TESTING FOR TRADE-INDUCED INVESTMENT-LED GROWTH

1. Introduction

The basic link between trade and growth relies on the logic of growth. From an accounting equation, it is clear that growth depends on the accumulation of factors, factors being skilled and unskilled labour, capital and technology. If trade has any effect on growth, this must be through its effect on the accumulation of factors. Most of the literature on trade and growth analyses the effect of trade through technology. Trade, for example, allows for international knowledge spillovers that lower the cost of new technology increasing total factor productivity and growth (Grossman and Helpman, 1991). Less attention has been devoted to the link through physical capital investment. Young (1992, 1995), however, argues that even the most spectacular cases of developing countries growth in East Asia appear to be instances of investment-led and skilled-led growth, rather than knowledge-led growth. Wacziarg and Welch (2003) use time series evidence to conclude that liberalisation has a positive effect on growth and investment.

The aim of this paper is to explore the implications of trade liberalization on the growth performance of nations, with special emphasis on investment-led growth. Most of the empirical papers on this subject support the idea that trade enhance economic growth. The literature, however, presents some flaws. First, several papers do not test for a specific channel, leading to difficulties in the interpretation of the results. Second, in the words of Rodriguez and Rodrik (2000),

> "for the most part, the strong results in this literature arise either from obvious mis-specification or from the use of measures of openness that are proxies for other policy or institutional variables that have an independent detrimental effect on growth".

This paper overcomes the first flaw since it tests a particular hypothesis, i.e., that trade affects growth via investment. The theoretical framework that underlines this hypothesis is the one

presented in Baldwin and Seghezza (1996), and Baldwin and Forslid (2000). For simplicity, however, this paper derives the two estimating equations, the growth equation and the investment equation, using a procedure similar to Mankiw *et al*. (1992). After testing for the impact of trade barriers on investment and growth, the paper looks at the relative importance of the trade-induced investment-led growth channel versus the trade-induced productivity-led growth channel.

This work uses as preferred proxy for trade barriers a trade-weighted tariff average. This choice overcomes the Rodriguez and Rodrik (2000) critique on the use of proxies for openness. According to this critique, simple trade-weighted tariff averages, or non-tariff coverage ratios, are the best indicators of trade restrictions.

After testing the general hypothesis that trade affects growth via investment, the paper investigates two contingent relationships between trade policy and growth. In particular, it investigates if trade restrictions operate differently in low- versus high-income countries, or in countries with a comparative advantage in primary products versus those with comparative advantage in manufactured goods.

The rest of the paper is organized as follows. Section 2 derives the two estimating equations. Section 3 addresses data issues and Section 4 presents our results. Presentation of the estimates is organized around its four main results. The first concerns the impact of trade barriers on investment and growth. The second looks at the relative importance of the trade-induced investment-led growth channel versus the trade-induced productivity-led growth channel. The third is about the different impact of trade barriers for rich and poor countries. The fourth concerns the different effect of trade barriers for capital-abundant and labour-abundant countries. The final section presents our concluding remarks.

2. Derivation of the estimating equations

Estimating equations are derived using a simple one-good, Cobb-Douglas economy with intertemporal optimization and exogenous labour-augmenting technical progress. While this approach is theoretically simplistic, Mankiw *et al*. (1992) show that it well-approximates the true relationship between factor stocks (labour, physical and knowledge capital) on one hand and *per capita* income on the other. Specifically, it is assumed an infinitely-lived representative consumer who is endowed with labour L, owns physical capital K, and has preferences $\int e^{-\rho t} \ln(C) dt$. The economy can produce

the single good according to $Y=K^{\alpha}(AL)^{1-\alpha}$, where A is the level of knowledge capital, i.e. labour-augmenting technology. Assuming that A and L grow at the exogenous rates of γ and η respectively, log-differentiation of the production function implies the *per capita* growth equation:

$$\hat{Y} - \hat{L} = (1-\alpha)\gamma - \alpha\eta + \alpha\frac{\dot{K}}{Y}\frac{Y}{K} \tag{1}$$

where 'hat' signify growth rates, and $\dot{K}/Y$ is the economy's gross investment rate. Furthermore, it is assumed that each country's γ equals a constant plus two terms – the first being dependent upon the initial gap between the country's own level of technology and that of the most advanced nation (the US), and the second being a country-specific error term ε. The first term is proxied for by the country *per capita* GDP gap with the US in the initial period. Thus for country i:

$$\gamma_i = \chi\left(\left(\frac{Y}{L}\right)_{i,0} - \left(\frac{Y}{L}\right)_{USA,0}\right) + \varepsilon_i \tag{2}$$

where χ is the catch-up parameter. Note that the investment ratio K/Y is an endogenous variable, so estimation of this equation by ordinary least squares yields inconsistent estimates.

The growth equation involves nothing more complicated than the manipulation of growth accounting relationships. Capital accumulation, however, is a far more complex phenomenon. This is unavoidable for one simple reason. In 'old' growth models, medium-run growth – i.e. the growth in transition – is endogenous even though long-run growth is exogenous. (By contrast, in the 'new' growth models long-run growth is endogenous, but transitional dynamics are often absent). As a direct consequence of this point, it is not possible to specify the investment equation without addressing all the dynamic aspects of the model. As usual, the issue of state variables and steady-state levels is addressed first.

Two laws of motion describe the economy's growth. Assuming away depreciation for convenience, K's law of motion is: $\dot{K} = \iota Y$, where ι is the endogenously determined and time-varying investment rate. The other law of motion is the Euler equation, $\dot{E}/E = \dot{C}/C = r - \rho$ where E is expenditure and r is the rate of return on savings. The natural state variables for this system would be E and K, however the system has no steady-state in these variables. By switching state variables to the convenient pair – k=K/AL and c=C/AL – it is possible to restate the laws of motion in terms of variables that do have steady state levels.

With perfect competition r is the value of the marginal product of capital, $r=\alpha k^{\alpha-1}$. Plugging this into the transformed Euler equation, the steady-state level of k is where $\dot{c}=0$, i.e. $r=\gamma+\eta+\rho$. This is true only for $\bar{k}=[\alpha/(\gamma+\eta+\rho)]^{1/(1-\alpha)}$. The next step is to find the implied steady-state level of the investment-GDP ratio. The law of motion for k is $\dot{k}/k=\iota k^{\alpha-1}-\gamma-\eta$, so the investment rate necessary to maintain $\bar{k}$ satisfies the expression $\bar{\iota}\bar{k}^{\alpha-1}=\gamma+\eta$, which implies $\bar{\iota}=\alpha(\gamma+\eta)/(\gamma+\eta+\rho)$. Since output is split between investment and consumption, the implied steady state C/AL must therefore satisfy $\bar{c}=\bar{y}(1-\bar{\iota})$.

This system is saddle path stable and the saddle path describes the evolution of the state variables. In principle the saddle path is nonlinear. The negative eigenvector of the Jacobian evaluated at the steady state provides a linear approximation of the saddle path, so it is possible to approximate the approach of c and k to their steady state values with the following form:

$$\begin{pmatrix} k_t-\bar{k} \\ c_t-\bar{c} \end{pmatrix}=\begin{pmatrix} (k_0-\bar{k})e^{\omega t} \\ (c_0-\bar{c})e^{\omega t} \end{pmatrix} \tag{3}$$

where ω is the negative eigenvalue of the Jacobian evaluated at the steady state.

Taking a first-order Taylor expansion of $\dot{k}/k=\iota k^{\alpha-1}-\gamma-\eta$ around the steady state – and approximating ι as constant near the steady state – the result is:

$$\frac{\dot{k}}{k}-0=\bar{\iota}(\alpha-1)\bar{k}^{\alpha-1}\left(\frac{k-\bar{k}}{\bar{k}}\right) \tag{4}$$

where the zero on the left-hand side represents the steady-state value of $\dot{k}/k$. Plugging in steady-state values, using equation (1), and using a log-linear approximation, the second estimating equation is[1]:

$$\frac{\dot{K}_T}{Y_T}=\frac{\gamma+\eta}{\frac{Y_T}{K_T}}+(1-\alpha)e^{\omega t}\frac{\gamma+\eta}{\frac{Y_T}{K_T}}\left(\ln(\bar{k})-\ln(k_0)\right) \tag{5}$$

Approximating the capital-output ratio as constant, it is possible to write the two simultaneous estimating equations (1) and (5) as:

---

[1] Using the fact that $\bar{\iota}\bar{k}^{\alpha-1}=\gamma+\eta$, the intermediate steps are:

$\dot{k}_t/k_t=(\gamma+\eta)(\alpha-1)(k_t-\bar{k})/k=(\gamma+\eta)\ (1-\alpha)(e^{\omega t}(\bar{k}-k_0)/\bar{k})$. Then using the log-linear approximation $\ln(x')\approx\ln(x^0)+(x'-x^0)(d\ln(x)/dx)$ and $(d\ln(x)/dx)=\frac{1}{x^0}$, we have $(\bar{k}-k_0)/k=\ln\bar{k}-\ln k_0$ so, $\dot{K}/K-(\gamma+\eta)=(1-\alpha)e^{\omega T}(\gamma+\eta)(\ln\bar{k}-\ln k_0)$. Finally using $\dot{K}/K=(\dot{K}/Y)Y/K$ yields the expression.

$$g = \beta_{10} - \beta_{11}\left(\frac{\text{population}}{\text{growth}}\right) - \beta_{12}\left(\frac{\text{GDP}}{\text{population}}\right)_{1960} + \beta_{13}\text{INV} - \beta_{14}\frac{Y_0}{L_0} + \varepsilon_1$$
$$\text{INV} = \beta_{21} + \beta_{22}\ln\bar{k} - \beta_{23}\ln k_0 + \varepsilon_2 \qquad (6)$$

where g is *per capita* income growth, INV is the gross investment to GDP ratio and the error terms are related to the ε discussed above. In practice, the initial level of k is proxied for by the country's initial level of income.

There are two main points to note in the equation system (6). First, the growth rate of the economy depends on investment. In this simple model, there is only physical capital, so growth depends only on investment in physical capital (and a catching up factor). In a more realistic setting, production depends also on human capital, and thereby growth depends on investment in physical and human capital. Second, any policy that increases the investment rate increases the growth rate of the economy. A policy that raises the steady-state capital-labour ratio $\bar{k}$ will raise the investment rate. This, then, provides the connection with the openness and investment-led growth links demonstrated in the literature. Baldwin and Seghezza (1996), and Baldwin and Forslid (2000), for instance, illustrate a number of ways in which openness can raise or lower the steady-state capital-labour ratio. Openness, for instance, can spur growth via a reduction in the cost of traded intermediates, or via a pro-competitive effect in sectors characterized by imperfect competition and increasing return to scales. The measure of openness varies according to the link considered, as do the precise way in which openness enter the expression for $\bar{k}$.

In what follows, we test the joint hypothesis consisting of the two-equation system (6) with the human capital included[2], and the assumption that the complex links between openness and the steady state capital-labour ratio can be captured in a simple way. Namely, it

[2] Human capital variables are included to control for two types of growth effects. First, Barro and others argue that human capital is a key driver of growth so, to avoid that the exclusion of human capital proxies impart biases to the estimate of the investment share variable, it is better to include them. Second, a high rate of human capital investment and/or a high level of secondary attainment may be an important determinant of the steady-state investment rate. In particular, it might be that a high level of human capital increases the steady-state capital-labour ratio.

is assumed that the logarithm of k depends upon a constant (which gets folded into the constants), the logarithm of the openness proxy, and the population growth rate. Under this additional hypothesis, the parameter estimate on the openness proxy can be interpreted as identifying the sign of the openness- logarithm of k relationship. The system estimated is therefore:

$$\begin{cases} g = \beta_{10} + \beta_{11}\,\text{InitialY/L} + \beta_{12}\,\text{PopulationGrowht} + \beta_{13}\,\text{HumanCapital} \\ \text{Investment} + \beta_{14}\,\text{InitialHumanCapital} + \beta_{15}\,\text{PhysicalCapitalInvestment} + \varepsilon_1 \\ \\ \text{PhysicalCapitalInvestment} = \beta_{20} + \beta_{21}\log\text{InitialY/L} + \beta_{22}\log\text{Pop Growth} \\ + \beta_{23}\log\text{HumanCapitalInvestment} + \beta_{24}\log\text{InitialHumanCapital} \\ + \beta_{25}\,\text{DomesticBarriers} + \beta_{26}\,\text{ForeignBarriers} + \varepsilon_2 \end{cases} \tag{7}$$

The intuition for expected signs of the coefficients is as follows. The motivation for the signs of the β_1's for population growth (negative) and physical and human capital investment rate (both positive) are well known from the neoclassical growth literature[3]. The initial Y/L level reflects a catch-up factor that is related to the initial technology gap, so it should have a negative coefficient. In the investment rate equation, the initial Y/L level should also enter negatively while investment in human capital should enter positively since it is a determinant of the steady-state human capital-labour ratio and this boosts the steady-state physical capital-labour ratio. For any given level of Y/L, a higher steady-state capital-labour ratio implies a higher investment to GDP ratio in the transition to steady state. Trade barriers should enter negatively in the investment equation.

3. Data issues

Most variables correspond to obvious data series. *Per capita* growth is most naturally measured by average real *per capita* income growth adjusted for international price differences. $\dot{K}/Y$ clearly corresponds to average real investment (public plus private) as a share of real GDP. The initial *per capita* income variable is simply *per capita* income for the initial period, and η (population growth) is measured by the standard UN data series.

[3] See Mankiw *et al*. (1992).

Several other variables, however, involve less obvious choices. A wide range of measures for the rate of investment in human capital variable exists. Several enrolment data series – e.g. secondary school enrolment ratios of males, females and total, primary school enrolment ratios of males, females and total and the sum of these – have been experimented, and the secondary enrolment rates for males proved to be the most satisfactory. It is reasonable to posit that investment in human capital is affected by endogenous variables such as *per capita* income. To allow for this, average human capital investment rate has been instrumented with a predetermined variable, the enrolment rate at the beginning of the time period sample[4]. For the initial stock of human capital, the instrument chosen has been the secondary achievement rates at the beginning of the time period sample.

Trade barrier variables also involved some discretion. For the domestic trade barriers, the closest corresponding variable is that of Lee and Swaigel (1992), which is found in the widely available Barro-Lee dataset as OWTI. This is an import-weighted average of *ad valorem* import charges on consumer, intermediate and capital goods using tariffs rates at the most detailed level of the Customs Cooperation Council Nomenclature which are collected by the United Nations from national sources. Since domestic protection should have more important economic consequences in countries that are 'naturally' open (say Hong Kong), than in countries that are 'naturally' closed (say the US), as pointed out by Lee (1993), trade barriers are adjusted for natural openness. The natural openness factors are taken from Lee (1993) and are the fitted values of an openness regression that he ran on Summers-Heston import to GDP ratios[5]. The use of fitted values has the merit of avoiding the usual downward bias that comes from using actual import shares.

To allow for the fact that different countries face different foreign tariff rates, a foreign trade variable has been introduced. The foreign trade barriers variable for a particular country is a trade-weighted average of OWTI for each country's top five export markets. The weights of the five partner countries sum to unity. To reduce the

[4] The point estimates were little changed by this but the human investment variable was more significant in the investment equation.

[5] The regressors were a constant, the log of national land area, the distance from the national capital of the world's top 20 exporters, and two proxies for trade barriers - the Lee-Swaigel tariff variable and the black market premium. The fitted values for free trade openness are generated setting the proxies for trade barriers to zero.

bias that protection introduces to the export weights, the weights employed are not actual export data, but the fitted values from a gravity model estimated by Baldwin (1994). Since the impact of foreign barriers on the home economy rests on how dependent the home country is on foreign markets, the weighted average of foreign barriers is multiplied by the natural openness factor of Lee (1993). The same procedure is undertaken with respect to several other trade barrier proxies. A final note concerns the treatment of intra-Western European trade. Since tariffs among EU and EFTA nations have been zero since 1974, (among EU members since 1968 and among EFTA members since 1969), a zero tariff rate has been imposed on bilateral trade flows among EU and EFTA nations.

A first sample-selection criterion for the countries included in the sample is suggested by the nature of new-trade models. These models, which are at the heart of the new literature on trade and growth, clearly correspond to countries that are primarily engaged in intra-industry trade in manufactured goods. The selection of countries has been done based on World Bank data on the structure of exports. First export commodities have been aggregated into three broad groups: 1) fuel, minerals and metals, 2) other primary commodities and 3) manufactures, which consists of machinery and transport equipment, other manufactures, and textiles and clothing. The countries included in the sample were those for which the manufactures share was the highest of the three shares. This selection was done for two base years, 1965 and 1989. The 1965-based sample is quite small consisting of only 21 countries. The 1989 sample contains 39 countries. Note that not all of the OECD countries qualify as manufacture exporters. The data appendix shows the export shares of manufactures for the 1989-based sample.

After testing the general hypothesis that trade affects growth via investment, a second sample selection criterion is suggested by the desire of testing whether trade liberalization has different effects on rich and poor countries or capital or labour abundant countries.

Given the assumptions of section 2, the investment ratio is the only endogenous variable in the growth equation; all other variables are predetermined. All independent variables in the investment equation are predetermined or exogenously chosen. The system of equations (7) is estimated using three-stage least squares[6].

[6] Both equations are identified. The system has 11 predetermined variables - the constant, log and level of initial GDP *per capita*, log and level of population

4. Results

Presentation of the estimates is organized around its four main results. The first concerns the impact of trade barriers on investment and growth. The second relates to one particular mechanism through which trade affects growth, i.e. trade induced investment-led growth. The third concerns the different impact of trade barriers for rich and poor countries. The fourth is about the different effect of trade barriers for capital-abundant and labour-abundant countries.

5. Anti-growth effects of domestic and foreign trade barriers

Table 1 shows the results for the preferred sample and specification, namely the sample of countries that were manufacture exporters in 1989 and the system of equations derived in section 2. All of the point estimates in the growth equation that are significant are of the right sign. The estimated coefficient on $(Y/L)_0$ is negative and highly significant, suggesting that a technology catch-up factor is in operation. The small magnitude of the point estimate reflects the mean of the dependent variable. Population growth is insignificant as is often the case in cross-country growth regressions. The estimate for the human capital investment is negative contrary to the prediction of the model, but insignificant. The point estimate for physical capital formation is 0.24 and is significant at all reasonable levels of confidence. The R-square is 0.53, which is high for cross-section data.

Results for the investment equation are also quite good. The $(Y/L)_0$ and population growth variables have negative coefficients as predicted but are both statistically insignificantly different from zero. The initial level of human capital has a negative coefficient contrary to the theory, but it is insignificant. The estimated parameter for human capital formation variable is significant and positive. The R-square is a remarkable 0.74.

The point estimates for the domestic and foreign trade barrier variables are quite interesting. Both coefficients are negative and

---

growth, the log and level of the two initial year human capital variables, and the trade proxies. The growth equation excludes six of these yet has only one endogenous right-hand side variable, so it is identified. The investment equation excludes four predetermined variables and have no endogenous right-hand side variables, so it also is identified.

highly significant. The literature highlighted many channels through which domestic barriers harm growth. One of these, for instance, lies on the importance of traded intermediates. Domestic barriers raise the rental rate on capital (because the import competing industry is capital-intensive) but also raise the cost of new capital since manufactured goods are used as an input in capital formation. The former boost the rate of return on physical capital formation while the latter reduces it. The empirical results suggest that the anti-investment aspects of domestic protection outweigh the pro-investment effects.

TABLE 1 – *Results for Preferred Sample and Specification*

Growth Equation		Investment Equation	
Constant	-0.02 (-1.5)	Constant	0.49 (3.4)
Initial Y/L	-4E-06 (-3.4)	Initial Y/L	-0.02 (-1.1)
Population Growth	0.29 (0.9)	Population Growth	-4E-03 (-0.3)
Human Capital Investment	-0.01 (-0.8)	Human Capital Investment	0.08 (4.9)
Initial Human Capital Stock	4E-04 (1.8)	Initial Human Capital Stock	-2E-03 (-0.2)
Physical Capital Investment	0.24 (6.2)	Domestic Trade Barriers	-1.05 (-3.8)
		Foreign Trade Barriers	-0.82 (-2.0)
R2	0.54		0.74

Notes:

1) t-statistics in parentheses

2) The sample includes only nations that were manufacture exporters in 1989

3) Y/L_0 is real *per capita* income in 1960 (GDPSH560). Population growth is average population growth of population for the period 1960-1984 (GPO6084). Human capital formation is the secondary school enrolment rate in 1960 (SM60). Initial human capital stock is the secondary school attainment rate (SEC60). Physical capital formation is the average investment to GDP ratio (INVSH6089). In the investment equation the above variables are in logs while the domestic and foreign trade barriers are HOM4 and FOR4 respectively. HOM4 is FREEOP times OWTI and FOR4 is (1-FREEOP) times OWTIP, where OWTIP is the OWTI's of a country's five most important export markets weighted by export shares

The estimated coefficient on foreign barriers is also significant and negative. Foreign barriers have conflicting effects on the rate of return to domestic capital formation and thereby conflicting effects on domestic investment. Foreign barriers depress operating profits

of home exporters. This reduces the rental rate on domestic capital because the export industry is capital-intensive. Foreign barriers also force a terms of trade loss in the sense that the domestic rental rate on capital falls relative to that of the foreign country. This tends to reduce the price of new capital and raise the return to capital. The empirical results suggest the foreign barriers do more to harm operating profits of capital intensive exporters than they do to lower the cost of new capital via the general equilibrium effect on domestic factor prices. Consequently, foreign trade barriers tend to depress investment.

Although the results suggest that foreign trade barriers – as well as domestic trade barriers – harm domestic investment and growth, the point estimates indicate that domestic protection is more harmful to investment and growth than foreign trade barriers.

Alternative Data Samples. To check the robustness of the results, the system is re-estimated on alternative data samples. The first column of Table 2 reproduces the results for the preferred specification and data sample. The other columns show the estimates of the preferred specification on different samples of countries. The second column shows the results for the sample of countries that were manufacture exporters in 1965 (as opposed to 1989 which was the selection year for the first column sample). The 1965-based sample is much smaller containing only 21 countries as opposed to 39 countries in the column-1 sample. Comparison of the two columns shows that the point estimates are very similar. The principal difference is that foreign barriers are insignificant in the smaller sample although the point estimate in the 1965-based sample is also negative[7]. The column-2 estimate for domestic barriers is negative, significant and approximately the same size as the column-1 estimate.

The third column presents estimates performed on a large data set that include all countries for which there were complete data without regard to their commodity trade pattern[8]. The column-3 results broadly confirm the column-1 findings. All variables that are insignificant in column-1 are also insignificant in column 3. All the column-1 variables that are significant are also significant. In

[7] The 1965-based results have the problem that investment in human capital is estimated to have a negative and significant impact on growth.

[8] 20 Specifically the Barro and Sala-i-Martin (1995) that includes 97 countries of which 75 have complete data.

particular, domestic barriers continue to show a highly significant and negative impact on the investment share. The point estimate of the foreign trade barrier variable coefficient is negative and significant at the 5% level.

TABLE 2 – *Preferred Specification with Alternate Data Sample*

Samples								
	Manufacturers Exporters in 1989		Manufacturers Exporters in 1965		Barro-Lee		Primary Goods Exporters in 1965	
	(# obs. =39)		(# obs. =20)		(# obs. =75)		(# obs. =40)	
Growth Equation								
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	-0.02	-1.5	-0.03	-2.1	1E-03	0.1	-8E-04	-0.1
Initial Y/L	-4E-06	-3.4	-4E-06	-3.4	-4E-06	-4.0	-6E-06	-2.6
Pop. Growth	0.29	0.9	0.74	1.7	-0.21	-0.9	-0.08	-0.2
Human Capital Investment	-0.01	-0.8	-0.03	-2.0	0.01	0.4	0.02	0.9
Initial Human Capital Stock	4E-04	1.8	7E-04	2.7	3E-04	1.6	8E-05	0.3
Physical Capital Investment	0.24	6.2	0.29	7.1	0.15	2.9	0.15	3.2
R**2	0.54		0.52		0.44		0.60	
Investment Equation								
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	0.49	3.4	0.67	3.3	0.31	2.8	0.39	2.7
Log initial Y/L	-0.02	-1.1	-0.02	-1.0	-4E-04	0.0	-0.02	-1.2
Log Pop. Growth	-4E-03	-0.3	0.01	0.4	-0.01	-0.5	-0.01	-0.3
Log Human Capital Investment	0.08	4.9	0.09	5.9	0.05	4.7	0.04	3.1
Log Initial Human Capital Stock	-2E-03	-0.2	-0.03	-2.1	-0.01	-1.0	0.02	2.2
Domestic Barriers	-1.05	-3.8	-1.32	-4.3	-0.97	-4.1	-1.31	-4.1
Foreign Barriers	-0.82	-2.0	-1.17	-0.2	-0.81	-2.0	-0.18	-0.2
R**2	0.74		0.72		0.62		0.67	

The last column shows the results from estimating the preferred specification on a data set that includes only countries whose mainly exports were primary goods (instead of manufactures)[9]. In particular, the sample includes those countries that were primary commodity exporters in 1965. Domestic trade barriers should hinder investment

[9] The country-selection procedure is similar to the selection for manufactures exports except we select countries for which the Other Primary Goods (i.e. non oil and minerals) export share was the highest of the three shares.

in countries that export primary goods since they raise the cost of new capital. By contrast, foreign barriers should have little effect on investment in these countries for two reasons. First, if their exports are not capital-intensive, foreign barriers will not depress their rental rates. This leaves only the weak general equilibrium effect. Second, the trade barrier variable is an average rate weighted by countries' own import pattern. This poses a problem since most primary goods – apart from temperate agricultural goods – are dutied at a systematically lower rate in developed countries than general imports. Consequently, the trade barrier proxy will systematically overestimate the true foreign barriers faced by primary good exporters.

The column-4 estimates are in line with this informal reasoning. Namely, the domestic barriers continue to be significant and negative, but foreign barriers are insignificant. Note that the point estimate on domestic barriers is fairly robust to sample changes in that it remains between -1.0 and -1.3 in all samples.

Reduced Form Estimates. From the system of equation (7) it is possible to derive a reduced-form growth equation. GDP growth is regressed on the initial level of GDP *per capita*, on the growth rate of population, on human capital investment, on the initial stock of human capital and on domestic and foreign trade barriers.

The results, presented in Table 3, show that human capital formation has a positive impact on growth (significant in two samples). Initial income has a negative and significant effect in all samples. For all of the data samples, the domestic trade variable has the expected

TABLE 3 – *Reduced Form Regression on Various Data Samples*

	Samples							
	Manufacturers Exporters in 1989		Manufacturers Exporters in 1965		Barro-Lee		Primary Goods Exporters in 1965	
	(# obs. =39)		(# obs. =20)		(# obs. =75)		(# obs. =40)	
	Reduced form							
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	-1.18	-0.7	-0.79	-0.5	0.49	0.3	2.60	1.0
Log Initial Y/L	-0.52	-2.5	-0.63	-2.6	-0.76	-4.0	-0.90	-2.4
Log Pop. Growth	-2E-03	0.0	-0.17	-0.7	-0.04	-0.2	0.38	0.9
Log Human Capital Investment	0.21	0.8	0.07	0.4	0.50	3.3	0.63	2.8
Log Initial Human Capital Stock	0.10	0.7	0.10	0.6	0.09	0.8	0.08	0.3
Domestic Barriers	-0.29	-2.3	-0.30	-2.0	-0.31	-2.7	-0.45	-2.1
Foreign Barriers	-0.09	-0.9	-0.02	-0.2	-0.12	-1.4	-0.20	-1.2
R**2	0.30		0.50		0.37		0.38	

sign (negative) and is significant. The foreign trade variable is not significant in any sample, although all point estimates are negative.

Alternative Specifications. To check for the possibility of misspecification errors (so that the results are due to a correlation between the included and omitted variables), the regression is run again including a number of growth correlates that researchers have frequently put into growth regressions. In particular, the regression is re-run introducing three of the growth correlates used in Barro (1991), namely REVCOUP (a measure of the number of revolutions and coup d'états), AVGGOVCONS (the average share of government consumption in GDP) and AVGFERT6084 (the average fertility rate from 1960 to 1984). Table 4 shows the results.

TABLE 4 – *Verifying Robustness to Inclusion of Extra Growth Correlates*

Extra Growth Correlates	Preferred Specification (hom4)		Number of Revolutions and Coup d'ètats		Average Share of Government Consumption in GDP		Average Fertility Rate from 1960 to 1984	
Sample Manufacture 1989	(# obs. =39)		(# obs. =33)		(# obs. =39)		(# obs. =39)	
Growth Equation								
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	-0.02	-1.5	-0.02	-1.9	-0.06	-1.6	7E-03	0.3
Initial Y/L	-4E-06	-3.4	-3E-06	-2.9	-4E-06	-2.9	-4E-06	-3.8
Pop. Growth	0.29	0.9	0.41	1.3	0.63	1.3	1.20	2.5
Human capital investment	-0.01	-0.8	-0.01	-0.9	-0.02	-1.0	-0.01	-1.0
Initial Human capital stock	4E-04	1.8	4E-04	2.1	4E-04	1.8	2E-04	1.0
Physical capital investment	0.24	6.2	0.23	6.0	0.33	3.3	0.20	3.9
REVCOUP			4E-04	0.0				
AVGGOVCONS					0.11	1.3		
AVGFERT6084							-0.01	-1.8
R**2	0.54		0.62		0.38		0.62	
Investment Equation								
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	0.49	3.4	0.48	2.4	0.37	3.0	0.77	4.4
Log initial Y/L	-0.02	-1.1	-0.02	-1.0	-0.02	-1.1	-0.03	-2.0
Log Pop. Growth	-4E-03	-0.3	-9E-03	-0.5	-0.03	-2.2	0.02	0.9
Log human capital investment	0.08	4.9	0.08	4.0	0.05	3.1	0.07	4.7
Log initial human capital stock	-2E-03	-0.2	-5E-04	0.0	8E-04	0.1	-0.01	-1.0
Domestic Barriers	-1.05	-3.8	-1.02	-3.3	-0.53	-2.2	-0.88	-3.3
Foreign Barriers	-0.82	-2.0	-0.06	-0.1	0.03	0.3	-0.23	-2.0
REVCOUP			-0.04	-1.1				
AVGGOVCONS					-0.62	-4.2		
AVGFERT6084							-0.02	-2.3
R**2	0.74		0.75		0.81		0.77	

Notes: REVCOUP= Number of coups and revolutions, AVGGOVCONS= Average Share of Government Consumption in GDP, AVGFERT6084= Average Fertility Rate from 1960 to 1984.

In the first column of the table, the favoured specification is reproduced for comparison. The next three pairs of columns show the point estimates and t-statistics for regressions that include extra growth correlates in both the growth and investment equations. The domestic trade barrier variable remains negative and significant in all regressions. The point estimates are changed somewhat but never more than two standard errors from the original point estimate (using the original standard error).

The foreign trade barrier variable is more fragile to the inclusion of these extra variables. The point estimates always remain negative, but they are always insignificant. In two of the three cases the point estimates remain stable, but when AVGGOVCONS is included the point estimate drops very close to zero.

Alternative Trade Barrier Proxies. The tariff variable developed by Lee (1993) is the preferred trade barrier proxy since it most closely matches the type of barriers in new trade models. Moreover, it is available for a wide range of countries, although not on a time-series basis. It is worthwhile, however, investigating the impact of using alternative trade-barrier proxies. Table 5 presents some other trade barrier proxies. The first pair of columns shows the results for the black market premium. This proxy has the obvious drawbacks that it does not directly measure import restrictions and it is zero for many of the countries in the 1989-based manufacture sample. Nonetheless, it produces a significant and negative estimate for domestic barriers, although the foreign barriers variable is insignificant. This latter result is entirely expected since the main trading partners of virtually all manufacture exporters are a handful of large, rich countries such as the US, Germany, Japan, France, etc. and these countries do not have positive black market premiums.

The second pair of columns shows results for an indicator of quantitative restrictions (QRs). This indicator, however, is seriously flawed in that it does not weight QRs by the amount of trade affected or the restrictiveness of the QR. The estimated coefficients on the trade barrier variables are both negative, but insignificant. The results for the Leamer (1988) measure of openness are presented in the third pair of columns. Again, domestic openness is found to boost investment but foreign openness is not statistically different than zero, although it is positive. The next pair of columns shows results for Leamer's measure of 'intervention' (the sum of the absolute values of residuals from his net-trade Hecksher-Ohlin model). Both

the domestic and foreign barriers are significant and positive. The relationship between Leamer's measure and trade protection is ill defined. For instance, if the average country were protectionist, then both extraordinarily open and extraordinarily closed countries would have large residuals. Other researchers have found mixed results for this proxy[10]. The last four columns show results for unadjusted export to GDP and import to GDP ratios. The estimates show that domestic openness has a positive and close to significant effect on the investment share. Foreign openness is insignificant.

TABLE 5 – *Verifying Robustness for other Trade Barrier Proxies*

Sample Manufacture 1989	Free Trade Openness Adjusted Black Market Premium		Free Trade Openness Adjusted Quantitative Restrictions		Leamer Openness Measure (Leam 1)		Leamer Intervention Measure (Leam 2)		Exports to GDP ratio		Imports to GDP ratio	
Growth Equation												
	(# obs. =39)		(# obs. =39)		(# obs. =28)		(# obs. =28)		(# obs. =39)		(# obs. =39)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef	t-stat
Constant	-0.02	-1.7	-0.02	-1.6	-2E-03	-0.1	-0.01	-1.1	-0.02	-1.9	-0.02	-1.9
Initial Y/L	-4E-06	-3.9	-4E-06	-3.7	-4E-06	-4.5	-4E-06	-5.0	-4E-06	-3.6	-4E-06	-3.6
Pop. Growth	0.27	0.8	0.30	0.9	0.14	0.5	0.27	0.9	0.34	1.0	0.36	1.1
Human Capital Investment	-0.02	-1.2	-0.02	-1.0	-0.01	-1.1	-0.01	-1.1	-0.02	-1.1	-0.02	-1.1
Initial Human Capital Stock	5E-04	2.3	4E-04	2.0	5E-04	2.7	5E-04	2.9	4E-04	1.8	4E-04	1.8
Physical Capital Investment	0.27	6.6	0.26	5.9	0.18	5.3	0.23	6.9	0.28	6.3	0.28	6.4
R**2	0.47		0.49		0.61		0.49		0.44		0.44	
Investment Equation												
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef	t-stat
Constant	0.23	2.0	0.22	1.5	-0.11	-0.7	-0.43	-2.2	0.09	0.6	0.06	0.4
Log initial Y/L	0.01	0.5	0.01	0.4	0.05	2.4	0.08	3.4	0.01	0.6	0.01	0.8
Log Pop. Growth	-0.01	-0.4	-0.01	-0.3	-0.01	-0.4	-0.02	-1.1	-0.02	-0.8	-0.02	-0.9
Log Human Capital Investment	0.05	3.8	0.06	3.4	0.03	1.2	0.02	1.0	0.05	3.1	0.05	3.2
Log Initial Human Capital Stock	-3E-03	-0.3	5E-03	0.5	-0.02	-1.3	-0.04	-2.6	4E-03	0.4	4E-03	0.4
Domestic Barriers	-0.54	-3.5	-0.18	-1.0	0.11	1.6	0.19	3.9	0.10	1.8	0.10	1.9
Foreign Barriers	0.11	0.3	-0.71	-1.3	0.66	1.8	0.30	1.8	0.07	0.3	0.11	0.6
R**2	0.70		0.65		0.62		0.62		0.65		0.65	

[10] Levine and Renelt find this to be robustly and positively related to investment. Edwards (1992) found it to be negative, although he does not robustness analysis.

5.1 Trade-induced Investment-led Growth or Export-led Growth?

In virtually any neoclassical growth model, trade does not affect output growth directly. Trade affects growth via its impact on investment. This is almost a tautology when one considers all types of investment, e.g. investment in human capital, physical capital and knowledge capital (technology). Neoclassical models, however, treat technological progress as exogenous, so the level of trade barriers should not affect output growth in an equation that includes investment in human and physical capital. Clearly, the hypothesis that technological progress is truly exogenous is strong as it is the hypothesis that trade barriers have nothing to do with technical progress. The test, however, is about how important trade barriers are in explaining growth controlling for their impact on the investment rate in physical capital.

To estimate the direct impact of trade on growth, controlling for its indirect impact via investment, the system is re-estimated including the trade variables in the growth equation and investment equations. If trade affects growth mainly via investment, the trade variables should be insignificant in the growth equation but significant in the investment equation.

The results in Table 6 broadly confirm this prediction. Both trade barrier variable are insignificant (at the 5% level) in all of the samples. This finding is in the spirit of the results that Levine and Renelt (1992) obtain using single-equation ordinary least squares estimation.

The point estimates on the trade variables in the *per capita* growth regression essentially measure the impact of trade openness on total factor productivity growth since the contribution of physical and human capital investment are controlled for directly. In this light, it is interesting to note that both domestic and foreign trade variables are significant at the 10% confidence level in the 1989-based manufacture exporter sample, but are much further from significant in the other samples. This suggests (optimistically) that international technology transfers are more closely tied to openness in manufacture exporters than average.

Although trade variables are never significant (at the 5% level) in the growth equation, this cannot be considered conclusive evidence against the hypothesis that trade can affect the rate of technology progress. Coe and Helpman (1995) for instance find that bilateral trade does affect the rate of technology progress. In this light, the results are best interpreted as saying that this sort of effect is not

strong enough to show up in such a broad cross-section data set. For instance, in many growth models (e.g. Helpman and Grossman, 1991, chapter 5), the rate of knowledge accumulation is proportional to the rate of physical capital formation. Thus with physical capital accumulation linearly related to investment, the estimated coefficient on the investment variable may be picking the influence of the omitted knowledge creation variable. In other words, it may be that there is such a close correlation between physical capital investment and technological progress that it is impossible to disentangle the impact of trade on innovation with cross-section data.

TABLE 6 – *Trade Variables in both Growth and Investment Equations*

Samples								
	Manufacturers Exporters in 1989		Manufacturers Exporters in 1965		Barro-Lee		Primary Goods Exporters in 1965	
	(# obs. =39)		(# obs. =20)		(# obs. =75)		(# obs. =40)	
Growth Equation								
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	-0.03	-2.4	-0.03	-2.4	-0.01	-0.7	-0.01	-0.9
Initial Y/L	-3E-06	-2.5	-6E-06	-4.1	-4E-06	-3.3	-5E-06	-2.1
Pop. Growth	0.23	0.7	1.76	2.9	-0.18	-0.7	-0.10	-0.3
Human Capital Investment	-0.04	-1.9	-0.02	-1.2	-0.01	-0.3	5E-03	0.1
Initial Human Capital Stock	5E-04	2.0	9E-04	2.8	3E-04	1.4	3E-05	0.1
Physical Capital Investment	0.32	6.3	0.30	7.1	0.22	2.2	0.21	3.1
Domestic Barriers	0.13	1.6	-0.16	-2.3	0.09	0.8	0.13	1.2
Foreign Barriers	0.21	1.9	-3.23	-1.7	0.09	0.8	-0.07	-0.4
R**2	0.39		0.62		0.36		0.61	
Investment Equation								
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	0.50	3.5	0.48	2.1	0.34	3.1	0.42	2.9
Log initial Y/L	-0.02	-1.3	-0.01	-0.3	-0.01	-0.4	-0.02	-1.3
Log Pop. Growth	-0.01	-0.4	-6E-03	-0.3	-0.01	-0.7	-0.01	-0.3
Log Human Capital Investment	0.07	4.8	0.09	5.6	0.05	4.9	0.04	3.3
Log Initial Human Capital Stock	1E-03	-0.1	-0.04	-2.4	-0.01	-0.7	0.02	2.1
Domestic Barriers	-1.12	-4.0	-0.98	-2.7	-1.0	-4.3	-1.29	-4.1
Foreign Barriers	-1.04	-2.5	4.53	0.8	-0.84	-2.1	-0.25	-0.3
R**2	0.74		0.73		0.61		0.67	

5.2 Is the Impact of Trade Barriers Different for Rich and Poor Countries?

The evidence up to now shows that trade affects growth via its effect on the investment ratio. A natural question that arises is whether trade-induced investment-led growth is relevant to developing nations by repeating the regressions on nations grouped by income classes.

In order to reduce sample selection biases, that is, countries get into high income classes due to high growth, *per capita* income levels from the beginning of the sample, 1960, are used. Since all definition of income classes are somewhat arbitrary, four divisions are tried. The first sample, 'poor 10', are the countries whose 1960 *per capita* incomes were less than or equal to 10% of the US 1960 *per capita* income, according to the Summer-Heston data. The complement of the poor 10 is called the 'rich 10'. The other three divisions follow the same procedure setting the bar at 15%, 20% and 35%. The countries in these samples are listed in Table 7.

Using the eight different samples with nine different openness proxies yields 72 pairs of regressions. Table 8 summarises the results[11] by focusing only on whether the model 'works' for a particular proxy and a particular sample (full results are available on request). The definition of 'works' is rather minimal, namely that the investment ratio is estimated to have a positive and significant coefficient in the growth regression, and the openness proxy is significant and of the expected sign in the investment equation. The criterion is chosen since for any proxy-sample pair that meets these two conditions, trade openness stimulates growth via its impact on the investment rate.

The table shows that three proxies work fairly well, the preferred trade barrier measure (adjusted tariff rates on intermediates and capital goods), the black market premium and Leamer's first measure of openness. However, two other openness proxies never work, namely the UNCTAD index of quantitative restrictions, and an index of openness suggested by Frankel and Romer (1996) – the working paper version of Frankel and Romer (1999) – equals to the residuals from a gravity model without income variables.

[11] Since foreign trade barriers were often fragile, they are not included in these estimates. Before dividing the sample into income groups, however, the specification without foreign trade variables has been estimated on the broadest possible sample and robustness tests has been carried out. The results, not reported but available on request, are similar to those presented in the paper.

TABLE 7 – *List of Countries in each Sub-group*

Poor 10	Rich 10	Rich 10 (cont'd)	Poor 15	Rich 15	Rich 15 (cont'd)
CAMEROON	ALGERIA	IRAN	BENIN	ALGERIA	ITALY
CEN. AFRICA REP.	BENIN	IRAQ	CAMEROON	MAURITIUS	NETHERLANDS
GHANA	CONGO	JAPAN	CEN. AFRICA REP.	BARBADOS	NORWAY
KENYA	MAURITIUS	JORDAN	CONGO	CANADA 50	PORTUGAL
MALAWI	MOZAMBIQUE	MALAYSIA	GHANA	COSTA RICA	SPAIN
RWANDA	SENEGAL	PHILIPPINES	KENYA	GUATEMALA	SWEDEN
TANZANIA	TUNISIA	SINGAPORE 100	MALAWI	JAMAICA	SWITZERLAND
UGANDA	ZIMBAWE	SRI LANKA	MOZAMBIQUE	MEXICO 60	TURKEY
ZAIRE	BARBADOS	AUSTRIA	RWANDA	NICARAGUA	UNITED KINGDOM
ZAMBIA	CANADA 50	BELGIUM	SENEGAL	TRINIDAD & TOBAGO	NEW ZEALAND
HAITI	COSTA RICA	CYPRUS	TANZANIA	UNITED STATES	
BANGLADESH	EL SALVADOR	DENMARK	TUNISIA	ARGENTINA	
INDIA	GUATEMALA	FINLAND	UGANDA	BRAZIL	
INDONESIA	JAMAICA	FRANCE	ZAIRE	CHILE 70	
KOREA	MEXICO 60	GERMANY, WEST	ZAMBIA	COLOMBIA	
NEPAL	NICARAGUA	GREECE	ZIMBAWE	GUYANA	
PAKISTAN	TRINIDAD & TOBAGO	IRELAND	EL SALVADOR	PERU	
THAILAND	UNITED STATES	ITALY	HAITI	URUGUAY	
	ARGENTINA	NETHERLANDS	BOLIVIA	VENEZUELA	
	BOLIVIA	NORWAY	ECUADOR	HONG KONG	
	BRAZIL	PORTUGAL	PARAGUAY	IRAN	
	CHILE 70	SPAIN	BANGLADESH	IRAQ	
	COLOMBIA	SWEDEN	INDIA	JAPAN	
	ECUADOR	SWITZERLAND	INDONESIA	SINGAPORE 100	
	GUYANA	TURKEY	JORDAN	AUSTRIA	
	PARAGUAY	UNITED KINGDOM	KOREA	BELGIUM	
	PERU	NEW ZEALAND	MALAYSIA	CYPRUS	
	URUGUAY	PAPUA N. GUINEA	NEPAL	DENMARK	
	VENEZUELA		PAKISTAN	FINLAND	
	HONG KONG		PHILIPPINES	FRANCE	
			SRI LANKA	GERMANY, WEST	
			THAILAND	GREECE	
			PAPUA N. GUINEA	IRELAND	

Poor 20	Poor 20 (cont'd)	Rich 20	Poor 35	Poor 35 (cont'd)	Rich 35
ALGERIA	KOREA	MAURITIUS	ALGERIA	PARAGUAY	CANADA 50
BENIN	MALAYSIA	BARBADOS	BENIN	PERU	TRINIDAD & TOBAGO
CAMEROON	NEPAL	CANADA 50	CAMEROON	BANGLADESH	UNITED STATES
CEN. AFRICA REP.	PAKISTAN	COSTA RICA	CEN. AFRICA REP.	HONG KONG	URUGUAY
CONGO	PHILIPPINES	MEXICO 60	CONGO	INDIA	VENEZUELA
GHANA	SINGAPORE 100	TRINIDAD & TOBAGO	GHANA	INDONESIA	AUSTRIA
KENYA	SRI LANKA	UNITED STATES	KENYA	IRAN	BELGIUM
MALAWI	THAILAND	ARGENTINA	MALAWI	IRAQ	DENMARK
MOZAMBIQUE	PORTUGAL	CHILE 70	MAURITIUS	JAPAN	FINLAND
RWANDA	TURKEY	URUGUAY	MOZAMBIQUE 30	JORDAN	FRANCE
SENEGAL	PAPUA N. GUINEA	VENEZUELA	RWANDA	KOREA	GERMANY, WEST
TANZANIA		HONG KONG	SENEGAL	MALAYSIA	ITALY
TUNISIA		IRAN	TANZANIA	NEPAL	NETHERLANDS
UGANDA		IRAQ	TUNISIA	PAKISTAN	NORWAY
ZAIRE		JAPAN	UGANDA	PHILIPPINES	SWEDEN
ZAMBIA		AUSTRIA	ZAIRE	SINGAPORE 100	SWITZERLAND
ZIMBAWE		BELGIUM	ZAMBIA	SRI LANKA	UNITED KINGDOM
EL SALVADOR		CYPRUS	ZIMBAWE	THAILAND	NEW ZEALAND
GUATEMALA		DENMARK	BARBADOS	CYPRUS	
HAITI		FINLAND	COSTA RICA	GREECE	
JAMAICA		FRANCE	EL SALVADOR	IRELAND	
NICARAGUA		GERMANY, WEST	GUATEMALA	PORTUGAL	
BOLIVIA		GREECE	HAITI	SPAIN	
BRAZIL		IRELAND	JAMAICA	TURKEY	
COLOMBIA		ITALY	MEXICO 60	PAPUA N. GUINEA	
ECUADOR		NETHERLANDS	NICARAGUA		
GUYANA		NORWAY	ARGENTINA		
PARAGUAY		SPAIN	BOLIVIA		
PERU		SWEDEN	BRAZIL		
BANGLADESH		SWITZERLAND	CHILE 70		
INDIA		UNITED KINGDOM	COLOMBIA		
INDONESIA		NEW ZEALAND	ECUADOR		
JORDAN			GUYANA		

Generally, the results are quite supportive of the belief that trade-induced investment-led growth is relevant to both rich and poor countries. The various proxies, however, focus on different types of openness, it is natural, therefore, that some proxies work

better than others in the different samples. The importance of the adjusted tariff rates on intermediates and capital goods in the rich countries is quite in line with the theory. The basic point is that since capital uses traded intermediates and capital goods as inputs, raising tariffs on these items raise the price of capital and thereby depresses the steady-state capital stock. The fact that it works for rich countries but not for poor ones may have something to do with poor-countries' protection structures. The story – which might be usefully investigated further – is that poor countries have low statutory and applied tariff rates on imported capital goods, but that such rates understate the level of import barriers since much protection takes the form of rationed foreign exchange and import licensing. This explanation fits rather well with the fact that the black market premium works well with poor countries, but less well for rich countries. The somewhat anomalously good results for black market premia in the rich-35 sample (the richest countries) is explained by the fact that while most rich 35 countries have zero premia (e.g., the US and the rich European nations), a couple of outliers, like Venezuela (which was quite rich in 1960), have positive premia and have subsequently experienced negative growth.

The results for the Leam1 proxy are also interesting. According to the proxy 'Leam1', a nation is open if its trade is unusually large compared with the prediction of Leamer's estimated Hechscher-Ohlin model. This proxy works for all but the richest samples. This result can be explained on the basis of the Hechscher-Ohlin model. As it is well known, the Hechscher-Ohlin model cannot explain intra-industry trade, so Leamer (1988) works with net trade rather than actual trade (i.e. exports minus imports in each of his product categories). Since most rich-country trade is intra-industry trade within Leamer's categories, the model fits badly for rich countries. Quite simply, their gross trade patterns differ substantially from their net trade patterns. This is a problem since many interesting trade and growth links rely on intraindustry trade. According to this explanation, Leamer's measure misses the relevant protection in the very rich countries, so it is not surprising that the regressions fail. The Hechscher-Ohlin model works much better for poor countries, since their gross and net trade patterns match up better.

The two proxies calculated in Frankle and Romer (1996) are based on deviations from two versions of the gravity-model predictions. The first version of the model includes only truly exogenous factors such as distance and land area. The second includes more traditional variables such as GDP. Since the first version of the model does not fit the data very well, it is not surprising that the proxy based

upon it fails systematically in all the income-group subsamples. The second model version fits the data very well (as the gravity always does), so it is not surprising that deviations between fitted and actual trade based on this version works fairly well.

TABLE 8 – *Testing for Investment-led Growth*

Summary Table for Income Group Regressions								
	Poor Country Samples				Rich Country Samples			
	10	15	20	35	10	15	20	35
Weighted Tariff Average					X	X	X	X
Black Market Exch. Rate Premium	X	X	X	X	X			X
Quantitative Restrictions								
Leam 1	na	X	X	X	X	X		
Leam 2	na		X					
Exports/GDP					X	X	X	
Imports/GDP					X	X	X	
Frankel-Romer 1								
Frankel-Romer 2			X	X	X	X		

Notes: Countries below the cutoff, *per capita* income level in 1960 are 'poor', those above are 'rich'. Cutoffs used: 10% of USA 1960 real *per capita* income and 15%, 20% and 35%.

An X indicates that the model 'works' for the proxy-sample pair indicated. See text for definition of 'works'.

Na indicates model could not be estimated due to insufficient observations.

A conclusion that can be drawn from the evidence of Table 8 is that trade induced investment led growth works for poor and rich countries. For rich countries, the beneficial effects of trade liberalization works through a reduction in intra-industry trade barriers. For poor countries, the beneficial of trade liberalization works through a reduction in inter-industry trade barriers (Leam1) and in the reduction in the black market exchange rate premium. This last variable, of course, represents not only a trade proxy but also a proxy for macroeconomic instability.

5.3 Does the Impact of Trade Barriers Differ with the Factor-endowment of the Countries?

The growth effects of trade liberalization are quite different in new and old trade models. The predictions of the two approaches are

easily illustrated even without formal models. Suppose to start with the post II world war where virtually all nations have very high levels of import protection in manufacturing. Starting from this situation, reciprocal liberalization in the Heckscher-Ohlin model tends to raise the capital's reward in capital-abundant nations, lowering it in capital-scarce nations. Reciprocal liberalization will therefore tend to be pro-medium-run-growth in nations that are already capital-rich, but will tend to have the opposite effect in capital-poor nations. While the price lowering effect of this may raise welfare even in the capital-poor nations, the old-trade-old-growth literature has implications that are not too far from what is sometimes called 'inequalizing trade'. Note that in a new trade model, reciprocal liberalization can easily raise capital's reward in all nations.

This section evaluates the evidence that this sort of win-lose effect is in operation. To this end, the broad sample is divided into a capital-rich subsample and a capital-poor subsample. With more than two factors it is impossible to unambiguously define capital intensive or capital abundance. Using 1972 data, each country that has a positive 'capital abundance ratio' according to the definition in Leamer (1987 p.95) is classified as capital abundant[12]. To identify countries that export capital intensive goods, it is used Leamer's chapter 3 classification of goods. Following Leamer's discussion (page 66), it is labelled as capital-intensive exporter any country that has positive net exports in 'Capital intensive' industries, 'Machinery', or 'Chemicals'. Table 9 lists the countries according to the two criteria.

The results of the regressions on the four subsamples are listed in Table 10. The first two columns show the results for the capital-rich/capital-poor samples that are chosen according to the factor abundance criteria. The results clearly show that the model 'works' for both the capital-rich and capital-poor samples, using the adjusted tariff proxy. In particular, for both samples, the investment ratio is significant in the growth equation and openness is significant in the investment equation. Thus even for capital-scarce countries, openness seems to stimulate growth via physical capital accumulation. The point estimate of the impact of openness on the investment rate is

[12] This 'capital abundance ratio' is actually the ratio of two ratios minus unity. The first ratio is the countries endowment of capital to its GNP. This is divided by the world's capital endowment divided by the world's GNP. The difference between this ratio of ratios and unity is the index.

much smaller, however, in the capital-poor nations than it is in the capital-rich nations.

TABLE 9 – *List of Countries for Factor Endowment Samples*

Capital Endowment Samples		Capital-Intensive Exports Samples	
Abundant	Not abundant	K-intensive	Not K-intensive
Canada	Ghana	Jamaica	Ghana
Japan	Mauritius	USA	Mauritius
Singapore	Costa Rica	India	Canada
Austria	El Salvador	Japan	Costa Rica
Belgium	Jamaica	Korea	El Salvador
Cyprus	Mexico	Austria	Mexico
Finland	United States	Belgium	Argentina
France	Argentina	France	Brazil
Germany, W.	Brazil	Germany, W.	Chile
Italy	Chile	Italy	Colombia
Netherlands	Colombia	Netherlands	Ecuador
Norway	Ecuador	Spain	Paraguay
Sweden	Paraguay	Sweden	Peru
Switzerland	Peru	Switzerland	Hong Kong
New Zealand	Hong Kong	UK	Indonesia
	India		Malaysia
	Indonesia		Philippines
	Korea		Singapore
	Malaysia		Sri Lanka
	Philippines		Thailand
	Sri Lanka		Cyprus
	Thailand		Denmark
	Denmark		Finland
	Greece		Greece
	Ireland		Ireland
	Portugal		Norway
	Spain		Portugal
	Turkey		Turkey
	UK		New Zealand

The third and fourth columns present the same sort of results for the sample divided according to the export capital-intensity criteria. The results are qualitative quite similar except that the point estimate on openness in the investment equation is slightly greater for the capital poor countries than for the capital rich countries.

Taken as a whole, these results reject the notion that trade liberalization is 'inequalizing', stimulating growth in capital-rich countries and stifling it in capital-poor countries. Regardless of a countries initial capital endowment, liberalization stimulates investment-led growth.

TABLE 10 – *Testing for Heckscher-Ohlin-like Growth Prediction*

(Broadest sample divided into capital-rich and capital-poor countries)				
	Factor Abundance Criteria		Export K-Intensity Criteria	
	Capital-rich	Capital-poor	Capital-rich	Capital-poor
Growth Equation				
Constant	2.3E-02 **	-3.6E-02	-1.4E-02	-4.1E-03
Initial GDP	-4.6E-06 **	-2.9E-06 **	-3.6E-06	-4.9E-06 **
Avg. Population Growth	2.9E-01	3.4E-01	1.1E-01	-1.1E-01
Initial Secondary Enrolment	-2.2E-02 **	-1.2E-02	1.4E-02	-2.0E-02
Initial Secondary Achievement	1.6E-04	3.8E-04	3.0E-04	3.3E-04
Avg. Investment-to-GDP ratio	1.4E-01 **	3.0E-01 **	1.8E-01 **	2.2E-01 **
	R2=.90	R2=.48	R2=.31	R2=.57
Investment Equation				
Constant	8.0E-01 **	4.9E-01 *	3.6E-01 **	3.0E-01 *
Ln(Initial GDP)	-3.5E-02 **	-3.3E-02	-3.6E-03 *	-1.6E-02
Ln(Avg. Population Growth)	6.9E-03	-1.8E-02	7.0E-03	-3.4E-02
Ln(Initial Secondary Enrolment)	1.0E-01 **	4.9E-02	-7.1E-03 **	4.4E-02
Ln(Initial Secondary Achievement)	-2.0E-02	-5.8E-03	-3.9E-03	9.7E-04
Weighted tariff average	-3.6E+00 **	-8.2E-01 **	-8.9E-01 **	-1.2E+00 **
	R2=.53	R2=.41	R2=.52	R2=.69

Notes: ** indicates significant at 5%, * at 10% confidence level.

5.4. Trade-induced Investment-led Growth or Trade-induced Productivity-led Growth for Countries Grouped by Income Classes

Trade-induced productivity-led growth is growth that stems from a connection between openness and countries' average total factor productivity (TFP) growth. Since the process of technology adoption is *a priori* quite different in developed and developing nations, the hypothesis is tested on the eight income group samples discussed above.

To estimate the direct impact of trade on TFP growth, controlling for its indirect impact via investment, the system is re-estimated including the trade variables in the growth equation and in the investment equation.

Table 11 shows the results when the system is estimated on the eight income group samples for each of the nine openness proxies[13].

[13] The system has also been estimated on the broadest possible sample for each of the nine openness proxies. The results, available on request, support the case that trade boosts growth via investment.

This yields 72 pairs of regressions. The table shows each proxy-sample pair. The pairs for which openness was significant in the growth equation are marked with an 'A'; these provide evidence that openness has affected the Solow residual. The symbol '(A)' indicates that the openness proxy is significant but has the 'wrong' sign in the sense that it indicates that openness is associated with lower TFP growth.

TABLE 11 – *Testing for Trade-induced Productivity-led Growth*

Summary Table for Income Group Regressions								
	Poor Country Samples				Rich Country Samples			
	10	15	20	35	10	15	20	35
Weighted Tariff Average								
Black Market Exch. Rate Premium	A	A	A	A	A	A		(A)
Quantitative Restrictions								
Leam 1	na	A	A	A				(A)
Leam 2	na			A	A			(A)
Exports/GDP	(A)		(A)			A	A	
Imports/GDP	(A)					A	A	
Frankel-Romer 1					A		A	
Frankel-Romer 2	A		A	A	A	A		

Notes: Countries below the cutoff, *per capita* income level in 1960 are 'poor', those above are 'rich'. Cutoffs used: 10% of USA 1960 real *per capita* income and 15%, 20% and 35%.
An A indicates openness in the growth equation has a t-statistic of at least 2 and is of the expected sign.
(A) indicates significant but 'wrong' sign.
Na indicates model could not be estimated due to insufficient observations.

The pattern in the table is not in line with the idea that trade is more important for TFP growth in poor countries. For instance, excluding the wrong-sign cases, there are 11 instances of trade-induced productivity-led growth in the poor samples and the same number in the rich samples. Admittedly, some of the rich and poor samples share a good number of nations. For instance, the rich 10 list includes most of the countries in poor 35. Indeed, only two pairs of rich-poor samples contain no overlap: poor 10 and rich 35, and poor 15 and rich 20. Yet, even when attention is limited to these proxy-sample pairs, the result is that openness is about equally important in the rich and poor samples. Note that the growth equation in the expanded model includes 7 right-hand side variables, so the fact that the extreme sample (rich 35 and poor 10) have only 18 observations implies difficulties with degrees of freedom.

Table 12 focuses on another aspect of the results by indicating all the proxy-sample pairs for which there is evidence of trade-induced investment-led growth in the specification with trade variables in both equations. As before, we apply the double criteria that investment has a positive and significant coefficient in the growth equation and openness is significant and of the right sign in the investment equation. Proxy-sample pairs matching this criterion are marked with an 'I'; there are 10 such pairings, equally divided among the rich and poor samples. Comparing the two previous tables, there are only two pairings (Leam1 with poor 15 and poor 20) in which there is evidence that trade stimulates growth via the two channels simultaneously. Lastly, if one put the focus only on the significance of openness for investment (i.e. dropping one of the two conditions), in 22 of the sample pairings openness has a positive impact on the investment ratio.

TABLE 12 – *Testing for Trade-induced Investment-led Growth*

Summary Table for Income Group Regressions								
	Poor Country Samples				Rich Country Samples			
	10	15	20	35	10	15	20	35
Weighted Tariff Average					I			I
Black Market Exch. Rate Premium		(I)						I
Quantitative Restrictions								I
Leam 1		I	I					
Leam 2			I					
Exports/GDP			I		I			
Imports/GDP			I					
Frankel-Romer 1								
Frankel-Romer 2	(I)							

Notes: Countries below the cutoff, *per capita* income level in 1960 are 'poor', those above are 'rich'. Cutoffs used: 10% of USA 1960 real *per capita* income and 15%, 20% and 35%.
An A indicates openness in the growth equation has a t-statistic of at least 2 and is of the expected sign. (A) indicates significant but 'wrong' sign.
Na indicates model could not be estimated due to insufficient observations.

6. CONCLUDING REMARKS

This paper explores the implications of trade liberalization on economic growth based on the theoretical model of Baldwin and Seghezza (1996) where trade liberalisation inducing capital formation and therefore produces medium-run growth. This framework naturally yields a two-equation system consisting of an investment equation and a growth equation, where investment affects growth.

Trade openness could affect growth, even controlling for investment, if openness speeds the adoption of technology. Additionally, openness may affect growth via its impact on the investment rate.

Growth and investment equations are first estimated (using three stage least squares) on a cross-country sample of manufacture exporters. Domestic barriers are found to depress investment and thereby growth. This result is robust in that it is present in a variety of samples and for a variety of openness proxies. Foreign trade barriers are also found to depress investment and growth, but the effect is less strong and much less robust to sample and proxy changes. These empirical results support the idea that trade liberalization affects growth via investment. The paper also reports a reduced-form growth regression, one in which only exogenous variables are included on the right-hand side. Results from this reduced-form regression show that domestic trade barriers slow growth, while foreign trade barriers are not significant.

To further test the hypothesis that trade affects growth mainly via its effects on investment and not via its effects on productivity, the system is re-estimated including the trade variables both in the growth and in the investment equation. If trade affects growth mainly via its effects on investment, trade variables should be insignificant in the growth equation but significant in the investment equation. The results confirm this prediction: domestic and foreign trade barrier variables are insignificant in all of the samples.

After providing evidence that trade affects growth via its effect on the investment ratio, the paper next tests whether trade-induced investment-led growth is relevant to developed and developing nations alike. To do this it repeats the regressions on nations grouped by income classes. The results are supportive of the belief that trade-induced investment-led growth is relevant to both rich and poor countries. For rich countries, the beneficial effects of trade liberalization works through a reduction in intra-industry trade barriers. For poor countries, the beneficial of trade liberalization works through a reduction in inter-industry trade barriers and in the reduction in the black market exchange rate premium. This last variable, of course, may represent not only a trade proxy but also a proxy for macroeconomic instability.

The paper then tests whether trade effects on growth are different according to the factor endowment of countries. To this end, the broad sample is divided into a capital-rich sample and a capital-poor sample. The results show that even for capital-scarce

countries, openness seems to stimulate growth via physical capital accumulation. The point estimate of the impact of openness on the investment rate is much smaller, however, in the capital-poor nations than it is in the capital-rich nations. The result is confirmed when the sample is divided according to the export capital-intensity criteria. The results are qualitative quite similar except that the point estimate on openness in the investment equation is slightly greater for the capital poor countries than for the capital rich countries. Taken as a whole, these results reject the notion that trade liberalization is 'inequalizing', stimulating growth in capital-rich countries and stifling it in capital-poor countries. Regardless of a countries initial capital endowment, liberalization stimulates investment-led growth.

Finally, the paper tests whether the channel through which trade affects growth is different for developing and developed countries. In particular it tests whether trade affects growth mainly via investment or via productivity improvements. To estimate the direct impact of trade on TFP growth, controlling for its indirect impact via investment, the system is re-estimated including the trade variables in the growth equation and investment equations. The paper refutes the idea that trade is more important for TFP growth in poor countries showing that openness is about equally important for total factor productivity growth in the rich and poor samples. In addition, the evidence that trade affects growth via investment in the specification with trade variables in both equations is equally important for rich and poor samples.

RICHARD E. BALDWIN

Graduate Institute of International Studies, Geneva, Switzerland

ELENA SEGHEZZA

Università di Genova, Facoltà di Scienze Politiche, Dipartimento di Scienze Economiche e Finanziarie, Genova, Italia

REFERENCES

Baldwin, R.E. (1994), Toward an Integrated Europe, Cepr: London.

Baldwin, R.E. and R. Forslid (2000), "Trade Liberalisation and Endogenous Growth: A q-Theory Approach", *Journal of International Economics*, 50(2), 497-517.

Baldwin, R.E. and E. Seghezza (1996), "Trade-induced Investment-led Growth", NBER Working Paper No. 5582.

Barro, R.J. (1991), "Economic Growth in a Cross-section of Countries", *Quarterly Journal of Economics*, 106(2), 407-443.

Barro, R. and X. Sala I Martin (1995), Economic Growth, McGraw Hill: New York.

Coe. D.T. e E. Helpman (1995) "International R&D Spillovers" *European Economic Review*, 39(5), 859-887.

Edwards, S. (1992) "Trade Orientation, Distortions and Growth in Developing Countries, *Journal of Development Economics*, 39(1), 31-57.

Frankel, J.A. e D. Romer (1999), "Does Trade Cause Growth?", *American Economic Review*, 89(3), 379-399.

Frankel, J.A. e D. Romer (1996), "Trade and Growth: An Empirical Investigation", NBER Working Papaer No. 5476.

Grossman, G.M. e E. Helpman (1991), Innovation and Growth in the World Economy, MIT Press: Cambridge, MA.

Leamer, E.E. (1988), *Measures of Openness*, in: R. Baldwin (Ed.), "Trade Policy Issues and Empirical Analysis", Chicago University Press for NBER: Chicago.

Lee, J-W. (1993) "International Trade, Distortions and Long-run Growth," *IMF Staff Papers*, 40(2), 299-328.

Lee, J.W. and P. Swaigel (1992), Measuring trade distortions, Harvard University. Mimeo.

Levine R. e D. Renelt (1992), "A Sensitivity Analysis of Cross-country Growth Regressions", *American Economic Review*, 82(4), 942-963.

Mankiw, N.G., D. Romer e P. Weil (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, 107(2), 407-437.

Rodriguez, F. e D. Rodrik (2000), *Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence*, in: B. Bernanke and K.S. Rogoff (Eds), "NBER Macroeconomics Annual 2000", MIT Press for NBER: Cambridge, MA.

Young, A. (1992), *A tale of two cities: factor accumulation and technical change in Hong Kong and Singapore,* in: O. Blanchard and S. Fischer (Eds), "NBER Macroeconomics Annual 1992", MIT Press: Cambridge, MA.

Young A. (1995), "The Tyranny of Numbers: Confronting the Statistical

Realities of the East Asian Growth Experience", The Quarterly Journal of Economics, 110(3), 641-680.

Wacziarg, R. e K.H. Welch (2003), "Trade Liberalisation and Growth: New Evidence", Stanford University manuscript.

ABSTRACT

This paper estimates a two equation system – an investment equation and a growth equation – that allows trade openness to affect growth directly via its impact on TFP growth, and indirectly via its impact on the investment rate. We find that domestic trade barriers depress investment and thereby growth. This result is robust in that it is present in a variety of samples and for a variety of openness proxies. Foreign trade barriers are also found to depress investment and growth, but the effect is less strong and much less robust to sample and proxy changes. We confirm the robustness of our results by using a series of data samples split according to the capital abundance of nations and the income levels of countries. Moreover, we deal with the Rodriguez-Rodrik critique by using, as our preferred trade proxy, a trade weighted tariff average.

Keywords: Trade Openness, Investment, Growth

JEL Classification: F12, F43

RIASSUNTO

Liberalizzazione commerciale e crescita economica: una verifica empirica degli effetti dell'apertura commerciale sugli investimenti

L'articolo stima un sistema a due equazioni – un'equazione degli investimenti e un'equazione del tasso di crescita dell'*output* – in cui l'apertura al commercio internazionale influisce sul tasso di crescita dell'*output* in due modi: in via diretta, attraverso il suo effetto sul tasso di crescita della produttività, e in via indiretta attraverso il suo impatto sul livello degli investimenti. Troviamo che le barriere tariffarie imposte dal paese deprimono gli investimenti e, quindi, la crescita dell'*output*. Questo risultato è robusto a diversi campioni di paesi e a diverse proxy per l'apertura commerciale. Anche le barriere tariffarie imposte dagli altri paesi deprimono gli investimenti e la crescita, ma il loro effetto è minore e molto meno robusto. Confermiamo la robustezza dei nostri risultati suddividendo i paesi per abbondanza di capitale e livello di reddito. Recepiamo, inoltre, la critica di Rodriguez-Rodrik usando come proxy preferita per il commercio una media delle tariffe ponderata per i volumi di commercio.