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Measuring the Dynamic Gains from Trade

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This article investigates the links between trade policy and economic growth in a panel of 57 countries between 1970 and 1989. It develops a new measure of trade policy openness based on the policy component of trade shares, using it in a simultaneous equations system to identify the effect of trade policy on several determinants of growth. The results suggest a positive impact of openness on economic growth, with the accelerated accumulation of physical capital accounting for more than half the total effect; enhanced technology transmission and improvements in macroeconomic policy account for smaller effects. This decomposition is robust with respect to alternative specifications and time periods. The article also successfully tests whether the model exhaustively captures the effects of trade policy on growth.

The relationship between trade openness and economic growth has been the subject of numerous empirical studies. Most uncover a positive empirical association between trade openness and per capita income growth; until recently, few economists challenged the findings.[1] Although theories promoting inward-oriented development strategies flourished in the 1950s and 1960s, the policies' unsustainable effects had, by and large, discredited the idea that the costs of an open trade regime may outweigh its potential benefits.

Recently, however, Rodrik and Rodríguez (2000) have questioned the empirical results on trade and growth, pointing to methodological problems associated with the measurement of openness and the specification of estimated equations.[2] In particular, the collinearity between trade protection and other measures of (possibly domestic) policy, such as the quality of macroeconomic policy, might lead researchers to conclude wrongly that trade protection depresses growth, when another omitted or poorly measured variable is in fact accounted

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1. See, for instance, Edwards (1992), Dollar (1992), Ben-David (1993), Sachs and Warner (1995), Frankel and Romer (1999), Alesina and others (2000), among many others.

2. Other recent studies casting doubt on a positive growth-openness link using macrodata include Rodrik (1998a) and Harrison and Hanson (1999). In a related literature, a study by Vamvakidis (1998) uncovers negative effects of regional arrangements, such as free trade areas, on growth in time-series data.

for by trade openness.[3] This challenge suggests two directions for research: improving existing measures of trade policy openness and being more explicit about how trade openness might affect growth by specifying more clearly the channels relating these variables. This allows for the possibility that negative channels may partially or fully outweigh positive ones. This article seeks to advance the literature on both fronts.

Theory points to a number of possible costs and benefits of trade openness, not mutually exclusive in general. Some theories stress technological spillovers and the international transmission of knowledge as a source of growth for open economies.[4] More traditional, static theories invoke 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 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.[5] More generally, by increasing the size of the market, trade openness allows economies to better capture the potential benefits of increasing returns to scale.[6] 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. On the cost side, some theories suggest that when comparative advantage patterns would lead a country to specialize in goods where technological innovations or learning by doing are largely exhausted, opening up to trade might actually reduce long-run growth (Young 1991). Another potentially negative channel was suggested in Rodrik's (1998b) findings on openness and government size: more open countries may face incentives to increase the size of government to insure agents in the face of foreign shocks. In turn, a larger government may distort resource allocation, to the detriment of economic growth.[7]

There has been little empirical work to determine the relative roles of these different factors in explaining the observed overall impact of trade policy openness on growth. The finding that trade openness spurs growth tends to be interpreted according to the observer's preferred theory, but two important possibilities are ignored: several forces may be operating simultaneously, and trade openness may also involve some dynamic costs, even if the benefits outweigh them. This be-

3. For example, Rodrik and Rodríguez (2000) criticize the Sachs and Warner (1995) contribution because much of the variance in their trade liberalization dummy is accounted for by the black market premium on the exchange rate, itself at least as much a measure of poor domestic policies as of a closed trade regime.

4. See, for instance, Grossman and Helpman (1991) and Barro and Sala-i-Martin (1997). This relies on the notion that more open economies are better able to import advanced technologies.

5. See, for instance, Wacziarg (1997).

6. See Ades and Glaeser (1999) and Alesina and others (2000).

7. Barro and Sala-i-Martin (1995) provide empirical evidence on this point.

comes especially important with increasing integration: by determining the source of the costs and benefits of trade liberalization, policymakers can hope to maximize the benefits and to minimize the costs.

This article employs a fully specified empirical model to evaluate the channels through which trade policy might affect growth. To this end, it presents two innovations. The first is a new measure of trade openness based on a weighted average of several indicators (tariff revenues, nontariff barriers, and an indicator of overall outward orientation). This new measure of trade policy openness corresponds to the policy-induced component of an average country's trade to gross domestic product (GDP) ratio.

The second innovation is a set of equations describing the incidence of trade policy on several determinants of growth. Moving away from single-equation, reduced-form growth empirics, these equations capture different theoretical arguments on the potential costs and benefits of trade policy openness. Various channel variables are included in a growth regression. By multiplying the effects of trade policy on the channel and the effect of the channel on growth, the effect of trade policy on growth through that specific channel can be identified. The results suggest a positive effect of trade policy openness on economic growth, with accelerated accumulation of physical capital accounting for more than half the effect.

The article first analyzes the theoretical basis for the six channels and describes the empirical methodology for measuring the channel effects. It then discusses measurement issues, provides preliminary evidence on trade policy and growth, and describes the channel effects. The model's robustness and exhaustiveness are also examined.

I. Theory and Methodology

This section discusses the six channel variables and outlines the article's empirical methodology.

The Six Channels in Economic Theory

The six links between trade policy and economic growth incorporated in the empirical model are meant to capture the dominant theories concerning dynamic gains (or possibly losses) from trade. The underlying assumption is that together these six channels adequately capture most of the effect of trade policy on growth. These channels are broadly classified under government policy, domestic allocation and distribution, and technology transmission.

Government policy. Trade openness may create incentives for policymakers to pursue virtuous *macroeconomic policies*, either because of the threat of capital flight or because of international agreements, implicit or explicit, that act as a check on policy. Preserving a competitive environment for domestic firms engaged in foreign transactions may also require policies that maintain macroeco-

nomic stability. In turn, macroeconomic stability is likely to favorably affect growth by reducing price uncertainty and moderating public deficit and debt levels, thereby reducing crowding out and the likelihood of future tax increases and furthering the ability of domestic firms to compete on global markets (Fischer 1993).

Another way to capture the effects of trade openness on government activity is to consider the 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 1998b). On the other hand, open economies may tend toward laissez-faire arguments and more limited taxation 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, theory points to a positive growth-maximizing size of government resulting from a tradeoff between the productive function of public activities and the distortionary nature of taxation (Barro and Sala-i-Martin 1992). In addition, Barro (1991) and Barro and Sala-i-Martin (1995) document the negative impact of a larger government on growth in a cross-section of countries.

ALLOCATION AND DISTRIBUTION. Open economies are less likely to have tradable goods prices that differ substantially from world market prices because free trade should facilitate price convergence of traded goods across countries. Open countries will tend to specialize according to their comparative advantage, so once the effect of nontradable goods on deviations from purchasing power parity has been eliminated, countries with open trade policies would be expected to have lower overall price levels (relative to some benchmark country, such as the United States) than closed economies (Dollar 1992). Hence, theory points to a lower degree of *price distortion* in open economies, and price distortions have been shown to adversely affect factor accumulation and growth (Easterly 1989, 1993).

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).[8] The investment channel may capture several theories. First, investment may respond to openness through a size of the market effect. As first stressed by Adam Smith, market

8. However, some scholars question the direction of causality between investment and growth, based on Granger causality tests (see Blomstron and others 1996). But these tests are typically based on relatively high-frequency data, whereas this study examines long-term relationships between growth and its determinants. The Solow model predicts that the long-term relationship runs from investment rates to growth. This article also uses an instrumental variables estimator, which should limit the incidence of this type of endogeneity.

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 that Murphy and others (1989) argued was required for less developed countries to move from a low growth equilibrium to a path of sustained industrialization.[9] Using a related argument, Wacziarg (1997) shows that the extent of the market is an important determinant of product market competition. The entry of new firms in export markets after an episode of liberalization may well entail large fixed investments.

Second, trade liberalization may simply allow domestic agents to import capital goods that were previously unavailable (or produced locally but at higher costs), thus removing structural constraints on investment. Capital goods imports, which make up sizable proportions of the imports of many recently liberalized developing economies, also embody more recent technologies, a further source of growth. In a related argument, Baldwin and Seghezza (1996a, 2) state that "assuming that traded goods are an input into capital formation, protection raises the cost of new capital goods and thereby tends to lower the rate of return on investment. With intertemporal optimization, this lowers the steady-state capital stock and slows growth in the transition."

Technological transmissions. The last two channels are drawn 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 trade openness can affect growth and convergence through *technology transmissions* (Barro and Sala-i-Martin 1997; Grossman and Helpman 1991).

One way openness can increase the exposure of the domestic economy to technology transmission is by making it easier, through more frequent and sustained international trade interactions, for domestic producers to imitate foreign technologies and incorporate that knowledge in their own productive processes (Edwards 1992). This increased exposure can stem from direct imports of high-tech 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-tech goods, through the imitation of technology originating in industrial countries.

9. Ades and Glaeser (1999) provided preliminary empirical evidence showing that the extent of the market boosts growth largely through an increase in the rate of capital accumulation, thus lending support to big push theories. The working paper version of this study (Wacziarg 1998) contains further evidence on this point.

A second channel for greater technology transmission is *foreign direct investment* (FDI), whether associated with joint ventures or not. FDI often transmits advanced types of technology, either through capital goods imports that are later imitated or through the diffusion of knowledge and expertise. However, it is unclear a priori that trade openness is associated with greater levels of FDI. FDI may act as a substitute for trade, because foreign investment is used to set up plants producing goods that cannot be imported because of trade restrictions (tariff-hopping). Or investors may view trade openness as a signal that a country is committed to stable and market-oriented economic policies, whereas trade openness allows them to import the intermediate goods required to initiate projects, expect repatriation of some profits, and export the goods they produce. Falling transport costs may allow a slicing up the value-added chain, so that firms can produce a good in stages in several locations, adding a little more value at each stage (Krugman 1995). In that case FDI may complement rather than substitute for trade openness. Indeed, evidence suggests that open economies attract more FDI than closed economies (Harrison and Revenga 1995).

In turn, FDI is likely to spur growth. Because the share of FDI in GDP is typically small (averaging about 1 percent), it is hard to argue that FDI would spur growth through traditional physical capital formation. If there is any significant dynamic effect of FDI, it likely captures the incidence of a certain type of technology transmission, an interpretation applied here to the FDI channel.[10]

Empirical Methodology

The estimates presented in this article use a method first employed in a cross-country growth context by Tavares and Wacziarg (2001) to analyze the effects of democracy on growth.[11] The underlying econometric theory is an extension of the three-stage least squares method of Zellner and Theil (1962) to panel data.

THE STRUCTURAL MODEL. The basic framework for the cross-sectional analysis consists of a simultaneous equations model aimed at identifying the effects of trade policy on growth. The model consists of an equation for the growth of per capita income, one for determining the nature of trade policy, and six channel equations describing the effects of trade policy on several growth determining variables. This constitutes the structural model, derived from economic theory: the channel variables are included in the growth regression, but the measure of trade policy openness appears only in the channel relationships.

10. However, Aitken and Harrison (1999), using plant-level data for Venezuela, show that foreign ownership adversely affects the productivity of domestically owned plants. I will use macroeconomic data to evaluate whether this result holds at the aggregate level.

11. Baldwin and Seghezza (1996) also employ three-stage least squares to estimate a system for the joint determination of growth and investment rates, as a function, among other variables, of the trade regime. Taylor (1998) uses a structural approach to growth empirics to study the impact of outward orientation on growth in Latin America.

To better understand the foundations for the channel analysis, consider a neoclassical production function: $Y = AK^{\alpha}H^{\beta}L^{-1\alpha-\beta}$, where A denotes the level of technology, K physical capital, H human capital, and L labor.[12] Dividing by L and totally differentiating with respect to time yields the traditional Solow decomposition:

$$\frac{\dot{y}}{y} = \frac{\dot{A}}{A} + \alpha\frac{\dot{k}}{k} + \beta\frac{\dot{h}}{h}, \tag{1}$$

where lowercase letters designate per worker quantities. Hence, the ultimate drivers of per capita growth are technological growth and the (per capita) growth of human and physical capital. Presumably, the nature of trade policy can affect either of these factors. The channel methodology therefore consists of excluding the trade policy index from the growth equation directly and examining its effects on the ultimate drivers of growth instead.

Limiting the number of ultimate growth determinants, however, may oversimplify the model. To enrich the stuctural model and allow for the effects of trade policy openness on growth through such factors as government policies or technology transmission (the latter being only part of the $\dot{A}/A$ term), the list of growth determinants can be augmented. For example, adding a measure of government consumption and macroeconomic policy allows consideration of the corresponding channels. Hence, although the analysis here takes a step away from purely reduced-form growth empirics, it stops short of a fully structural model. Such a model would involve explicit consideration of the effects of, for example, government consumption on factor accumulation and technological progress, which are in turn the ultimate drivers of growth.[13] In contrast, in the model developed here, government consumption and factor accumulation appear jointly in the growth equation, so any effects of openness mediated by government consumption (including those going through investment) will be reflected in the government consumption channel.

An equation is formulated relating trade policy and other determinants to each channel variable under consideration, with the intention of fully exhausting the ways that openness could affect growth. (Formal evidence concerning this issue is provided in section III.) Finally, the equation describing the determinants of trade policy openness explicitly deals with the 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.

12. I am grateful to an anonymous referee for suggesting this interpretation.

13. In this case, the analysis would involve three rather than just two steps: a fully structural model would consider the effect of trade policy on government consumption, the effect of government consumption on technological and factor growth, and the effect of technological and factor growth on per capita income growth. However, such a system would be extremely cumbersome and would involve the estimation of a large number of parameters relative to the available data.

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 of the eight equations in the structural model is formulated for four time periods under scrutiny (1970–74, 1975–79, 1980–84, 1985–89). 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 allowed to differ from zero. This ensures the efficiency of the estimates. Taking cross-period error correlations into account is similar to assuming that the error terms contain country-specific effects uncorrelated with the right-hand-side variables. The flexibility of the error covariance matrix allows for substantial efficiency gains relative to estimating each equation separately (that is, assuming zero cross-equation error covariances).

Because several endogenous variables appear on the right-hand side of the structural equations, endogeneity bias is a concern. Consistency requires instrumenting for every endogenous variable that appears as a regressor. This is done by first rewriting every endogenous variable as a function of all the exogenous variables in the system in the model's reduced form. The fitted values of each endogenous variable from ordinary least squares estimation of the reduced form equations will provide suitable instruments for each corresponding endogenous variable in the structural form.[14] Because of concerns about the endogeneity of per capita income levels in the context of a random effects estimator with a lagged dependent variable, per capita income was excluded from the list of instruments (see Caselli and others 1996).

The second stage of the three-stage least squares procedure consists of estimating each equation in the structural model separately through 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. The third stage employs 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.

IDENTIFICATION AND RESTRICTIONS. Some assumptions about specifications are required for this methodology to carry through. For each equation, enough instruments must be validly excluded for the order condition to be met: at least

14. Given the above specification of the baseline model, the instruments are male and female human capital, the island dummy variable, 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 age 65, the share of population under age 15, ethnolinguistic fractionalization, and postwar independence status, each taken at every time period when applicable.

as many exogenous variables must be excluded as regressors because there are endogenous variables included on the right-hand side.

The chosen specification is based on empirical work on the determinants of the 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). The specification of the government size equation is based on Rodrik (1998b) and Alesina and Wacziarg (1998). For other channels, priors were used to determine the set of exclusions.[15] (Table C-1 in appendix C displays parameter estimates of each equation in the system for the baseline model, allowing readers to infer the specification of each of the equations in the system.)[16]

To assess the long-run effects of trade policy on growth in a unified manner, cross-period parameter equality restrictions are imposed: none of the estimates of the parameters in the structural model is allowed to vary across time. This allows efficiency gains through higher degrees of freedom, as the number of estimated parameters in the system is divided by four. Whether these cross-period parameter equality restrictions are justified is examined in section III.

II. Measurement Issues and Preliminary Evidence

This section considers issues involved in measuring trade openness and the channel variables, and presents simple correlations between the main variables of interest.

Existing Measures of Trade Openness

Measuring the extent of trade openness is a major challenge for any study involving the analysis of trade policy, as suggested in Rodrik and Rodríguez (2000) and Pritchett (1996a). There are three broad categories of existing measures of trade openness.

Outcome measures. Outcome measures describe the volume of trade or its components. This type of indicator is most subject to endogeneity problems with respect to growth (Frankel and Romer 1999), but because it measures actual exposure to trade interactions, it may account quite well for the effective level of integration. It may correlate only imperfectly, however, with attitudes or institutions relating to openness. Past research has tended to confuse outcome measures with policy attitudes (which are presumed to partly determine the outcome), largely because precise measures of actual trade policies were not widely available.

Because most theories about dynamic gains from trade have to do with policy measures, contrasting free trade to restricted trade or autarky, an index of trade

15. Tavares and Wacziarg (2001) discuss in more detail the specification search for the type of system that is considered here. A previous report on this study (Wacziarg 1998) describes the specification of each equation in the system.

16. Because each equation is estimated for four time periods, with estimated parameters constrained to equality across periods, the table reports R^2 statistics corresponding to each of these time periods.

policy had to be constructed for this study that adequately captures the nature of the policy regime for international trade.[17] The use of outcome measures seems undesirable on these grounds, because they also reflect the gravity component of trade openness. The choice is then between direct policy indicators and effective protection measures.

POLICY INDICATORS. Tariff rates, nontariff barriers, tariff revenues, and related matters describe the institutional features of a country's attitude toward the rest of the world with respect to trade and factor flows. As such, they are likely to be an important determinant of the outcome measures. However, there are endogeneity problems in their relationship with growth, and they tend to have limited availability. Furthermore, they may not directly reflect the degree of effective protection faced by domestic agents, but only the legal framework they confront.

The main drawback of such trade policy measures as tariff barriers, nontariff barriers, and broader measures of a country's liberalization status is that they are weakly correlated among themselves. Pritchett (1996a) showed that no such single policy measure adequately captures a country's outward orientation. Because various measures may reflect different aspects of a country's trade policy, using a single indicator may not be very informative. This suggests combining the variation in several measures to obtain an indicator of trade openness.

DEVIATION MEASURES. Deviations of observed trade volume from the predicted free-trade volume are also used to provide a measure of how restrictive the trade regime really is.[18] Factor endowment and gravity models of trade generate predictions about a country's propensity to trade internationally. For instance, small country size, distance from major trading partners, and negative terms of trade shocks can be thought to affect trade volumes negatively. Similarly, relative endowments of skilled labor, unskilled labor, and capital and natural resources may have an impact on overall trade volumes. This type of variable can be used to predict a country's potential free trade volume of international commercial transactions.

There are three drawbacks to measures based on deviations. First, some determinants of potential trade may have been omitted, so the predicted level of trade may not adequately measure the volume of commercial transactions that would prevail under complete free trade.[19] Second, some gravity or endowment determinants of potential trade may be highly correlated with policy attitudes, so the deviation of observed from potential trade may exclude some valid infor-

17. The working paper on this study (Wacziarg 1998) presents empirical evidence in favor of this choice: the growth effects of trade openness seem mostly due to the trade policy regime, rather than to the gravity component of trade shares.

18. The classic reference on such residual measures is Leamer (1988).

19. Frankel and Romer (1999) presents a state-of-the-art method for computing the gravity component of trade volumes by regressing bilateral trade on exogenous characteristics of country pairs, such as distance and common language.

mation about policy. Third, 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 its use will result in increased downward bias associated with measurement error.

Construction of the Trade Policy Openness Index

The approach used here attempts to avoid these problems with existing measures of trade openness. A country's trade to GDP ratio can be viewed as resulting from policy, factor endowment, and gravity determinant variables. The trade policy index is computed by isolating the variation in trade shares attributable to a variety of trade policy measures.

More specifically, trade shares (the ratio of imports plus exports to GDP) are regressed on several openness-determining variables, including policy, gravity, and endowment variables. The estimated coefficients on the policy variables are used as weights in constructing a weighted average of these variables. This weighted average is the index of trade policy openness, equal to the portion of observed trade shares attributable 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 shares (because it is not constructed as a residual) and the problem of collinearity between gravity and endowment and policy factors.

Components of the Openness Index

The objective is to construct an openness measure that applies to a broad range of countries over the period 1970–89 and that adequately accounts for tariff barriers, nontariff barriers, and other policy attitudes toward international trade that capture outward orientation.

TARIFF BARRIERS. The effects of tariff barriers are captured by the share of import duty revenues in total imports (from the International Monetary Fund's [IMF] *Government Finance Statistics Yearbook*). This has three advantages. First, it better captures the effective degree of tariff restrictions. Direct overall measures of tariff protection obtained from the U.N. Conference on Trade and Development (UNCTAD) are unweighted averages of goods-specific tariff rates. However, duty revenues are by construction weighted by the composition of imports. Second, officially declared tariff rates and effectively implemented rates may vary substantially. Duty revenues once again avoid this problem by measuring the tariff revenues actually collected. Third, data based on revenues are available for more countries and a wider time span than direct measures of tariff rates.[20]

20. Unweighted tariff rates were available for the period 1980–93 only, and for approximately 50 countries.

One potential limitation of the use of tariff revenues is that prohibitive tariff rates tend to reduce revenues through a Laffer curve effect applied to imports. However, the problem is likely greatly attenuated by the fact that duty revenues are treated as a share of total imports (high tariff rates work to reduce revenues by deterring imports, so the ratio of the two should roughly reflect effective tariff rates). Correlations between tariff revenues and tariff rates, for the dates and countries available for both measures, are relatively high, ranging from 66 (64?) percent to 83 percent (table 1).

NONTARIFF BARRIERS. Existing measures of nontariff barriers are highly imperfect, dealing mainly with coverage rates (percentage of goods affected by quotas, voluntary export restraints, and the like) and ignoring whether the constraints are binding. Furthermore, there is no consistent panel data set for nontariff barriers. The meausure used here is an unweighted coverage ratio for the pre–Uruguay Round time period published by UNCTAD. Although the extent of nontariff barriers has no doubt varied across time, like tariffs it is likely to be highly autocorrelated within countries. The data do not permit accounting for this time-series variation, because there is only one observation for the 20 years under consideration. Presumably, this type of measurement error weakens the relationship of nontariff barriers with trade volumes and correspondingly reduces the weight of this indicator in the overall index.

LIBERALIZATION STATUS. A third component for the index of trade policy was developed to capture the overall attitude of policymakers. Dummy variables were constructed for a country's liberalization status for each year using the list of trade liberalization episodes compiled by Sachs and Warner (1995) for a large sample of countries.[21] These were then averaged over the four time periods under study. Insofar as this indicator receives some weight in the index, it captures factors other than just tariffs and nontariff barriers; in particular, it may help account for the effect of time variations in nontariff barriers, which cannot be explicitly accounted for because of data unavailability.

Rodrik and Rodríguez (2000) have recently raised strong doubts about the indicator used in Sachs and Warner (1995), arguing that much of the variation in the liberalization dummy variable is attributable to the black market premium on the exchange rate (a proxy for distorted macroeconomic management as much

21. 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 sources for the dates for each country are reported in the appendix to their article. Note that the dates of liberalization computed by Sachs and Warner (1995) and their cross-sectional liberalization dummy (for the mid-1980s) are derived using different methodologies. In particular, because much of the tariff and nontariff data were not available for periods before the 1980s, Sachs and Warner (1995, 24, n. 44) resorted to a literature search to determine when countries opened their trade regimes, rather than to the five formal criteria used to derive their well-known liberalization dummy variable (the latter is computed for the mid-1980s only).

TABLE 1. Correlations between Duty Revenues and Unweighted Tariff Rates

	Import duties		
Tariff rate	1980–84	1985–89	1990–94
1980–84	0.667	0.744	0.725
1985–89	0.638	0.754	0.717
1990–94	0.802	0.837	0.831

Note: 50 observations.

as for the degree of openness) and the existence of an export marketing board (a characteristic mainly of slow-growing African economies). Hence, they argue that the Sachs and Warner variable is constructed in a way that is conducive to finding a positive effect of openness on economic growth. For this reason, results are also presented here based on an index of openness that excludes the Sachs and Warner liberalization status.[22]

Correlations between these underlying components of the trade policy index are displayed in table 2. The signs of the correlations are as expected. The nontariff barriers measure is most weakly correlated with the other indicators, suggesting either that its inclusion may provide useful information about trade policy or that it is a poor measure of openness. Insofar as the nontariff barrier measure poorly reflects the true orientation of trade policy, however, it should receive a small weight in the overall index.

Trade Shares Regressions

Estimates pertaining to the determination of trade shares are shown in table 3.[23] The explanatory variables feature the three policy indicators (import duties as a share of total imports, the pre–Uruguay Round nontariff barriers 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 log of land area and log of population, as well as the growth rate of per capita GDP.[24]

As expected, trade shares are positively affected by liberalization status and negatively affected by tariffs and nontariff barriers. The lack of precision of the

22. This study uses an indicator based on Sachs and Warner's liberalization dates rather than on their (purely cross-sectional) liberalization dummy. This may reduce the incidence of the Rodrik and Rodríguez critique, insofar as the liberalization dates are based on the broad survey of the literature on specific countries' trade regimes. Entirely removing this indicator from the index, however, allows the Rodrik and Rodríguez critique to be addressed more fully.

23. The three-stage least squares estimator described earlier is used to obtain these estimates.

24. The working paper on this study (Wacziarg 1998) provides evidence of reverse causation from growth to trade shares, justifying the inclusion of economic growth in the equation for the trade to GDP ratio.

TABLE 2. Correlations between Underlying Components of the Trade Policy Index

Index component	Duty				Nontariff barriers	Liberalization		
	1970–74	1975–79	1980–84	1985–89		1970–74	1975–79	1980–84
Duty 1970–74	1.000							
Duty 1975–79	0.944	1.000						
Duty 1980–84	0.825	0.887	1.000					
Duty 1985–89	0.753	0.808	0.935	1.000				
Nontariff barriers	0.190	0.232	0.157	0.212	1.000			
Liberalization 1970–74	–0.467	–0.460	–0.470	–0.459	–0.120	1.000		
Liberalization 1975–79	–0.471	–0.465	–0.474	–0.455	–0.085	0.994	1.000	
Liberalization 1980–84	–0.470	–0.464	–0.473	–0.446	–0.048	0.978	0.994	1.000
Liberalization 1985–89	–0.429	–0.469	–0.469	–0.479	–0.182	0.900	0.890	0.870

Note: 57 observations.

TABLE 3. Trade Shares Regression
(three-stage least squares estimates)

Independent variable	Trade Policy 1: baseline index	Trade Policy 2: excluding the Sachs and Warner variable
Constant	182.561	186.830
	(9.70)	(8.55)
Growth of per capita income	0.322	0.444
	(1.12)	(1.40)
Log of land area	–8.029	–9.164
	(–3.69)	(–2.23)
Log of population	–9.121	–8.052
	(–3.42)	(–2.31)
Import duties / total imports	**–34.733**	**–60.912**
	(–1.16)	**(–1.78)**
Pre–Uruguay Round	**–0.217**	**–0.239**
nontariff barrier coverage	**(–0.73)**	**(–0.74)**
Sachs/Warner	**11.262**	**—**
liberalization status	**(2.12)**	
Adjusted R^2	0.60 0.55	0.60 0.54
	0.53 0.49	0.50 0.47
Number of observations (number of periods)	71 (4)	71 (4)

Note: The dependent variable is imports plus exports as a share of GDP. Numbers in parentheses are *t*-statistics. Because each equation is estimated for four time periods, with estimated parameters constrained to equality across periods, the table reports R^2 statistics corresponding to each of these time periods. The instruments used were: initial income; population density; dummy variables for religion, oil producers, postwar independence; log of population; share of population over 65; and log of area.

estimates, largely due to collinearity between the policy measures, is not really a concern since the objective is only to generate rough weights for how the three components affect trade shares. Minor variations in these weights are not likely to influence the final results.

Two indices of trade policy were computed using estimates from the two regressions in table 3 as weights on the various policy measures. For each period, the trade policy openness indices were computed as:

$$\text{Trade Policy 1} = -34.73(\text{Import Duty Share}) - 0.22(\text{Nontariff Barriers}) + 11.26^{*}(\text{Liberalization Status})$$

$$\text{Trade Policy 2} = -60.91(\text{Import Duty Share}) - 0.24(\text{Nontariff Barriers})$$

Correlating the baseline index (Trade Policy 1) with its three components (table 4) gives an idea of the relative weights attached to each. For all the components, correlations with the overall index are larger than 0.449 in absolute value, but the duty revenue component dominates with a correlation ranging from 0.634 to 0.790, depending on time period. As expected, the nontariff barriers component received the smallest weight. Correlations between the two indices of trade

TABLE 4. Correlations between Trade Policy 1 and Underlying Components

	Trade Policy 1			
Index component	1970–74	1975–79	1980–84	1985–89
Duty 1970–74	–0.713	–0.703	–0.690	–0.643
Duty 1975–79	–0.705	–0.733	–0.725	–0.704
Duty 1980–84	–0.645	–0.673	–0.747	–0.737
Duty 1985–90	–0.634	–0.654	–0.724	–0.790
Nontariff barriers	–0.507	–0.501	–0.449	–0.526
Liberalization 1970–74	0.867	0.862	0.860	0.752
Liberalization 1975–79	0.851	0.854	0.860	0.733
Liberalization 1980–84	0.826	0.837	0.850	0.706
Liberalization 1985–90	0.810	0.818	0.812	0.838

Note: 57 observations.

openness used in this study correlations are always greater than 80 percent (table 5). Although high, this shows that the exclusion of the Sachs and Warner liberalization status from the index can be expected to have some impact on the results.

Summary Statistics for Growth and the Openness Index

Summary statistics for growth and the trade policy index provide preliminary insights into the relationship between them. Tables 6 and 7 display first and second moments for per capita GDP growth and the policy index for five-year averages during 1970–89. The simple contemporaneous correlations between growth and Trade Policy 1 are positive, but their magnitudes are somewhat small, especially for 1975–79, when the oil shock may have negatively affected the relationship between openness and growth (table 7). Furthermore, the simple correlations between growth and Trade Policy 2 are small in magnitude and negative in three out of four periods. Overall these correlations suggest that the relationship between trade policy openness and growth, if any, will be conditional on other determinants of growth.

Measurement of Channel Variables

Three of the channel variables considered in section I— FDI inflows as a share of GDP, government consumption as a share of GDP, and the domestic investment rate—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. 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 for each time period: level of public debt as a percentage of GDP, level of government deficit as a share of GDP, and growth of M2 net of total real output growth (higher numbers signal better policies). The rankings are averaged to obtain an index of overall macroeconomic policy quality, which

TABLE 5. Correlation between the Two Trade Policy Indices

	Trade Policy 1				Trade Policy 2		
	1970–74	1975–79	1980–84	1985–89	1970–74	1975–79	1980–84
Trade Policy 1, 1975–79	0.991	1					
Trade Policy 1, 1980–84	0.967	0.982	1				
Trade Policy 1, 1985–89	0.908	0.919	0.930	1			
Trade Policy 2, 1970–74	**0.806**	0.795	0.758	0.763	1		
Trade Policy 2, 1975–79	0.787	**0.805**	0.772	0.796	0.968	1	
Trade Policy 2, 1980–84	0.763	0.782	**0.817**	0.846	0.889	0.927	1
Trade Policy 2, 1985–89	0.731	0.746	0.785	**0.870**	0.834	0.867	0.955

Note: 57 observations.

reflects a country's position relative to others. This avoids the problem of having to characterize a "good" macroeconomic policy in absolute terms.[25]

The extent of technology transmission is approximated by the share of manufactured exports in total merchandise exports, admittedly an imperfect proxy.[26] 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. The crucial point is that technological advances and knowledge embodied in existing goods must make their way into production processes to truly qualify as technology transmission. The share of manufactured imports in merchandise imports, another possible measure, was not used because imports of manufactures may act as a substitute rather than a proxy for technology transmission.[27]

The black market premium on the official exchange rate is used as a measure of price distortions prevailing within the economy, to capture the effect of trade policy on the efficiency of the price system. The black market premium is widely used in cross-country analyses. Barro and Sala-i-Martin (1995) argue that the black market premium on foreign exchange is a widely available and apparently accurate measure of a particular price distortion and can serve as a proxy for government distortions of markets more generally.[28]

25. The working paper on this study (Wacziarg 1998) presents greater detail on the method used to compute the macroeconomic policy quality index.

26. The share of manufactures in merchandise exports was used as a proxy for technology transmission in World Bank (1996).

27. It attempts to employ the share of manufactured imports to total merchandise imports as a proxy for technology transmission, instead of the share of manufactured exports, no statistically significant relationship was found between this variable and growth on the one hand and trade policy openness on the other, even when controlling for a diverse set of variables.

28. I am grateful to an anonymous referee for pointing out that the black market premium is a component of the Sachs and Warner dummy and that estimates of the coefficient on a variable that includes black market premium in a black market premium equation will be tainted by endogeneity bias. There are three answers to this objection in the context here: first, as stated above, this study employs an indicator based on the Sachs and Warner liberalization dates, rather than their dummy

TABLE 6. Summary Statistics for Growth and the Trade Policy Indices

	Mean	Standard deviation	Minimum	Maximum
Growth 1970–74	3.990	2.520	–0.499	12.351
Growth 1975–79	2.333	2.845	–6.688	10.433
Growth 1980–84	0.380	2.740	–8.277	6.018
Growth 1985–89	1.974	2.455	–3.063	8.770
Trade Policy 1, 1970–74	–1.305	8.496	–17.840	10.438
Trade Policy 1, 1975–79	–0.937	8.460	–18.716	10.781
Trade Policy 1, 1980–84	–0.712	8.663	–19.358	10.784
Trade Policy 1, 1985–89	–0.326	9.425	–26.000	10.781
Trade Policy 2, 1970–74	–9.659	6.518	–26.103	–1.136
Trade Policy 2, 1975–79	–9.151	6.704	–26.877	–0.535
Trade Policy 2, 1980–84	–8.896	7.188	–30.746	–0.528
Trade Policy 2, 1985–89	–9.605	8.835	–41.662	–0.535

Note: 57 observations.

Simple statistics for openness, growth, and the channel variables, averaged over the period under consideration, provide preliminary evidence of the relevance of the choice of channels (tables 8 and 9). Unconditional correlations suggest that all of the channels involve a positive effect of trade on economic growth (first column of table 9). The largest correlations are in the investment and manufactured exports channels. Overall, this shows that the trade policy index is positively related to FDI as a share of GDP, macroeconomic policy quality, manufactured exports as a share of merchandise exports, and the domestic investment ratio. Each of these is positively correlated with growth. Trade policy openness is negatively related to the black market premium and government size, and each of these is negatively associated with growth. Although these simple correlations are suggestive, results obtained when controlling for other determinants of growth and the channel variables are likely to differ greatly.

III. EMPIRICAL RESULTS

Table 10 reports summary effects of each channel on growth, the effect of openness on each channel, and the product of the two coefficients for the baseline model for 57 countries for 1970–89.[29] Trade policy openness works positively

variables. Second, a full set of exogenous variables in the system is used to instrument for openness, which should eliminate the bias in the distortions equation. Last, section III shows that the estimated effect of trade policy openness on the black market premium is statistically indistinguishable from zero, so the endogeneity-induced concerns for an upward bias on the magnitude of this effect are not borne out in the estimates.

29. Appendix C, Table C-1 contains the entire set of coefficient estimates for each equation in the system, from which the channel effects are obtained. The working paper on this study describes in great

TABLE 7. Correlation between Growth and the Trade Policy Indices

	Growth			
	1970–74	1975–79	1980–84	1985–89
Trade Policy 1, 1970–74	**0.242**	0.168	0.259	0.286
Trade Policy 1, 1975–79	0.241	**0.168**	0.270	0.284
Trade Policy 1, 1980–84	0.267	0.177	**0.285**	0.294
Trade Policy 1, 1985–89	0.325	0.101	0.118	**0.223**
Trade Policy 2, 1970–74	**0.178**	–0.102	–0.067	–0.129
Trade Policy 2, 1975–79	0.192	**–0.109**	–0.076	–0.125
Trade Policy 2, 1980–84	0.270	–0.084	**–0.055**	–0.076
Trade Policy 2, 1985–89	0.334	–0.095	–0.112	**–0.066**

Note: 57 observations.

for growth through five out of six channels, three of which—investment, FDI, and macroeconomic policy quality—involve statistically significant effects at the 90 percent level. In each case these involve a positive effect of trade policy on the channel variable and a positive effect of the channel variable on growth.

The remaining channel estimates are statistically insignificant at the 90 percent level, although government size comes close to being a significantly negative channel (the *p*-value associated with the *t*-statistic on the channel effect is 13 percent). For price distortions, this is due to the absence of a significant effect of trade openness on the black market premium once other determinants of this variable (such as per capita income) are held fixed. However, the black market premium was found to bear a negative relationship to economic growth. For manufactured exports, the absence of a statistically significant overall channel effect is due to the fact that this variable does not seem to affect growth in the model specification. However, trade openness was found to be positively associated with the share of manufactured exports in total exports.

The overall effect of all the channels is significant at the 99 percent level. The magnitude of the effects is small for some channels: reduced distortions account for roughly 3 percent of the net effect of trade policy openness on growth and are statistically insignificant due to the absence of a significant estimated effect of trade policy on the black market premium. This is a surprising result in light of the importance accorded allocative efficiency in arguments about static and dynamic gains from trade. The same holds for manufactured exports, meant to capture technology transmission. Government size works negatively for growth,

detail the specification choices for the channel equations, as well as the results for each equation in the baseline system (Wacziarg 1998). 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 the estimated parameters pertaining to different equations in the system.

TABLE 8. Summary Statistics for the Main Variables (1970–89 Averages)

	Mean	Standard deviation	Minimum	Maximum
Growth	2.169	1.858	–1.798	7.513
Trade Policy 1	–0.820	8.588	–19.511	10.696
Trade Policy 2	–9.328	7.047	–30.076	–0.683
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

Note: 57 observations.

although the effect is weak for both magnitude and 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 percent of the total effects of trade policy on growth.

The most important channel by far is investment rate, which accounts for close to 63 percent of the total effect of trade policy on growth.[30] Several theoretical arguments point to the potential direct impact of trade policy openness on investment, such as those outlined in section I. It is also possible that measurement error in some of the channel variables leads to overstatement of the effect of trade policy through the investment rate. For instance, if investment is positively correlated with technology transmission and if the share of manufactured exports in total merchandise exports is a weak proxy for the extent of technology transmission, part of this effect may be accounted for by the investment channel. However, the scope of this argument is somewhat limited by the use of a wide set of instruments for all of the channel variables: if measurement errors in the instruments are independent of measurement errors in the channel variables, attenuation bias will be reduced.

To summarize, this model provides evidence for a beneficial total effect of trade policy on growth. An 8.5 percentage point increase in the trade policy measure, corresponding roughly to one standard deviation, is associated with a 0.601 percentage point increase in the annual growth rate once all channels of influence are brought into the picture. This effect is estimated with great precision. The most important channel by far seems to be through investment (63 percent of the total effect). Technology transmission explains 22.5 percent of the overall positive effect of trade on growth; macroeconomic policy quality accounts for

30. This is in line with empirical results in Baldwin and Seghezza (1996a) and Levine and Renelt (1992), who found evidence of trade-induced, investment-led growth.

TABLE 9. Correlation Matrix for Main Variables

	Growth	Trade Policy 1	Macro policy quality	Black market premium	Government consumption	Manufactured exports	Investment rate	FDI	Human capital
Trade Policy 1	0.331	1							
Macro policy quality	**0.384**	**0.420**	1						
Black market premium	**–0.408**	**–0.404**	–0.304	1					
Government consumption	**–0.421**	**–0.265**	–0.594	0.390	1				
Manufactured exports	**0.387**	**0.602**	0.393	–0.484	–0.268	1			
Investment rate	**0.483**	**0.674**	0.441	–0.498	–0.428	0.556	1		
FDI	**0.503**	**0.263**	0.155	–0.255	–0.296	–0.012	0.342	1	
Human capital	**0.185**	**0.554**	0.361	–0.357	–0.334	0.487	0.522	0.116	1
Log income	0.266	0.743	0.469	–0.530	–0.504	0.648	0.754	0.188	0.750

Note: 57 observations.

TABLE 10. Summary of the Channel Effects Using Trade Policy 1

Channel variable	Effect of channel on growth	Effect of openness on channel	Effect of Trade Policy 1 on growth
Price distortions	–0.0066	–0.3445	0.0023
	(–9.08)	(–0.63)	(0.63)
Government consumption	–0.0425	0.1539	–0.0065
	(–1.57)	(3.73)	(–1.52)
Manufactured exports	0.0036	0.6345	0.0023
	(0.45)	(4.59)	(0.45)
Investment rate	0.1425	0.3173	0.0452
	(6.86)	(6.72)	(5.12)
FDI	0.3203	0.0450	0.0144
	(4.68)	(4.01)	(3.79)
Macro policy quality	0.4887	0.0267	0.0130
	(4.22)	(2.19)	(1.90)
Total effect			**0.0707**
			(5.94)

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors.

18 percent of the effect. The only negative channel, government size, is significant at the 87 percent level only.

Robustness Analysis

The model was tested for robustness to the choice of liberalization indicator, to model specification, and to time coverage.

EXCLUDING THE SACHS AND WARNER INDICATOR. Table 11 replicates the estimation of the baseline model replacing Trade Policy 1 with Trade Policy 2 as a measure of openness. Trade Policy 2 excludes the Sachs and Warner liberalization status variable critiqued by Rodrik and Rodríguez (2000).[31] The magnitude and precision of the overall estimated channel effects fall, although the investment effect and the overall effect are still positive and statistically significant. A one-standard-deviation change in Trade Policy 2 (8 percentage points) is now associated with a 0.264 increase in the annual growth rate of per capita GDP. The proportional contributions of most channels remains roughly unchanged, with the investment channel accounting for the bulk of the effect.

The main change in the channel effects is the disappearance of the macroeconomic policy quality channel, now statistically indistinguishable from zero. This is due entirely to the fact that Trade Policy 2 now bears no relationship to the

31. Referring explicitly to the earlier working paper on this study (Wacziarg 1998), they state that "we are skeptical that the Sachs-Warner measure, on which the Wacziarg indicator is partly based, is a meaningful indicator of trade policy. . . . We would have preferred to see estimates based only on tariff and [nontariff barrier] indicators." I am grateful to them and to anonymous referees for this suggestion.

TABLE 11. Summary of the Channel Effects (Using Trade Policy 2)

Channel variable	Effect of channel on growth	Effect of openness on channel	Effect of Trade Policy 2 on growth
Price distortions	–0.0068	0.4886	–0.0033
	(–9.63)	(0.65)	(–0.65)
Government consumption	–0.0497	0.2030	–0.0101
	(–1.69)	(6.14)	(–1.60)
Manufactured exports	0.0033	–0.0653	–0.0002
	(0.41)	(–0.52)	(–0.33)
Investment rate	0.1365	0.2086	0.0285
	(6.09)	(4.39)	(3.67)
FDI	0.3066	0.0805	0.0247
	(4.38)	(5.41)	(4.22)
Macro policy quality	0.4989	–0.0129	–0.0064
	(4.13)	(–0.87)	(–0.83)
Total effect			**0.0331**
			(2.50)

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors.

index of macroeconomic policy. This is consistent with the Rodrik and Rodríguez (2000) critique of the Sachs and Warner indicator for proxying distorted domestic policies, which may not be the case for the other measures of trade openness used to construct the index. The result is also consistent with an alternative view, more favorable to the baseline model: that the Sachs and Warner liberalization dates reflect a component of a country's trade orientation that is only weakly related to direct measures of trade policy, such as tariffs and nontariff barriers, but is nonetheless causally linked to the quality of macroeconomic policy.

ROBUSTNESS TO THE SPECIFICATION. Table 12 displays several modifications of the baseline model to examine its sensitivity to changes in specification and estimation method. It presents *t*-statistics and Wald tests for the significance of the products of coefficients. The 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, for each of the five models in table 12.

The third column examines the robustness of the model with respect to estimation method, employing the seemingly unrelated regression estimator. This estimator, though inconsistent (no instruments are used), is characterized by greater efficiency and may provide some indication of the model's robustness. It shows that changing the estimator does not greatly affect the sign or magnitude of the estimated effects. In fact, the overall effect of trade policy is roughly the same as in the baseline model.

The fourth column restricts the sample to developing countries. The magnitude of the effect of Trade Policy 1 on economic growth increases when the sample

TABLE 12. Channel Effects under Alternative Models

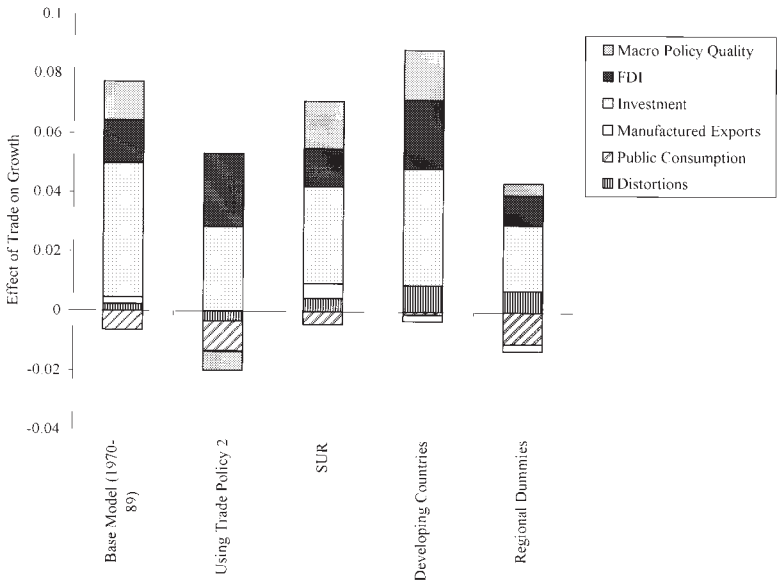
	Base model 1970–89	Using Trade Policy 2	Seemingly unrelated regression estimates	Developing economies	Regional dummy variables
Distortions	0.0023	–0.0033	0.0046	0.0090	0.0072
	(0.63)	(–0.65)	(1.73)	(2.51)	(1.71)
Wald test	0.3986	0.4222	2.9825	6.3154	2.9240
(*p*-value)	(0.53)	(0.52)	(0.08)	(0.01)	(0.09)
Government consumption	–0.0065	–0.0101	–0.0044	–0.0009	–0.0107
	(–1.52)	(–1.60)	(–1.57)	(–1.14)	(–1.93)
Wald test	2.3087	2.5534	2.4766	1.2913	3.7085
(*p*-value)	(0.13)	(0.11)	(0.12)	(0.26)	(0.05)
Manufactured exports	0.0023	–0.0002	0.0049	–0.0023	–0.0025
	(0.45)	(–0.33)	(1.11)	(–1.00)	(–0.70)
Wald test	0.2011	0.1103	1.2284	0.9943	0.4901
(*p*-value)	(0.65)	(0.74)	(0.27)	(0.32)	(0.48)
Investment rate	0.0452	0.0285	0.0326	0.0394	0.0222
	(5.12)	(3.67)	(4.37)	(5.20)	(3.54)
Wald test	26.1985	13.4690	19.0749	27.0762	12.5666
(*p*-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Foreign direct investment	0.0144	0.0247	0.0129	0.0231	0.0101
	(3.79)	(4.22)	(3.46)	(4.90)	(2.37)
Wald test	14.3848	17.8191	11.9667	24.0583	5.6374
(*p*-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)
Macro policy quality	0.0130	–0.0064	0.0161	0.0169	0.0040
	(1.90)	(–0.83)	(2.84)	(3.36)	(1.18)
Wald test	3.6089	0.6917	8.0783	11.2935	1.4016
(*p*-value)	(0.06)	(0.41)	(0.00)	(0.00)	(0.24)
Total effect	**0.0707**	**0.0331**	**0.0667**	**0.0853**	**0.0303**
	(5.94)	**(2.50)**	**(5.73)**	**(7.85)**	**(2.38)**
Wald test	35.3319	6.2294	32.8881	61.6244	5.6878
(*p*-value)	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors.

is restricted to developing economies. This is due to the fact that the distortions channel is now significant and represents roughly 10 percent of the overall effect. The other channels are preserved.

The last column shows the results of adding regional dummy variables to every equation to account for time-invariant region-specific effects that can covary with the right-hand-side variables. To account for the possibility that regional specificities might be the driving force of the results, regional dummy variables for Latin America, Sub-Saharan Africa, Southeast Asia, and coun-

FIGURE 1. Graphical View of the Channel Effects



tries in the Organisation for Economic Co-operation and Development (OECD) were added to each of the channel equations and to the list of instruments. Because accounting for fixed effects tends to wipe out much of the cross-sectional variation (a fixed-effects estimator uses only the variation within regions across time), the inclusion of regional dummy variables would be expected to lower the estimated effects of trade policy. The total effect of trade policy is reduced by the inclusion of region-specific dummy variables, but each channel's shares are roughly preserved. In particular, the dominant role of physical capital formation is maintained, and the overall effect remains statistically significant.

ROBUSTNESS TO TIME COVERAGE. Three issues related to the study's time coverage were also examined (table 13). First, the cross-equation parameter equality restrictions may not be warranted. Second, a wider time span, though reducing the number of countries for which the data are available, might provide a further robustness check on the results. Third, the use of five-year averages, though increasing the number of data points in the estimation, may highlight short-term variability in the data (due, for example, to business cycle effects) and obscure the long-run relationships.[32]

32. Rodrik and Rodríguez (2000), referring to this article, state that "we are not sure that the regularities revealed by the data over time horizons of five years or less are particularly informative about the relationship between trade policy and long-run economic performance. It would be interesting to see if the results hold up with averages constructed over a decade or more." I am grateful to them for this suggestion.

TABLE 13. Sensitivity to Time Period Coverage

	I Excl. 1970–74	II Excl. 1975–79	III Excl. 1980–84	IV Excl. 1985–89	V 1970–92	VI 10-year averages
Distortions	–0.0067	–0.0015	0.0126	0.0008	0.0045	0.0431
	(–1.15)	(–0.37)	(1.30)	(0.07)	(7.28)	(1.78)
Wald test	1.3148	0.1332	1.6789	0.0052	53.0421	3.1682
(*p*-value)	(0.25)	(0.72)	(0.20)	(0.94)	(0.00)	(0.08)
Government	–0.0057	0.0018	0.0050	–0.0105	–0.0066	0.0011
consumption	(–1.09)	(0.19)	(0.62)	(–1.53)	(–5.85)	(0.13)
Wald test	1.1960	0.0350	0.3905	2.3511	34.1841	0.0177
(*p*-value)	(0.27)	(0.85)	(0.53)	(0.13)	(0.00)	(0.89)
Manufactured	0.0129	0.0094	0.0037	0.0099	0.0009	0.0397
exports	(1.83)	(0.89)	(0.54)	(0.70)	(0.53)	(1.55)
Wald test	3.3573	0.7916	0.2935	0.4940	0.2820	2.4178
(*p*-value)	(0.07)	(0.37)	(0.59)	(0.48)	(0.60)	(0.12)
Investment rate	0.0317	0.0933	0.0206	0.0349	0.0212	0.1078
	(2.62)	(5.05)	(1.80)	(2.07)	(7.98)	(3.34)
Wald test	6.8634	25.5079	3.2294	4.2808	63.6389	11.1376
(*p*-value)	(0.01)	(0.00)	(0.07)	(0.04)	(0.00)	(0.00)
FDI	0.0206	0.0040	0.0118	0.0155	0.0148	0.0232
	(4.09)	(1.17)	(2.43)	(2.41)	(6.02)	(2.23)
Wald test	16.7045	1.3678	5.9239	5.8298	36.2359	4.9735
(*p*-value)	(0.00)	(0.24)	(0.01)	(0.02)	(0.00)	(0.03)
Macro policy	–0.0258	0.0009	0.0076	0.0089	0.0111	–0.0258
quality	(–1.98)	(0.11)	(0.78)	(1.08)	(4.24)	(–1.11)
Wald test	3.9058	0.0126	0.6099	1.1630	17.9800	1.2340
(*p*-value)	(0.05)	(0.91)	(0.43)	(0.28)	(0.00)	(0.27)
Total effect	**0.0271**	**0.1078**	**0.0612**	**0.0595**	**0.0459**	**0.1890**
	(1.48)	**(3.87)**	**(3.62)**	**(2.53)**	**(11.71)**	**(3.25)**
Wald test	2.2031	15.0079	13.1403	6.3990	137.2148	10.5605
(*p*-value)	(0.14)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors.

First, *each of the four time periods was excluded from the baseline model* one at a time (columns one to four in table 13).[33] This should greatly reduce the precision of the parameter estimates, because a quarter of the data is being excluded. Indeed, 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 are no longer statistically significant. However, both the signs and magnitudes of the estimates are remarkably close to those in the baseline model. 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.

When the *timespan is widened* by adding 1990–92, distortions and government size become statistically significant channels, although still relatively small in magnitude. The addition of this time period reduces the number of observations from 57 to 50, while raising the number of data points used to estimate each parameter, thus improving the precision of the estimates. 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 magnitude of the investment channel.

With respect to the third issue, results are quite robust when *10-year averages of the data* are used rather than 5-year averages (last column of table 13). In particular, the investment channel remains statistically significant and still accounts for over half the total effect of trade policy on economic growth. Moreover, the total effect is more than double the previous magnitude, although as expected it is estimated with lower precision. One interpretation of the increase in magnitude is that data averaged over 5 years reflect to some extent short-term variability in the data, analogous to measurement error, whereas data averaged over 10 years are more likely to reflect long-term relationships.

Exhaustiveness of the Model

The last concern is whether the six channels fully capture the total effect of trade policy on growth. The omission of one or more channels could lead 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 channel variables covary with the included ones in the growth regression).

Other Possible Channels

Among other possible channels for the effect of trade policy on growth, this study looked briefly at human capital, income inequality, and corruption.

HUMAN CAPITAL. The accumulation of human capital might be one of the channels linking trade policy and economic growth. If trade openness modifies the relative returns to factors, it may create greater incentives to accumulate human

33. Furthermore, the exogenous variables corresponding to the excluded period were removed from the list of instruments.

capital. For instance, if an open trade policy spurs technology transmission and if technology and skills are complements, then trade openness will increase the returns to accumulating human capital. However, no significant linkage effect was found when a human capital channel was specified: 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 the model's growth specification, a problem compounded by the opposite signs of male and female human capital.[34] Hence, human capital did not appear to be an important channel linking trade policy and growth.

INCOME INEQUALITY. Neoclassical trade theory provides several tools for the analysis of income distribution in relation to trade openness. The simple factor endowments theory of Hecksher-Ohlin-Samuelson predicts that returns to unskilled labor should increase in relative terms, with presumed positive effects on income distribution, when a relatively unskilled labor- abundant country moves from autarky to free trade. 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 (1996), among others who have studied the issue of distribution and growth, argue that when the poor have a larger weight in political decisionmaking, they tend to vote for transfer schemes that involve distortive (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, 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.

CORRUPTION. Ades and Di Tella (1999) show convincingly that enhanced openness to international trade may limit corruption by increasing the degree of internal market competition and reducing opportunities for local bureaucrats to demand bribes. Mauro (1995) provides evidence that corruption has adverse effects on growth. When Mauro's data (from Business International) were included, however, there was evidence of an effect of trade openness on corruption, but the effect of corruption on growth, though negative, was insignificant and not robust to alternative specifications. This may be due to the fact that the

34. This is consistent with estimates in Barro and Sala-i-Martin (1995) and Pritchett (1996b). Pritchett (1996b, 1) documents that "cross-national data on economic growth rates show that increases in educational capital resulting from improvements in the educational attainment of the labor force have had no positive impact on the growth rate of output per worker."

index of corruption, based on survey methods (and hence likely subject to measurement error), was entered in the growth regression along with government size, the black market premium, and the quality of macroeconomic policy, each of which may proxy in part for corruption. Adding the corruption channel also resulted in a loss of degrees of freedom. The corruption data used in Mauro are available only for the 1980s, forcing abandonment of two of four time periods from the estimation and a loss of five countries.[35]

Unconditional Effect of Trade Policy Openness

Further evidence of the model's exhaustiveness is provided by comparing the total effect under the channel methodology with the unconditional effect of trade policy on growth obtained by removing all of the channel variables from the growth regression and using only the trade policy index. The resulting estimates suggest 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 (table 14).

With the exclusion of many variables from the growth equation, the trade policy index captures much of their effect on growth that is not necessarily linked to trade policy. However, this coefficient is useful in that it provides a rough 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 is roughly of the same magnitude as the total effect of trade policy computed earlier.

Tests Based on the Residuals from the Growth Equation

A more formal test of exhaustiveness can be carried out by regressing the residual vector obtained from the system estimates of the growth regression on the index of trade policy. A correlation between the estimated residual and the measure of trade openness could indicate that a significant channel has been left out of the growth regression. The results, based on a seemingly unrelated regression estimator, show that this is not the case (table 15).[36] In most of the models, the residual effect of trade policy is generally positive but not significantly different from zero at any reasonable level of significance. This again reinforces confidence in the exhaustiveness of the model. That the estimate is positive in the baseline model shows, if anything, that the channel methodology has uncovered a lower bound on the total effect of trade openness. In all cases, the residual effect is statistically insignificant.

35. Results for the income inequality, human capital, and corruption channels are available from the author on request.

36. Again, this should not be taken as an absolute proof of exhaustiveness. To the extent that potentially omitted channels covary with the included ones, the included variables 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.

TABLE 14. Unconditional Effect of Trade Policy in the Growth Equation

	Baseline 1970–89	1970–92	Seemingly unrelated regression estimates	Developing economies	Regional dummy variables
Intercept	2.6656	1.7436	4.1590	1.6855	4.7800
	(1.42)	(2.24)	(2.34)	(1.13)	(1.61)
Log of initial income	–0.0777	0.0375	–0.2586	0.0056	–0.0857
	(–0.32)	(0.38)	(–1.12)	(0.03)	(–0.23)
Male human capital	0.7252	0.9481	0.6709	1.8925	–0.2851
	(2.11)	(5.30)	(2.18)	(13.54)	(–0.92)
Female human capital	–0.9261	–1.2652	–0.8367	–1.8404	0.0190
	(–3.04)	(–8.02)	(–2.99)	(–7.48)	(0.06)
Trade policy openness	0.0659	0.0608	0.0908	0.0947	0.0729
	(3.00)	(7.18)	(4.44)	(5.97)	(2.93)
Latin America dummy variable	—	—	—	—	–2.1983 (–6.74)
East Asia dummy variable	—	—	—	—	0.9702 (1.77)
Sub-Saharan Africa dummy variable	—	—	—	—	–3.0903 (–5.70)
OECD dummy variable	—	—	—	—	–1.4381 (–3.71)
R^2	0.120 0.060	0.119 0.089	0.120 0.061	0.231 0.204	0.114 0.313
	0.095 0.035	0.088 0.035	0.082 0.026	0.222 0.024	0.446 0.105
		0.111			
Number of observations	57	49	57	36	57
(number of periods)	(4)	(5)	(4)	(4)	(4)

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors. Because each equation is estimated for four time periods, with estimated parameters constrained to equality across periods, the table reports R^2 statistics corresponding to each of these time periods. Five time periods were reported for 1970–92.

IV. CONCLUSION

This article is a first attempt, in a cross-country context, to evaluate empirically 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 percent and 63 percent of the impact of trade policy on economic growth. FDI, as a proxy for technology transmission, and the quality of macroeconomic policies each account for roughly 20 percent of the overall effect. There is also weak evidence that the size of government, measured by the ratio of public consumption to GDP, constitutes a channel through which trade policy affects economic growth negatively.

The lack of statistically significant results for manufactured exports and price distortions may be due to measurement problems. Measurement, although improving on past attempts, is still subject to considerable shortcomings. The black

TABLE 15. Regression of the Residuals from the Growth Equation on the Trade Policy Index

	Baseline 1970–89	Trade Policy 2	Seemingly unrelated regression estimates	Developing economies	Regional dummy variables
Intercept	0.0318	–0.1668	0.0484	–0.1794	–0.1362
	(0.18)	(–0.67)	(0.30)	(–0.80)	(–0.92)
Trade policy openness	**0.0135**	**–0.0193**	**0.0098**	**–0.0038**	**0.0188**
	(0.83)	**(–0.97)**	**(0.64)**	**(–0.24)**	**(1.36)**
R^2	0.001 0.015	0.011 0.008	0.000 0.006	0.068 0.065	0.002 0.009
	0.025 0.0002	0.004 0.017	0.019 0.000	0.010 0.043	0.0003 0.002
Number of observations (number of periods)	57(4)	57(4)	57(4)	36(4)	57(4)

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors.

market premium may be a weak proxy for the overall efficiency of the price system. International technology transmission is extremely hard to measure as well, perhaps downwardly biasing estimates for this channel and overstating the others. Future research should seek to improve on the measures used in this study.

The important role of investment in physical capital poses a theoretical challenge. Some theories about gains from trade predict positive effects of openness on the rate of return to capital, but some of these effects should be captured either by the price distortions or technological transmission channel. Furthermore, theories based on dynamic gains from technology transmission and efficiency improvement focus on the improvement of the overall productivity of factors, rather than on accelerated accumulation. If specialization is limited by the extent of the market, under increasing returns to scales trade openness should allow entrepreneurs to undertake previously unprofitable investments. Similarly, if trade liberalization involves procompetitive effects, the entry of new firms may entail large fixed capital costs. Applying such theories to the study of the growth effects of trade openness may provide useful insights into the nature of dynamic gains from trade.

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Appendix A.

Table A-1. List of Countries

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

Appendix B. Data Sources and Description

Growth. *Source:* Heston and Summers (1995). *Description:* Growth rate of purchasing power parity (PPP) adjusted GDP (percentage points).

Import duties as a percentage of total imports. *Source:* IMF. *Description:* Import duties in local currency as a percentage of total imports in local currency (percentage points).

Pre–Uruguay Round nontariff barrier coverage. *Source:* UNCTAD. *Description:* Coverage rate of nontariff barriers pre-Uruguay Round (percentage points).

Sachs and Warner liberalization status. *Source:* Sachs-Warner (1995). *Description:* For each year, a dummy variable was constructed based on the years of liberalization in Sachs and Warner (1995). Takes a value of 1 for liberalized countries and 0 for closed countries. The data were averaged over the relevant five-year subperiods.

Manufactured exports share. *Source:* World Bank. Description: Share of manufactured goods in merchandise exports (percentage points).

FDI ratio. *Source:* IMF. *Description:* Ratio of gross foreign direct investment inflows to GDP (percentage points).

Democracy. *Source:* Gastil (*Freedom in the World Reports*). *Description:* Index of how democratic institutions are (regular elections, broad franchise, wide access to office, and relevance of elected officials). Takes values from 0 (nondemocracy) to 1 (country with fully developed democratic institutions).

Initial income. *Source:* Heston and Summers (1995). *Description:* Real GDP per capita in a given year (PPP adjusted) (log of per capita GDP in dollars).
Human capital. *Source:* Barro and Lee (1993). *Description:* Average years of secondary and higher education in the total population over age 25.
Secondary school completion rate. *Source:* Barro and Lee (1993). *Description:* Percentage of the total population that has completed secondary school.
Macroeconomic policy quality. *Source:* World Bank and IMF. *Description:* Index of macroeconomic policy quality. Constructed by ranking countries according to their 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.
Black market premium. *Source:* Tavares and Wacziarg (2001) data set, initially *World Currency Yearbook* and IMF. *Description:* Black market premium on the official exchange rate (black market rate minus official rate/official rate as a percentage).
Public consumption. *Source:* Heston and Summers (1995). *Description:* Share of government consumption of goods and services in GDP, excluding transfers and public investment (percent).
Population over 65. *Source:* Barro and Lee (1994). *Description:* Share of population aged over age 65 in the total population (percent).
Population over 15. *Source:* Barro and Lee (1994). *Description:* Share of population over age age 15 in the total population (percent).
Terms of trade shocks. *Source:* Tavares and Wacziarg (2001), initially from the World Bank. *Description:* Growth rate of manufactured export prices minus growth rate of manufactured import price (percent).
Population. *Source:* Barro and Lee (1994). *Description:* Country population; log of population.
Population density. *Source:* Barro and Lee (1994). *Unit:* Thousands of people per million square kilometers.
Ethnolinguistic fractionalization. *Source:* Mauro (1994). *Description:* Probability that two randomly selected people from a given country will not belong to the same ethnolinguistic group.
Postwar independence. *Source:* Barro and Lee (1994). *Description:* Takes on a value of 1 if the country gained independence after World War II and 0 otherwise.

Appendix C. Model Details

Table C-1. Baseline Specification of the Structural System (57 countries, 1970–89)

	Growth	Openness	Distortions	Government consumption	Manufactured exports	Investment	FDI	Macro policy quality
Intercept	10. 5977 (4.70)	–53.8507 (–16.55)	39.7204 (0.83)	57.7178 (10.58)	–75.7958 (–6.94)	27.4932 (3.72)	1.1773 (5.73)	5.9803 (5.14)
Endogenous variables								
Trade policy	**—**	**—**	**–0.3445** **(–0.63)**	**0.1539** **(3.73)**	**0.6345** **(4.59)**	**0.3173** **(6.72)**	**0.0450** **(4.01)**	**0.0267** **(2.19)**
Growth	—	0.3215 (10.44)	—	—	—	—	—	—
Log initial income	–1.6721 (–5.81)	6.5481 (17.55)	–2.5352 (–0.43)	–4.4392 (–9.58)	7.2888 (5.18)	1.0034 (1.56)	—	0.1869 (1.42)
Distortions	–0.0066 (–9.08)	—	—	0.0084 (20.19)	–0.0131 (–5.49)	–0.0101 (–7.15)	–0.0008 (–3.60)	–0.0016 (–1.90)
Government consumption	–0.0425 (–1.57)	—	3.8212 (8.13)	—	—	—	–0.0545 (–4.15)	–0.1265 (–8.25)
Manufactured exports	0.0036 (0.45)	—	—	—	—	—	—	—
Investment rate	0.1425 (6.86)	—	—	—	—	—	—	—
FDI	0.3203 (4.68)	—	—	—	—	—	—	—
Macro policy quality	0.4887 (4.22)	—	—	—	—	1.0265 (6.97)	—	—
Exogenous variables (*instruments*)								
Male human capital	0.4812 (1.59)	—	—	—	—	—	—	—
Female human capital	–0.3867 (–1.39)	—	—	—	—	—	—	—

Secondary school enrollment	—	—	—	—	0.2907 (3.09)	—	—	—
Democracy index	—	—	–51.9867 (-4.69)	—	—	—	—	—
Island dummy	—	–3.0493 (–2.37)	—	—	—	—	0.9878 (4.74)	—
Log of land area	—	–0.8879 (–2.20)	—	—	—	—	—	—
Terms of trade shocks	—	–7.1484 (–4.97)	71.5887 (2.87)	—	—	—	—	–1.3179 (–1.86)
Log population	—	0.4201 (0.79)	—	–0.9107 (–4.52)	5.2154 (5.68)	—	—	—
Population density	—	—	–0.0253 (–3.37)	–0.0033 (–5.87)	0.0189 (5.22)	—	—	—
Population over 65	—	—	—	16.2617 (1.54)	—	–88.3531 (–5.45)	—	—
Population under 15	—	—	—	1.6533 (0.29)	—	–38.3206 (–5.16)	—	—
Ethnolinguistic fractionalization	—	—	—	0.0377 (3.23)	—	–0.0471 (–3.02)	—	–0.0056 (–1.45)
Postwar independence	—	—	—	—	—	—	0.9285 (3.96)	—
R^2	0.251 0.287 0.412 0.314	0.551 0.526 0.560 0.538	0.189 0.235 0.104 0.272	0.276 0.284 0.419 0.531	0.501 0.522 0.487 0.526	0.443 0.556 0.614 0.622	0.330 0.356 0.284 0.231	0.362 0.284 0.344 0.362

Note: Numbers in parentheses are *t*-statistics based on heteroscedastic-consistent (White robust) standard errors. Because each equation is estimated for four time periods, with estimated parameters constrained to equality across periods, the table reports R^2 statistics corresponding to each of these time periods.

Source: See Appendix B.