here is not immediately evident. Errors are most likely correlated, and hence the system estimators (SUR and 3SLS) should deliver greater efficiency (even though the OLS and 2SLS would still be unbiased). However, if one of the equations were misspecified, then a system estimator implies that the other equations would also be affected. With respect to endogeneity, landlocked and the controls in each equation seem to be pre-determined and exogenous. Nevertheless, in equation (1), there is potential for reverse causality and hence institutional quality and trade might be endogenous. This potential endogeneity could be attenuated, but not necessarily eliminated, if per-capita income is measured at the end of the period while institutional quality and trade are measured as averages over the entire sample period.

All in all, it is probably best to take a pragmatic approach and use all of the four estimators. For the purpose of presentation, the single equation estimators are reported in

the Appendix. However results turn out to be quite robust across different estimators. In 2SLS and 3SLS, institutional quality and trade in equation (1) are treated as endogenous. Instruments are generated from the exclusion restrictions incorporated in the specification of the set of controls **x**, **z,** and **w**. The full set of excluded instruments for equation (1) therefore includes: malaria ecology, ethnic fragmentation, the legal origin dummies, the size of population, and land area. There are instead no excluded instruments in the other two equations because none of the regressors appears to be endogenous. To assess the validity of these instruments, the following diagnostics are reported in the Appendix together with the 2SLS estimates: test of underidentification (null hypothesis is that the model is underidentified), test of weak-identification (higher values indicate that the model is not weakly identified), and test of overidentifying restrictions (null hypothesis is that the overidentifying restrictions implied by the choice of instruments are valid).

Estimation is based on cross-sectional data for the period 1970-2005. Per-capita income refers to year 2005 and is measured in logs of constant US dollars. Institutional quality is the period average value of the ratio of non-currency money to total money supply[6] . This measure has two advantages over other indicators of institutional quality that have been used in previous work. First, it is objective rather than subjective. Second, it can be computed for a large number of countries over a long period of time. Incidentally, its correlation with other institutional quality measures (such as those used by Acemoglu et al., 2001; Rodrik et al., 2004; and Glaeser et al., 2004) is generally positive and very high, albeit smaller than one. Trade is defined as the period average ratio of exports plus imports to GDP. Landlockedness is a dummy variable taking value 1 if country i is landlocked and zero

[6] This measure is called "contract intensive money" and is introduced by Clague et al. (1999). The underlying idea is that in societies where contracts are not effectively enforced (that is, societies with weaker institutions), transactions are mostly carried out in currency. Conversely, in a stronger institutional environment other means of payment are used. The ratio is formally defined as (M2-C)/M2, where C is currency in circulation outside banks. Higher values denote better institutions.

otherwise. Latitude is simply measured as country's distance from the equator. Malaria ecology is an index that combines temperature, mosquito abundance, and mosquito vectors into an ecologically-based measure of malaria risk. Ethnic fragmentation is the probability that two randomly selected individuals do not belong to the same ethnic group. Legal origins are captured by a set of four dummies, each representing a specific origin of the legal system (UK, Scandinavian, German, Socialist). Total population and land area are log transformed. The oil dummy takes value 1 if country i is oil rich and zero otherwise. Further details on variables definition and sources are provided in the Appendix.

3. Results

Results are separately presented for the SUR and the 3SLS estimators. The results from the single equation estimators (OLS and 2SLS) are reported in the Appendix.

3.1 SUR (and OLS) estimates

Table 1 reports the SUR estimates of equations (1), (2), and (3). As noted, the SUR estimator allows for non-zero correlations in errors across equations, but also assumes that all regressors are exogenous. While this assumption might not hold for equation (1), the SUR estimates still provide a useful benchmark.

INSERT TABLE 1 ABOUT HERE

To start with, consider the estimates reported in the first three columns of the table: column I is the income equation (1), column II is the institutional quality equation (2), and column III is the trade equation (3). The key finding is that the effect of landlockedness on income is transmitted through institutional quality rather than trade. Being landlocked lowers the quality of institutions. At the same time, better institutions increase per-capita

income. Therefore, landlockedness reduces per-capita income through its negative effect on institutions. Conversely, there is little evidence of transmission through trade. The coefficient of the trade variable in the income equation is positive and significant, albeit at the 10% confidence level only, meaning that greater openness to international trade increases per-capita income. However, the negative effect of landlockedness on trade openness is negligible in statistical terms, as it was already suggested by the stylized facts discussed in the Introduction. Hence, it is not by reducing openness to international trade that landlockedness affects income.

The second interesting piece of evidence is that even after controlling for the effect through institutional quality, landlockedness has a residual negative effect on per-capita income. As discussed, this residual effect might incorporate the adverse impact of the landlocked status on proximate determinants of income and/or cultural values.

Turning to the other controls, latitude has a positive and significant coefficients in the income equation. This means that geography does matter, and not just because of the landlocked status. The oil dummy also has a positive and significant coefficient, meaning that natural resources in the long term are a blessing rather than a curse. In the institutional equation, malaria ecology and some of the legal origin dummies are significant, while neither oil abundance nor ethnic fragmentation seem to be relevant. Finally, country size, measured in terms of both population and land area, appears to be the main driver of international trade openness.

In the first three columns, the system is estimated on a total of 104 countries[7] . This sample includes economies at all stages of development. In order to check whether results are strongly affected by the inclusion of the most advanced economies, columns IV, V, and VI

[7] The total number of countries in the dataset is 150, but some variables are not available for some of the countries.

report SUR estimates for a subsample of economies whose per-capita income at the beginning of the sample period was lower than US$ 10000[8] . As can be seen, results are qualitatively the same. In particular, the evidence concerning the impact of the landlocked status is very similar to what emerges from the first three columns. The only relevant difference is that in this sub-sample, the coefficient of the oil dummy in the income equation is no longer significant, while instead it was positive and significant in the full sample estimates. So, it appears that once the most advanced economies are excluded, oil abundance ceases to be a driver of development. However, even in this case, it does not appear to be a curse, in the sense that it does not significantly reduce per-capita income.

As a further sensitivity check, the model has been re-estimated with a slight, but important, twist in equation (2): the malaria ecology variable has been replaced by the log of the settlers' mortality rate originally used by Acemoglu et al. (2001). As discussed in footnote 5, the theory of Acemoglu et al. (2001) suggests that worse institutions emerge in countries where the environment is more conducive to tropical diseases. The malaria ecology index picks this effect, but a strict adherence to the original argument suggests estimating the model with the settlers' mortality rate as a regressor of institutional quality. A problem however emerges: the settlers' mortality data are available only for a relatively small sub-sample of countries, so that the number of observations available for estimation drops to less than 60. Results are available upon request and look remarkably similar to those shown in Table 1. The only important difference is that the coefficient of landlockedness turns insignificant in the income equation. That is, in this specific subsample, there is no longer evidence of a significant residual effect of landlockedness on income after controlling for the transmission through institutional quality.

[8] This is equivalent to excluding the top 20% of the income distribution in 1970. Results do not appear to be sensitive to changes in the cut-off line. For the sake of brevity, this sample will be referred to as "restricted sample" in the rest of this section.

Finally, Table A1 in the Appendix reports the results from the OLS estimator, which differs from the SUR estimator because it assumes zero correlation across errors. Results are both qualitatively and quantitatively very similar.

3.2 3SLS (and 2SLS) estimates

Estimates from 3SLS are reported in Table 2. With this estimator, errors are allowed to be cross-correlated across equation and institutional quality and trade in equation (1) are treated as endogenous. The full set of instruments arising from the exclusion restrictions presented in Section 2 is used. Similarly to Table 1, the first three columns of Table 2 show the estimates for the full sample of all countries while the next three columns present the results for the restricted sample which excludes the richest economies.

INSERT TABLE 2 ABOUT HERE

It is immediately evident that for the institutional and the trade equation results are very similar to those reported in Table 1. This is hardly surprising given that in those two equations all variables are exogenous. Some differences from Table 2 instead arise with respect to the income equation. In particular, the estimated coefficient of the trade variable is no longer significant. This confirms the lack of relevance of the trade channel: not only landlockedness has a negligible effect on overall trade openness, but trade openness does not evan appear to be a significant determinant of income. The results concerning the other determinants of per-capita income are instead confirmed, including the existence of a residual negative effect of the landlocked status on income after controlling for the transmission through institutional quality.

Table A2 in the Appendix reports the 2SLS estimates of the three equations. Results are again very similar to the 3SLS and the only important difference with respect to the

OLS estimates in Table A1 concerns the lack of significance of trade in the income equation. The table also reports the diagnostic tests to assess the validity of instruments[9] . The null hypothesis of the under-identification test is comfortably rejected, meaning that the model is not underidentified. The overidentifying restrictions appear to be valid in the full sample case, but not necessarily so in the subsample that excludes the richest economies. Even more worrying is the fact that the test statistic of the weak identification test is only 5.588 while the 10% critical value computed by Stock and Yogo (2005) is around 10.

In fact, the lack of relevance of some instruments does not come as a surprise. The full set of instruments does include some variables that are not strongly correlated with the regressors they are supposed to instrument. In particular, the estimates from equation (2) suggest that ethnic fragmentation and some of the legal origin variables are not significantly correlated with institutional quality. This consideration suggests re-estimating the model using as excluded instruments in equation (1) only those variables that are most strongly correlated with institutional quality and trade in equations (2) and (3) respectively. This means instrumenting institutional quality by malaria ecology only and trade openness by population and land area.

The 3SLS estimates obtained from this selected set of instruments are presented in Table 3. The corresponding 2SLS estimates are shown in Table A3. Both tables report, as usual, full sample estimates in the first three columns and restricted sample estimates in the next three columns.

INSERT TABLE 3 ABOUT HERE

The evidence on the institutional quality channel is still quite strong and significant: landlockedness negatively affects institutions and worse institutions in turn reduce per-capita

[9] Diagnostics are reported for the income equation only as this is the only equation where instruments are used.

income. The weakness of the trade channel is also confirmed: the negative effect of landlockedness on trade openness is statistically negligible and the impact of trade openness on per-capita income is, again, not different from zero in statistical terms. The residual effect of landlockedness on income remains negative, but with the 3SLS estimator the coefficient fails to be significant in the restricted sample. All the other results are qualitatively the same as those shown in Table 2. The diagnostics tests from the 2SLS regressions in Table A3 are now more satisfactory. In particular, the weak identification test statistic is well above the Stock and Yogo's critical value and the null hypothesis of the test of overidentifying restrictions can never be rejected. Overall, the tests indicate that these selected instruments are both relevant and exogenous.

According to the estimates in Table 3, the per-capita income of the median landlocked economy should be approximately 55% of the per-capita income of the median coastal economy, after controlling for all other income determinants. In the full sample of all countries, the income of the median landlocked economy is US$ 2627 and the income of the median coastal economy is US$7944. Therefore, the estimated effect of landlockedness explains about 2/3 of the actual difference between median landlocked and median coastal economy (the explained proportion grows to 70% when using the restricted sample without the richest economies). The implied monetary cost of being landlocked is large: evaluated at the median per-capita income of coastal economies, this cost is US$ 3574 per-capita or, equivalently, approximately 1.3 times the actual per-capita income of the medial landlocked economy.

4. Conclusions

The prevailing view in policy circles is that landlockedness is bad for development because of its adverse effects on trade. In fact, gravity models generally indicate that the landlocked

status reduces bilateral trade flows. Yet, this might not be enough to conclude that trade is the main channel of transmission of the development effects of landlockedness. First of all, the evidence on the income or growth effects of trade is controversial. Second, the correlation between landlockedness and trade seems to disappear once trade is measured in proportion of total GDP. Third, a number of recent empirical papers find landlockedness not to be significantly related to per-capita income or growth.

Against this background, the paper revisits and extends the evidence on the relationship between development and landlocked status. Development is here measured by the level of per-capita GDP. The landlocked status is allowed to affect per-capita income not just through trade, but also through its effect on institutional quality. A residual effect is also accounted for, which might pick the impact of landlockedness on proximate determinants of income (like human and physical capital or technology) and/or on cultural values. Estimates of a structural model of three equations indicate that: (i) institutional quality rather than trade openness seems to be the main channel of transmission of the effect of landlockedness and (ii) there is a negative residual effect of landlockedness on income after controlling for the transmission through institutional quality (and trade). These findings are generally robust to the use of different estimators and to the exclusion of the most advanced economies from the sample.

The results presented in this paper are not meant to neglect the obstacles that landlocked countries face in integrating into the world economy. In this regard, the initiatives for trade facilitation that characterize international assistance to landlocked countries are still important and welcome. What the paper, however, shows is that the development impact of the landlocked status is not limited to trade effects. Other transmission mechanisms are at work and the monetary costs associated with these mechanisms is large. The adverse effect

of landlockedness on the quality of institutions is one such mechanism. It is important for policymakers to recognize the existence and relevance of these other mechanisms in order to accompany trade facilitation with other policies and reforms that can help boost the development prospects of landlocked countries.

Finally, this paper opens up some potentially interesting avenues of future research. One concerns the apparent clash between the findings from gravity models and the evidence reported here that landlockedness is not correlated to openness to international trade. A tentative explanation, which would be consistent with the other results of the paper, is that landlockedness separately affects both the numerator and the denominator of the trade to GDP ratio. The effect on the numerator is what emerges from gravity models. The effect on the denominator would arise, for given population size, from the negative impact of landlockedness on income via institutions (or channels other than trade). If the two effects are of roughly the same magnitude, then landlockedness reduces bilateral trade flows without affecting overall trade openness.

Another avenue of research is to experiment with different measures of access to the sea. Here, the landlocked status is simply captured by a dummy variable. However, different countries can be landlocked to a different extent. To capture these differences, slightly more sophisticated measures could be used, such as the proportion of population living within 100 km from the coast or the distance from the nearest port. Finally, it will be interesting to investigate the spatial dimension of the effect of landlockedness. This means allowing the coefficient of the landlocked measure to vary depending on certain characteristics (e.g. quality of institutions or density of transport infrastructures) of the transit economies.

5. Appendix

5.1 Variables definition, data sources, and summary statistics

- Landlocked status: Dummy variable taking value 1 if a country is landlocked and zero otherwise. Source: CIA World Factbook (various editions). Mean: 0.191. Standard deviation: 0.394.

- Latitude: Absolute latitude of capital city divided by 90. Source: La Porta et al. (1999). Mean: 0.283 . Standard deviation: 0.189

- Oil dummy: Dummy variable taking value 1 if a country is oil rich and zero otherwise. Source: Sala-i-Martin et al. (2004). Mean: 0.087. Standard deviation: 0.283.

- Openness to international trade: Imports plus exports in percent of GDP. Source: Penn World Tables. Mean: 79% . Standard deviation: 43.206

- Institutional quality: Contract Intensive Money, computed as (M2-C)/M2, where M2 is money supply and C is currency in circulation outside banks. Source: Clague et al. (1999). . Mean: 0.498. Standard deviation: 0.189.

- Malaria ecology: Ecologically-based measure of malaria risk. Source: Sachs (2003). Mean: 3.688. Standard deviation: 6.468.

- Ethnic fragmentation: Probability that two randomly selected individuals do not belong to the same ethnic group. Source: La Porta et al. (1999). Mean: 0.338. Standard deviation: 0.302.

- Legal origin UK: Dummy variable taking value 1 if the country has UK legal origins. Source: La Porta et al. (1999). Mean: 0.337. Standard deviation: 0.473.

- Legal origin Germany: Dummy variable taking value 1 if the country has German legal origins. Source: La Porta et al. (1999). Mean: 0.029. Standard deviation: 0.170

- Legal origin Scandinavia: Dummy variable taking value 1 if the country has Scandinavian legal origins. Source: La Porta et al. (1999). Mean: 0.024. Standard deviation: 0.156.

- Legal origin Socialist: Dummy variable taking value 1 if the country has Socialist legal origins. Source: La Porta et al. (1999). Mean: 0.173. Standard deviation: 0.379.

- Population: Log of total country's population. Source: World Development Indicators. Mean: 15.207. Standard deviation: 2.371.

- Land Area: Log of country's land area. Source: Rodrik et al. (2004). Mean: 10.728. Standard deviation: 2.423.

- Per-capita income: Log of per-capita GDP in 2005. Source: Penn World Tables. Mean: 8.792. Standard deviation: 1.209.

5.2 Equation-by-equation estimation results

The tables with the OLS and 2SLS results mentioned in the text are reported below. The structure of the tables is the same as in the text: the first three columns report full sample estimates and the next three columns report estimates from the restricted sample (i.e. the sample that excludes the richest economies).

The 2SLS estimates are completed by the diagnostic tests to assess the validity of the instruments. The test of underidentification is an LM test of the null hypothesis that the matrix of reduced form coefficients on the excluded instruments has rank equal to $k-1$, where k is the number of endogenous regressors. A rejection of this null hypothesis indicates that

the matrix is full rank and hence that the model is identified. The test of weak identification is an F version of the Cragg and Donald (1993) Wald statistic for underidentification and is discussed in Stock and Yogo (2005). Under the null hypothesis, the estimator is weakly identified. The test of overidentifying restrictions is based on the Sargan statistic. The null hypothesis is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation.

INSERT TABLES A1, A2, A3 ABOUT HERE

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Table 1. SUR estimates

	I - income	II - inst. quality	III - trade	IV - income	V - inst. quality	VI - trade
landlocked	-.388 (.173)**	-.071 (.033)**	-7.374 (9.02)	-.412 (.177)**	-.073 (.035)**	-9.831 (10.028)
latitude	3.113 (.456)***	..	..	2.606 (.617)***	..	..
oil dummy	.705 (.313)**	-.018 (.059)	19.692 (16.795)	.515 (.341)	-.016 (.069)	22.316 (19.867)
trade	.003 (.002)*	..	..	.004 (.002)***	..	..
institutional quality	3.073 (.404)***	..	..	2.587 (.421)***	..	..
malaria ecology	..	-.011 (.002)***	..	..	-.011 (.002)***	..
ethnic fragment.	..	-.069 (.051)	..	..	-.065 (.055)	..
legal UK	..	.168 (.026)***	..	..	.159 (.028)***	..
legal Germany	..	.244 (.075)***	..	..	.190 (.130)	..
legal Socialist	..	.087 (.065)	..	..	.092 (.078)	..
legal Scandinavia	..	.165 (.066)**	..	..	..	..
log population	..	..	-6.404 (2.732)**	..	..	-7.084 (3.157)**
log area	..	..	-7.566 (2.321)***	..	..	-6.961 (2.721)**
Observations	104	104	104	88	88	88

Notes: Estimation is by SUR. Standard errors in brackets. Estimates of the constant term in each equation not reported *, **, *** denote statistical significance at usual confidence levels.

Table 2. 3SLS estimates, full set of instruments

	I - income	II - inst. quality	III - trade	IV - income	V - inst. quality	VI - trade
landlocked	-.407 (.181)**	-.071 (.033)**	-7.380 (9.018)	-.441 (.185)**	-.073 (.035)**	-9.915 (10.029)
latitude	3.086 (.532)***	..	..	2.556 (.677)***	..	..
oil dummy	.695 (.316)**	-.018 (.059)**	19.600 (16.795)	.507 (.345)	-.017 (.069)	22.178 (19.867)
trade	.001 (0.003)	..	..	.002 (.003)	..	..
institutional quality	3.041 (.618)***	..	..	2.563 (.677)***	..	..
malaria ecology	..	-.011 (.002)***	..	..	-.011 (.002)***	..
ethnic fragment.	..	-.068 (.051)	..	..	-.062 (.055)	..
legal UK	..	.169 (.026)***	..	..	.161 (.029)***	..
legal Germany	..	.242 (.074)***	..	..	.186 (.130)	..
legal Socialist	..	-.089 (.065)	..	..	.093 (.078)	..
legal Scandinavia	..	.165 (.066)**	..	..	..	..
log population	..	..	-6.370 (2.730)**	..	..	-7.171 (3.156)**
log area	..	..	-7.540 (2.319)***	..	..	-6.835 (2.720)**
Observations	104	104	104	88	88	88

Notes: Estimation is by 3SLS. Standard errors in brackets. Estimates of the constant term in each equation not reported. The endogenous variables in the income equation are instrumented by all the exogenous variables. *, **, *** denote statistical significance at usual confidence levels.

Table 3. 3SLS estimates, selected instruments

	I - income	II - inst. quality	III - trade	IV - income	V - inst. quality	VI - trade
landlocked	-.314 (.188)*	-.073 (.032)**	-7.262 (9.021)	-.301 (.195)	-.073 (.034)**	-9.280 (10.038)
latitude	2.789 (.590)***	..	..	2.130 (.719)***	..	..
oil dummy	.751 (.320)***	-.018 (.059)	20.364 (16.810)	.608 (.354)*	-0.12 (.068)	23.758 (19.890)
trade	.002 (.003)	..	..	.003 (.003)	..	..
institutional quality	3.783 (.815)***	..	..	3.725 (.824)***	..	..
malaria ecology	..	-.011 (.002)***	..	..	-.011 (.002)***	..
ethnic fragment.	..	-.081 (.052)	..	..	-.085 (.057)	..
legal UK	..	.175 (.027)***	..	..	.167 (.0300)***	..
legal Germany	..	.223 (.078)***	..	..	.167 (.134)	..
legal Socialist	..	.080 (.066)	..	..	.083 (.080)	..
legal Scandinavia	..	.146 (.067)**	..	..	..	..
log population	..	..	-6.448 (2.797)**	..	..	-6.857 (3.249)**
log area	..	..	-7.907 (2.378)***	..	..	-7.828 (2.797)***
Observations	104	104	104	88	88	88

Estimation is by 3SLS. Standard errors in brackets. Estimates of the constant term in each equation not reported. The endogenous variables in the income equation are instrumented by malaria ecology, log population and log area. *, **, *** denote statistical significance at usual confidence levels.

Table A1. OLS estimates

	I - income	II - inst. quality	III - trade	IV - income	V - inst. quality	VI - trade
landlocked	-.380 (.179)**	-.073 (.034)**	-7.254 (9.246)	-.392 (.183)**	-.073 (.037)**	-9.278 (10.336)
latitude	3.081 (.469)***	..	..	2.517 (.641)***	..	..
oil dummy	.711 (.323)**	-.018 (.062)	20.368 (17.229)	.533 (.353)	-.013 (.073)	23.759 (20.480)
trade	.003 (.002)*	..	..	.004 (.002)**	..	..
institutional quality	3.160 (.416)***	..	..	2.810 (.437)***	..	..
malaria ecology	..	-.011 (.002)***	..	..	-.010 (.002)***	..
ethnic fragment.	..	-.076 (.054)	..	..	-.080 (.060)	..
legal UK	..	.177 (.028)***	..	..	.168 (.031)***	..
legal Germany	..	.228 (.080)***	..	..	.173 (.143)	..
legal Socialist	..	.085 (.070)	..	..	.087 (.085)	..
legal Scandinavia	..	.151 (.071)**	..	..	..	..
log population	..	..	-6.425 (2.867)**	..	..	-6.854 (3.346)
log area	..	..	-7.925 (2.437)***	..	..	-7.832 (2.880)
Observations	104	104	104	88	88	88

Notes: Estimation is by OLS pplied to each equation separately. Standard errors in brackets. Estimates of the constant term in each equation not reported *, **, *** denote statistical significance at usual confidence levels.

Table A2. 2SLS estimates, full set of instruments

	I - income	II - inst. quality	III - trade	IV - income	V - inst. quality	VI - trade
landlocked	-.405 (.186)**	-.073 (.034)**	-7.254 (9.246)	-.432 (.192)**	-.073 (.037)**	-9.278 (10.336)
latitude	3.065 (.550)***	..	..	2.543 (.707)***	..	..
oil dummy	.693 (.325)**	-.018 (.062)	20.368 (17.229)	.509 (.358)	-.013 (.073)	23.795 (20.480)
trade	.001 (.003)	..	..	.003 (.003)	..	..
institutional quality	3.051 (.639)***	..	..	2.583 (.697)***	..	..
malaria ecology	..	-.011 (.002)***	..	..	-.010 (.002)***	..
ethnic fragment.	..	-.076 (.054)	..	..	-.080 (.060)	..
legal UK	..	.177 (.028)***	..	..	.168 (.031)***	..
legal Germany	..	.228 (.080)***	..	..	.173 (.142)	..
legal Socialist	..	.085 (.070)	..	..	.087 (.084)	..
legal Scandinavia	..	.151 (.071)**	..	..	..	..
log population	..	..	-6.425 (2.867)**	..	..	-6.854 (3.346)**
log area	..	..	-7.925 (2.437)***	..	..	-7.832 (2.880)***
Observations	104	104	104	88	88	88
Under id test (p-value)	34.009 (0.000)	..	..	25.968 (0.000)	..	..
Weak id test	5.588	..	..	4.605	..	..
Over id test (p-value)	9.733 (0.136)	..	..	11.587 (.0409)	..	..

Notes: Estimation is by 3SLS. Standard errors in brackets. Estimates of the constant term in each equation not reported. The endogenous variables in the income equation are instrumented by all the exogenous variables. The Stock-Yogo weak id test critical value at 10% is 10.22 for the regression in column I and 9.92 for the regression in column IV. *, **, *** denote statistical significance at usual confidence levels.

Table A3. 2SLS estimates, selected set of instruments

	I - income	II - inst. quality	III - trade	IV - income	V - inst. quality	VI - trade
landlocked	-.312 (.166)*	-.073 (.034)**	-7.254 (9.246)	-.299 (.158)*	-.073 (.037)**	-9.278 (10.336)
latitude	2.752 (.521)***	..	..	2.059 (.590)***	..	..
oil dummy	.774 (.221)**	-.018 (.062)	20.368 (17.229)	.553 (.251)**	-.013 (.073)	23.795 (20.480)
trade	.002 (0.003)	..	..	.003 (.003)	..	..
institutional quality	3.797 (.800)***	..	..	3.715 (.783)***	..	..
malaria ecology	..	-.011 (.002)***	..	..	-.010 (.002)***	..
ethnic fragment.	..	-.076 (.054)	..	..	-.080 (.060)	..
legal UK	..	.177 (.028)***	..	..	.168 (.031)***	..
legal Germany	..	.228 (.080)***	..	..	.173 (.142)	..
legal Socialist	..	.085 (.070)	..	..	.087 (.084)	..
legal Scandinavia	..	.151 (.071)**	..	..	..	..
log population	..	..	-6.425 (2.867)**	..	..	-6.854 (3.346)**
log area	..	..	-7.925 (2.437)***	..	..	-7.832 (2.880)***
Observations	104	104	104	88	88	88
Under id test (p-value)	28.027 (0.000)	..	..	24.813 (0.000)	..	..
Weak id test	18.685	..	..	16.175	..	..
Over id test (p-value)	0.324 (0.569)	..	..	.019 (.890)	..	..

Estimation is by 3SLS. Standard errors in brackets. Estimates of the constant terms not reported. The endogenous variables in the income equation are instrumented by malaria ecology, log population, and log area. The Stock-Yogo weak id test critical value at 10% is 13.43. *, **, *** denote statistical significance at usual confidence levels.