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Measuring the Dynamic Gains from Trade

Romain Wacziarg

Empirical analysis confirms that a policy of trade openness has a strong positive impact on economic growth. The accelerated accumulation of physical capital accounts for more than half this growth. Enhanced technological transmissions and improvements in the quality of macroeconomic policy each account for about 20 percent of the effect of openness on growth.

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Summary findings

Wacziarg investigates the links between trade policy and economic growth using data from a panel of 57 countries from 1970–89. This is the first attempt to empirically evaluate, in a cross-country context, the respective roles of various theories of dynamic gains from trade in explaining the observed positive impact of trade openness on economic growth.

Wacziarg uses a new measure of trade openness, based on the effective policy component of trade shares, in a simultaneous equations system aimed at identifying the effect of trade policy on several determinants of growth. The results suggest that a policy of trade openness has a strong positive impact on economic growth.

The accelerated accumulation of physical capital accounts for more than half this effect. Enhanced technological transmissions and improvements in the quality of macroeconomic policy each account for about 20 percent of the impact of trade openness on growth.

This decomposition is robust to alternative specifications and time periods. Wacziarg also successfully tests whether the empirical methodology captures all or most of the effects of trade policy on growth.

The lack of statistically significant results concerning several other channels may be due to measurement problems. The black market premium may be a weak proxy for the efficiency of the price system. Moreover, international technological transmissions are very hard to measure, so there may be a downward bias in the estimates based on the manufactured exports channel, and a corresponding overstatement of other channels.

This paper — a product of the Development Prospects Group, Development Economics — is part of a larger effort in the Bank to analyze the relationship between openness and economic growth. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Sarah Crow, room MC4-706, telephone 202-473-0763, fax 202-522-2578, Internet address scrow@worldbank.org. The author may be contacted at wacziarg@gsb.stanford.edu. November 1998. (52 pages)

Measuring the Dynamic Gains from Trade

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1 Introduction

The positive empirical association between trade openness and economic growth is a topic of little disagreement among economists.[1] Although theories promoting inward-oriented development strategies flourished in the fifties and sixties, the unsustainable and often destructive effects of import-substitution policies have, by and large, discredited the idea that the costs of an open trade regime may outweigh its potential benefits. Even relatively recent theories of imperfect competition applied to international trade, although they often overturn the results of more conventional approaches, have led to notoriously cautious policy prescriptions as far as protection is concerned.

However, it is unclear whether economists have a clear empirical understanding of the sources of these gains from trade, especially in a dynamic framework. Theory points to a number of possible costs and benefits of trade openness, not mutually exclusive in general. Some of these theories stress the role of technological spillovers and the international transmission of knowledge as a source of growth for open economies[2]. More traditional, static theories involve the role of allocative efficiency, which can be achieved more easily with an open trade regime even when factors of production are assumed to be immobile. Higher levels of output are attained when countries specialize according to their comparative advantage, so growth rates can be expected to increase in the transition that follows a liberalization episode. The increased degree of market competition resulting from a wider scale of market interactions yields further gains in efficiency.[3] More generally, by increasing the size of the market, trade openness allows economies to better capture the potential benefits of increasing returns to scale. Yet another set of theories points to the complementary aspects of virtuous policies: Trade policy openness may create incentives for governments to adopt less distortionary domestic policies and more disciplined types of macroeconomic management.

There has been very little empirical work trying to determine the relative roles of these different factors in explaining the observed positive impact of trade openness on growth. One tends to interpret the finding that trade openness spurs growth according to one's preferred theory, and to disregard two important possibilities: several of these forces may be operating simultaneously; and trade openness may also involve some dynamic costs, even if these are outweighed by the benefits. This becomes especially important in the context of increasing integration: by determining the source of the costs and benefits of trade liberalization, policy makers can hope to maximize the latter and to minimize the former.

This paper employs a fully specified empirical model to evaluate the channels whereby trade policy may affect growth. It starts with the specification of equations describing the incidence of trade policy on several growth determining variables. These equations are meant to capture different theoretical arguments used to characterize the potential costs and benefits of trade policy openness. The next step involves including the various channel variables in a growth regression. By multiplying the effects of trade policy on

[1] See, for instance, Sachs and Warner (1995a), Vamvakidis (1996), Edwards (1992), Frankel (1996) among many other studies.

[2] See, for instance, Grossman and Helpman (1991).

[3] For instance, in Wacziarg (1997).

the channel and the effect of the channel on growth, one is able to identify the effect of trade policy on growth through that specific mechanism. The results of this paper suggest a strong positive effect of trade policy openness on economic growth, with accelerated accumulation of physical capital accounting for more than one half of this total effect.

The paper is organized as follows: Section 2 analyzes the theoretical basis for the six channels, discusses measurement issues and provides preliminary evidence concerning trade policy and growth. Section 3 describes the empirical methodology, based on a random effects, instrumental variables, efficient estimator. Section 4 provides parameter estimates for the various equations in the model. Section 5 contains a summary of the channel effects and addresses issues of robustness and exhaustiveness. Section 6 concludes.

2 Theory, Measurement and Preliminary Evidence

2.1 The Six Channels in Economic Theory

Six linkages between trade policy and economic growth are considered in our empirical model.[4] These are meant to capture the dominant theories concerning dynamic gains (or possibly losses) from trade. The underlying assumption is that these six channels, taken together, adequately capture most or all of the total effect of trade policy on growth. We can classify them according to three broad categories: government policy, domestic allocation and distribution, and technological transmissions.

2.1.1 Government Policy

The first possibility is that trade openness creates incentives for policy makers to pursue virtuous *macroeconomic policies*, either because they face the threat of capital flight or because they have bound themselves in international agreements, implicit or explicit, that provide a check on policy. The requirement to maintain a competitive environment for domestic firms engaged in foreign transactions may also require the maintenance of a stable macroeconomic context. In turn, the quality of macroeconomic policy is likely to have favorable effects on growth (Fischer (1993)). Indeed, macroeconomic stability may reduce the level of price uncertainty; furthermore, moderate levels of public deficit and public debt reduce the extent of crowding out as well as the likelihood of future tax increases, furthering the ability of domestic firms to compete on global markets.

Another way to capture the effects of trade openness on governmental activity is to consider its effect on the *size of government.* If more open economies are subject to larger exogenous supply and demand shocks, a larger government may be better able to provide insurance or consumption smoothing through redistribution or other forms of social programs (Rodrik (1996)). On the other hand, open economies may tend to subscribe more widely to laissez-faire arguments, and to limit the extent of taxation in order to preserve the economy's price competitiveness and attractiveness to foreign investors. The effect of trade policy openness on government size, measured by the public consumption of goods and services, is therefore theoretically ambiguous. On the other hand, although theory points to the existence of a positive growth-maximizing size of government resulting from a

[4]Other, possibly omitted channels are discussed in Section 5.

trade-off between the productive function of public activities and the distortionary nature of taxation (Barro and Sala-i-Martin (1992)), the negative impact of a larger government on growth in a cross-section of countries seems to be an established empirical fact (Barro (1991)).

2.1.2 Allocation and Distribution

Open economies are less likely to have tradable goods prices that differ substantially from those prevailing on world markets, because free trade should lead to an equalization of the prices of traded goods across countries. Once the effect of non-tradable goods on deviations from purchasing power parity has been eliminated, one should expect countries with open trade policies to have lower overall price levels (relative to some benchmark country like the United States) than closed economies (Dollar (1992)). Such a result stems from the fact that open countries tend to specialize according to their comparative advantage. Hence, theory points to a lower degree of *price distortions* in open economies. In turn, price distortions have been shown to adversely affect accumulation and growth (Easterly (1989) and (1993)). This is just one aspect of the allocation effects of free trade, having to do with a more efficient price system in open economies.

Factor accumulation may also be of crucial importance. Much of the effect of trade policy on growth may well work through the domestic rate of physical investment, which is a determinant of economic growth in a nearly tautological sense (Levine and Renelt (1992), Baldwin and Seghezza (1996)). The investment channel may capture several types of theories. Firstly, countries that are relatively labor abundant, when they adopt open trade policies, are likely to experience an increase in the wage-rental ratio, because tendencies towards factor price equalization lead to upward pressures on the wage rate and downward pressures on the price of investment goods. Translated into a dynamic context, this should lead to a greater level of investment relative to GDP. The growth benefits from this effects should fade out as more and more countries become open. Although this type of theoretical argument can only apply to relatively labor abundant economies, most protectionist countries tend to be more labor abundant, so that the benefits of openness in terms of growth may be greatest precisely for those countries that are still closed.[5]

Secondly, and perhaps more importantly, investment may respond to openness through a size of the market effect.[6] As first stressed by Adam Smith, market size imposes a constraint on the division of labor, so that more open countries are better able to exploit increasing returns to scale. Trade liberalization may thus provide the type of 'big push' effect on capital accumulation which Murphy, Shleifer and Vishny (1989) argued was required in order for less developed countries to move from a low growth equilibrium

[5]However, the scope of this argument is somewhat limited. Since currently 'open' economies tend to be relatively capital abundant, we would be left with the task of explaining why their investment rates tend to be higher than in 'closed' countries, once other determinants of investment are kept constant. Indeed, openness for capital abundant countries is associated with a lower wage-rental ratio under free trade compared to autarky, hence presumably with lower investment rates under free trade. Hence, this type of theory helps make a normative case in favor of liberalization, but does not really explain the currently observed positive impact of trade on investment.

[6]We need to explain why lower restrictions on imports should lead to a larger market for exports: since economies face an intertemporal budget constraint, balanced trade must hold at least in the long-run. In this case, removing restrictions to imports is equivalent to allowing a greater volume of exports.

to a path of sustained industrialization. Preliminary empirical evidence showing that the extent of the market raises growth largely through an increase in the rate of capital accumulation was provided by Ades and Glaeser (1994), thus lending support to 'Big Push' theories. Using a related argument, Wacziarg (1997) argues that the extent of the market is an important determinant of the degree of product market competition. The entry of new firms on export markets, after an episode of liberalization, may well entail large fixed investments. This points to the rate of investment as a potentially important channel linking trade policy openness and growth.

Thirdly, trade liberalization may simply allow domestic agents to import capital goods that were unavailable previously (or produced locally but at higher costs), thus removing structural constraints on investment. These imports of capital goods, which make up sizable proportions of the imports of many recently liberalized developing countries, also embody more recent technologies, a further source of growth.

2.1.3 Technological Transmission

The last channels that we consider stem from the recent literature on endogenous growth: if knowledge spillovers are a driving force for sustained, long-run growth, and open economies are more exposed to a worldwide stock of productivity enhancing knowledge, then *technological transmissions* can be a channel through which trade openness affects growth and convergence (Barro and Sala-i-Martin (1997), Grossman and Helpman (1991)). There are two potential ways by which openness may increase the exposure of the domestic economy to technological transmissions.

Firstly, more frequent and sustained international trade interactions may make it easier for domestic producers to imitate foreign technologies and to incorporate this knowledge in their own productive processes (Edwards (1992)). This increased exposure can stem from direct imports of high technology goods or from greater interaction with the sources of innovation (through enhanced international communication and mobility brought forth by economic integration). This should translate into a higher capacity to compete with more advanced economies on world markets. Such a pattern was certainly part of the East Asian growth miracle, characterized by broad transformations in the product composition of output and exports from agriculture to heavy industry and finally to high technology goods, via the imitation of technology originating in Europe and the United States.

Secondly, *foreign direct investment*, whether or not it is associated with joint ventures, often leads to the direct international transmission of advanced types of technology, either through capital goods imports which are later imitated, or through the diffusion of knowhow and expertise. However, it is unclear, a priori, that trade openness is associated with greater levels of foreign direct investment. On the one hand, FDI may act as a substitute for trade, as foreign investment is used to set up plants producing goods that cannot be imported due to trade restrictions ("tariff-hopping"). On the other hand, investors may view trade openness as a signal that a country is committed to stable and market oriented economic policies; in addition, trade openness allows them to import the intermediate goods that are required to initiate the projects, to expect repatriation of some profits and to export the goods that they produce. Falling transport costs may allow a 'slicing up the value added chain', whereby firms can "produce a good in a number of stages in a number

of locations, adding a little bit of value at each stage" (Krugman (1995)). Hence, one can plausibly argue that FDI acts as a complement, not a substitute, to trade openness. Indeed, existing evidence suggests that open economies tend to attract more foreign direct investment than closed economies (Harrison and Revenga (1995)).

In turn, FDI is likely to spur growth. In fact, since the share of FDI in GDP is typically small (on the order of 1% of GDP on average), it is hard to argue that FDI spurs growth via traditional physical capital formation. It is likely that, if there is any significant dynamic effect of FDI, it captures the incidence of a certain type of technological transmissions. This, indeed, is the interpretation that we shall favor for the FDI channel.

2.2 Characteristics of the Data

2.2.1 Construction of the Trade Policy Openness Index

Measuring the nature of trade regimes constitutes a major challenge for any study involving the analysis of trade policy. Indeed, measures of protection are not readily available for a vast number of countries and time periods. It is worth spending some time assessing the existing measures of trade openness, of which there are three broad categories:

Outcome measures describe the volume of existing trade, or its components. This type of indicator is most subject to endogeneity problems with respect to growth (Frankel and Romer (1995)), but measures actual exposure to trade interactions and hence may account quite well for the effective level of integration. On the other hand, it may correlate only imperfectly with attitudes or institutions relating to openness. The tendency to confuse outcome measures with policy attitudes (which are presumed to partly determine the outcome) has been a feature of past research, largely because precise measures of actual trade policies are not widely available.

Policy indicators, such as tariff rates, non tariff barriers, tariff revenues, etc., describe the institutional features of a country's attitude towards the rest of the world, as far as trade and factor flows are concerned. As such, they are likely to be an important determinant of the outcome measures. However, endogeneity problems in their relationship with growth are not absent, and their availability tends to be limited. Furthermore, they may not directly reflect the degree of effective protection faced by domestic agents, but only the legal framework to which they are confronted.

Lastly, we can consider measures of *effective protection* based on deviations from the predicted free trade volume of trade. Factor endowment and gravity models of trade generate predictions about a country's propensity to trade internationally. For instance, country size, distance from major trading partners, negative terms of trade shocks can be thought to affect trade volumes negatively. Similarly, relative endowments of skilled labor, unskilled labor, capital and land (or natural resources) may have an impact on overall trade volumes, as well as, perhaps more obviously, their composition. Using this type of variables only, one can attempt to predict a country's potential free trade volume of international commercial transactions. Deviations of the observed trade volume from this potential volume provide a measure of how restrictive the trade regime really is.

Given these three alternatives, which one should we choose ? Because most theories about dynamic gains from trade have to do with policy measures, in the sense that the

relevant comparisons generally involve contrasting free trade to restricted trade or autarky, our objective must be to construct an index of trade policy that adequately captures the nature of the policy regime vis-à-vis international trade.[7] The use of outcome measures seems undesirable on these grounds. We are left with a choice between direct policy indicators and effective protection measures. In fact, this paper employs a (presumably optimal) combination of both.

There are three drawbacks to using effective protection measures. First, there is no guarantee that the predicted level of trade adequately measures the volume of commercial transactions that would prevail under complete free trade, because determinants of potential trade may have been omitted. Second, some gravity or endowment determinants of potential trade may be highly correlated with policy attitudes. For instance, large countries tend to have more restrictive trade policies, and so do relatively labor abundant countries. If this is the case, the deviation of observed from potential trade may exclude some valid information about policy (all the variation in policy due to size effects and labor abundance has been removed). Lastly, as long as the observed volume of trade contains a white noise disturbance term, deviations from predicted volumes will also contain a white noise disturbance (whose share of the variance in the total variance of the measure has increased due to the differencing), and any use of such a variable as a regressor will induce downward bias associated with measurement error. The most serious problem is probably the second one, because gravity-type variables can be shown empirically to be important determinants of policy itself (we shall return to this issue in Section 4).

The major drawback of direct policy attitude measures is that they may not capture effective levels of protection. The approach in this paper constitutes an attempt to avoid this problem as well as those associated with effective protection measures. Outcome measures can be viewed as resulting from a series of factors: gravity determinants, factor endowments and policy variables. Appendix IV examines a regression of trade volumes on several openness-determining variables. The objective is to largely explain the extent of observed trade interactions. This can then be broken down into several components: the policy component of observed trade shares is obtained as the weighted sum of the policy measures included in the regression, where the weights are the estimated coefficients from the trade volume regression. This measure can then be used as an index of trade policy openness, which can be interpreted as the portion of observed trade shares that is due to the effective impact of trade policy. This procedure avoids both the problem of measurement error due to the construction of the difference between observed and potential trade volumes, and the problem of collinearity between gravity/endowment factors and policy factors. It also limits the potential effect of omitted variables in the equation that determines trade volumes, insofar as these omitted factors can be assumed to bear a weak correlation with the policy determinants that are included in the regression.

Our main concern is to obtain a measure that applies to a broad range of countries over the period 1970-1989, and that adequately accounts for several aspects of trade policy: tariff barriers, non-tariff barriers and other forms of attitudes towards international trade which capture whether the trade policy regime is outward-oriented or not. These consid-

[7] Appendix IV presents empirical evidence in favor of this choice: the growth effects of trade openness are due mostly to the trade policy regime, rather than to the gravity component of trade shares.

erations inspired the choice of the policy indicators chosen to construct the index.[8] First, tariff rates were available for the period 1980-1993 only, and for approximately 50 countries. To capture the effects of tariff barriers, we used the share of *import duty revenues* in total imports (from the IMF's government finance statistics), available for more countries and a wider time span. This has two advantages. First, it better captures the effective degree of tariff restrictions. Direct overall measures of tariff protection obtained from UNCTAD are unweighted averages of goods-specific tariff rates. However, duty revenues are by construction weighted by the composition of imports. Furthermore, there may be a weak relationship between officially declared tariff rates and those that are effectively implemented. Duty revenues once again avoid this problem by measuring the amount of tariff revenue actually collected. One potential limitation of the use of tariff revenues is that prohibitive tariff rates will tend to reduce revenues through a "Laffer curve" effect applied to imports. Hence, the use of revenues may lead to underestimate the true level of tariff barriers. However, we are considering duty revenues as a share of total imports, which may greatly limit the incidence of this problem (high tariff rates work to reduce revenues by deterring imports, so the ratio of the two should roughly reflect effective tariff rates). Table I contains correlations between tariff revenues and tariff rates, for the dates and countries available for both measures. The correlations are very high, suggesting that the choice between the two measures may not be a crucial issue.

Table I. Correlations Between Duty Revenues and Unweighted Tariff Rates

	Import Duties 1980-84	Import Duties 1985-89	Import Duties 1990-94
Tariff rate 1980-84	0.67	0.74	0.73
Tariff rate 1985-89	0.64	0.75	0.72
Tariff rate 1990-94	0.80	0.84	0.83

Number of countries: 50.

Non-tariff barriers constitute the second component of our trade policy index. Insofar as policy-makers employ a diverse set of tools to attain certain policy objectives, and the mix varies across countries, NTBs may actually capture much of the effective degree of protection. However, measures of NTBs are highly imperfect. Available data concern the coverage rate of NTBs, i.e. the percentage of goods affected by quotas, voluntary export restraints, etc., but not the extent to which these constraints are binding. Furthermore, time series data for NTBs have yet to be assembled. We use an unweighted coverage ratio for the pre-Uruguay Round time period, published by UNCTAD. Presumably, the extent of NTBs has varied somewhat across time although, as with tariffs, it is likely to be highly autocorrelated within countries. We are unable to account for this time-series variation, since we only have one observation for the 23 years under consideration. Presumably, this type of measurement error should weaken the relationship of NTBs with trade volumes, and correspondingly reduce the weight of this indicator in the overall index.

We try to capture the overall attitude of policy makers using a third component for the index of trade policy. Sachs and Warner (1995a) have compiled a list of dates of trade liberalization, including episodes of temporary liberalization, for a large sample of

[8] Appendix III describes in more detail the procedure used to construct this index of trade policy.

countries. These dates were constructed by examining trade policy data and by conducting a systematic analysis of the literature concerning the trade regimes of specific countries (the results of this search are reported, for each country, in the appendix to their paper). We constructed dummy variables for a country's liberalization status, for each year. These were then averaged over the time periods under study (1970-74, 1975-79, 1980-84, 1985-89). Liberalization status is highly correlated with other components of trade policy, and is meant to capture the prevailing policy attitude towards foreign trade. Insofar as this indicator receives some weight in the index, it captures factors other than just tariffs barriers and NTBs; in particular, it may help account for the effect of time variations in NTBs which we cannot explicitly account for, due to data unavailability.[9]

Correlating the trade policy index with its three components (Appendix III, Table A-III-II) can give an idea of the relative weights attached to each of these. All the components bear correlations with the overall index that are larger than 0.4 in absolute value but the duty revenue component dominates with a correlation ranging from 0.72 to 0.77, depending on the time period under consideration. The non-tariff barriers component received the smallest weight.

We can obtain preliminary insights into the relationship between growth and trade policy by examining summary statistics for the two variables. Tables II and III display first and second moments for per capita GDP growth and the policy index for five-year averages, over the 1970-89 period.

Table II. Summary statistics for Growth and the Trade Policy Index

	Mean	Std. Dev.	Minimum	Maximum
Growth 70-74	3.990	2.520	-0.499	12.351
Growth 75-79	2.333	2.845	-6.688	10.433
Growth 80-84	0.380	2.740	-8.277	6.018
Growth 85-89	1.974	2.455	-3.063	8.770
Trade Policy 70-74	-1.305	8.496	-17.840	10.438
Trade Policy 75-79	-0.937	8.460	-18.716	10.781
Trade Policy 80-84	-0.712	8.663	-19.358	10.784
Trade Policy 85-89	-0.326	9.425	-26.000	10.781

Number of Observations: 57

Table III indicates that trade policy tends to be much more persistent over time than growth rates. The simple contemporaneous correlations between growth and openness are positive but their magnitudes are somewhat small, especially for the 1975-79 period during which the oil shock may have affected the relationship between openness and growth in a negative way. Overall these simple correlation suggest that the relationship between trade policy openness and growth may be conditional on other growth determinants rather than absolute.

[9]The exclusion of this indicator from the trade policy index reduced the precision of the estimates presented below, but did not change the qualitative nature of the results.

Table III. Correlation Matrix for Growth and the Trade Policy Index

	Growth 70-74	Growth 75-79	Growth 80-84	Growth 85-89	Trade 70-74	Trade 75-79	Trade 80-84
Growth 75-79	0.283	1.000					
Growth 80-84	0.249	0.397	1.000				
Growth 85-89	0.264	0.361	0.391	1.000			
Trade Pol. 70-74	0.242	0.168	0.259	0.286	1.000		
Trade Pol. 75-79	0.241	0.168	0.270	0.284	0.991	1.000	
Trade Pol. 80-84	0.267	0.177	0.285	0.294	0.967	0.982	1.000
Trade Pol. 85-89	0.325	0.101	0.118	0.223	0.908	0.919	0.930

Number of Observations: 57

2.2.2 Measurement of the Channel Variables

Some of the channel variables considered in Section 2.1 can be readily measured. Such is the case for foreign direct investment inflows as a share of GDP, government consumption of goods and services as a share of GDP and the domestic investment rate. So three of our six channels can be captured in fairly uncontroversial ways as far as measurement is concerned.

The other three channels are captured by composite indices or approximated using available data.[10] The *quality of macroeconomic policy* is captured by an index that gives equal weight to each of three decile rankings of policy characteristics for each country. Specifically, for each time period, each country is ranked on a scale of 1 to 10 according to its decile position for the level of the public debt as a percentage of GDP, the level of the government deficit as a share of GDP, and the growth of M2 net of total real output growth (higher numbers signal better policies). The rankings are then averaged to obtain an index of overall macroeconomic policy quality, which reflects a country's position relative to others. This avoids the problem of having to characterize a 'good' macroeconomic policy in absolute terms.

The extent of *technological transmissions* is approximated by the share of manufactured exports in total merchandise exports, admittedly an imperfect proxy for technological transmissions.[11] The main rationale for this measure is that countries able to compete effectively on world markets for manufactured goods and to produce at world standards are likely to incorporate more of the existing modern technologies in their productive processes. Other suggestions for the measurement of technological transmissions include the share of manufactured *imports* in merchandise imports, but this measure suffers a major drawback: imports of manufactures may act as a substitute rather than a proxy for technological transmissions.[12] On the other hand, if a country is able to produce at world

[10] Appendix III describes the construction of these indices and proxies in more detail.

[11] The share of manufactures in merchandise exports was used as a proxy for technological transmissions in the World Bank's Global Economic Prospects, 1996.

[12] We tried to employ the share of manufactured imports to total merchandise imports as a proxy for technological transmissions, instead of the share of manufactured exports. We could determine no statistically significant relationship between this variable and growth on the one hand, and with trade policy openness on the other, even when controlling for a diverse set of variables.

standards, the likelihood of it absorbing relatively modern technologies is higher. The crucial point is that technological advances and knowledge embodied in existing goods must make their way into production processes in order to truly qualify as technological transmissions. More direct measures of technological absorption, such as patent licensing agreements, are extremely difficult to assemble for a wide array of countries.

Lastly, we need a measure of *price distortions* prevailing within the economy, in order to capture the effect of trade policy on the efficiency of the price system. Appendix III-3 describes a direct way to measure price distortions originating from trade policy or domestic sources such as taxation, subsidies and imperfectly competitive pricing.[13] However, our analysis employs a less direct approach. The black market premium on the official exchange rate is widely used in cross-country analyses, to approximate the implementation of distortionary policies. As argued in Barro (1995), "the black market premium on foreign exchange is a widely available and apparently accurate measure of a particular price distortion. The premium likely serves as a proxy for governmental distortions of markets more generally".

It is useful to examine simple statistics for the channels variables, openness and growth averaged over the period under consideration (Tables IV and V). This might provide some preliminary evidence about the relevance of our choice of channels. Table IV provides information about the means and standard deviations of the main variables, which may prove useful when interpreting the regression results.

Table IV. Summary Statistics for the main variables.

	Mean	Std. Dev.	Minimum	Maximum
Growth	2.169	1.858	-1.798	7.513
Trade Policy Openness	-0.820	8.588	-19.511	10.696
Macro Policy Quality	5.203	1.711	1.750	8.833
Black Market Premium	42.417	83.247	-0.471	437.182
Government Consumption	15.591	6.681	7.731	33.962
Manufactured Exports	36.933	25.138	0.421	83.664
Investment Share	19.381	7.745	1.320	36.135
Foreign Direct Investment	0.871	1.217	-0.761	7.876
Human Capital	1.515	1.163	0.084	5.343
Log Income Per Capita	8.159	0.993	6.154	9.586

Number of Observations: 57

Table V displays correlations between the main variables. The most interesting columns to examine for our purposes are the first and second. The first column shows the unconditional relationship between channel variables and growth, while the second one contains the correlations of trade policy with the channels. Multiplying the numbers in each column gives a rough idea of what to expect in terms of channels. In particular, simple correlations suggest that all of the channels involve a positive effect of trade on economic growth. The largest correlations appear to be in the investment and manufactured exports channels. Overall, these correlations show that the trade policy index is positively

[13] Appendix III-3 also explains why this index was not used in the analysis.

related to FDI as a share of GDP, macroeconomic policy quality, manufactured exports as a share of merchandise exports and the domestic investment ratio. In turn, each of these are positively related to growth. Trade policy openness is negatively related to the black market premium and government size. In turn, each of these is negatively associated with growth.

Table V. Correlation matrix for the main variables

	Growth	Trade Policy	Macro Policy	BMP	Govt. Cons.	Manuf Exp.	Inves. Share	FDI	Hum. Cap.
Trade Pol.	0.331	1.000							
Macro Pol.	0.384	0.420	1.000						
BMP	-0.408	-0.404	-0.304	1.000					
Govt. Cons.	-0.421	-0.265	-0.594	0.390	1.000				
Manuf. Exp.	0.387	0.602	0.393	-0.484	-0.268	1.000			
Invest. Sh.	0.483	0.674	0.441	-0.498	-0.428	0.556	1.000		
FDI	0.503	0.263	0.155	-0.255	-0.296	-0.012	0.342	1.000	
Human Cap.	0.185	0.554	0.361	-0.357	-0.334	0.487	0.522	0.116	1.000
Log Income	0.266	0.743	0.469	-0.530	-0.504	0.648	0.754	0.188	0.750

Number of Observations: 57

3 Estimation Framework

This section briefly reviews the technical aspects of the estimation method employed in this paper. The method was first developed and employed in a cross-country growth context by Tavares and Wacziarg (1998), to analyze the effects of democracy on growth. The underlying econometric theory is an extension of Zellner and Theil (1962) to the case of panel data.

3.1 The Structural Model

The basic framework for the cross-sectional analysis consists of a simultaneous equations model aimed at identifying the various effects of trade policy on growth. The model consists of a growth equation, an equation determining the nature of trade policy, and a series of channel equations describing the effects of trade policy on several growth determining variables. This series of equations constitutes the structural model, derived from economic theory: the channel variables are included in the growth regression, but the measure of trade policy openness only appears in the channel relationships. The hope is that the specification of the channels fully exhausts the potential ways in which openness affects growth (some formal evidence concerning this issue will be provided in Section 5). The equation describing the determinants of trade policy openness only appears in order to make explicit endogeneity issues, having to do with the simultaneous determination of trade policy, growth and the channel variables. In particular, several channel variables may appear on the right-hand side of the trade policy equation. But this relationship could be removed altogether with no implication on the estimation of the channel effects.

3.2 Estimation

The parameters of the structural model are estimated jointly using three-stage least squares. This method achieves consistency by appropriate instrumenting, and efficiency through optimal weighting. It combines features of instrumental variables, random effects and generalized least squares models.

Each equation in the structural model is formulated for the four time periods under scrutiny (1970-74, 1975-79, 1980-84, 1985-89).[14] Joint estimation allows the derivation of a large covariance matrix for the error terms of all 32 equations. Hence, both cross-period and cross-equation error correlations are brought into the picture. This ensures the efficiency of the estimates. The fact that cross-period error correlations are taken into account is akin to assuming that the error terms contain country-specific effects that are uncorrelated with the right-hand side variables. The flexibility of the error covariance matrix means that we are able to obtain substantial efficiency gains compared to estimating each equation separately.

Since several endogenous variables appear on the right-hand side of the structural equations, endogeneity bias must be a major concern. To achieve consistency, we need to instrument for every endogenous variable appearing as a regressor. This is done by first writing the model's reduced form, in which every endogenous variable is rewritten as a function of all the exogenous variables in the system. The fitted values of each endogenous variables from OLS estimation of the reduced form will provide suitable instruments for each corresponding endogenous variables in the structural form.[15] Constructing these fitted values constitutes the first stage of the 3SLS procedure. The second stage consists of estimating each equation in the structural model separately via instrumental variables (or two-stage least squares), using the instruments constructed in the first stage. This allows the derivation of a consistent covariance matrix for the error terms of the model. Lastly, the third stage involves employing this covariance matrix as a weighting matrix as well as the instruments derived in the first stage, to jointly estimate the equations in the structural model using instrumental variables-generalized least squares. Instrumenting ensures consistency, while joint estimation ensures asymptotic efficiency.

3.3 Identification and Restrictions

As far as specification is concerned, some assumptions are required for this methodology to carry through. Enough instruments must be validly excludable from each equation for the order condition to be met. For each equation, the order condition for identification states that at least as many exogenous variables must be excluded as regressors as there are endogenous variables included on the right-hand side: enough exogenous variables

[14] In addition, we present results including the 1990-92 period, although this leads to a loss in degrees of freedom. For this reason, the baseline model only extends until 1989.

[15] Given the above specification of the baseline model, the instruments are: male and female human capital, the island dummy, the log of population, the democracy index, the log of area, terms of trade shocks, population density, the secondary school completion rate, the share of population over 65, the share of population under 15, ethnolinguistic fractionalization, postwar independence status, each taken at every time period when applicable. Reflecting concerns for the endogeneity of per capita income levels, this variable was excluded from the instrument list (see Caselli et al., (1996)).

must be validly left out of each equation for the system as a whole to be identified.[16]

The chosen specification is based on existing empirical work on the determinants of the various endogenous variables under study. For instance, the growth and investment equations are based on common specifications used in the cross-country growth literature (Barro and Sala-i-Martin (1995)). Similarly, the specification of the government size equation is based on Rodrik (1996) and Alesina and Wacziarg (1997). For other channels, such as the macroeconomic policy quality channel, we relied on theoretical priors to determine the set of exclusions.[17] The specification of each equation is given in Section 4, which contains the results for the parameter estimates of each equation in the system.

In order to assess the long-run effects of trade policy on growth in a unified manner, we impose cross-period parameter equality restrictions: none of the estimates of the parameters in the structural model are allowed to vary across time. This allows efficiency gains via higher degrees of freedom, as the number of estimated parameters in the system is divided by four. To examine whether these restrictions are justified, there are two alternatives. The first one is to run the system without the restrictions and to test the hypothesis that the parameters are jointly equal between the two models. However, the loss in degrees of freedom is such, that it is unclear whether the difference in parameters is due to the imprecision of the estimates in the unrestricted model, or to the time varying nature of the processes being modeled. The second, preferred alternative is to examine whether the results are sensitive to the inclusion of any given period. This is done is Section 5.

4 Parameter Estimates

This section presents, for each equation in the system, the results of the estimation procedure applied to five variants of the same model. Model I is the baseline model for this paper, for the period 1970-89. Model II includes the 1990-92 period into the analysis, with a corresponding loss of 8 observations. Model III restricts the sample to developing countries. Model IV examines the robustness of the model to the estimation method, by employing the Seemingly Unrelated Regression estimator. This estimator, while inconsistent (no instruments are used), is characterized by greater efficiency and may provide some indication of the model's robustness. Lastly, in model V, regional dummy variables were added to every equation in the system, to account for time invariant region specific effects. We should expect this inclusion to reduce the overall effect of trade policy on growth, as much of the between-country variation in the endogenous variables is now accounted for by the regional dummies.

4.1 Growth equation

The results for the *growth equation* closely match existing findings in the cross-country empirical growth literature (see, for example, Barro (1991)). The rate of conditional convergence in our sample (equal to the estimated coefficient of the log of initial income), 1.67%, is in line with common analyses of convergence in a cross-sectional framework.

[16] We do not check the rank condition for identification, which can be safely assumed to hold for a system of this size.

[17] Tavares and Wacziarg (1998) discuss in more detail the issue of specification search for the type of system that we are considering.

Table VI: Growth Equation

Dep. Var: Growth	Baseline 1970-89	1970-92	Devel. Countries	SUR	Regional Dummies
Intercept	10.598	7.815	5.543	9.006	7.113
	(4.70)	(6.74)	(3.55)	(4.59)	(2.99)
Log Initial	-1.672	-1.132	-1.106	-1.390	-0.740
Income	(-5.81)	(-7.66)	(-5.45)	(-5.17)	(-2.24)
BMP	-0.007	-0.005	-0.005	-0.005	-0.007
	(-9.08)	(-21.81)	(-13.09)	(-8.85)	(-9.14)
Government	-0.042	-0.055	-0.025	-0.043	-0.043
Consumption	(-1.57)	(-5.76)	(-1.84)	(-2.20)	(-2.13)
Manufactured	0.004	0.002	0.006	0.007	-0.004
Exports	(0.45)	(0.53)	(1.01)	(1.14)	(-0.72)
Investment	0.143	0.132	0.146	0.143	0.109
Rate	(6.86)	(12.10)	(7.27)	(7.99)	(5.06)
FDI	0.320	0.249	0.271	0.355	0.178
	(4.68)	(8.44)	(4.79)	(4.83)	(2.75)
Macro Policy	0.489	0.290	0.505	0.333	0.280
Quality	(4.22)	(8.62)	(8.70)	(5.03)	(3.27)
Male Human	0.481	0.732	1.351	0.448	-0.136
Capital	(1.59)	(4.24)	(5.47)	(1.57)	(-0.42)
Female Human	-0.387	-0.862	-1.284	-0.429	0.005
Capital	(-1.39)	(-5.65)	(-5.30)	(-1.58)	(0.02)
Latin America	-	-	-	-	-2.291
Dummy					(-6.32)
South East	-	-	-	-	0.047
Asia Dummy					(0.06)
Sub-Saharan	-	-	-	-	-2.126
Africa Dummy					(-4.39)
OECD	-	-	-	-	-1.466
Dummy					(-3.15)
R-squared	.25 .29	.24 .26 .46	.34 .41	.27 .28	.23 .41
	.41 .31	.39 .18	.54 .37	.45 .32	.52 .30
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

Most of the other estimates reflect the current "Washington consensus" on the determinants of growth: Table VI contains evidence pointing to the positive effects of the domestic investment rate, male human capital, macroeconomic policy quality and FDI on growth. Negative factors include the black market premium, female human capital and government consumption of goods and services, while manufactured exports seem largely unrelated to economic growth in most specifications. The pattern of human capital coefficients is in line with results by Barro (1991), and can be interpreted as resulting from conditional convergence.[18]

[18] A larger gap between male and female human capital signals a lower level of per capita income. Conditional on steady-state determining variables, this gap should be negatively associated with growth.

These results do not seem sensitive to changes in the specification. Both the signs and orders of magnitude of the coefficients are preserved in most cases. In particular, the signs and magnitudes of all of the channel variables are maintained.

4.2 Openness equation

The equation accounting for the degree of *trade policy openness* (Table VII) is considered solely to capture various endogeneity issues. Its inclusion in the model should not affect the estimates in the other equations, except insofar as efficiency gains are concerned. The growth rate of per capita GDP is included to control for endogeneity in the growth-openness relationship. A one percentage point increase in growth is shown to trigger a .32 percentage point increase in the policy component of the trade ratio. While highly significant statistically, this effect is very small economically.

Table VII. Openness Equation

Dep. Var: Trade Policy	Baseline 1970-89	1970-92	Devel. Countries	SUR	Regional Dummies
Intercept	-53.851	-49.902	-23.667	-53.115	-46.642
	(-16.55)	(-21.34)	(-6.56)	(-17.66)	(-9.77)
Log Initial Income	6.548	6.559	3.468	6.422	5.528
	(17.55)	(30.36)	(10.07)	(18.57)	(12.96)
Island Dummy	-3.049	-3.483	-2.124	-3.177	-3.848
	(-2.37)	(-5.08)	(-1.83)	(-2.58)	(-2.96)
Log Area	-0.888	-0.653	-0.005	-0.866	-0.718
	(-2.20)	(-3.73)	(-0.02)	(-2.35)	(-2.35)
Terms of Trade Shocks	-7.148	-13.690	-1.480	-6.877	-5.014
	(-4.97)	(-23.73)	(-1.56)	(-4.63)	(-4.01)
Growth	0.321	0.228	0.385	0.377	0.230
	(10.44)	(20.31)	(30.24)	(12.03)	(8.13)
Log Population	0.420	-0.044	-0.973	0.432	-0.177
	(0.79)	(-0.19)	(-2.19)	(0.90)	(-0.40)
Latin America Dummy	-	-	-	-	3.570
					(2.41)
South East Asia Dummy	-	-	-	-	12.173
					(6.99)
Sub-Saharan Africa Dummy	-	-	-	-	6.597
					(4.16)
OECD Dummy	-	-	-	-	8.950
					(5.65)
R-squared	.55 .53	.54 .52.58	.26 .28	.55 .53	.67 .66
	.60 .54	.53.45	.37 .32	.60 .54	.74 .72
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

If, in addition to this, the average level of human capital (male and female) has a positive effect on the steady-state income level, we obtain the observed pattern of male and female human capital coefficients.

Measuring country size using the log of area, we find that larger countries have more restrictive trade policies, reflecting several possible theoretical explanations. Firstly, under any model with increasing returns, larger countries should experience smaller losses from protection than smaller ones, prompting them to a greater vulnerability to protectionist arguments. Secondly, in the neoclassical trade theory, the optimal trade policy for a large country is not complete free trade. Because they can affect their terms of trade, large countries should implement an optimal tariff in order to reach allocative efficiency, and this incentive may be partly reflected in the estimated effect of land area (note however that the coefficient country size measured by the log of population is not significantly different from zero).[19] At any rate, the significance of the area variable and of the island dummy indicate that 'gravity' variables do bear some relationship with trade policy, and provide further justification for the method used to construct the trade policy openness index.

4.3 Government Policy

4.3.1 Macroeconomic Policy Quality

The policy quality equation brings out the positive effects of democracy and trade openness on the *quality of macroeconomic management* (Table VIII). In the baseline model, a 10 percentage point difference in trade policy openness, which corresponds to one standard deviation of the index, is associated with a 0.27 increase in the index of macroeconomic policy quality, which ranges from 1 to 10. This estimate remains statistically significant in four of the five models, and increases in magnitude when the sample is restricted to developing countries.

The effect of initial per capita income on the quality of macroeconomic policy is generally positive, but not significant at the 5% level in the baseline model. Countries with a larger share of government consumption and a high black market premium also have worse macroeconomic policies, indicating that bad policies tend to go together. The negative coefficient on the terms of trade shocks may reflect the fiscal response to economic shocks.

[19] See also the discussion in Alesina and Wacziarg (1997) and Alesina, Spolaore and Wacziarg (1997) for more on the relationship between country size and trade openness.

Table VIII: Macroeconomic policy quality channel

Dep. Var: Macro Policy	Baseline 1970-89	1970-92	Devel. Countries	SUR	Regional Dummies
Intercept	5.980	5.695	11.534	6.647	4.371
	(5.14)	(6.49)	(8.49)	(5.14)	(2.81)
Log Initial	0.187	0.203	-0.501	0.093	0.393
Income	(1.42)	(2.13)	(2.99)	(0.65)	(2.00)
Trade Policy	**0.027**	**0.038**	**0.033**	**0.048**	**0.014**
Openness	**(2.19)**	**(5.57)**	**(3.81)**	**(4.07)**	**(1.28)**
BMP	-0.002	-0.004	-0.001	-0.001	0.0002
	(-1.90)	(-7.92)	(-3.42)	(-1.16)	(-0.20)
Government	-0.126	-0.126	-0.124	-0.122	-0.130
Consumption	(-8.25)	(-11.67)	(-12.09)	(-10.44)	(-8.57)
Ethnolinguistic	-0.006	0.001	-0.014	-0.005	-0.005
Fractionalization	(-1.45)	(-0.16)	(-5.37)	(-1.21)	(-0.96)
Terms of Trade	-1.318	0.213	-1.091	-1.475	-1.252
Shocks	(-1.86)	(-0.54)	(-2.03)	(-2.35)	(-1.95)
Latin America	-	-	-	-	-0.310
Dummy					(-0.87)
South East Asia	-	-	-	-	0.631
Dummy					(-1.51)
Sub-Saharan	-	-	-	-	-0.176
Africa Dummy					(-0.45)
OECD	-	-	-	-	-0.147
Dummy					(-0.32)
R-squared	.36 .28	.35 .36 .45	.34 .37	.37 .28	.34 .29
	.34 .36	.42 .35	.42 .34	.35 .36	.38 .37
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

4.3.2 Government Size Equation

Trade policy has a positive impact on *government size* (Table IX) in the baseline regression. This provides some support to results by Rodrik (1996), who also reported a significantly positive impact of trade shares on government size, although the result disappears when the sample is restricted to developing countries.[20] Taken together with the results of the growth regression, this suggests that government size may be a channel whereby openness works *negatively* for growth.

Other determinants of government size are included in the regression, following Rodrik's specification. The log of initial per capita income is negatively related to government consumption. Its inclusion into the regression drives much of the positive effect of trade

[20] However, Alesina and Wacziarg (1997), using a wider sample of countries, have cast some doubt on Rodrik's results, by showing that they are sensitive to the chosen specification and to the inclusion of country size in the regression.

policy (the sign of this variable is reversed when initial income is excluded from the regression). The role of a large population in limiting the size of government can be viewed as the result of increasing returns in the provision of public goods (Alesina and Wacziarg, (1997)). These may result from the partly nonrival character of many such goods, such as defense, diplomacy and the maintenance of law and order. The signs of most of the other determinants of government size are as expected: population density is associated with a smaller government, perhaps capturing another type of scale effect. Dependency rates are associated with larger governments, in line with the idea that government consumption is likely to respond positively to increased schooling and retirement needs.

Table IX: Size of Government Channel

Dep. Var.: Govt. Cons.	**Baseline 1970-89**	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Intercept	57.718	37.621	31.387	33.873	40.759
	(10.58)	(22.73)	(8.14)	(8.50)	(7.88)
Log Initial	-4.439	-2.848	-0.875	-2.332	-2.463
Income	(-9.58)	(-32.57)	(-2.84)	(-5.93)	(-5.34)
Trade Policy	**0.154**	**0.121**	**0.034**	**0.102**	**0.249**
Openness	**(3.73)**	**(43.28)**	**(1.34)**	**(2.50)**	**(5.73)**
BMP	0.008	0.004	0.006	0.006	0.007
	(20.19)	(30.77)	(24.17)	(15.55)	(20.57)
Log Population	-0.911	-0.900	-1.856	-0.977	-0.726
	(-4.52)	(-8.08)	(-7.45)	(-4.82)	(-3.25)
Population	-0.003	-0.003	-0.005	-0.004	-0.004
Density	(-5.87)	(-16.65)	(-8.59)	(-6.60)	(-6.47)
Population	16.262	32.549	-10.267	26.215	14.491
over 65	(1.54)	(4.94)	(0.79)	(2.85)	(1.39)
Population	1.653	18.525	14.574	18.595	12.093
under 15	(0.29)	(7.76)	(4.07)	(3.80)	(2.48)
Ethnolinguistic	0.038	0.039	0.107	0.056	0.032
Fractionalization	(3.23)	(5.26)	(12.21)	(4.66)	(1.97)
Latin America	-	-	-	-	-6.095
Dummy					(-4.51)
South East Asia	-	-	-	-	-4.565
Dummy					(-3.18)
Sub-Saharan	-	-	-	-	-2.003
Africa Dummy					(-1.30)
OECD Dummy	-	-	-	-	-5.846
					(-3.91)
R-squared	.28 .28	.21 .29 .47	.25 .33	.29 .33	.35 .36
	.42 .53	.55 .55	.47 .48	.46 .52	.48 .59
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

4.4 Allocation effects: Distortions and Capital Accumulation

4.4.1 Distortions channel

The baseline model displays a negative but insignificant effect of trade policy on *price distortions*, proxied by the level of the black market premium, once other determinants of distortions are held constant (Table X). A 10 point increase in the trade policy index is associated with a 3.4 percentage point reduction in the black market premium, although the slope parameter is estimated very imprecisely. However, this effect becomes significant at the 90% level in all other specifications. In particular, the estimated coefficient become large economically when OECD countries are excluded from the sample, as we find that a 10 point increase in trade policy openness reduces the black market premium by 18 percentage points.

Table X: Distortions Channel

Dep. Var: BMP	**Baseline 1970-89**	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Intercept	39.720	80.849	168.293	124.906	104.804
	(0.83)	(8.48)	(3.66)	(2.91)	(1.81)
Log Initial	-2.535	-5.314	-17.208	-11.666	-13.617
Income	(-0.43)	(-4.49)	(-2.78)	(-2.18)	(-1.90)
Trade Policy	**-0.344**	**-0.855**	**-1.826**	**-0.900**	**-1.092**
Openness	**(-0.63)**	**(-7.56)**	**(-2.45)**	**(-1.77)**	**(-1.69)**
Government	3.821	1.493	2.407	2.452	3.688
Consumption	(8.13)	(14.62)	(8.44)	(6.49)	(8.28)
Democracy	-51.987	-42.665	-46.554	-35.274	-56.272
	(-4.69)	(-15.57)	(-3.65)	(-3.62)	(-4.74)
Population	-0.025	-0.012	-0.016	-0.027	-0.0004
Density	(-3.37)	(-10.16)	(-1.50)	(-3.77)	(-0.03)
Terms of Trade	71.589	-36.730	47.780	57.464	76.925
Shocks	(2.87)	(2.77)	(1.73)	(2.29)	(2.87)
Latin America	-	-	-	-	44.517
Dummy					(3.55)
South East	-	-	-	-	-11.335
Asia Dummy					(-0.64)
Sub-Saharan	-	-	-	-	11.584
Africa Dummy					(0.89)
OECD	-	-	-	-	42.212
Dummy					(3.24)
R-squared	.19 .23	.17 .18 .06	.15 .28	.24 .29	.20 .27
	.10 .27	.18 .23	.09 .17	.12 .27	.13 .33
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

The inclusion of government size, which enters with a positive sign, provides further evidence of the complementarity between maintaining a small level of public spending and policies aimed at ensuring the efficiency of the price system. Democracy, measured by an

objective index compiled by Gastil and his followers for the yearly Freedom in the World reports, is associated with lower distortions, even when controlling for initial income. This may reflect the ability of democracy to provide a check on the abuses of policy-makers, as argued in Tavares and Wacziarg (1998). Finally, and as expected, a higher level of per capita income is associated with reduced distortions.

4.4.2 Investment channel

Trade policy bears a strong and robust positive relationship with the *share of investment in GDP* (Table XI). This constitutes one of the main findings of this paper. Estimates from the baseline model suggest that a one standard deviation difference in the trade policy index is directly associated with a 3.2 percentage point increase in the ratio of domestic investment to GDP. This effect is robust with respect to alternative models, although its magnitude is reduced when the 1990-92 period is brought into the picture.

Table XI: Investment Channel

Dep. Var: Inves. Rate	**Baseline 1970-89**	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Intercept	27.493	12.459	8.243	15.498	25.778
	(3.72)	(2.82)	(1.27)	(2.41)	(3.46)
Log Initial	1.003	2.609	2.746	2.414	1.277
Income	(1.56)	(6.59)	(5.38)	(4.25)	(1.98)
Trade Policy	**0.317**	**0.161**	**0.270**	**0.228**	**0.204**
Openness	**(6.72)**	**(9.77)**	**(7.04)**	**(5.40)**	**(4.40)**
BMP	-0.010	-0.010	-0.006	-0.007	-0.007
	(-7.15)	(-20.13)	(-18.60)	(-8.97)	(-5.70)
Macro Policy	1.027	0.609	0.381	0.390	0.250
Index	(6.97)	(9.79)	(5.31)	(3.16)	(1.88)
Population	-38.321	-33.230	-24.285	-30.457	-30.237
under 15	(-5.16)	(-7.54)	(-4.27)	(-4.12)	(-4.06)
Population	-88.353	-65.596	-67.586	-73.547	-88.871
over 65	(-5.45)	(-7.58)	(-2.66)	(-4.33)	(-5.90)
Ethnolinguistic	-0.047	-0.036	-0.014	-0.051	-0.058
Fractionaliz.	(-3.02)	(-4.37)	(-0.85)	(-3.43)	(-3.38)
Latin America	-	-	-	-	-1.809
Dummy					(-1.35)
South East	-	-	-	-	3.778
Asia Dummy					(2.16)
Sub-Saharan	-	-	-	-	-2.227
Africa Dummy					(-1.57)
OECD	-	-	-	-	3.520
Dummy					(2.30)
R-squared	.44 .56	.49 .60 .61	.21 .52	.49 .62	.53 .67
	.61 .62	.73 .58	.57 .50	.62 .65	.69 .70
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

Other determinants of domestic investment include life cycle variables (dependency ratios), ethnolinguistic fractionalization and initial income. Contrary to what conditional convergence would imply, the share of investment in GDP is larger for richer countries when other determinants of investment are held constant. This suggests that the forces behind conditional convergence may have little to do with the traditional assumption of diminishing marginal product of capital, but perhaps with some form of convergence-inducing technological transfers (Barro and Sala-i-Martin, 1995). Furthermore, as expected, a low level of distortions and a high quality of macroeconomic management appear conducive to physical capital investment.

4.5 Technological Transmissions

4.5.1 Manufactured exports channel

The transmission of technology, proxied by the ratio of manufactured exports in total merchandise exports, is strongly influenced by trade policy (Table XII). In the baseline model, a 10 percentage point increase in the policy component of trade shares is associated with a 6.35 percentage point rise in the manufactures to merchandise exports ratio. Both the magnitude and the precision of the estimates are robust in four out of five specifications of the model.

Other regressors included in this equation bear the expected signs: population density, which proxies for the labor/land ratio, is positively associated with the export share of manufactures (presumed to be relatively labor intensive rather than land intensive); human capital, measured by the proportion of the adult population having completed secondary school, captures the ratio of skilled to unskilled labor, which is also expected to bear a positive relationship with the share of manufactures in merchandise exports. Initial income displays a positive and significant estimated coefficient. All of these conditioning variables can be interpreted as relative endowments, which are obvious determinants of the composition of exports.

Table XII: Manufactured Exports Channel

Dep. Var: Manuf. Exp.	Baseline 1970-89	1970-92	Devel. Countries	SUR	Regional Dummies
Intercept	-75.796	-82.105	-46.472	-73.793	-38.292
	(-6.94)	(-12.76)	(-5.15)	(-8.23)	(-2.77)
Log Initial	7.289	8.482	3.718	7.497	5.310
Income	(5.18)	(11.15)	(4.32)	(6.99)	(3.18)
Trade Policy	**0.635**	**0.567**	**-0.369**	**0.676**	**0.619**
Openness	**(4.59)**	**(10.15)**	**(-4.82)**	**(6.87)**	**(4.32)**
BMP	-0.013	-0.024	-0.024	-0.020	-0.019
	(-5.49)	(-22.95)	(-19.90)	(-14.81)	(-7.69)
Secondary Sch.	0.291	0.205	1.743	0.232	0.164
Completion	(3.09)	(2.41)	(19.75)	(2.57)	(2.05)
Log Population	5.215	5.216	3.451	4.964	4.219
	(5.68)	(8.76)	(4.92)	(5.53)	(5.18)
Population	0.019	0.014	0.015	0.017	0.020
Density	(5.22)	(9.10)	(7.33)	(4.91)	(6.05)
Latin America	-	-	-	-	-20.070
Dummy					(-5.17)
South East	-	-	-	-	-18.118
Asia Dummy					(-3.97)
Sub-Saharan	-	-	-	-	-18.010
Africa Dummy					(-4.65)
OECD	-	-	-	-	-5.017
Dummy					(-1.15)
R-squared	.50 .52	.48 .48 .43	.21 .38	.51 .53	.55 .59
	.49 .53	.51 .50	.34 .53	.49 .53	.54 .62
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

4.5.2 Foreign Direct Investment Channel

Foreign direct investment appears to be a complement, rather than as substitute to trade policy openness (Table XIII). A 10 points change in the trade policy index is associated with a 0.46% direct increase in the FDI to GDP ratio, which represents about 50% of this variable's mean, a large effect indeed. Countries with lower distortions, which in turn attracts more FDI. A similar effect holds for countries with relatively smaller governments. Non-distortionary policies, a commitment to non-interventionist policies and free trade all appear conducive to attracting foreign capital. In turn, the effect of FDI on growth can be interpreted as a technological transmission mechanism, since FDI represents too small an effect on the growth of the domestic capital stock to represent a direct accumulation effect.[21] The estimates from the FDI channel equation are robust across the five variants

[21] We tried to use the investment rate net of the foreign direct investment rate in the investment channel, to better separate the two effects. The results for both equations were similar. However, the precision of the parameter estimate for the trade policy coefficient in the investment equation decreased somewhat. At

of the baseline model. Furthermore, isolating developing countries leads to a doubling of the trade policy coefficient.

Among the other determinants of FDI, former colonies having gained independence after the Second World War tend to attract more FDI, other things equal. This may reflect privileged economic ties between certain countries and their former colonizers.

Table XIII: Foreign Direct Investment Channel

Dep. Var.: FDI share	**Baseline 1970-89**	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Intercept	1.177	1.124	1.805	1.149	1.679
	(5.73)	(8.52)	(13.55)	(7.24)	(4.90)
Trade Policy Openness	**0.045**	**0.059**	**0.085**	**0.036**	**0.057**
	(4.01)	**(9.62)**	**(13.82)**	**(3.41)**	**(4.29)**
BMP	-0.001	-0.001	-0.001	-0.001	-0.0002
	(-3.60)	(-20.54)	(-3.48)	(-3.09)	(-0.92)
Government Consumption	-0.054	-0.048	-0.047	-0.051	-0.060
	(-4.15)	(-11.70)	(-6.67)	(-4.36)	(-5.82)
Postwar Dummy	0.928	1.009	0.329	0.787	0.634
	(3.96)	(6.17)	(1.92)	(3.41)	(3.23)
Island Dummy	0.988	1.192	1.239	1.076	0.943
	(4.74)	(6.07)	(13.17)	(4.87)	(4.29)
Latin America Dummy	-	-	-	-	0.086
					(0.31)
South East Asia Dummy	-	-	-	-	0.150
					(0.36)
Sub-Saharan Africa Dummy	-	-	-	-	-0.261
					(-1.34)
OECD Dummy	-	-	-	-	-0.748
					(-1.96)
R-squared	.33 .36	.22 .32 .31	.45 .50	.34 .35	.37 .39
	.28 .23	.24 .26	.40 .29	.28 .23	.35 .24
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

any rate, FDI represents a very small fraction of total domestic capital formation in our sample.

5 Summary of the Channel Effects and Robustness Analysis

5.1 Analyzing the channel effects in the baseline model

The summary of the channel effect of trade policy on growth, based on the baseline model, is given in Table XIV, which reports the effects of each channel on growth and the effect of trade policy on each channel. The last column displays the product of the two coefficients. The t-statistics for the channel effects are obtained by computing linear approximations of the products of the parameters around the estimated parameter values, and applying the usual formula for the variance of linear functions of random variables to this linear approximation. Computing these standard errors is possible thanks to the joint estimation of all the equations in the system, which allows the derivation of the covariance matrix for all of the estimated parameters. In the baseline model, three of the six channels involve statistically significant effects of trade policy openness on growth at the 90% level. The overall effect, once all the channels have been added, is significant at the 99% level.

Table XIV: Summary of Channel Effects (Baseline Model)

Channel	Effect of the Channel on Growth	Effect of Trade Policy on Channel	Effect of Trade Policy on Growth
Distortions	-0.007	-0.344	0.002
	(-9.08)	(-0.63)	(0.63)
Government Consumption	-0.042	0.154	-0.007
	(-1.57)	(3.73)	(-1.52)
Manufactured Exports	0.004	0.635	0.002
	(0.45)	(4.59)	(0.45)
Investment Rate	0.143	0.317	0.045
	(6.86)	(6.72)	(5.12)
Foreign Direct Investment	0.320	0.045	0.014
	(4.68)	(4.01)	(3.79)
Macro Policy Quality	0.489	0.027	0.013
	(4.22)	(2.19)	(1.90)
Total Effect			**0.071**
			(5.94)

(t-ststistics based on heteroskedastic-consistent (White-Robust) standard errors in parentheses)

According to Table XIV, trade policy openness works positively for growth through five out of six of the channels. Some channels are weak in magnitude: reduced distortions account for roughly 3% of the net effect of open trade policy openness on growth, and is statistically insignificant. This is a surprising result in light of the importance that allocative efficiency has received in the arguments about static and dynamic gains from trade. The same holds for the manufactured exports channel, meant to capture technological transmissions. The government size channel works negatively for growth, although the effect is weak both in terms of magnitude and in terms of statistical significance. Differences in the quality of macroeconomic policy and in the ratio of FDI to GDP appear to be relatively important channels, each accounting for roughly 20% of the total effects of trade policy on growth.

The most important channel by far seems to be the investment rate. It accounts for close to 63% of the total effect of trade policy on growth, a somewhat unexpected result. Several theoretical arguments point to the potential direct impact of trade policy openness on investment, such as those outlined in section 2.1.2. However, dominant theories about dynamic gains from trade generally do not put physical capital accumulation directly at the center of their logic, although the returns to capital are predicted to increase as a result of openness in most of these theories.

Furthermore, theories that stress the favorable effects of trade openness on capital accumulation are often of a static nature. Either through its pro-competitive effects of through enhanced efficiency in the sectoral composition of output, openness raises the steady state capital-labor ratio, which requires more investment in the transition to the steady state. Common estimates of the speed of convergence to the steady state (2%) suggest that this convergence might be rather slow, implying that a country that liberalizes might experience a rather lasting surge in its investment ratio, before the marginal product of capital falls back to its steady state level. Since many of the countries in our sample liberalized their trade regimes either during the period under consideration, or just before, our estimate of the investment effects of trade policy openness might well be capturing this transitional effect.

Long-run effects of trade openness on growth are also theoretically possible. In the endogenous growth literature, any mechanism that prevents the marginal product of capital from falling to zero spurs growth by preventing a fall in the rate of investment. Technological transmissions, improved policy quality and allocative efficiency are thought to work mainly by raising the productivity of factors, and generate long-run growth through endogenous mechanisms. However, given our methodology, such an effect should show up through the technological transmissions, distortions or policy quality channels.

Another possible explanations for the results is that measurement error in some of the channel variables leads us to overstate the effect of trade policy via investment. Indeed, if investment is positively correlated with technological transmissions, and the share of manufactured exports in total merchandise exports is a weak proxy for the extent of technological transmissions, then part of this effect will be accounted for by the investment channel. This again, seems to point to the logical complementarity between physical capital accumulation and the overall improvement in the productivity of existing factors. A similar argument could be made concerning price distortions. However, the scope of this argument is somewhat limited by the fact that we are using instruments for all of the channel variables: if the measurement errors in the instruments are uncorrelated with measurement errors in the channel variables, the incidence of attenuation bias will be greatly reduced.

To summarize, this model provides strong evidence in favor of the beneficial total effect of trade policy on growth. A 10 percentage point increase in the trade policy measure, which corresponds roughly to one standard deviation, is associated with a 0.71 percentage point increase in the annual growth rate once all of the channels of influence are brought into the picture. This effect is estimated with great precision. The most important channels by far seem to be through investment (63% of the total effect). Technological transmissions, according to our accounting framework, explain 22.5% of the overall positive effect of trade on growth, and macroeconomic policy quality accounts for 18% of this effect.

5.2 Robustness analysis

5.2.1 Robustness to the Specification

We now turn to the analysis of sensitivity for our model. Table XV contains the channel decomposition of the impact of trade on growth in the five different specifications of the model. In addition to the t-statistics, this channel also contains Wald tests for the significance of the products of coefficients. These Wald statistics are asymptotically distributed as χ^2 variables with 1 degree of freedom. As the table shows, the p-values implied by the t-tests and those obtained from the Wald tests are very similar. Figure 1 displays the six channels graphically.

Table XV. Channel Effects under Alternative Models

I	II	III	IV	V	VI
	Baseline 1970-89	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Distortions	0.002	0.005	0.009	0.005	0.007
	(0.63)	(7.28)	(2.51)	(1.73)	(1.71)
Wald Test	0.399	53.042	6.315	2.983	2.924
p-value	(0.53)	(0.00)	(0.01)	(0.08)	(0.09)
Govt.	-0.007	-0.007	-0.001	-0.004	-0.011
Consump.	(-1.52)	(-5.85)	(-1.14)	(-1.57)	(-1.93)
Wald Test	2.309	34.184	1.291	2.477	3.709
p-value	(0.13)	(0.00)	(0.26)	(0.12)	(0.05)
Manuf.	0.002	0.001	-0.002	0.005	-0.003
Exports	(0.45)	(0.53)	(-1.00)	(1.11)	(-0.70)
Wald Test	0.201	0.282	0.994	1.228	0.490
p-value	(0.65)	(0.60)	(0.32)	(0.27)	(0.48)
Investment	0.045	0.021	0.039	0.033	0.022
Rate	(5.12)	(7.98)	(5.20)	(4.37)	(3.54)
Wald Test	26.199	63.639	27.076	19.075	12.567
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Foreign Dir.	0.014	0.015	0.023	0.013	0.010
Investment	(3.79)	(6.02)	(4.90)	(3.46)	(2.37)
Wald Test	14.385	36.236	24.058	11.967	5.637
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)
Macro Policy	0.013	0.011	0.017	0.016	0.004
Quality	(1.90)	(4.24)	(3.36)	(2.84)	(1.18)
Wald Test	3.609	17.980	11.293	8.078	1.402
p-value	(0.06)	(0.00)	(0.00)	(0.00)	(0.24)
Total Effect	**0.071**	**0.046**	**0.085**	**0.067**	**0.030**
	(5.94)	**(11.71)**	**(7.85)**	**(5.73)**	**(2.38)**
Wald Test	35.332	137.215	61.624	32.888	5.688
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)

Column III shows that, when adding the 1990-92 time period, most of the previously insignificant effects become significant. Although the addition of this time period reduces the number of observations, it raises by 20% the amount of data used to estimate each parameter compared to the case where only four time periods are used. The signs and relative magnitudes of most of the effects are maintained. The reduction in the overall effect, from 0.71 to 0.46, is almost entirely due to a reduction in the investment channel. Distortions and government size become statistically significant channels, although relatively small in magnitude.

Column IV shows that the effect of trade policy on economic growth is actually increased when the sample is restricted to developing countries. This is due to the fact that the distortions channel is now significant, and represents roughly 10% of the overall effect. The other channels are preserved. Column V shows that changing the estimator used for the analysis does not greatly affect the sign and magnitude of the estimated effects. In fact, the overall effect of trade policy is roughly preserved compared to the baseline model.

Our estimator does not allow for country specific fixed effects that can covary with the right-hand side variables in the various equations. Accounting for country specific fixed effects would involve rewriting the econometric theory underlying the estimation procedure, a task that is left for future research. However, in order to account for the possibility that regional specificities might be the driving force of the results, regional dummies for Latin America, Sub-Saharan Africa, South East Asia and the OECD countries were added to each of the channel equations, as well as to the list of instruments (Column VI). Since accounting for fixed effects tends to wipe out much of the cross-sectional variation (the fixed effects estimator uses only the variation within regions across time, discarding the between-country variation), we should expect the inclusion of these variables to lower the estimated effects of trade policy. This is indeed the case, as shown in Figure 1. The total effect of trade policy is reduced by the inclusion of region specific dummies, but the respective shares of each channel are roughly preserved. In particular, the dominant role of physical capital formation is maintained.

To summarize, the main message of this paper, namely that trade policy openness works mostly through the rate of physical capital investment, appears robust to a variety of modifications of the baseline model.

5.2.2 Robustness to the Time Coverage

In order to examine the robustness of the model with respect to its time coverage, and therefore with respect to the cross-equation parameter equality restrictions, we excluded each time period from the baseline model one at a time. Furthermore, the exogenous variables corresponding to the excluded period were removed from the list of instruments. The resulting channel effects are presented in Table XVI. We should expect the precision of the parameter estimates to be greatly reduced, as we are now throwing out 25% of the data in each case. This is indeed the case, as the t-statistics on most of the channel effects are considerably lower when only three time periods are used for estimation. For example, the macroeconomic policy and government size channels no longer appear significant statistically. However, both the signs and magnitudes of the estimates are remarkably close to those of the baseline model. In particular, the investment effect is preserved in

all specifications, and in all but one case the overall effect of trade policy remains of the same magnitude. This provides evidence that the estimates are robust with respect to the time period coverage.

Table XVI - Sensitivity to the Time Period Coverage

	excl. 1970-84	**excl. 1975-79**	**excl. 1980-84**	**excl. 1985-89**
Distortions	-0.007	-0.002	0.013	0.001
	(-1.15)	(-0.37)	(1.30)	(0.07)
Wald Test	1.315	0.133	1.679	0.005
p-value	(0.25)	(0.72)	(0.20)	(0.94)
Government	-0.006	0.002	0.005	-0.010
Consumption	(-1.09)	(0.19)	(0.62)	(-1.53)
Wald Test	1.196	0.035	0.391	2.351
p-value	(0.27)	(0.85)	(0.53)	(0.13)
Manufactured	0.013	0.009	0.004	0.010
Exports	(1.83)	(0.89)	(0.54)	(0.70)
Wald Test	3.357	0.792	0.294	0.494
p-value	(0.07)	(0.37)	(0.59)	(0.48)
Investment	0.032	0.093	0.021	0.035
Rate	(2.62)	(5.05)	(1.80)	(2.07)
Wald Test	6.863	25.508	3.229	4.281
p-value	(0.01)	(0.00)	(0.07)	(0.04)
Foreign Dir.	0.021	0.004	0.012	0.016
Investment	(4.09)	(1.17)	(2.43)	(2.41)
Wald Test	16.705	1.368	5.924	5.830
p-value	(0.00)	(0.24)	(0.01)	(0.02)
Macro	-0.026	0.001	0.008	0.009
Policy	(-1.98)	(0.11)	(0.78)	(1.08)
Wald Test	3.906	0.013	0.610	1.163
p-value	(0.05)	(0.91)	(0.43)	(0.28)
Total Effect	**0.027**	**0.108**	**0.061**	**0.060**
	(1.48)	(3.87)	(3.62)	(2.53)
Wald Test	2.203	15.008	13.140	6.399
p-value	(0.14)	(0.00)	(0.00)	(0.01)

5.3 Exhaustiveness of the model

The last concern that we address is that the six channels considered above may not fully capture the total effect of trade policy on growth. In particular, we may have omitted one channel or more, leading both to an incomplete characterization of the effects of trade policy and to potential biases in the estimates of the included channels (insofar as the omitted channels covary with the included ones in the growth regression).

5.3.1 Other possible channels

We start with a brief discussion of other possible linkages which may have been omitted from the system. Firstly, the accumulation of human capital might be one of the channels linking trade policy and economic growth. Indeed, if trade openness modifies the relative returns to factors, then it may create greater incentives to accumulate human capital. For instance, if an open trade policy spurs technological transmissions, and if technology and skills are complements, then trade openness will increase the returns to accumulating human capital. However, specifying a human capital channel led to no significant linkage effect: the coefficient on the trade policy variable was essentially zero once other determinants of human capital formation, such as per capita income, were held constant. This was robust with respect to the inclusion of a diverse set of controls. Furthermore, the effects of human capital on growth are not robust in our growth specification, a problem which is compounded by the opposite signs of male and female human capital. Hence, human capital does not appear to be an important channel linking trade policy and growth.

We carried out a similar exercise for income inequality. Neoclassical trade theory provides several tools for the analysis of income distribution in relation to trade openness. For example, the simple factor endowments theory of Hecksher-Ohlin-Samuelson predicts that when a relatively unskilled labor abundant country moves from autarky to free trade, returns to unskilled labor should increase in relative terms, with presumed positive effects on income distribution. In turn, there are reasons to believe that inequality has an effect on growth, although the direction of this effect appears a priori ambiguous. Alesina and Perotti (1993), among others, have studied the issue of distribution and growth. They argue that when the poor have a larger weight in the political decision making process, they tend to vote for transfer schemes that involve distortive (i.e. growth reducing) taxation. Empirically, they report that more unequal societies tend to display lower growth rates, once other determinants of growth are held constant. However, including a measure of income inequality (the Gini coefficient) in the basic growth regression gave rise to an insignificant effect. Furthermore, the effect of trade policy on income inequality, once controlling for the level of per capita income, was found to be essentially zero. Hence, the income inequality channel does not appear to operate either, although the poor quality of cross-country inequality data may be the source of this result.[22]

5.3.2 Unconditional effect of trade policy openness

The unconditional effect of trade policy on growth can be calculated by removing all of the channel variables from the growth regression, and including the trade policy index in their place (Table XVII). The resulting estimate suggests a strong association between the trade regime and growth: A 10 percentage point increase in the trade policy index is associated with a 0.66 percentage point increase in the annual growth rate in the baseline model.

With the exclusion of many variables from the growth equation, the trade policy index now captures much of the portion of their effect on growth that is not necessarily linked to trade policy. However, this coefficient is useful in that it provides us with a rough

[22]Results for the income inequality and human capital channels are available from the author upon request.

order of magnitude against which to compare the total effect of trade policy computed above. Indeed, in all five models, the unconditional effect of trade policy (where we take 'unconditional' to mean that we are not conditioning on the channel variables) is roughly of the same magnitude as the total effect of trade policy computed in Table XV. This increases our confidence that no major channel has been omitted.[23]

Table XVII. Unconditional Effect of Trade Policy in the Growth Regression

	Baseline 1970-89	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Intercept	2.666	1.744	1.686	4.159	4.780
	(1.42)	(2.24)	(1.13)	(2.34)	(1.61)
Log Initial	-0.078	0.037	0.006	-0.259	-0.086
Income	(-0.32)	(0.38)	(0.03)	(-1.12)	(-0.23)
Male Human	0.725	0.948	1.893	0.671	-0.285
Capital	(2.11)	(5.30)	(13.54)	(2.18)	(-0.92)
Female Human	-0.926	-1.265	-1.840	-0.837	0.019
Capital	(-3.04)	(-8.02)	(-7.48)	(-2.99)	(0.06)
Trade Policy	**0.066**	**0.061**	**0.095**	**0.091**	**0.073**
Openness	**(3.00)**	**(7.18)**	**(5.97)**	**(4.44)**	**(2.93)**
Latin America	-	-	-	-	-2.198
Dummy					(-6.74)
South East	-	-	-	-	0.970
Asia Dummy					(1.77)
Sub-Saharan	-	-	-	-	-3.090
Africa Dummy					(-5.70)
OECD	-	-	-	-	-1.438
Dummy					(-3.71)
R-squared	.12 .06	.12 .09 .09	.23 .20	.12 .06	.11 .31
	.09 .03	.04 .11	.22 .02	.08 .03	.45 .11
Obs (Periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

5.3.3 Tests based on the residuals from the growth equation

A perhaps more formal test of exhaustiveness can be carried out by regressing the residual vector from the growth regression on the index of trade policy. If any significant channel has been left out of the growth regression, this should generate some correlation between the estimated residual and the measure of trade openness. The results presented in Table XVIII, based on a seemingly unrelated regression estimator, show that this is not the case.[24] In most of the models, the residual effect of trade policy is generally positive, but

[23] A remaining possibility is that we have omitted an important negative channel and an offsetting positive channel, although this would be an unlikely coincidence.

[24] Again, this should not be taken as an absolute proof of exhaustiveness. To the extent that potentially omitted channels covary with the included ones, then the latter will pick up the effects of trade policy that should be accounted for by the missing channels; this would be reflected by a lower correlation between the growth residual and trade policy openness. However, this test provides yet another indication that no major channel has been omitted.

not significantly different from zero at any reasonable level of significance. This, again, reinforces our confidence in the exhaustiveness of the model. The fact that the estimates are generally positive shows that, if anything, our channel methodology has uncovered a lower bound on the total effect of trade openness. In the only case where the estimate is negative, the effect is very small in magnitude.

Table XVIII. Regression of the residuals from the growth equation on the trade policy index

	Baseline 1970-89	**1970-92**	**Devel. Countries**	**SUR**	**Regional Dummies**
Intercept	0.033 (0.18)	0.042 (0.24)	-0.183 (-0.81)	0.048 (0.30)	-0.138 (-0.94)
Trade Policy Openness	**0.013** **(0.83)**	**0.019** **(1.20)**	**-0.004** **(-0.25)**	**0.010** **(0.64)**	**0.019** **(1.36)**
R-squared	.0009 .01 .02 .0002	.00003 .007 .02 .005 .02	.07 .07 .01 .04	.000004 .006 .02 .00003	.002 .01 .03 .002
Obs. (periods)	57(4)	49(5)	36(4)	57(4)	57(4)

(t-statistics based on heteroskedastic-consistent (White-Robust) standard errors, in parentheses)

6 Conclusion

This paper constitutes the first attempt to empirically evaluate, in a cross-country context, the respective roles of various theories of dynamic gains from trade in explaining the observed positive impact of trade openness on economic growth. Trade openness affects growth mainly by raising the ratio of domestic investment to GDP. Depending on the specification, the rate of physical capital accumulation explains between 46% and 63% of the impact of trade policy on economic growth. Foreign Direct Investment, used as a proxy for technological transmissions, and the quality of macroeconomic policies each account for roughly 20% of the overall effect. Lastly, we found weak evidence that the size of government, measured by the ratio of public consumption to GDP, constitutes a channel whereby trade policy affects economic growth negatively.

The lack of statistically significant results concerning manufactured exports and distortions may be due to measurement problems. These are the two channels for which measurement, although improving on past attempts, is still subject to considerable shortcomings. The black market premium may be a weak proxy for the overall efficiency of the price system. International technological transmissions are extremely hard to measure as well, resulting perhaps in a downward bias in the estimates corresponding to this channel, and a concurrent overstatement of the other channels. Future research should seek to improve upon the measures used in this study.

The important role of investment in physical capital poses a serious theoretical challenge. While some theories about gains from trade do predict positive effects of openness on the rate of return to capital, these effects should be captured either by the distortions or the technological transmissions channels. Furthermore, theories based on dynamic gains from technological transmissions and efficiency improvements center on the improvement

of the overall productivity of factors, rather than on the acceleration of their accumulation. If specialization is limited by the extent of the market, under increasing returns to scale theories, trade openness should allow entrepreneurs to undertake previously unprofitable investments. Theories based on such a 'Big Push' may provide useful insights into the nature of dynamic gains from trade.[25] Further theoretical investigations into the interplay between investment rates, trade openness and growth seem called for.

[25] Results presented in appendix V, however, suggests that such theories may not provide the full picture.

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Appendix I. List of countries

OECD	Asia	Latin America	Africa
Australia	Cyprus	Argentina	Ghana
Austria	India	Barbados	Kenya
Belgium	Israel	Brazil	Malawi
Canada	Jordan	Colombia	Mauritius
Finland	Korea	Costa Rica	Sierra Leone
France	Malaysia	Dominican Republic	South Africa
Germany, West	Myanmar (Burma)	El Salvador	Tanzania
Greece	Pakistan	Guyana	The Gambia
Ireland	Philippines	Mexico	Tunisia
Italy	Singapore	Paraguay	Zaire
Japan	Sri Lanka	Peru	Zambia
Netherlands	Syria	Venezuela	
New Zealand	Thailand		
Norway			
Portugal			
Spain			
Sweden			
Switzerland			
Turkey			
U.S.A.			
United Kingdom			

Appendix II: Data Sources and Description

Variable Name: **Growth**
Source: Summers-Heston v. 5.6
Unit: % points
Description: Growth rate of PPP adjusted Gross Domestic Product

Variable Name: **Import duties as a % of total imports**
Source: IMF-IFS and IMF-GFS
Unit: % points
Description: Import duties in local currency as a percentage of total imports in local currency.

Variable Name: **Pre-Uruguay Round NTB coverage**
Source: UNCTAD/World Bank
Unit: % points
Description: Coverage rate of non-tariff barriers pre-Uruguay Round

Variable Name: **Sachs and Warner Liberalization Status**
Source: Sachs-Warner (1995)
Unit: Values ranging from 0 to 1.
Description: For each year, a dummy variable was constructed based on the years of liberalization in Sachs and Warner (1995). Liberalized countries took a value of 1, closed countries took a value of zero. The data were averaged over the relevant 5 year sub-periods.

Variable Name: **Manufactured Exports Share**
Source: World Bank
Unit: % points
Description: Share of manufactured goods in merchandise exports

Variable Name: **FDI ratio**
Source: IMF
Unit: % points
Description: Ratio of gross Foreign Direct Investment inflows to GDP.

Variable Name: **Democracy**
Source: Gastil (Freedom In the World Reports, various issues)
Unit: Takes values from 0 (non-democracy) to 1 (country with fully developed democratic institutions)
Description: Index of how democratic institutions are (regular elections, broad franchise, wide access to office and relevance of elected officials).

Variable Name: **Initial Income**
Source: Summers-Heston v. 5.6
Unit: Log of per capita GDP in Dollars
Description: Real Gross Domestic Product per capita in a given year (PPP adjusted)

Variable Name: **Human Capital**
Source: Barro-Lee
Unit: Years
Description: Average years of secondary and higher education in the total population over age 25.

Variable Name: **Secondary School Completion Rate**
Source: Barro-Lee
Unit: %
Description: Percentage of "secondary school complete" in the total population.

Variable Name: **Macroeconomic Policy Quality**
Source: Wacziarg / World Bank / IMF
Unit: index
Description: Index of macroeconomic policy quality. Constructed by ranking countries according to the public debt to GDP ratio, deficit to GDP ratio and growth of M1 net of total output growth and assigning values from 1 to 10 to each decile, then averaging the three resulting indicators. Index also ranges from 1 to 10. Higher numbers signal better policies.

Variable Name: **Black Market Premium**
Source: Tavares-Wacziarg data set, initially World Currency Yearbook and IMF.
Unit: (Black market rate-official rate)/official rate. %
Description: Black market premium on the official exchange rate.

Variable Name: **Public Consumption**
Source: Summers-Heston v. 5.
Unit: %
Description: Share of government consumption of goods and services in GDP, excluding transfers and public investment.

Variable Name: **Population over 65**
Source: Barro-Lee
Unit: %
Description: Share of population aged over 65 in the total population

Variable Name: **Population over 15**
Source: Barro-Lee
Unit: %
Description: Share of population aged over 15 in the total population

Variable Name: **Terms of Trade Shocks**
Source: Tavares-Wacziarg, initially from the World Bank.
Unit: %. A positive value means terms of trade move favorably, a negative value the opposite.
Description: Growth rate of manufactured export prices minus growth rate of manufactured import price

Variable Name: **Population**
Source: Barro-Lee
Unit: Logarithm of population.
Description: Country population

Variable Name: **Population Density**
Source: Barro-Lee
Unit: 1000 population per million square km
Description: Population density

Variable Name: **Ethnolinguistic fractionalization**
Source: Mauro (1994)
Unit: Probability.
Description: Probability that two randomly selected persons from a given country will not belong to the same ethnolinguistic group.

Variable Name: **Postwar Independence**
Source: Barro-Lee
Unit: Dummy variable
Description: Takes on a value of 1 if the country gained independence after the Second World War.

Appendix III. Issues in Measurement

A-III-1. The Trade Policy Index.

Section 2.2.1 discusses the conceptual basis of the trade policy index used throughout the paper. This part of the appendix describes the actual computation of the index in more detail. Table A-III-I displays the results of the regression used to construct the weights on the three components of trade policy, namely import duties as a share of total imports, the per-Uruguay round NTB coverage ratio and the Sachs-Warner liberalization status indicator (averaged over the relevant five-year time periods). The regression also features gravity components such as land area and the log of population, as well as the growth rate (Appendix IV provides evidence of reverse causation from growth to trade shares).

Table A-III-I. Trade Volumes Regression

Dependent Variable: Imports + Exports / GDP	**3SLS***
Constant	182.561 (9.70)
Growth of per capita income	0.322 (1.12)
Land Area	-8.029 (-3.69)
Log of Population	-9.121 (-3.42)
Import duties over total imports	-34.733 (-1.16)
Pre-Uruguay Round NTB coverage	-0.217 (-0.73)
Sachs/Warner liberalization status	11.2622 (2.12)
Adj. R-squared	.60 .55 .53 .49
# of obs. (# of periods)	71 (4)

(t-statistics in parentheses)

* The instruments used were: Initial income, population density, religious dummies, oil producer dummy, postwar independence dummy, log of population, share of population over 65, log of area.

As expected, the share of import duties in total imports and the NTB coverage ratio receive a negative weight in the index, while the liberalization status receives a positive weight. The lack of precision of the estimates, largely due to collinearity between the policy measures, is not really a source of concern since the objective is only to generate weights that provide a rough notion of how the three components effectively impact trade volumes. Minor variations in these weights are not likely to affect the final results.[26]

[26] In fact, the results for the channels model are not very sensitive to the inclusion of NTBs in the index.

For each period, the trade policy openness index was computed as:

Trade Policy = -34.73*(Import Duty Share) - 0.217*(NTB) + 11.262*(Liber. Status)

Table A-III-II contains correlations between the resulting trade policy index and its various components for the time periods under consideration. This shows that the liberalization status and the duty ratio receive the greatest weight in the index, although the correlation of NTBs with the overall index is substantial.

Table A-III-II. Correlations between the Components of the Index and the Index Itself

	Index 1970-74	Index 1975-79	Index 1980-84	Index 1985-90
Duty 70-74	-0.72	-0.70	-0.67	-0.64
Duty 75-79	-0.72	-0.75	-0.72	-0.69
Duty 80-84	-0.66	-0.68	-0.73	-0.71
Duty 85-90	-0.63	-0.64	-0.70	-0.77
NTB	-0.47	-0.48	-0.45	-0.50
Liberalization 70-74	0.88	0.87	0.85	0.75
Liberalization 75-79	0.87	0.87	0.85	0.73
Liberalization 80-84	0.83	0.83	0.86	0.73
Liberalization 85-90	0.79	0.79	0.79	0.84

(Number of observations: 71)

The correlations between the underlying components of the trade policy indicator are displayed in Table A-III-III. The signs of the correlations are as expected. The NTB measure is weakly correlated with the other indicators, suggesting that its inclusion may provide useful information about trade policy. However, the NTB coverage ratio receives the smallest weight in the overall index.

Table A-III-III. Correlations between the Underlying Components of the Index

	Duty 1970-74	Duty 1975-79	Duty 1980-84	Duty 1985-90	NTB	Liber. 1970-74	Liber. 1975-79	Liber. 1980-84
Duty 70-74	1.00							
Duty 75-79	0.94	1.00						
Duty 80-84	0.84	0.89	1.00					
Duty 85-90	0.74	0.78	0.92	1.00				
NTB	0.07	0.14	0.11	0.17	1.00			
Liber. 70-74	-0.52	-0.52	-0.50	-0.46	-0.13	1.00		
Liber. 75-79	-0.53	-0.53	-0.50	-0.46	-0.10	1.00	1.00	
Liber. 80-84	-0.51	-0.51	-0.48	-0.44	-0.07	0.95	0.97	1.00
Liber. 85-90	-0.49	-0.52	-0.46	-0.47	-0.15	0.87	0.86	0.87

(Number of observations: 71)

A-III-2. The Macroeconomic Policy Quality Index.

The index of macroeconomic policy quality used in this paper is based on three underlying components: The ratio of government deficit to GDP, the ratio of government debt to GDP and a measure of excessive monetary creation, equal to the difference between the growth rate of M2 and the growth rate of real GDP (this is based on the fact that a growing economy needs to be supplied with liquidity; any excessive money growth sustained for a long time is likely to result in nothing more than inflation). Each country is first ranked according to each component. Each decile is then given a number from 1 to 10, with higher numbers signaling better policies (low excess money growth, low deficit ratio, low debt ratio), and these rankings are simply summed up. The use of quantiles avoids having to decide what a good policy is in absolute terms, and defines the quality of macroeconomic policy relative to the policies adopted in the rest of the world. It also avoids having an index that increases systematically through time due to the accumulation of the public debt. Lastly, it increases the spread of the index compared to an index based on scaled values of the underlying data, which provides more within- and cross-country variation.

Summary statistics for the macroeconomic policy index are contained in Tables A-III-IV and A-III-V. The correlations suggest that the excessive growth of money plays the least part in the variation of the index of macroeconomic policy.

Table A-III-IV. Summary Statistics for the Macroeconomic Policy Index and its Components

Variable	Mean	Std. Dev.	Minimum	Maximum
Macro Index 70-74	5.26	1.84	1.33	9.33
Macro Index 75-79	5.13	1.84	1.33	8.67
Macro Index 80-84	5.20	1.99	1.00	9.33
Macro Index 85-89	5.47	1.86	1.00	9.00
Deficit ratio 70-74	-2.61	3.20	-19.44	3.60
Deficit ratio 75-79	-4.72	4.49	-16.53	5.29
Deficit ratio 80-84	-6.34	6.18	-43.62	2.43
Deficit ratio 85-89	-5.30	6.19	-47.02	3.64
Public Debt Ratio 70-74	25.15	18.74	0.00	118.67
Public Debt Ratio 75-79	33.51	26.33	0.00	174.86
Public Debt Ratio 80-84	52.29	50.74	0.00	332.28
Public Debt Ratio 85-89	74.08	67.87	0.00	436.85
Excess Money Growth 70-74	13.99	15.59	-0.33	143.14
Excess Money Growth 75-79	17.06	20.08	3.15	158.29
Excess Money Growth 80-84	22.37	36.75	3.49	233.15
Excess Money Growth 85-90	34.97	106.83	-7.01	853.53

Number of Observations: 88

Table A-III-V. Correlations of the Macroeconomic Policy Index with its Components

	Macro Index 1970-74	Macro Index 1975-79	Macro Index 1980-84	Macro Index 1985-89
Deficit ratio 70-74	0.75	0.65	0.50	0.49
Deficit ratio 75-79	0.53	0.76	0.56	0.49
Deficit ratio 80-84	0.46	0.52	0.73	0.63
Deficit ratio 85-89	0.37	0.39	0.49	0.64
Public Debt Ratio 70-74	-0.65	-0.62	-0.46	-0.42
Public Debt Ratio 75-79	-0.64	-0.72	-0.63	-0.52
Public Debt Ratio 80-84	-0.48	-0.55	-0.67	-0.54
Public Debt Ratio 85-89	-0.41	-0.47	-0.65	-0.66
Excess Money Growth 70-74	-0.33	-0.07	0.04	-0.06
Excess Money Growth 75-79	-0.30	-0.26	-0.12	-0.23
Excess Money Growth 80-84	-0.35	-0.34	-0.40	-0.40
Excess Money Growth 85-90	-0.19	-0.22	-0.24	-0.38

Number of Observations: 88

A-III-3. An Alternative Measure of Price Distortions.

Dollar (1992) proposed a measure of outward orientation (or more generally, of distortions) based on an internationally comparable consumer price index compiled by Summers and Heston (1994). This index is constructed by pricing the same basket of goods across countries, taking the US price basket as a numeraire. In the absence of nontradable goods, trade-induced price distortions and domestic price distortions brought forth by taxes, subsidies, and imperfectly competitive pricing (the extent of which can be expected to vary systematically from country to country), full purchasing power parity ought to hold, and the value of the index should be equal across countries. Hence, if one could somehow eliminate price level differences due to the existence of non-tradable goods, one could obtain an index of price distortions.

Systematic price level differences due to the existence of non-tradable are related to differences in factor endowments. Hence, the residual from a regression of the price level on country factor endowments should yield a measure of distortions. However, it is not clear that distortions themselves are unrelated to endowments, so that the residual may be leaving out important variation in price distortions. Furthermore, measures of factor endowments are missing for many countries, especially as far as the capital stock is concerned.

Estimates of price distortions obtained using this methodology did not give very convincing results.[27] OECD countries displayed abnormally high distortions levels, similar to those of Africa. Both Latin America and South East Asia displayed relatively low distortions. This does not accord with our priors concerning the efficiency of price systems across countries. Further research into a measure of distortions based on overall price levels seems warranted.

[27] Results are available from the author upon request.

Appendix IV. Trade Policy Matters for Growth

This appendix investigates which component of the trade shares, policy or gravity, affects growth mostly. The objective is also to examine the issue of reverse causality between trade shares and growth. Unlike in the text, the channel relationships are absent from this Appendix. The system, made up of two sets of equations (the four growth equations for periods 1970-74, 1975-79, 1980-84 and 1985-1989, and the four openness equations for the same periods), is estimated jointly using three-stage least squares.[28] The estimator used is the same as the one discussed in the text. Note that the measure of openness now consists of the ratio of imports plus exports over GDP, which appears directly in the growth equation.

A-IV-1. Reverse Causation

We first consider the effects of a higher trade to GDP ratio on the growth rate, as well as the possibility of reverse causation whereby growth might affect the degree of openness rather than the opposite. The regressors that appear in the growth equation are: the log of initial GDP, the level of human capital (measured by the average number of years of schooling in the total population over age 25), the black market premium on the exchange rate, the investment share in GDP, the measure of trade openness (imports plus exports over GDP) and the share of government consumption in GDP. The regressors included in the openness equation are: the growth rate of GDP (to assess the magnitude of endogeneity), the log of the country's area, a measure of terms of trade shocks, the log of population, and the Sachs and Warner dummy for liberalization status (averaged over 5-year time periods), and a measure of the country's distance from the capitals of the world's 20 major exporters. The results for this procedure are reported in Table A-IV-I.

The coefficient on the trade to GDP ratio is positive and significant at the 90% confidence level. The magnitude of the coefficient suggests that a 10 percentage point increase in the trade to GDP ratio leads to a 0.17 percentage point increase in the annual growth rate of the economy. Although this is admittedly a small effect, it might be important intertemporally (if the US had grown just 1 percentage point slower per annum since 1870, its per capita income would be that of today's Hungary or Mexico, see Barro and Sala-i-Martin (1995), p.1).

We reestimated this growth relationship without controlling for the endogeneity of the openness variable. Specifically, the growth regression above was reestimated in isolation of the openness equation, and the openness variable was added to the list of instruments (this is equivalent to not instrumenting for openness). The coefficient on the trade ratio decreased to 0.004 and became insignificant at any reasonable confidence level (t=.52).

[28] The instruments used are: the log of initial income for all periods, population density for all periods, a dummy for major religions (Muslim, Confucian/Buddhist, Catholic, Other Christians), a dummy for oil exporting countries, the number of years the country was involved in an external war during the period 1960-1985, a dummy for whether the country obtained independence after the Second World War, the log of population for all periods, the share of population over 65 for all periods, the log of the country's land area, the log of the distance measure, and the measure of terms of trade shocks for all periods. The panel data used throughout this Appendix contain 61 countries for 4 time periods (averages over 1970-74, 1975-79, 1980-84, 1985-89).

This broadly confirms previous results by Frankel (1996), showing that the effect of trade openness on growth increases when controlling for endogeneity.

Table A-IV-I: Openness and Growth

Dep.= Growth (%)	**3SLS**
Constant	14.041
	(4.88)
Log of Initial	-1.865
Income	(-4.89)
Trade to GDP	0.017
ratio (% GDP)	(1.91)
Years of schooling	2.03
(male)	(3.33)
Years of schooling	-1.82
(female)	(-2.79)
Black Market	-0.839
Premium	(-5.08)
Investment	0.155
share (% GDP)	(4.53)
Government	-0.119
consumption (% GDP)	(-2.77)
R-Squared	.31 .22 .22 .28

Dep.= Trade ratio (%)	**3SLS**
Constant	150.545
	(10.50)
Growth rate (%)	1.092
	(5.60)
Log of land area	-3.628
	(-2.40)
Terms of trade	20.972
shocks	(3.55)
Log of population	-7.464
	(-4.37)
Sachs-Warner	7.54
dummy (averaged)	(1.82)
Log of distance	-8.282
	(-2.05)
R-squared	.51 .57 .56 .55

(t-statistics in parentheses)

The trade openness equation also displays common patterns: country size, as measured by land area or population, has a significantly negative effect on trade openness. The distance from the world's main trading nations also has a negative impact on the trade ratio. Positive terms of trade shocks potentially lead to both more exports and more imports, hence a positive impact on the trade ratio. The Sachs and Warner measure of an open trade policy also has the expected sign, and is large in magnitude (economies with open trade policies have trade to GDP ratios 7.54 percentage points higher than those with policies that discourage trade, all other things equal). Lastly, the contemporaneous growth rate has a positive and significant effect on the trade to GDP ratio. The magnitude of this coefficient is rather small: a 1 percentage point increase in the growth rate leads to a 1.1 percentage point increase in the trade to GDP ratio. But we do find statistically significant evidence of reverse causation: growth positively affects the trade to GDP ratio, even if the effect may be considered small (especially compared to the effects of, for instance, country size or the trade policy regime).

A-IV-2. Separating the impact of gravity effects from policy effects.

We now attempt to separate the effects of gravity-type variables on growth (country land area and population, terms of trade shocks) from policy effects. In order to do this, we first run a regression of trade openness, measured by the ratio of imports and exports to GDP, on land area, distance, growth, terms of trade shocks and the log of population. The fitted value from this regression is a country's "potential degree of openness". The deviation of this fitted value from the observed measure of openness is interpreted as

the effect of policy on openness.[29] The smaller the deviation, the more distortionary the policy (negative deviations signal a policy that reduces the effective trade to GDP ratio through protection, while positive deviations signal policies that favor international trade integration). Results from this regression are as follows:

Table A-IV-II. Gravity Equation

Dep= Trade ratio (%)	3SLS
Constant	157.131
	(10.72)
Growth rate (%)	0.943
	(4.68)
Log of land area	-3.719
	(-2.39)
Terms of trade shocks	23.503
	(3.76)
Log of population	-7.048
	(-4.12)
Log of distance	-12.031
	(-3.26)
R-squared	.51 .56 .52 .55

(t-statistics in parentheses)

Following are summary statistics for the "potential openness component" and for the "policy attitude component":

Table A-IV-III. Summary Statistics (Openness Decomposition)

	Mean	Std dev.	Minimum	Maximum
Gravity component 1970-74	53.23	15.87	7.81	81.34
Gravity component 1975-79	53.42	16.35	9.25	81.45
Gravity component 1980-84	51.28	16.34	8.93	77.98
Gravity component 1985-89	48.44	16.30	11.15	77.45
Policy component 1970-74	-4.66	15.76	-44.51	33.53
Policy component 1975-79	1.44	16.82	-33.23	36.53
Policy component 1980-84	5.11	20.28	-35.07	65.03
Policy component 1985-89	5.93	17.89	-31.32	65.63

These two measures are then included in the growth regression instead of the observed trade to GDP ratio. The results from this growth regression appear in table A-IV-IV.[30] The estimates suggest that it is the "trade policy" component of openness that matters

[29] This is a much less reliable measure of trade policy openness than the one used in the text. Indeed, the residual from the gravity equation may contain more than policy effects. Other potential defects of this deviation approach are discussed in section 2.2.1 of the text. However, by purging out the gravity component, we can gain some insight into the relative role of gravity and other components.

[30] The growth model was, once again, estimated jointly with a trade openness equation in which the observed trade ratio was the dependent variable. The results for that equation are essentially the same as those presented in the first part of this note.

most for growth. The gravity component alone is not statistically different from zero. Once geographical and environmental factors have been "purged" out of the openness measure, the effect of openness on growth increases by 60% and becomes significant at the 5% level.

Table A-IV-IV. Growth Regression with Decomposed Trade Effects

Dep = Growth rate (%)	3SLS
Constant	13.503
	(4.56)
Log of Initial income	-1.690
	(-4.13)
"Trade policy component"	0.027
	(2.08)
"Gravity component"	0.0036
	(0.28)
Years of schooling (male)	1.884
	(3.01)
Years of schooling (female)	-1.806
	(-2.72)
Black Market Premium	-0.834
	(-5.01)
Investment share	0.155
	(4.48)
Government consumption	-0.118
	(-2.69)
R-squared	.33 .22 .22 .28

(t-statistics in parentheses)

A-IV-3. Conclusion

1. There is some evidence of reverse causation, although the magnitude of the effect of growth on openness is rather small. A 1 percentage point increase in a country's growth rate leads to a 1.1 percentage point increase in its trade to GDP ratio, other things equal. Once endogeneity is controlled for, the estimated effect of trade openness on growth increases and becomes statistically significant.

2. Once trade ratios have been "purged" of their gravity component, their effect on growth becomes larger and even more significant. This can be considered evidence that what matters most for growth is not the trade to GDP ratio per se, but the prevailing trade policy. This provides justification the focus on trade policy openness throughout this paper.

Appendix V. Increasing Returns, the Size of the Market and Growth: A Replication Exercise

This appendix replicates and checks the robustness of the findings in a paper by Ades and Glaeser (1994, henceforth AG), in which the authors document the fact that, in two sets of economies (US States in the 19th century and developing countries since 1960), increasing returns operate by expanding the extent of the market. Their evidence shows that, in samples that display absolute divergence (which is possible only under increasing returns technologies), countries with larger internal markets benefit less from openness in terms of growth. Put differently, more open countries tend to display a smaller correlation of growth with initial income than closed countries, with openness measured as the ratio of exports plus imports to GDP. This is the case because openness eliminates the constraint imposed on growth by the size of the internal market. Under increasing returns-size of the market theories, what matters for growth is how much effective demand can be directed towards the productive sector. Greater effective demand originates either from a larger internal market of from foreign markets, but only open countries can benefit from the latter.

A-V-I. Divergence and the Extent of the Market.

The basic test of divergence involves regressing the growth rate (averaged between 1960 and 1985) on initial income in 1960 measured in PPP adjusted dollars. To evaluate the role of openness and market size, two other regressors are added: openness (trade to GDP ratio, averaged over 1960-1985) and an interaction term between openness and the initial level of GDP.[31] To examine robustness, other variables such as regional dummies and an education variable are added. Table A-V-II below replicates table 3 in AG (appendix). The only difference compared to their set up is that the openness variable here is taken from the latest version of the Summers-Heston data set, whereas AG used World Bank data. Income and growth are from version 4.0 of Summers-Heston, as in AG. Results based on the latest version of the Penn World tables (version 5.6) display no significant differences compared to the ones presented in table A-V-II.

In addition to the developing countries sample chosen by AG, in which they selected countries with per capita income lower than $1,500 (in 1980 constant dollars), we run the same regressions for an extended sample, which includes the OECD as well as a broader range of developing economies. AG only sought to examine how increasing returns operated, so they selected a sample of countries in which they knew unconditional divergence did hold. However, in order to analyze the effect of market size on growth in a broader framework, and to check the robustness of the AG results, we extended the sample. An increased market size should not be a channel whereby openness spurs growth in a sample where increasing returns does not operate.

[31] Note that there is no control for the endogeneity of the openness measure. When replication the estimations using an instrumental variables estimator, neither the sign nor the magnitude of the coefficients were affected. The precision of the estimates, however, decreased significantly. This is a natural consequence of using IV. See appendix IV for a more thorough investigation of this aspect of the growth-openness relationship.

Table A-V-I. Summary Statistics for the Main Variables

	Mean	Std. Dev.	Mean	Std. Dev.
Summers Heston v.4.0				
Initial GDP 1960 (thsds of US$)	0.739	0.366	1.79	1.753
Growth 1960-1980 (annual)	0.0187	0.018	0.020	0.019
Number of countries	64*	64*	113	113
Summers Heston v.5.6				
Openness 1960-85 (share)	0.563	0.282	0.615	0.391
Initial GDP 1960 (thsds of US$)	0.747	0.364	1.800	1.755
Growth 1960-1980 (annual)	0.0187	0.018	0.020	0.018
Number of countries	63*	63*	112	112

(* All part of the AG 65 country sample)

Table A-V-II. OLS Estimates of the AG regressions

	AG dev.	countries	sample	Full	sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.00704	-0.014	-0.0096	0.022	0.0015	0.0021
	(1.39)	(-1.29)	(-1.02)	(10.63)	(0.34)	(0.43)
Initial income	0.015	0.033	0.016	-0.001	0.0038	-0.0021
	(2.47)	(2.63)	(1.40)	(-2.63)	(2.03)	(-1.37)
Openness	-	0.041	0.045	-	0.028	0.0201
		(2.28)	(2.80)		(4.13)	(3.83)
Openness*initial	-	-0.035	-0.038	-	-0.0044	-0.0034
income		(-1.813)	(-2.42)		(-1.64)	(-1.69)
Primary school	-	-	0.031	-	-	0.033
enrollment			(4.12)			(5.57)
Latin America	-	-	-0.016	-	-	-0.019
			(-3.06)			(-5.50)
Sub-Saharan	-	-	-0.015	-	-	-0.017
Africa			(-2.63)			(-4.59)
R-Squared	.088	.165	.505	.049	.186	.57
Obs.	65	64	63	115	113	111

(t-statistics in parentheses)

Data is from Penn World Tables v.4.0, except openness measure, from Penn World Tables v.5.6

The results of the replication exercise are satisfactory. Both in terms of orders of magnitude and in terms of the signs of the coefficients, regressions (1)-(3) closely track those reported in AG. In regression (1), initial income bears a positive and significant coefficient, suggesting absolute divergence in our sample. In regression (2), the inclusion of openness and the interaction term also confirms the results in AG: in more open countries, the size of the internal market, proxied by per capita income, has a lower effect on subsequent growth.[32] Put differently, the effect of openness on growth is lower for countries with a larger internal market. This strongly suggests that one channel through which openness

[32]The relevance of this approximation is debatable. After all, total GDP is arguably a better proxy for

may matter for growth is the market size channel. The results do not seem sensitive to the inclusion of regional dummies and the primary school enrollment rate. In all regressions, openness in isolation of the interaction term has a strong positive impact on growth (a 10 percentage point increase in the trade to GDP ratio rises the growth rate by 0.4 percentage points per year, which is in line with the results in note #3).

Much of this breaks down when we consider a larger sample of countries. The unconditional regression (4) displays evidence of very weak absolute convergence (the coefficient is very small: a 1000 dollar difference in per capita initial income (1980 base) entails a 0.1 percentage point difference in growth rates across countries).[33] Although openness retains its strong positive influence on growth, the interaction term is now insignificant and ten times smaller than for the restricted sample. In a sample that includes countries that do not seem to display increasing returns, there are no substantial gains to having a larger market in terms of growth. This, admittedly, may not be considered very useful: we know that, in theory, size cannot matter unless there are increasing returns. However, this result suggests that, although the extent of the market channel may operate for certain countries (mainly the poorest ones), it is certainly not the only channel whereby openness spurs growth. Indeed, with this extended sample, openness still has a positive impact on growth despite that fact that the increasing returns/size of the market story breaks down.

A-V-II. Growth Decomposition

We continue the replication of the AG results by considering a decomposition of growth rates according to a factorial analysis akin to growth accounting. Specifically, we start with a simple production function in which output per capita is a function of technology, of per capita physical capital stock and of per capita human capital:

$$Y_{it} = F(A, K_{it}, H_{it}) = Ae^{\theta_i t} K_{it}^{\beta} H_{it}^{\alpha} \tag{1}$$

or:

$$\log Y_{it} = \log A + \beta \log K_{it} + \alpha \log H_{it} + \theta_i t \tag{2}$$

where A grows at a constant rate θ_i and the coefficients α and β are assumed to be time and country invariant.

Taking first differences of (2) yields:

$$\log \frac{Y_{it}}{Y_{it-1}} = \beta \log \frac{K_{it}}{K_{it-1}} + \alpha \log \frac{H_{it}}{H_{it-1}} + \theta_i \tag{3}$$

This is just a growth regression in which the right hand side variables represent the change in factor inputs for a given country over time, and the residual qi captures the contribution

the size of the market than per capita GDP. Countries with a relatively high per capita GDP may still display a small internal market if they are sparsely populated. In this case, the size of their internal market, if they are closed to trade, is imposing a constraint on their growth rates, as indivisibilities prevent certain investments from being profitable unless the market for the corresponding products becomes larger. See Alesina, Spolaore and Wacziarg (1997) for a discussion of this issue.

[33] The fact that increasing returns seem to hold for poorest countries (as in the AG sample) but no longer when richer economies are brought into the picture may suggest interesting paths for future research: Why is it that initial income has a positive impact on growth for poorer countries but not for richer ones ? The study of the endogenous change in market structure is largely absent from economics.

of technological progress to growth (akin to Total Factor Productivity). For each country, we can use (3) to determine the respective contributions of physical capital accumulation, human capital accumulation, and technological change, to the overall observed growth rate.

To estimate the parameters of (3), we can either estimate (2) using a country-specific fixed effects estimator, and then proceed with the appropriate algebraic manipulation to obtain (3), or we can directly estimate equation (3) for two dates (1960 and 1985), as in table A-V-III below.[34] The two solutions should yield algebraically the same estimates.

Table A-V-III. Estimates of the Parameters in Equation (3)[35]

	OLS
α (human capital)	-0.045 (-1.00)
β (physical capital)	0.614 (10.27)
Number of Obs.	43
R-squared	.55

(t-statistics in parentheses)

We then construct a measure of the extent of the market based on a weighted average of initial GDP, openness and the interaction between the two. As in AG, the weights are obtained by running the basic growth regression (Table A-V-II) and using the respective estimates as the weights in the construction of the extent variable. The growth in per capita human capital, the growth in per capita capital stock and the estimated residual from equation (3) are then regressed on a constant and the extent of the market variable to determine the magnitude of each channel (Table A-V-IV).

Table A-V-IV - Extent of the Market and the Sources of Growth

Dep. var.:	**Growth of per cap. capital (1960-85)**	**Growth of human capital (1960-85)**	**Residual from equation (3)**
Constant	0.177 (0.45)	0.521 (0.91)	0.132 (0.28)
Extent of the Market	1.208 (1.67)	0.970 (0.86)	1.783 (2.06)
Number of Obs.	42	42	42
R-squared	.06	0.018	.10

(t-statistics in parentheses)

The total effect of the extent of the market on growth, through each of the channels, is given in Table A-V-V:

[34] AG prefer a third method. They stack the initial income data for 1960 and 1985, and run a regression of this stacked initial income vector on time specific dummies (one for 1960 and one for 1985), the log of human capital in 1960 and the log of capital stock per capita in 1960. It is not clear what connection there is between this specification and the relationship derived from theory as above. Additionally, I have not been able to reproduce their results using their specification.

[35] Data for the capital stock are from Dhareshwar and Nehru (1994), population data and the human capital measure (percentage of the population having completed secondary schooling) are from Barro-Lee.

Table A-V-V- Channel Effects of the Extent of the Market

Channel	Estimated effect
Via Human Capital	-0.044
Via Physical Capital	0.742
Via the unexplained residual (productivity gains)	1.783
Total Effect	2.481

The results broadly confirm the AG findings (their table 8b):[36] The most important channel appears to be the unexplained increase in productivity, which accounts for two thirds of the effect of the extent of the market on growth. Physical capital accumulation accounts for the remaining third, while the growth in human capital accounts for virtually nothing (mainly because it does not affect the growth performance in this sample). The effect of a larger market on growth is thus twofold: Firstly, the level of investment in physical capital is raised by a larger market. This is in line with theories that stress the importance of demand spillovers and backward linkages (Rosenstein-Rodan, Murphy-Shleifer-Vishny). Secondly, market size works by increasing the speed of technological progress, embodied in the residual from regression (3). Several hypotheses can be formulated to explain this. By allowing a greater degree of division of labor, a larger market size may allow a shift towards the production of goods that embody more technology (this goes hand in hand with an expansion of the variety of goods). Secondly, the technology effect may simply be capturing the fact that more open economies tend to be more exposed to foreign technology. An accelerated transmission of technology may well be an important channel whereby openness spurs growth. These results tend to lend support to this type of explanation.

A-V-III. Conclusion.

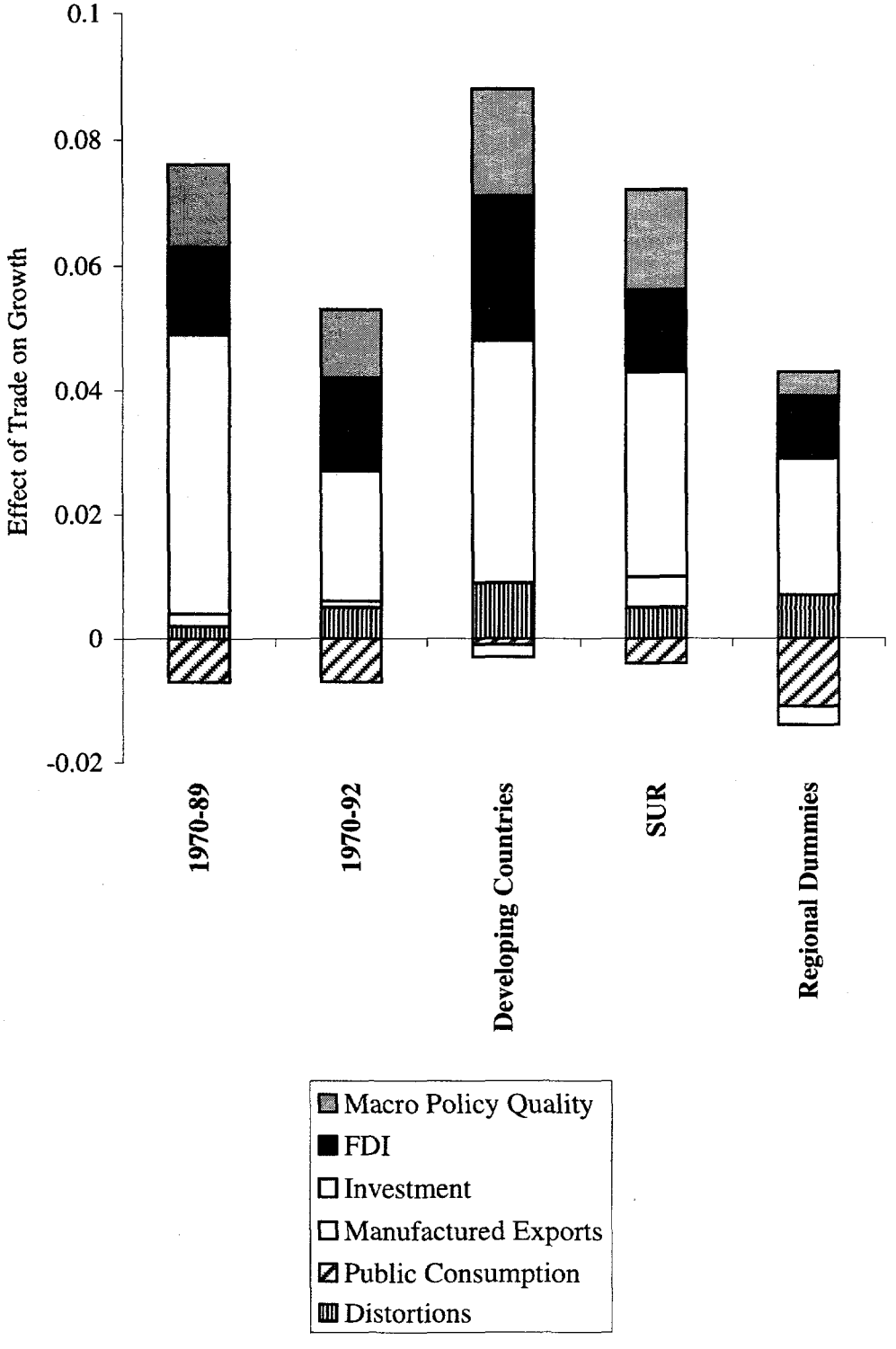
This appendix has explored the relationship between the extent of the market and growth, using the methodology in Ades and Glaeser (1994). In a sample of the poorest developing countries, which exhibits increasing returns to scale (unconditional divergence), openness and initial income have a positive impact on growth. The interaction between the two has a negative effect on accumulation. The effect of these 'extent of the market' variables works mainly through growth enhancing technological improvements and the accumulation of physical capital. Possible interpretations of these results are the following:

(1). The size of the internal market is an important constraint on growth. By integrating in the world economy, many poor and small countries are likely to be better able to exploit dynamic increasing returns and grow faster. However, this channel is by far not the only channel whereby openness improves growth.

(2). Access to larger markets works in two ways: it makes previously unprofitable investments worth undertaking, thus solving a coordination problem within the economy. Furthermore, it allows technological improvements to take place, either through direct technological transmissions, or through a shift in the product mix towards goods that embody more sophisticated technology.

[36] The magnitudes of the estimates are not directly comparable due to differences in units between the data in AG and the data used herein. However, the estimated contributions of the factors can be compared.

Figure I - Graphical View of the Channel Effects



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