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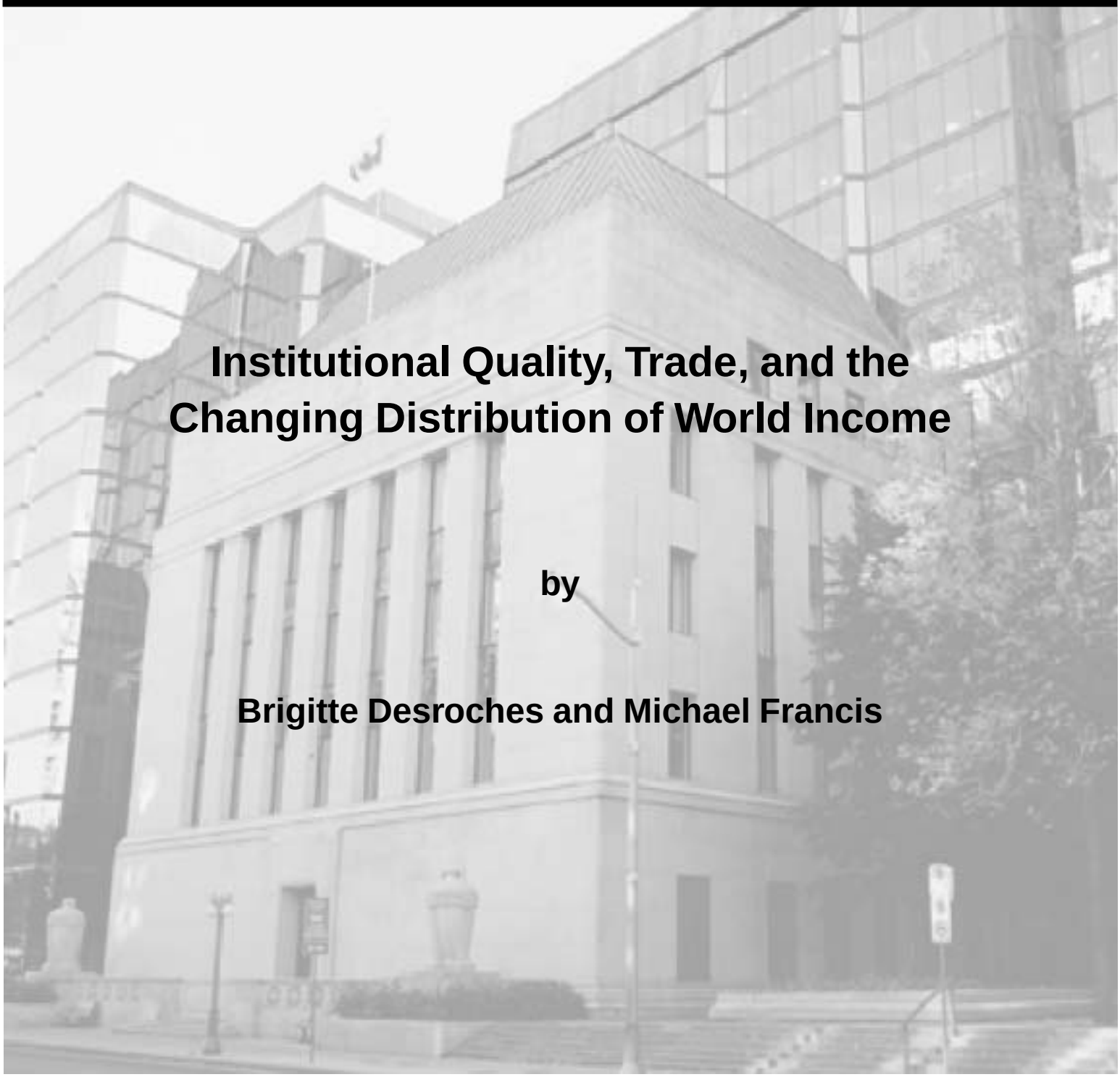

Institutional Quality, Trade, and the Changing Distribution of World Income

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Contents

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Abstract

Conventional wisdom holds that institutional changes and trade liberalization are two main sources of growth in per capita income around the world. However, recent research (e.g., Rigobon and Rodrik 2004) suggests that the Frankel and Romer (1999) trade and growth finding is not robust to the inclusion of institutional quality. In this paper, the authors argue that this "trade and growth puzzle" can be explained once institutional quality is acknowledged as a determinant of the willingness to save and invest, and hence acknowledged as a determinant of long-run comparative advantage. The paper consists of two parts. First, the authors develop a theoretical model which predicts that institutions determine a country's underlying comparative advantage: countries that have good institutions will tend to export relatively more capital-intensive (or sophisticated) goods compared with countries that have poor institutions; trade can magnify the effect of institutional quality on income, leading to greater income divergence than if countries remain in autarky. Second, using a panel of over eighty countries and twenty years of data, the authors find empirical support for their hypotheses.

JEL classification: F11, F15, O11, P48
Bank classification: International topics; Development economics

Résumé

Les changements institutionnels et la libéralisation des échanges sont généralement considérés comme deux grandes sources de la croissance du revenu par habitant dans le monde. Cependant, des travaux récents (p. ex., Rigobon et Rodrik, 2004) indiquent que le lien positif établi par Frankel et Romer (1999) entre commerce et croissance s'estompe si l'on tient compte de la qualité des institutions. Selon les auteurs de l'étude résumée ici, cette « énigme du commerce et de la croissance » peut être résolue dès lors qu'on reconnaît que la qualité des institutions est l'un des déterminants de la propension à épargner et à investir, et donc l'un des déterminants d'un avantage comparatif durable. La première partie du document est consacrée à l'élaboration d'un modèle théorique où l'avantage comparatif sous-jacent d'un pays dépend des institutions de celui-ci. Selon ce modèle, les États dotés de bonnes institutions tendent à exporter des biens d'une intensité capitalistique (complexité) relativement plus élevée que les États ayant de faibles institutions. Le commerce pouvant amplifier l'effet que la qualité des institutions a sur le revenu, il accentue à terme les disparités de revenu qui auraient été observées si les nations étaient restées autarciques. Dans la deuxième partie, les auteurs se livrent à une analyse des données de plus de 80 pays couvrant une période de 20 ans; leurs résultats corroborent leurs hypothèses.

Classification JEL : F11, F15, O11, P48
Classification de la Banque : Questions internationales; Économie du développement

1. Introduction

Conventional wisdom holds that institutional changes and trade liberalization are the two main factors behind the growth experiences of fast-growing economies, such as China and India. However, recent empirical research suggests that the channel through which trade affects income is still not well understood. For example, consider the Frankel and Romer (1999) finding that trade contributes positively to growth. While some authors continue to find evidence that this result holds (see, for example, Lee, Ricci, and Rigobon 2004, or Dollar and Kraay 2004), it is increasingly being challenged. Research by Rigobon and Rodrik (2004), for example, suggests that the "trade and growth" finding is not robust to the inclusion of institutional quality, while Rodrik, Subramanian, and Trebbi (2002) find that trade may even have a weakly negative affect on the level of income when institutional quality is controlled for in cross-country income regressions.

Other research, such as by Slaughter (2001) and Dutt and Mukhopadhyay (2005), suggests that trade liberalization is a source of income divergence among countries, which would seem to link trade to the well-known Pritchett (1997) finding that per capita income levels between the richest and poorest nations diverged dramatically between 1870 and 1985. As a result, it is not clear empirically to what extent trade liberalization is the underlying contributor to the recent performance of fast-growing poor countries, which we consider to be somewhat of a puzzle.

Interestingly, there is no strong theoretical reason for presuming that trade liberalization should have a positive impact on income in all countries.[1] Indeed, although an extensive theoretical literature (see Baldwin 1992 and Findlay 1995, for example) suggests that factor accumulation is strongly influenced by trade and the long-run determinants of comparative advantage, this literature does not suggest that trade should lead to dynamic income gains among all trading partners. Rather, the effect of trade on income is predicted to depend on a country's comparative advantage. If a country has a comparative advantage in capital-intensive production, then these models of trade and dynamic factor

[1] This paper is positive in nature. We do not consider welfare effects; hence, the usual arguments regarding welfare gains from trade are not explored.

accumulation suggest that trade will result in increases in income levels over time. On the other hand, for a country with a comparative advantage in labour-intensive production, these models suggest that trade may encourage a rundown in the capital stock. Thus, standard trade theory provides an important first step towards understanding the relationship between trade and the changing distribution of world income, as well as some guidance as to how empirical models could be better specified to capture the effects that traditional theory predicts.

The key question is what determines long-run comparative advantage. A rapidly growing literature that offers to tie the pieces of the puzzle together suggests that, in addition to its effect on long-run income levels, institutional quality plays an important part in determining comparative advantage. According to North,

> Institutions are the humanly devised constraints that structure human interaction. They are made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behaviour, conventions, and self imposed codes of conduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies. Institutions and the technology employed determine the transaction and transformation costs that add up to the costs of production. (North 1990)

Since costs and incentives shape the production structure of the economy, institutions help determine a country's comparative advantage.

Institutions are well known to be particularly important in governing the behaviour of participants in financial markets that channel savings to investment opportunities. Problems of asymmetric information and conflict of interest between borrowers and lenders abound in these markets, resulting in potentially severe "agency costs." From our point of view, good institutions, by mitigating these agency costs, can ultimately lower

the costs of capital-intensive production and thus determine whether a country becomes capital abundant, and hence this can affect a country's comparative advantage.

We are not alone in highlighting the importance of institutions as a determinant of comparative advantage. For example, Nunn (2005) develops, and finds empirical support for, a static model of trade with incomplete contracts, which predicts that countries with better contracting environments should specialize in the production of goods that require relationship-specific investments. Similarly, using a static Heckscher-Ohlin model, Levchenko (2004), posits that contract enforcement may be a key determinant of comparative advantage.[2]

In this paper, however, we use the link between institutions and comparative advantage in an attempt to offer a solution to the trade and income puzzle. Our story involves two steps. First, it demonstrates that institutions determine the cost of specializing in capital-intensive production and are therefore a determinant of comparative advantage and long-run income levels. In particular, we argue that countries that have good institutions will enjoy a lower cost of capital (and hence a comparative advantage in capital-intensive production) and higher income levels than countries that have poor institutions. Second, it follows that trade liberalization should be expected to magnify the effects of institutions on capital accumulation and income. Specifically, via the Stolper-Samuelson effect, in economies that have good (bad) institutions, trade liberalization will raise (lower) the return to capital in the short run and, over time, encourage (discourage) capital accumulation and specialization in capital-intensive production. Consequently, we should expect trade liberalization to generate greater increases in income in countries that have better institutions compared with countries that have weak institutions.

Our paper is organized as follows. To provide a framework to support our hypothesis, section 2 develops a theoretical model that links institutional quality, comparative advantage, trade, and income distribution. This model formally demonstrates that, first,

[2] Antràs (2003) also makes an important contribution to this literature. He incorporates an incomplete contracting, property rights model of the firm into a standard monopolistic competition trade model to explain the determinants of intra-industry trade.

institutional quality can act as an underlying determinant of comparative advantage. Interestingly, our model also predicts that countries can be ranked in such a way that countries that have good institutions will tend to export relatively more capital-intensive (or sophisticated) goods compared with countries that have poor institutions. This ranking is consistent with the concept of a chain of comparative advantage as proposed by Jones (1965) and Deardorff (1979), and Bhagwati's (1997) ladder of comparative advantage. Second, through the process of specialization, our model demonstrates how trade magnifies the effects of institutional quality on income, and hence the mechanism through which trade can explain differences in income levels across economies.

The third section of our paper is empirical. To test our hypothesis, we deal with two points separately. First, we look for, and find, evidence that institutional quality determines comparative advantage. To do this, we use a technique developed by Kwan (2002) to develop an index of export sophistication. This approach has been used by Desroches, Francis, and Painchaud (2004) and by Hausmann, Hwang, and Rodrik (2005) to rank countries in the chain or ladder of comparative advantage. We find that once the level of a country's openness is controlled for, that institutional quality is positively associated with having a comparative advantage in relatively sophisticated goods. Second, we estimate transitional growth equations in search of evidence that trade liberalization positively affects income conditional on the quality of institutions. Our results, which are robust to the choice of estimation technique, confirm our hypothesis and thus help to make light of Slaughter's (2001) finding of income divergence among trade liberalizers. Moreover, we believe that our framework provides a simple way to rationalize the "trade" variable's failure to perform consistently in traditional growth equations. A final section concludes.

2. The Theory

Following the work of Manning (1981), Manning, Markusen, and Melvin (1993), Baxter (1992), Findlay (1995), and Brecher, Chen, and Choudhri (2002), our model combines a neo-classical Ramsey (exogenous) growth model with a standard neo-classical trade

framework. However, there are two main differences between the model developed here and that developed elsewhere in the literature. First, we allow for cross-country differences in rental rates owing to differences in institutional quality. Second, making use of the Heckscher-Ohlin model developed by Dornbusch, Fischer, and Samuelson (1980) (hereafter denoted DFS), we extend the analysis to a two-country, many-goods framework.

2.1 The autarkic economy

To start with, we consider the case of an autarkic economy in which institutional quality plays a role in determining equilibrium factor prices and hence the country's underlying comparative advantage. We leave for the next subsection the question of how the movement from autarky to free trade between two economies affects steady-state income. Thus, we consider (in this subsection) a closed economy that produces a continuum of consumption goods indexed by z, $0 \leq z \leq 1$, and a capital good denoted by the letter c. All goods are produced according to a neo-classical constant-returns-to-scale production function using capital, K, and labour, L. Letting $y(z)$ and $k(z)$ denote output and capital per worker used in production of good z, and similarly for $y(c)$ and $k(c)$, we write,

$$y(z) = f_z(k(z)) \tag{1}$$

and

$$y(c) = f_c(k_c). \tag{1a}$$

Following DFS, the consumption goods are indexed in order of capital intensity, with zero being the most capital intensive and one being the most labour intensive. There are no factor-intensity reversals.

Firms

Operating in a perfectly competitive market, firms hire capital and labour so as to equate the value of their marginal products with the market rental and wage rates, respectively. Letting $p(z)$ denote the price of good z, and R and W be the market rental and wages rates, we have,

$$p(z) f_z'(k(z)) = R\,, \tag{2}$$

$$p(z)[f_z(k(z)) - k(z) f_z'(k(z))] = W\,, \tag{3}$$

with similar equations for the capital-producing sector.

Theft

In order to introduce institutional quality into this framework, we assume that a fraction of capital earnings, (1-a), is stolen by firm managers. Firm managers do not anticipate that their actions affect market prices in any way and treat the proceeds of theft as a lump-sum transfer, *T*. As a result, capital owners (who may also be managers or workers) receive a return on capital equal to a of capital's marginal product. That is,

$$\hat{R} = aR\,. \tag{4}$$

We posit that the value of a ($0<a=1$) depends positively on the quality of institutions designed to protect the rights of investors.[3, 4]

Households

A key feature of our model is that we incorporate household savings into our model. Thus, we allow households to optimally choose their consumption bundles in each period

[3] This approach mirrors the traditional approach of introducing the distortionary effects of capital taxation (see Blanchard and Fischer 1989). It is assumed that managers do not take into account the aggregate impact that they have on the return to capital and hence the representative household does not "internalize" the distorting pecuniary externality that theft causes. This is simply one of many ways in which poor institutions could conceivably be introduced into the Ramsey model. We could also assume that managers compete for the rents from theft, with the result that a part of the economy's endowment of labour is used up in rent-seeking activities; however, this would not significantly change our results. An alternative approach would involve modelling the theft of capital earnings as an optimizing behaviour of managers faced with imperfect monitoring (see, for example, Johnson et al. 2000). Yet another approach is taken by Linder and Strulik (2004), who assume that private property rights over final output are absent and thus treated as an open-access good in the Ramsey model. This assumption, like ours, results in excessive consumption and suboptimal savings.

[4] Institutional quality may be endogenous (see IMF 2005 for a discussion), and the decision to adopt and enforce property rights may be a function of openness (see, for example, Francis 2005). Although our empirical section takes endogeneity problems into account, the objective of this paper is to illustrate that institutional quality is a determinant of comparative advantage and hence the long-run level of income. The assumptions in our theory section are made with this objective in mind.

and their level of savings. Specifically, we follow DFS and assume that the instantaneous utility function, U, takes the form $U = \int_0^1 b(z)[\ln d(z)]dz$, where $b(z)$ is the expenditure share and $d(z)$ is the per capita consumption demand for good z.[5] In addition to choosing their consumption in each period, we allow for household savings. In keeping with the Ramsey model of optimal savings, we assume that, subject to the household budget constraint, which requires the sum of consumption expenditure and savings to equal income, the infinitely lived representative household maximizes the present value of utility from consumption of the continuum of consumption goods. Thus, the representative household maximizes $\int_0^\infty e^{-rt}Udt$ subject to the constraint that $\int_0^1 p(z)d(z)dz + p(c)\dot{k} - p(c)nk = W + \hat{R}k + T$, where r is the rate of time preference, k is the per capita capital stock, $\dot{k}$ is the accumulation of capital per capita, n is the population growth rate, $\hat{R}$ is the nominal return on capital realized by the household, and T represents transfers to the household from the theft of rental payments.[6]

Steady state

In steady state, the Ramsey rule for intertemporal optimization arising from the households' maximization problem implies that $\hat{R}/p(c) = r + n$. As a result, substituting using equations (2) and (4), we obtain a variation on the Ramsey rule for optimal savings,

$$f_c'(k(c)) = (r + n)/a \ . \qquad (5)$$

Equation (5) is the key equilibrium condition upon which the rest of the equilibrium conditions for the economy depend. Equation (5) solves uniquely for $k(c)$, and hence together with (2) and (3) it can be determined that (5), in turn, also solves for the equilibrium wage to rental ratio, which we shall denote by s :

[5] By ensuring that the utility function is homothetic, we can focus on the problem of the representative household.

[6] In setting up our problem we take prices as fixed. This is a shortcoming of our approach, because it does not take into account endogenous changes in the price of capital and hence the prospect of capital gain. However, our objective is to focus on the steady state in which prices are constant.

$$s \equiv W / R = \frac{[f_c(k(c)) - k(cf_c'(k(c))]}{f_c'(k(c))}. \qquad (6)$$

It follows that that an improvement in the quality of institutions (i.e., a higher value of a) results in a higher wage to rental ratio. With the wage to rental ratio determined, equation (6a) determines the equilibrium value of $k(z)$ for all z:

$$s = \frac{[f_z(k(z)) - k(z) f_z'(k(z))]}{f_z'(k(z))}. \qquad (6a)$$

With wages, rental rates, and the factor intensities of production all determined by the Ramsey rule, unit production costs are also determined, and thus the competitive supply price in each industry follows from the zero-profit condition $p(z)Y(z) = [WL(z)+RK(z)]$. Relative prices of good z in terms of good z' can therefore be written as follows:

$$\frac{p(z)}{p(z')} = \frac{a(z)(s + k(z))}{a(z)(s + k(z'))}, \qquad (7)$$

where a_z is the unit labour requirement for good z, $a_z = 1/[f_z(k(z))]$.

The equilibrium for the diversified autarkic economy can be illustrated most simply using the Lerner-Pearce diagram. We show for convenience just two consumption goods and the one capital good, but there is a continuum of consumption goods (which we avoid illustrating so as to not clutter our diagram!). In Figure 1, the parameters r and a solve for the wage to rental ratio and fix the slope of the unit isocost line, labelled AA′. In autarky, when all goods are domestically produced, the relative price of each must adjust to ensure equilibrium. Thus, the relative price of, say, good i will adjust, shifting the unit isoquant inwards (as p_i rises) or outwards (as p_i falls), until such time as losses or profits, respectively, have been eliminated and the unit isoquant, Vi, is just tangent to the unit isocost AA line. The resulting set of equilibrium relative prices is the only set of prices that is consistent with the long-run competitive supply of all goods in the domestic economy. The resulting equilibrium capital to labour ratios in each sector are also

illustrated as the ray from the origin to the tangency point on AA′ (e.g., by $k(1)$ for good 1).

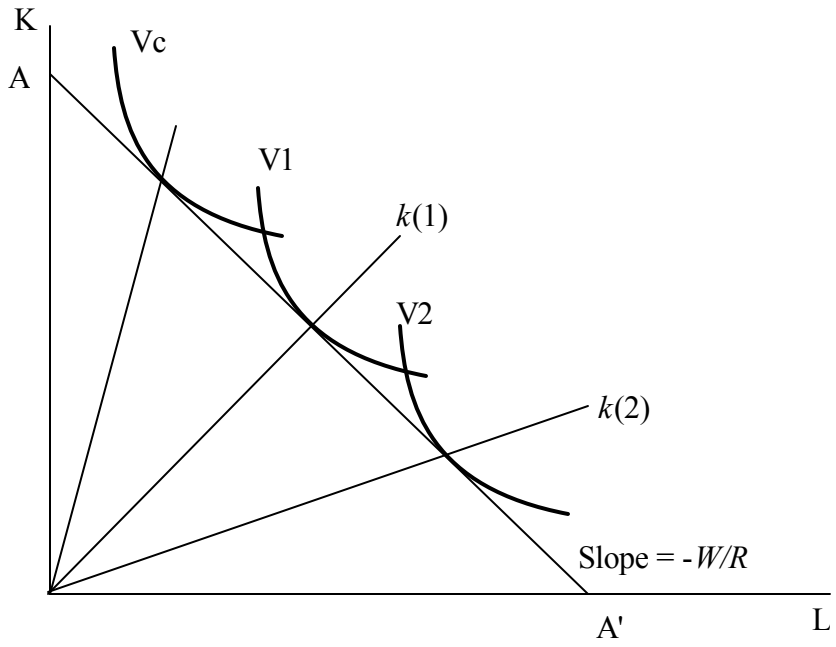


Figure 1: The Lerner-Pearce Diagram

An interesting aspect of these types of models is that, since capital is endogenous, the labour constraint is the only binding resource constraint in the long-run equilibrium. Making use of Jones's (1965) analysis of the standard Heckscher-Ohlin model, the long-run production possibility constraint for the economy can be determined from the labour constraint, $\int_0^1 L(z)dz + L(c) = L$, and the unit labour requirement, $a(z)$, $a(c)$, for each good. That is, the production possibilities frontier is defined by the following constraint:

$$L = \int_0^1 a(z)Y(z)dz + a(c)Y(c)dz .$$

Next, we make use of the zero-profit conditions and the labour constraint to determine the equilibrium capital to labour ratio employed in the non-capital-producing sector. We use the subscript T to denote the non-capital, consumption-goods-producing sector (later this will be the traded goods sector). Zero profit requires that expenditure on a good equal

the cost of production. That is, $b(z)[WL_T + RK_T] = [WL(z)+RK(z)]$, or $\frac{L(z)}{L_T} = \frac{b(z)[s + k_T]}{[s + k(z)]}$. Combining this with the labour constraint facing the non-capital-producing sector, $\int_0^1 L(z)dz = L_T$, gives:

$$\int_0^1 \frac{b(z)[s + k_T]}{[s + k(z)]} dz = 1. \qquad (8)$$

Clearly, with σ and $k(z)$ fixed by the Ramsey rule, equation (8) solves for k_T.

A similar manipulation of the capital constraint gives

$$\int_0^1 \frac{b(z)}{[s + k(z)]} [k_T - k(z)]dz = 0. \qquad (8a)$$

This leaves us to determine the equilibrium size of the capital stock for the economy (and implicitly the equilibrium outputs of the economy). In steady state, $f_c(k(c))L(c)/L = nk$. Making use of the capital constraint, $k_T \frac{L_T}{L} + k_c \frac{L_c}{L} = k$, and the fact that $\frac{L_T}{L} = \frac{L - L_c}{L}$,

$$k = \frac{f_c k_T}{f_c - n(k_c - k_T)}, \qquad (9)$$

the right-hand side of which must be positive in the steady state, because output of the capital-producing sector must be greater than the capital requirements of the capital sector itself.

This completes the description of the autarkic steady-state equilibrium. We next perform some simple comparative statics.

Comparative statics in the autarkic economy

It is instructive at this point to consider the effect of a change in institutional quality. Suppose that institutional quality improves to $a' > a$. In the short run, with a fixed stock of capital, the benefits of a fall in α accumulate to the owners of the fixed factor. As such, there is no immediate pressure for firms to change the factor intensity of production. However, with $f_c'(k_c) > r/a'$, there is now an incentive to save. Households therefore increase their savings, resulting in an expansion in the capital stock. As is well known from the Rybczynski theorem, the capital-intensive sectors of the economy would (on the whole) expand at the expense of the labour-intensive sectors. Meanwhile, as capital accumulation results in increased GDP, the assumption of homothetic tastes ensures that the demand for all goods would rise proportionately. Thus, in an autarkic economy, the price of capital-intensive goods would have to fall relative to the price of labour-intensive goods to restore equilibrium in the goods market. The change in relative price reduces the demand for capital relative to labour, producing a Stolper-Samuelson result, which lowers the rental rate on capital relative to the wage rate. The process continues until $f_c'(k_c') = r/a'$. The following proposition summarizes the results.

Proposition 1: An increase in α results in an increase in k_T, k, and s, and a change in relative prices such that $p(z_i)/p(z_j)$, $z_i<z_j$, falls (that is, the price of capital-intensive consumption goods falls relative to the price of labour-intensive consumption goods).
Proof: See Appendix A.

2.2 Free trade equilibrium in a North–South model: comparative advantage and the pattern of trade

In this section, we introduce a second country to examine how trade between two countries with different levels of institutional quality affects steady-state income. We shall refer to the country with better institutions as the North and the other country as the South, denoted by the superscripts *N* and *S,* respectively. For convenience, we assume that institutional quality (i.e., the value of a) is the only difference between the two countries. From Proposition 1, we know that in autarky, $s^N > s^S$ and

$(p(z_i)/p(z_j))^N < (p(z_i)/p(z_j))^S$, $z_i<z_j$. Thus, we have the following corollary to Proposition 1:

Corollary (comparative advantage): in the autarkic equilibrium, the North has a comparative advantage in capital-intensive production compared with the South.

Moreover, since the value of s is fixed by the choice of a and r, the equilibrium values of s will be unaffected in the long run by the nature of the trading regime. Consequently, under free trade, the pattern of trade will be consistent with the "chain of comparative advantage" as proposed by Jones (1956–57) and Bhagwati (1972), and rigorously analyzed by Deardorff (1979). When countries face different real rental rates, Deardorff (1979) explains that the neo-classical trade model predicts that, under free trade conditions, the resulting pattern of trade could be described as a "chain of goods ranked by capital intensity, … broken into segments, one for each country, and the segments are ordered identically with the relative capital abundance of the countries" (Deardorff 1979, 204).[7]

Given that firms in countries with better economic institutions can be expected to face lower rental rates, our framework offers a simple explanation of how the ranking of countries is determined and predicts that countries with good institutions will find themselves specialized in the production of capital-intensive (or more sophisticated) exports relative to those with weak institutions.[8]

To illustrate, consider Figure 2. The North's isocost line is illustrated by the line AA', while the South's is illustrated by BB'. Lying along AA' is the set of tangency points between the isocost and isoquants for each good produced in the North, and, similarly,

[7] For the purposes of this paper, the country ordering offered by Deardorff's "chain of comparative advantage" is referred to as the "ladder of comparative advantage," with countries that have the highest capital to labour ratio, and that therefore specialize in the production of those goods with the highest capital intensity, at the top of the ladder, and those that have a low capital to labour ratio at the bottom.

[8] For the interested reader, the theoretical foundations of the paper are explained in more detail in Appendix A.

lying along BB' is the set of tangency points for each good produced in the South. We next consider trade. Since the capital good is non-traded, we consider trade only in the continuum of consumption goods, z. When trade is permitted, Deardorff's analysis tells us that production will be broken up into two distinct segments determined by the intersection of AA' and BB', at point M, with the North specializing in capital-intensive production along AM and labour-intensive production occurring in the South with the equilibrium tangencies lying along MB'. Trade therefore involves the North specializing in capital-intensive goods z, $0 \le z \le \bar{z}$, and the South specializing in the production of z, $\bar{z} \le z \le 1$.

Corollary: (the pattern of trade): under free trade, the North specializes in the production of capital-intensive goods and the South in labour-intensive goods.

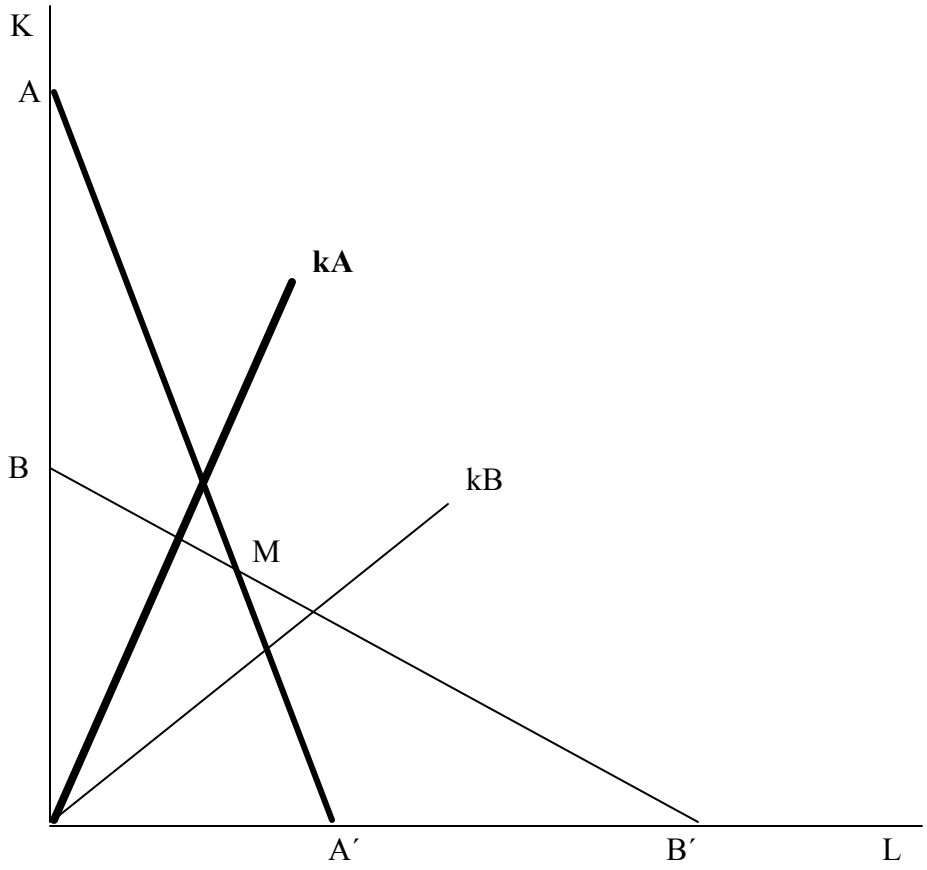


Figure 2: The Pattern of Trade

The "borderline" good, $\bar{z}$, (illustrated by point M) is determined by the interaction of supply and demand. As was illustrated above, the supply-side parameters for each economy (the equilibrium wage to rental ratios, sectoral capital to labour ratios, and unit costs) are determined by the quality of institutions. The demand side determines the equilibrium outputs in each country and the overall size of the capital stock consistent with those demands.

To complete the description of the free trade equilibrium, it remains for us to determine the equilibrium values of k_T , $\bar{z}$, and k for each country. First, consider the North. The equilibrium capital and labour constraints can be written as follows:

$$K^N = \int_0^{\bar{z}} c^N(z)b(z)(W^N L_T^N + R^N K_T^N + W^S L_T^S + R^S K_T^S)/\, p(z)dz\,,$$
$$L^N = \int_0^{\bar{z}} a^N(z)b(z)(W^N L_T^N + R^N K_T^N + W^S L_T^S + R^S K_T^S)/\, p(z)dz\,, \qquad (10)$$

or alternatively as,

$$1 = \int_0^{\bar{z}} c^N(z)b(z)(W^N L_T^N + R^N K_T^N + W^S L_T^S + R^S K_T^S)/[K_T^N\, p(z)]dz\,, \qquad (11a)$$

$$1 = \int_0^{\bar{z}} a^N(z)b(z)(W^N L_T^N + R^N K_T^N + W^S L_T^S + R^S K_T^S)/[L_T^N\, p(z)]dz\,. \qquad (12a)$$

Subtracting (11a) and (12a) from one another and dividing through by world expenditure on traded consumption goods gives,

$$0 = \int_0^{\bar{z}} [a^N(z)b(z)/\, L_T^N - c^N(z)b(z)/\, K_T^N]/\, p(z)dz\,.$$

This, after some rearranging, gives,

$$0 = \int_0^{\bar{z}} \frac{b(z)}{s^N + k^N(z)}(k_T^N - k^N(z))dz \qquad (13)$$

for the North. And, by similar reasoning, we get

$$0 = \int_{\bar{z}}^{1} \frac{b(z)}{s^{S} + k^{S}(z)} (k_T^S - k^S(z)) dz \qquad (14)$$

for the South.

As with the autarkic case, equations (13) and (14) solve for k_T^N and k_T^S. However, in this case the equilibrium value of each will depend on the value of $\bar{z}$, which is determined by the requirement that trade be balanced,

$$\int_0^{\bar{z}} (W^N L_T^N + R^N K_T^N) b(z) dz = \int_{\bar{z}}^{1} (W^S L_T^S + R^S K_T^S) b(z) dz \,. \qquad (15)$$

The total stock of capital for each country follows from (7) as

$$k^j = \frac{f_c k_T^j}{f_c - n(k_c - k_T^j)}, \qquad j = N, S. \qquad (16)$$

2.3 Trade liberalization

Having formally illustrated one way in which institutional quality may work to determine the capital intensity or sophistication of a country's exports, and how institutional quality leads to a ranking of countries according to their comparative advantage, we turn to the next key question in our paper: How does trade liberalization affect steady-state income? An important feature of our model is the fact that the equilibrium wages to rental ratio, and the capital intensity of production for each good *z*, remain unchanged as a result of a movement from autarky to free trade. What does change when trade takes place is the range of goods produced, and the overall capital stock. Intuitively, one would expect that moving from autarky to free trade would induce capital accumulation in the North (since the North specializes in capital-intensive production) and a rundown of the capital stock in the South (since the South specializes in labour-intensive production).

Formally, we have the following proposition:

Proposition 2 (impact of trade): Under free trade, the steady-state capital stock in the North (South) is higher (lower) than in autarky.

Proof:
A comparison of equation (8a) with (13) and (14) suggests that to determine the effect of trade liberalization in the North requires considering how the value of k_T^N changes when the range of goods produced in the North falls from all goods to a subset of capital-intensive goods.

Thus, to prove Proposition 2, let the range of goods produced in the North be denoted $0 \le z \le z^N$, and differentiate (13) to see how k_T^N changes when z^N falls from 1 to $\bar{z}$.

Totally differentiating (13),

$$\frac{dk_T^N}{d\bar{z}} = \frac{b(\bar{z})/(s^N + k^N(\bar{z}))}{\int_0^{\bar{z}} [b(z)/(s^N + k^N(z))]dz}[k^N(\bar{z}) - k_T^N] < 0, \qquad (17)$$

which is negative, given that the capital to labour ratio of the most labour-intensive traded good produced in the North must be less than the North's aggregate capital to labour ratio of the traded-goods sector. This implies that as z^N falls from 1 to $\bar{z}$, k_T^N rises.

Similarly, with the South being specialized in the production of labour-intensive goods, let $z^S \le z \le 1$ denote the range of goods produced in the South. It follows that

$$\frac{dk_T^S}{d\bar{z}} > 0, \qquad (18)$$

which implies that as z^S rises from 0 to $\bar{z}$, k_T^S falls. In other words, moving from autarky to free trade results in capital accumulation in the North and a rundown of the capital stock in the South.[9]

3. Institutions, Comparative Advantage, Trade, and Transitional Growth: The Empirics

This section of our paper is empirical. In keeping with the previous section, we first look for empirical evidence that institutional quality is a determinant of a country's underlying comparative advantage. We then ask whether there is empirical evidence that trade liberalization interacts with institutional quality to affect the level of per capita income in the non-linear manner we predict. That is, we ask whether trade liberalization contributes to (detracts from) short- to medium-term growth in per capita GDP in countries that have relatively good (weak) institutions, as is predicted in our model from the previous section. In doing so, we also examine whether there is evidence that improvements in institutional quality contribute to short-run growth.

3.1 Comparative advantage and institutional quality

In this section, we examine the proposition that institutional quality is an underlying determinant of comparative advantage. To test this proposition, we use scores of export sophistication based on Kwan (2002) (see also Hausmann, Hwang, and Rodrik 2005). The export sophistication index (ESI) provides a score that reflects a country's relative position in the chain of comparative advantage – a higher score reflects exports of greater sophistication than goods with a lower score.[10] We then use this ranking to test whether better institutions are associated with higher levels of export sophistication.

[9] It should be stressed that our results do not imply that trade immiserizes the South. In the short run (not analyzed in our model), both countries enjoy the usual, static gains from trade. In the long run, the cost of lower GDP is offset to some degree by gains in terms of higher consumption (a lower savings rate) in the transition to the new steady state. Thus, we posit that, although the South ends up in a steady state with lower per capita GDP, the present value of welfare may have increased. A rigorous treatment of this issue would require an examination of welfare along the saddle path to the free trade equilibrium following trade liberalization. Such an analysis, while interesting, is beyond the scope of this paper.

[10] The ESI scores used in this paper are from Desroches, Francis, and Painchaud (2004).

The export sophistication score for a country is determined in two steps. The first step involves calculating a product sophistication index (PSI) for each good traded in the global economy (DFP use 3-digit SITC trade data).[11] The PSI number for each good reveals the expected per capita GDP of countries that export that good. Goods with low (high) PSI scores tend to be exported by countries with low (high) per capita GDPs. That is, the PSI for good j is as follows:

$$PSI_j = \sum_i x_{ij} PCGDP_i ,$$

where x_{ij} is country i's share of world exports in good j.

These data are then used to calculate ESI scores for each country in the data set. The ESI score for each country is simply the mean PSI value of its exports.[12] That is, for country i,

$$ESI_i = \sum_j y_{ij} PSI_j ,$$

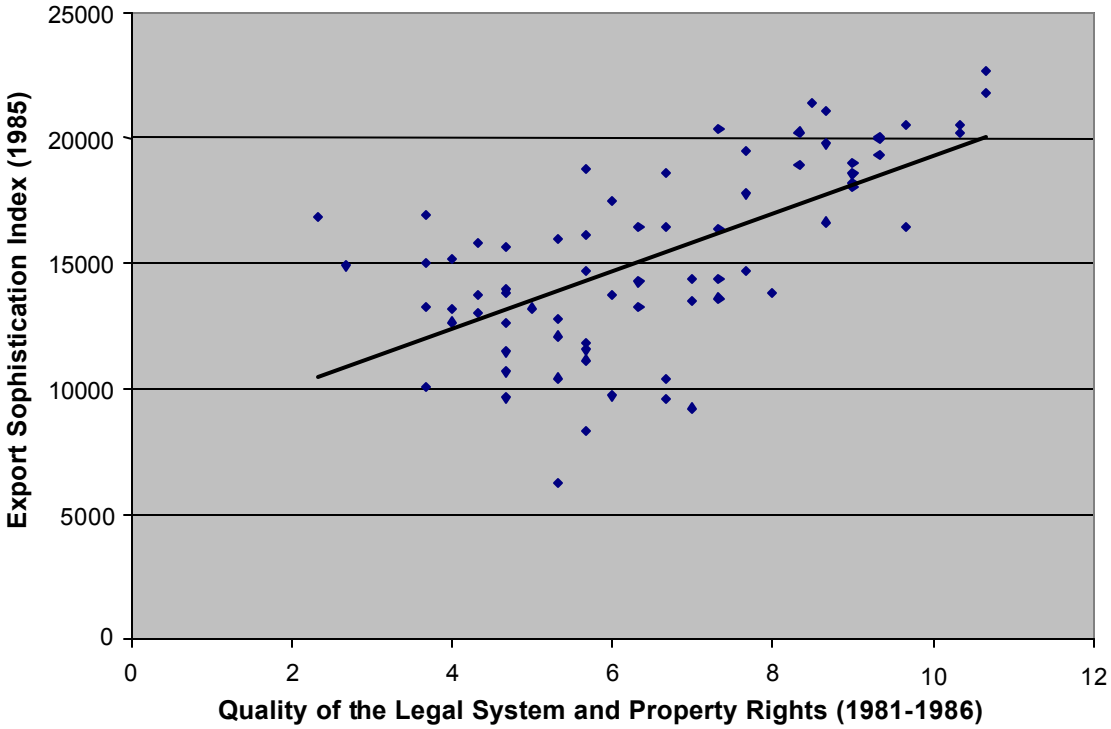
where y_{ij} is the share of good j in country i's total exports.

Figure 3 illustrates a simple scatter plot of ESI against the quality of the legal system and property rights, and the quality of investor protection. Interestingly, Figure 3 suggests that institutions may shape the nature of comparative advantage in the manner that we predict. It is, however, by no means conclusive – obviously, we would like to control for other factors that may be correlated with institutional quality, such as per capita GDP. To this end, we estimate a simple instrumental variables regression of the following form:

$$\ln(ESI_{i,t}) = f_1 + f_2 X_{1i,t} + f_3 y_{i,t} + f_4 Z_{i,t} + f_5 time , \qquad (3.1a)$$

where $X1_{i,t}$ is a measure of institutional quality in country i at time t; $y_{i,t}$ is log per capita GDP in country i at time t; $Z_{i,t}$ is a measure of human capital (average years of secondary schooling); and *time* is a time dummy.

[11] This methodology is based on Kwan (2002).
[12] The reader is directed to Desroches, Francis, and Painchaud (2004) and Kwan (2002) for more details on the calculation of PSI and ESI scores.



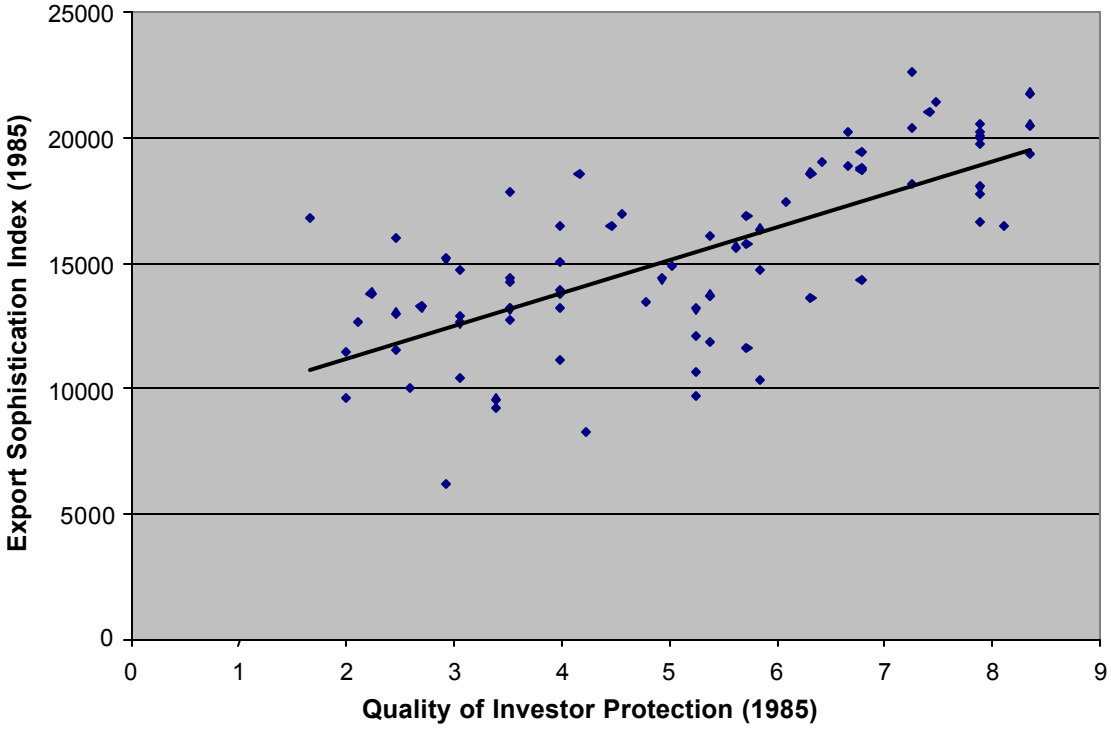


Figure 3: ESI vs. Institutional Quality

Our theory predicts that the sign on institutional quality should be positive. However, we may also want to take into account each country's openness (defined as imports plus exports as a share of GDP) and, more importantly, the interaction between openness and institutional quality. The latter term is important because we use an export-based measure to reveal comparative advantage. In the presence of tariffs (or other trade restrictions), one would expect the range of goods that a country exports to become broader, as the economy becomes more open, and this should affect its ESI score in a systematic manner. In the case of a relatively closed economy with a comparative advantage in sophisticated goods (say, as the economy is opened up), one would expect the range of goods that it exports to expand from being only those in which it has the greatest cost advantage to those in which its cost advantage is more marginal. Thus, as the trade is liberalized, for an economy with good institutions, we would expect its ESI score to fall! That is, we expect that a country's ESI score (i.e., the average level of sophistication of the country's exports) should depend positively on the quality of that country's institutions, but that score should be offset somewhat by the degree of openness. That is, we expect f_2 to be negatively affected by the degree of openness (log of the sum of exports and imports as a share of GDP, denoted X_2), or, $f_2 = (q_1 + q_2 X_2)$ where q_1>0, q_2<0 , but f_2> 0. Thus, we rewrite equation (3.1) as:

$$\ln(ESI_{i,t}) = f_1 + q_1 X_{1i,t} + q_2 X_{2i,t} * X_{1i,t} + f_3 y_{i,t} + f_4 Z_{i,t} + f_5 time \qquad (3.1b)$$

We estimate equation (3.1b) using an instrumental variable estimation using observations for ESI calculated in 1985 and 2001 (the first and last years in our data set). The results are reported in Table 1. We want to be reasonably confident that our interaction term reflects how the coefficient on institutional quality is affected by the degree of openness (rather than how institutional quality affects the coefficient on openness), so three sets of regressions are provided (labelled groups 1, 2, and 3). The first set has openness entering in both the interaction term and separately; in the second, openness enters in the interaction term and an indicator of tariff levels is included separately. In the third, we omit any measure of openness, except in the interaction term, since our model would

suggest no obvious role for this variable other than as a control. In each subgroup of regressions (subgroups a, b, c, and d), our two different measures of institutional quality are used in different combinations.[13] In columns a and b of each subgroup, the same measure of institutional quality (legal system and property rights and investor protection, respectively) is used in both the interaction term and the separate term. In columns c and d, we allow the institutional quality measure used in the interaction term and separate term to differ from one another. Although the interpretation of the coefficients in this case is different from that explained above, the results are included as a robustness check, and also because there may be some multicollinearity problems with the institutional variables and the interaction term.[14]

The results are broadly consistent with what our theory would predict. In each subgroup of equations, with the exception of column c, the quality of institutions has the expected positive sign and is statistically significant, suggesting that institutional quality is, after controlling for educational quality and per capita GDP, positively associated with exporting higher-value-added goods. The interaction term has the expected negative coefficient and is generally statistically significant. Given the importance of institutional quality in determining comparative advantage, this result suggests that trade restrictions do, in fact, reduce the competitiveness of those goods in which a country's comparative advantage is weakest. Equation c in each subgroup, however, indicates that our results are not as robust as we would like: the interaction term has the expected sign, but the coefficient on the institutional quality term sometimes has the wrong sign, although it is not significant. Furthermore, although our results are qualitatively similar across groups, the quantitative results tend to vary. Nevertheless, we find the results to be encouraging and, on the whole, supportive of our hypothesis that institutional quality is an important determinant of comparative advantage. With this finding in mind, we next ask whether

[13] A third measure of institutional variable (law and order) was also included. The results are qualitatively the same and are available from the authors.

[14] In the next section, which uses a fuller data set because of the availability of more data, the interpretation of the interaction term favours using the two different measures for institutional quality. Moreover, it alleviates what appears to be significant multicollinearity problems between the two terms when the same institutional quality measure is used.

Table 1: The Determinants of Comparative Advantage

Dependent Variable: ln(ESI)

	1a	1b	1c	1d	2a	2b	2c	2d	3a	3b	3c	3d
i	Legal system and property rights	Investor protection	Legal system and property rights	Investor protection	Legal system and property rights	Investor protection	Legal system and property rights	Investor protection	Legal system and property rights	Investor protection	Legal system and property rights	Investor protection
ii	Legal system and property rights	Investor protection	Investor protection	Legal system and property rights	Legal system and property rights	Investor protection	Investor protection	Legal system and property rights	Legal system and property rights	Investor protection	Investor protection	Legal system and property rights
Institutional quality (a)	**0.282****	**0.393***	**-0.022**	**0.076***	**0.074****	**0.129*****	**0.004**	**0.110***	**0.060****	**0.103*****	**-0.005**	**0.079***
	0.121	***0.202****	***0.024***	***0.042***	***0.035***	***0.046***	***0.028***	***0.061***	***0.029***	***0.038***	***0.025***	***0.042***
Inst x ln(openness) (b)	**-0.074****	**-0.090**	**0.010**	**-0.013***	**-0.020*****	**-0.019*****	**-0.011****	**-0.016****	**-0.016*****	**-0.014*****	**-0.007***	**-0.015*****
	0.030	***0.048***	***0.008***	***0.007***	***0.006***	***0.006***	***0.005***	***0.007***	***0.005***	***0.005***	***0.004***	***0.005***
ln(openness)	0.361*	0.562	-0.173**	-0.029	-	-	-	-	-	-	-	-
	0.186	*0.340*	*0.075*	*0.061*								
tariff	-	-	-	-	-0.004*	-0.003	-0.004	0.001	-	-	-	-
					0.002	*0.003*	*0.003*	*0.003*				
ln(education)	-0.004	-0.097	0.055	0.122	0.079	0.032	0.064	0.152	-0.034	-0.031	-0.005	0.154
	0.113	*0.114*	*0.108*	*0.134*	*0.104*	*0.110*	*0.139*	*0.163*	*0.088*	*0.100*	*0.119*	*0.125*
ln(per capita GDP)	0.125***	0.115**	0.080*	0.061	0.060	0.040	0.081	0.047	0.126***	0.086***	0.131***	0.058
	0.042	*0.057*	*0.045*	*0.056*	*0.051*	*0.054*	*0.054*	*0.075*	*0.033*	*0.046*	*0.041*	*0.058*
time dummy	-0.285***	-0.259	-0.237	-0.212	-0.225***	-0.182***	-0.263***	-0.185*	-0.287***	-0.230***	-0.306***	-0.210***
	0.039	*0.060*	*0.046*	*0.057*	*0.049*	*0.055*	*0.049*	*0.077*	*0.033*	*0.046*	*0.042*	*0.059*
const	7.558***	6.552	9.734	9.193	9.484***	9.192***	9.603***	8.987***	8.946***	8.886****	9.098***	9.129***
	0.790	*1.401*	*0.368*	*0.336*	*0.376*	*0.427*	*0.441*	*0.575*	*0.230*	*0.277*	*0.283*	*0.331*
No. obs.	*119*	*115*	*115*	*115*	*119*	*115*	*115*	*115*	*119*	*115*	*115*	*115*

Notes: Std errors in italics.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

there is evidence that trade has an effect on growth that is conditional on institutional quality.

3.2 The interaction of trade with institutions and transitional growth

Empirically, it is increasingly unclear what impact trade has on income over time. The most well known finding in the literature is that of Frankel and Romer (1999), who demonstrate that openness to trade has a large and beneficial impact on income. It is a finding that is often repeated in the literature.[15] More recently, however, authors such as Rodrik, Subramanian, and Trebbi (2002) have questioned this result, arguing that institutions, not trade, are the source of growth. Rigobon and Rodrik (2004) even find evidence to suggest that trade contributes negatively to growth when institutional quality is accounted for. Thus, Frankel and Romer's results do not seem to be robust to changes in the specification that includes institutional quality.

Traditionally, when examining the relationship between trade, institutions, and growth, researchers have estimated a specification such as:

$$\Delta y_{i,t} = a_i + (b_{0i} - 1) y_{i,t-1} + b_1 X_{1it} + b_2 X_{2it} + b_3 X_{3it} + u_{i,t}, \qquad (3.2a)$$

where $y_{i,t}$ is the log of real per capita GDP in country i, a_i is a country-specific constant, X_{1it} is a measure of institutional quality, $X_{2i,t}$ is a measure of openness in country i at time t, and $X_{1i,t}$ is a vector of country-specific control variables. Empirically, to take into account that an economy is growing towards its steady-state level, the lagged value of $y_{i,t}$ is also included. Lastly, $u_{i,t}$ is an unobserved error term.

According to the theory presented in section 2, however, the effect of trade on growth may also depend on the level of institutional quality (see Appendix B), such that openness generates growth when trade occurs in an environment where institutions are

[15] For example, Lee, Ricci, and Rigobon (2004) find that trade has had a positive impact on growth using Rigobon's (2003) "identification through heteroscedasticity" approach.

better. Such an interaction can be easily incorporated in (3.2a) by assuming that $\beta_2 = (\gamma_1 + \gamma_2 X_1)$. Thus, a specification such as:

$$\Delta y_{i,t} = \alpha_i + \lambda_t + (\beta_{0i} - 1) y_{i,t-1} + \beta_1 X_{1i} + \gamma_1 X_{2i} + \gamma_2 X_{1i} * X_{2i} + \beta_3 X_{3i} + \mu_{i,t} \quad (3.2b)$$

is more appropriate. In terms of our theoretical model, our prior expectation is that trade should have a positive impact on growth ($\beta_2 > 0$) when institutions are good, but negative ($\beta_2 < 0$) when institutions are weak. That is, $\gamma_1 < 0$ and $\gamma_2 > 0$. Note, however, that our specification also requires that $-(\gamma_1/\gamma_2) < \max(X_2)$, because X_2 is bounded.

As recommended by Bond (2002), we use a dynamic generalized method of moments (GMM) system estimator approach to estimate equation (3.2b).[16] Briefly, the technique involves undertaking the following steps. First, the growth regression is expressed as a dynamic model in the level of real per capita GDP.[17] Second, we difference the regression equation in order to eliminate the country-specific effects. Third, we instrument the explanatory variables using lagged values of the levels and differences of the original regressors and dependent variable. The latter step eliminates the potential inconsistency coming from the endogeneity of the explanatory variables, while differencing eliminates the potential inconsistency resulting from the correlation between the unobserved country-specific effects and the explanatory variables.

As mentioned previously, in estimating (3.2b) we also control for determinants of growth other than institutions and openness. Real per capita GDP represents the initial conditions (i.e., the state variable), and as such, this variable is measured at the beginning of each five-year period. Other explanatory variables (X_3) include investment as a share of GDP, share of government consumption in GDP, and the rate of inflation.[18] All these variables

[16] The system estimator is preferred to the difference estimator when the regressors are close to an AR(1) process. This is especially pertinent for the estimation-of-growth equation.
[17] The lagged dependent variables can be introduced to either fixed- or random-effects models.
[18] Other variables, such as financial development, were considered, but their coefficients were not statistically significant. This is consistent with results found in the literature (Dalgaard, Hansen, and Tarp 2004).

are measured as averages over five-year periods and represent the control variables.[19] The unobservable country-specific effects, a_i, are designed to capture the determinants of a country's steady state that do not vary over time and that are not already contained in the other explanatory variables. The methodology employed allows us to estimate the coefficients without having to restrict the individual effects to being either fixed or random. The time-specific effect, h_t, captures the effects of global shocks on economic growth common to all countries.[20]

In Table 2 we report results from four regressions that use various combinations of institutional quality for the institutions term and the interaction term.[21] Because investor protection is the primary institutional variable of interest, we limit ourselves to combinations that include this most economic of institutional variables. Overall, the results tend to tell a reasonably straightforward story. In each case, institutional quality, independent of the degree of openness, is seen to have a positive and statistically significant impact on income dynamics. The impact of trade, however, clearly depends on the quality of institutions, with the interaction term being positive and highly significant in all of our regressions. None of our regressions suggests that trade, *in the absence of some degree of institutional quality*, has a statistically positive impact on growth. Rather, the results generally support our view that trade has a positive impact on income in countries with relatively good institutions and a negative impact on income in countries with relatively poor institutions. For middle institution countries, our results suggest that the impact of trade on income is somewhat ambiguous.[22]

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[19] For a definition and sources of all the variables and countries, see Appendixes B and C, respectively.

[20] Because of additional data constraints, the number of countries in our data set falls from 119, in our analysis used to estimate the relationship between institutional quality and ESI, to 87 in our growth regressions.

[21] When only our institutional quality measure or the interaction term is in the regression, the coefficients are always positive and significant. However, when we use the same institutional quality measure in the interaction term and to capture the direct effect of institutional quality, there are cases where the coefficients become insignificant. Because of multicollinearity problems, it proved useful to use a different measure of institutional quality in the interaction term from that used to capture the direct effects of institutional quality. Since we are interested in how the growth effects of trade are affected by institutional quality (rather than how the effects of institutional quality are affected by trade), this is not problematic.

[22] It should be stressed that our results are positive in nature. They omit a clear measure of the static gains from trade and say very little about the welfare (i.e., normative) implications of opening an economy up to trade. Thus, one cannot conclude that trade reduces welfare, even in the case of countries with relatively poor institutions.

Figure 4 illustrates the impact of trade on growth for different levels of institutional quality (legal system and property rights). Since our institutional quality measure (X_2) is bounded, equation (3.2b) requires that $-(g_1/g_2) < \max(X_2)$. The threshold implied by our model for this measure of institutional quality is 6.9 (out of a possible score of 12). Countries with an index of institutional quality higher than 6.9 would see a positive economic impact of trade on their growth, and countries with an index lower than the threshold would experience a negative economic impact of openness to trade on their growth. Figure 4 shows that all high-income countries (real GDP per capita higher than US$15,000) that have relatively good institutions would benefit from increased openness to trade. Other countries, such as Jordan and Tunisia, despite having a relatively low level of income per capita (real GDP per capita lower than US$3,500), have a relatively good level of institutional quality and would consequently benefit from more openness to trade.

Our results are still valid when using other estimation techniques. In Appendix D, we report the ordinary least squares results (Table D1) as well as the results from the instrumental variables (IV) approach (Table D2). Also, in order to take into account the non-linear dynamics of the interaction variables (since the institutional quality variables are bounded), we estimate a model with non-linearity introduced for the interaction variable. The results of the non-linear regressions are reported in Table D3.

Table 2
Growth Regressions: The Interaction Between Institutions and Trade

GMM System Estimator*				
	1	**2**	**3**	**4**
i. Institutions var.	Inst: LO	Inst: IP	Inst: LSPR	Inst: IP
ii. Institutions var. used in interact. term	Inter: IP	Inter: LO	Inter: IP	Inter: LSPR
GDP per capita	-2.11	-1.85	-3.41	-3.56
	0.09	*0.16*	*0.01*	*0.01*
Population growth	-2.03	-1.71	-2.13	-2.17
	0.21	*0.26*	*0.13*	*0.12*
Inflation	-1.01	-0.77	-0.84	-0.82
	0.01	*0.08*	*0.03*	*0.04*
Capital formation	17.80	13.32	19.55	19.22
	0.00	*0.00*	*0.00*	*0.00*
Government expenditure	-5.54	-5.85	-6.10	-5.95
	0.11	*0.08*	*0.06*	*0.07*
Trade openness	-5.88	-2.26	-4.55	-4.11
	0.04	*0.44*	*0.10*	*0.12*
Institutional quality (a)	1.23	2.90	2.50	2.36
	0.19	*0.00*	*0.00*	*0.00*
Openness x institutions interaction (b)	0.72	0.33	0.54	0.59
	0.00	*0.15*	*0.00*	*0.00*
Constant	-10.64	-14.71	-13.93	-14.64
	0.58	*0.42*	*0.45*	*0.45*
Hansen test (*p*-value)	0.885	0.829	0.955	0.962
AR(1) test for residuals (*p*-value)	0.001	0.000	0.000	0.000
AR(2) test for residuals (*p*-value)	0.067	0.066	0.033	0.033

Notes: LO = Law and order. IP = Investor protection. LSPR = Legal system and property rights.
* Coefficients for time dummies and lagged dependent variable are not reported. *P*-values are shown in italics.

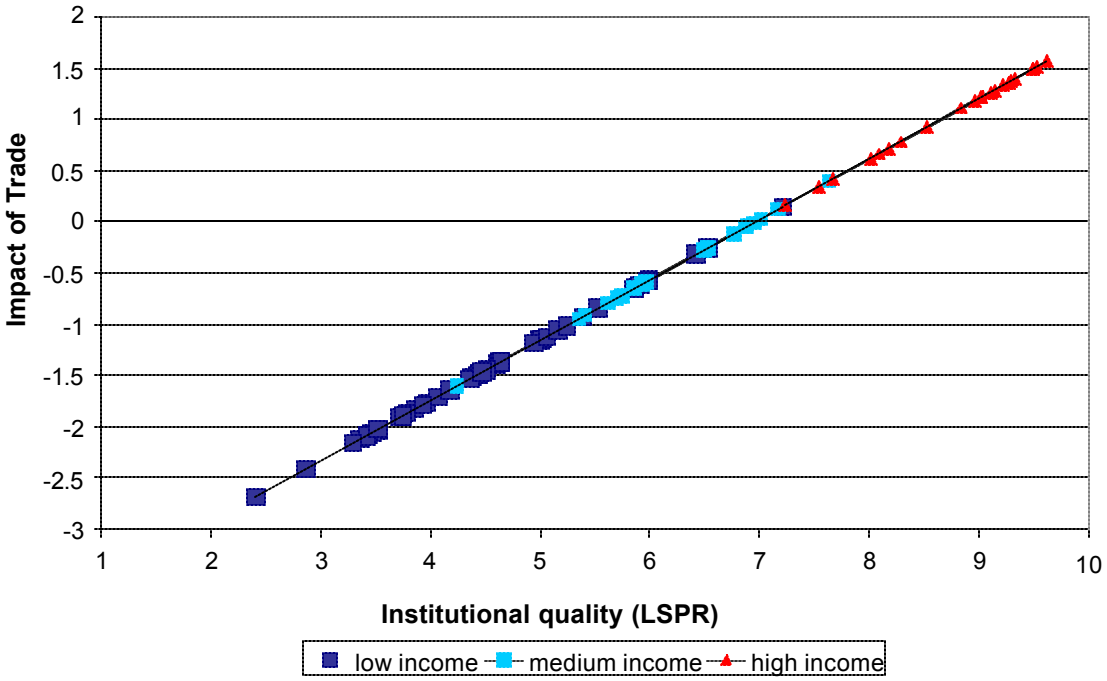

Figure 4: The Non-Linear Impact of Trade on Growth

4. Conclusion

In this paper we examine the determinants of long-run income levels with a particular focus on institutions, comparative advantage, and trade. Our central argument is that in order to understand how institutions and trade contribute to changes in income over time (or transitional growth) and across countries, one must understand how institutional quality affects long-run comparative advantage and, hence, the extent to which trade can magnify the benefits of institutional reform. To date, the existing literature has overlooked this interaction, and hence an important piece of the trade and growth puzzle has been omitted from the analysis.

The evidence we find, both theoretical and empirical, suggests that (i) institutional quality is an important determinant of comparative advantage, and (ii) that a country can

stimulate transitional growth by improving the quality of its institutions, although, when institutions are poor, a country may not enjoy the *dynamic* gains from trade liberalization. Indeed, our results provide strong evidence to suggest that trade affects growth conditional on the quality of institutions, in that countries that have good institutions experience faster growth resulting from trade, whereas trade apparently weakens the growth performance of countries that have weak institutions. This is consistent with our view that weak institutions distort the capital accumulation process, and that trade can magnify the effect of the distortion.

An interesting implication of our paper is that, to date, trade has not been an engine of growth for countries with middle levels of institutional quality (such as China and India), but rather institutional reform may have been more important for these types of economies.[23] Our results therefore reinforce earlier findings in the literature that there is a need for ongoing institutional reform in developing economies. Interestingly, just as our model suggests that trade can magnify the impact of weak institutions, our results also suggest that the effect of institutional reform is magnified in more open economies. Thus, relatively open economies have the most to gain from institutional reform.

We conclude by stressing that our analysis is not a welfare analysis. In our theoretical section, which compares long-run steady state equilibria, we make no attempt to measure the present discounted value of the gains from trade. Thus, our analysis says little about the welfare implications of trade liberalization and institutional reform—an interesting issue that could be pursued further. Another shortcoming of our work is that it focuses on institutions that are likely to affect borrower-lender relationships, but the literature has also highlighted that institutions are important for other markets that are interrelated with comparative advantage, trade, and income, the most notable being environmental institutions (see, for example, Copeland and Taylor 2004) and labour market institutions (Davis 1998).

[23] The role of institutional reform in India and China is discussed more fully in Desroches, Francis, and Painchaud (2004), and, for China, in Francis, Painchaud, and Morin (2005).

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Appendix A: Theoretical Foundations

In this appendix we restate the key equilibrium relationships for the two economies under conditions of autarky and then free trade; we also prove Propositions 1 and 2. Letting $j = N, S$ denote the North and South, respectively, recall the following equilibrium factor market equations:

$$p(z)f_z'(k^j(z)) = R^j, \tag{2}$$

$$p(z)[f_z(k^j(z)) - k^j(z)f_z'(k^j(z))] = W^j, \tag{3}$$

and similarly, for the capital-producing sector, we have,

$$p(c)f_c'(k^j(c)) = R^j, \tag{2a}$$

and,

$$p(c)[f_c(k^j(c)) - k^j(c)f_c'(k^j(c))] = W^j. \tag{3a}$$

The Ramsey rule for capital accumulation implies that

$$f_c'(k^j(c)) = (r + n)/a^j. \tag{5}$$

Equation (5) serves to determine the long-run equilibrium value of $k^j(c)$. Dividing (3a) by (2a) gives the equilibrium value of s^i,

$$s^i \equiv W^j/R^j = \frac{[f_c(k^j(c)) - k^j(c)f_c'(k^j(c))]}{f_c'(k^j(c))}, \tag{6}$$

and hence $k^j(z)$ can be found from the condition that

$$s^j = \frac{[f_z^j(k^j(z)) - k^j(z)f_z'^j(k^j(z))]}{f_z'^j(k^j(z))}. \tag{6a}$$

Thus, the quality of institutions serves to determine the equilibrium values of s^i, $k^j(c)$, $k^j(z)$, and, implicitly, the full set of relative autarkic goods prices.

In the autarkic economy, the description of equilibrium is completed by equations (7) and (9):

$$\int_0^1 \frac{b(z)[s^j + k_T^j]}{[s^j + k^j(z)]}dz = 1, \tag{7}$$

$$k^j = \frac{f_c^j k_T^j}{f_c^j - n^j(k_c^j - k_T^j)}. \tag{9}$$

This completes the description of the autarkic economy. It remains to describe the equilibrium of the free trading North-South model. Since $k^j(c)$, s^i, and $k^j(z)$ are independent of the trade equilibrium, their equilibrium values are described by equations (5), (6), and (6a). It remains therefore to determine the equilibrium values of k_T^j and the equilibrium value of $\bar{z}$, which determines the range of goods produced by the North, $0 \le z \le \bar{z}$, and the South, $\bar{z} \le z \le 1$. Using the equilibrium values of s^i, $k^j(c)$, and $k^j(z)$, the values of k_T^j and $\bar{z}$ are jointly determined by the resource constraints for each of the economies and the balanced trade condition; that is, by

$$0 = \int_0^{\bar{z}} \frac{b(z)}{s^N + k^N(z)} (k_T^N - k^N(z))dz \tag{13}$$

for the North. By similar reasoning, we get

$$0 = \int_{\bar{z}}^1 \frac{b(z)}{s^S + k^S(z)} (k_T^S - k^S(z))dz \tag{14}$$

for the South. Equations (13) and (14) solve for k_T^N and k_T^S. However, in this case the equilibrium value of each will depend on the value of $\bar{z}$, the equilibrium value of which is determined by the requirement that trade be balanced,

$$B(\bar{z}) = \frac{N^N}{N^S} \frac{s^N + k_T^N}{s^S + k_T^S} \frac{a^S(\bar{z})}{a^N(\bar{z})} \frac{s^S + k^S(\bar{z})}{s^N + k^N(\bar{z})}. \tag{15a}$$

Finally, the total stock of capital for each country follows from (7) as

$$k^j = \frac{f_c k_T^j}{f_c - n(k_c - k_T^j)}, \qquad j = N, S. \tag{16}$$

Proof of Proposition 1:

To prove Proposition 1, use equations (5), (6), (7), and (9) and totally differentiate to give the following system:

$$[M] \begin{bmatrix} dk_c \\ ds \\ dk_T \\ dk \end{bmatrix} = [N][da],$$

where,

$m_{11} = f_c''$, $m_{12} = 0$, $m_{13} = 0$, $m_{14} = 0$

$m_{21} = k_c f_c''$, $m_{22} = 1$, $m_{23} = 0$, $m_{24} = 0$

$m_{31} = 0$, $m_{32} = \int_0^1 \frac{b(z)}{s + k(z)}[(k(z) - k_T) - (s + k_T)\frac{\partial k(z)}{\partial s}]dz$,

$$m_{33} = \int_0^1 \frac{b(z)}{s + k(z)} dz\ ,\ m_{34} = 0$$

$m_{41} = -\frac{nk_T[f_c - k_c f_c' + k_T f_c']}{[f_c - nk_c + nk_T]^2}$, $m_{42} = 0$, $m_{43} = -\frac{f_c(f_c - nk_c)}{[f_c - nk_c + nk_T]^2}$, $m_{44} = 1$

$n_{11} = -\frac{(r + n)}{a^2}$, $n_{21} = 0$, $n_{31} = 0$, $n_{41} = 0$

Note that $|M| < 0$.

Using Cramer's rule, the following results can be derived:

$$\frac{dk_c}{da} = \frac{n_{11}m_{22}m_{33}m_{44}}{|M|} > 0,$$

$$\frac{ds}{da} = -\frac{n_{11}m_{21}m_{33}m_{44}}{|M|} > 0,$$

$$\frac{dk_T}{da} = \frac{n_{11}m_{21}m_{32}m_{44}}{|M|} > 0,$$

$$\frac{dk}{da} = -\frac{n_{11}(m_{21}m_{32}m_{43} + m_{22}m_{41}m_{43})}{|M|} > 0,$$

and, by differentiating equation (6a), we get

$$\frac{dk(z)}{ds} = -\frac{(f_z')^2}{f_z'' f_z(k^j(z))} > 0.$$

This completes the proof of Proposition 1. QED.

Appendix B: Sources and Definitions of Variables

Dependent Variable

1. Growth rate of per capita GDP in constant 1995 U.S. dollars. Refer to (*A*) below for source.

Explanatory variables

(A) Economic and Financial Variables

All variables are obtained from the World Bank's *World Development Indicators* and are computed as five-year averages for the periods 1972 to 1976, 1977 to 1981, 1982 to 1986, 1987 to 1991, 1992 to 1996, and 1997 to 2001.

2. Per capita GDP in constant 1995 U.S. dollars.
3. Gross capital formation as a percentage of GDP.
4. General government final consumption expenditure as a percentage of GDP.
5. Overall government budget balance, including grants as a percentage of GDP.
6. Domestic credit to private sector as a percentage of GDP.
7. Domestic credit provided by banking sector as a percentage of GDP.
8. Consumer price index, 1995=100.
9. Imports of goods and services from the world in constant 1995 U.S. dollars.
10. Exports of goods and services to the world in constant 1995 U.S. dollars.
11. GDP in constant 1995 U.S. dollars.
12. Total trade as a percentage of GDP. Computed as ((no. 9 + no. 10)/ no. 11) from above.
13. Education levels: average years of secondary schooling in the total population, from the Barro-Lee data set on educational attainment.

(B) Institutional Quality

From the PRS Group's *International Country Risk Guide*.

14. Law and order.
15. Investment profile.

From the Fraser Institute's *Economic Freedom of the World: 2004 Annual Report*.

16. Legal system and property rights.

Appendix C: List of Countries Used in Growth Regressions

IFS Code	Country Name
111	United States
112	United Kingdom
122	Austria
124	Belgium
128	Denmark
132	France
134	Germany
136	Italy
138	Netherlands
142	Norway
144	Sweden
146	Switzerland
156	Canada
158	Japan
172	Finland
174	Greece
176	Iceland
178	Ireland
181	Malta
182	Portugal
184	Spain
186	Turkey
193	Australia
196	New Zealand
199	South
213	Argentina
218	Bolivia
223	Brazil
228	Chile
238	Costa Rica
243	Dominican
248	Ecuador
253	El Salvador
258	Guatemala
263	Haiti
268	Honduras
273	Mexico
278	Nicaragua
283	Panama
288	Paraguay
293	Peru
298	Uruguay
299	Venezuela
336	Guyana
343	Jamaica
369	Trinidad & Tobago
419	Bahrain
423	Cyprus
429	Iran
436	Israel
439	Jordan
443	Kuwait
463	Syrian
469	Egypt
513	Bangladesh
518	Myanmar
524	Sri Lanka
532	Hong Kong
534	India
536	Indonesia
542	South Korea
548	Malaysia
564	Pakistan
566	Philippines
576	Singapore
578	Thailand
612	Algeria
616	Botswana
622	Cameroon
632	Comoros
636	Congo, Dem.
652	Ghana
664	Kenya
676	Malawi
678	Mali
692	Niger
698	Zimbabwe
722	Senegal
724	Sierra Leone
742	Togo
744	Tunisia
746	Uganda
754	Zambia
853	Papua New Guinea
924	China
944	Hungary
964	Poland

Appendix D: Estimation Results

Table D1 Growth Regressions: The Interaction Between Institutions and Trade				
Ordinary Least Squares (OLS)*				
	1	**2**	**3**	**4**
a. Institutions var. b. Institutions var. used in interact. term	Inst: LO Inter: IP	Inst: IP Inter: LO	Inst: LSPR Inter: IP	Inst: IP Inter: LSPR
GDP per capita	-1.95	-1.96	-2.17	-2.21
	0.01	*0.01*	*0.01*	*0.01*
Population growth	-1.80	-1.87	-1.94	-2.00
	0.034	*0.03*	*0.02*	*0.02*
Inflation	-1.01	-0.99	-1.01	-0.99
	0.00	*0.00*	*0.00*	*0.00*
Capital formation	21.34	21.36	21.98	22.04
	0.00	*0.00*	*0.00*	*0.00*
Government expenditure	-6.08	-6.06	-6.66	-6.70
	0.01	*0.01*	*0.00*	*0.00*
Trade openness	-3.56	-1.60	-3.04	-2.04
	0.04	*0.35*	*0.07*	*0.25*
Institutional quality (a)	1.52	2.05	1.43	1.88
	0.03	*0.00*	*0.01*	*0.00*
Openness x Institutions interaction (b)	0.51	0.37	0.46	0.36
	0.00	*0.03*	*0.00*	*0.01*
Constant	-23.18	-30.87	-24.61	-28.45
	0.02	*0.00*	*0.01*	*0.01*

Notes: LO = Law and order. IP = Investor protection. LSPR = Legal system and property rights.
* Coefficients for time dummies and lagged dependent variable are not reported. *P*-values are in italics.

Table D2
Growth Regressions: The Interaction Between Institutions and Trade

Three-Stage Least Square*

	1	**2**	**3**	**4**
a. Institutions var.	Inst: LO	Inst: IP	Inst: LSPR	Inst: IP
b. Institutions var. used in interact. term	Inter: IP	Inter: LO	Inter: IP	Inter: LSPR
GDP per capita	-2.30	-6.13	-3.49	-4.95
	0.00	*0.00*	*0.00*	*0.00*
Population growth	-1.77	0.36	-1.95	-0.84
	0.04	*0.75*	*0.02*	*0.39*
Inflation	-0.73	-0.20	-0.61	-0.17
	0.01	*0.63*	*0.02*	*0.65*
Capital formation	6.50	-11.82	12.46	5.22
	0.47	*0.22*	*0.16*	*0.56*
Government expenditure	-6.19	-5.88	-7.17	-6.83
	0.00	*0.00*	*0.00*	*0.00*
Trade openness	-2.35	-25.43	-2.42	-13.23
	0.10	*0.00*	*0.08*	*0.01*
Institutional quality (a)	1.96	8.40	2.77	5.83
	0.00	*0.00*	*0.00*	*0.00*
Openness x Institutions interaction (b)	0.43	1.65	0.31	0.88
	0.00	*0.00*	*0.00*	*0.00*
Constant	17.65	127.37	6.43	43.43
	0.44	0.00	0.77	0.10

Notes: LO = Law and order. IP = Investor protection. LSPR = Legal system and property rights.
* Coefficients for time dummies and lagged dependent variable are not reported. *P*-values are in italics.

Table D3
Growth Regressions: The Interaction Between Institutions and Trade

Non-Linear IV Regression (NL IV) and Three-Stage Least Square (3SLS)*

a. Institutions var. b. Institutions var. used in interact. term	Inst: IP Inter: LSPR	Inst: IP Inter: LO
	NL IV	**3SLS**
GDP per capita	-3.04	-3.16
	0.01	*0.00*
Population growth	-2.64	-1.52
	0.03	*0.10*
Inflation	-0.75	-0.44
	0.05	*0.30*
Capital formation	18.75	13.25
	0.00	*0.15*
Government expenditure	-5.33	-5.37
	0.11	*0.00*
Trade openness	-8.73	-26.48
	0.04	*0.09*
Institutional quality (a)	2.04	3.51
	0.00	*0.04*
Openness x Institutions interaction (b)	3.36	13.55
	0.13	*0.18*
(Openness x Institutions interaction)^2	*-0.48*	-3.49
	0.24	*0.21*
(Openness x Institutions Interaction)^3	*0.02*	0.29
	0.288	*0.22*

Notes: LO = Law and order. IP = Investor protection. LSPR = Legal system and property rights.
* Coefficients for time dummies and lagged dependent variable are not reported. *P*-values are in italics.

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