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International Trade, Distortions, and Long-Run Economic Growth

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The links between trade and growth are examined in a neoclassical model of an open economy in which domestic production requires both domestic and imported inputs. The model shows that trade distortions induced by policies such as tariffs and exchange controls generate cross-country divergences in growth rates and in per capita income over a long period. The empirical results confirm that tariff rates and black market premia, interacting with the estimated share of free trade imports, have significant negative effects on the growth rate of per capita income across countries. [JEL F13, F43, O41]

HOW ARE INTERNATIONAL trade and trade policy linked to long-run economic growth? To what extent can differences in trade policy explain cross-country variations in long-run growth rates? This paper attempts to answer these long-standing questions in the framework of a neoclassical model of an open economy.

Among economists there is an ongoing controversy about the role of government intervention in overall economic performance. In particular, the role of trade policy in economic growth is often at issue, as trade policy is considered one of the most significant policy instruments to be used in the industrialization of developing countries. Despite the considerable literature on this topic, it is still an open question whether liberal

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trade policy is optimal for promoting growth. Even overwhelming evidence showing the strong positive link between "outward-oriented" trade regimes and economic growth (for example, Edwards (1989)) have not dispelled all doubts. One reason for such persistent debate is the dearth of theory to explain and direct evidence to illustrate how trade and trade strategy are linked to long-term economic growth.

The theoretical foundation of the long-run linkages between trade and growth has always been fragile. According to the standard neoclassical growth model, government policies cannot affect the growth rate of income in the steady state, and the "engine of growth" is exogenous technological progress. Therefore, in the neoclassical framework, differences in trade regimes are not linked with variations in long-term growth rates.

Because neoclassical growth models give little weight to trade policy in the determination of long-run economic growth, many economists in the field of international and development economics have relied on internal or external scale economies to explain the positive link between trade and growth. They argue that international trade and a more outward-oriented trade policy permit specialization in the industries that have scale economies, and may thereby increase efficiency in the economy over the long run (see Bhagwati (1988) and Kruger (1980)). This specialization and the consequent dynamic efficiency argument have recently been energized by the influential literature on endogenous growth. International trade and trade policy may increase long-run growth by permitting the economy to specialize in those sectors with scale economies that arise from research and development, human capital accumulation, or learning-by-doing.[1]

Although the dynamic scale theory is quite suggestive of an important link between trade and growth, it is often plagued by a multiplicity of equilibria: comparative advantage may lead the economy to specialize in a sector that is regressing rather than progressing. Thus, theoretical predictions about the link between trade and growth are ambiguous. Tariffs can either increase or decrease growth rates, depending on which sector is protected. As the current theory is inconclusive, so is the empirical evidence: the link between trade policy and dynamic efficiency is vague, depending on the industry and country considered (see the survey in Havrylyshyn (1990)). Cross-country studies show little evidence of scale effects on growth (Backus, Kehoe, and Kehoe (1990)).

[1] For work on the research and development side, see Grossman and Helpman (1990) and Rivera-Batiz and Romer (1991). For human capital accumulation, see Lucas (1988) and Romer (1990). For learning-by-doing, see Krugman (1987), Lucas (1988), and Young (1991).

The purpose of this paper is to provide and to test another link between trade and growth in a neoclassical model that does not depend on hypothetical scale effects. International trade is emphasized as a vehicle for providing foreign inputs to domestic production. It is well known, dating back to the two-gap theory during the 1960s, that international trade promotes economic growth by facilitating foreign inputs into the economy. Imported intermediate inputs and capital goods are more efficient, and they are essential for production, especially in less developed countries. A study of automobile industries in Latin American countries demonstrates this point very succinctly by illustrating the problems of autarkic development: "Many basic materials that are considered standard stock in open economies often must be procured locally or be specially ordered in small batches at considerably higher cost or at inferior quality" (Baranson (1969), p. 25).

When foreign inputs are important for production, any trade policy that restricts their availability hurts the economy. However, even a small government distortion in international transactions is shown in the model to substantially lower the productivity of capital and thus the growth rate over a long period. Also, the open-economy model, which permits foreign inputs in the neoclassical production function, gives some interesting results not found in a closed-economy model. Trade distortions caused by tariffs and exchange controls lower the long-run growth rates more significantly in a country that needs to import more under a free trade regime. This implies that trade distortions have more serious repercussions for growth in small, resource-scarce countries than in large, resource-abundant ones. The model also explains why capital may not flow from high-income to low-income countries as in the usual neoclassical model: because trade distortions decrease substantially the marginal productivity of capital, they may cause capital to flow from highly distorted low-income countries to high-income countries with low distortions.

This paper also tests the model's predictions on the links between trade distortions and economic growth by using direct measures of trade distortions. Several earlier studies have demonstrated the positive relation between exports or imports and growth (see Harrison (1991)). It is unclear, however, whether the growth rate or the share of imports or exports in GDP is a good indicator of trade policies. Moreover, some studies show that causality may run from output to trade rather than in the opposite direction (see Jung and Marshall (1985)). Other studies, such as Agarwala (1983) and Easterly (1990), use an index that combines a number of quantitative and qualitative indexes of trade orientation. They show the strong link between the index and growth, but their method is subject to substantial problems, as the classification may be biased by the authors' considerable *previous* knowledge about the growth performance of the sample countries. By contrast, in the present paper, more direct measures are constructed for government intervention in international transactions. Cross-country data on trade and exchange distortions, represented by tariff rates on imports of foreign inputs and black market premia, are used to test the model.

I. Neoclassical Model with International Trade

This section presents the neoclassical model of an open economy. The theory developed here will be used to discuss the effects of trade distortions on economic growth in later sections.

Model

The consumption side of this model is a stylized version of neoclassical growth models in which an infinitely lived household (one in which the generations are assumed to be continuously linked) maximizes an overall utility:

$$U = \int_0^\infty u(c_t) L_t e^{-\rho t} dt, \tag{1}$$

where c is consumption per person and $\rho > 0$ is the constant rate of time preference. The number of individuals in the household is denoted by L_t, which grows at the exogenous rate of n. As in Barro (1974), it is assumed that individuals care about their children's utility. In order for $U(c)$ to be bounded in the steady state, $\rho > n$ is assumed.

The instantaneous utility function is given by

$$u(c_t) = \frac{c^{1-\theta}}{1-\theta}, \quad \text{for } \theta > 0, \tag{2}$$

where $-\theta$ is the constant elasticity of marginal utility. Households hold assets in the form of "capital" and internal loans. There are no foreign assets in this model. Capital can be envisaged as a broad concept, including both physical capital and human capital. The real rate of return on assets is r. Then, the budget constraint for the household is given by

$$\dot{a} = ra + w - c - na, \tag{3}$$

where a is assets per person and a dot over a variable denotes its differentiation with respect to time. It is assumed that each person supplies one unit of labor. Thus, the wage income per person equals the real wage rate w.

The household maximizes its utility given in equation (1), subject to the budget constraint in equation (3) and to a given stock of initial assets $a(0)$. Thus, the first-order conditions for maximization give the growth rate of consumption:

$$\dot{c}/c = (1/\theta)(r - \rho). \tag{4}$$

In this economy, there is a single good produced by a neoclassical production function. It is assumed that domestic production requires foreign inputs—such as raw materials, intermediate goods, and capital goods—in addition to domestic inputs. A small open economy that imports foreign inputs in exchange for the domestic good at given world prices is considered. Since there is no opportunity for foreign borrowing or lending, trade is balanced in every period. Domestic inputs—labor and capital—are assumed to be combined by a Cobb-Douglas process, and, by using imported foreign goods as intermediate inputs, total output is produced by a constant elasticity of substitution production function:

$$Q = [\gamma_1(K^{\alpha}\hat{L}^{1-\alpha})^{\mu} + \gamma_2 M^{\mu}]^{1/\mu},$$
$$\text{for } \mu < 1, \quad \gamma_1 > 0, \quad \gamma_2 > 0, \quad \text{and} \quad 0 < \alpha < 1, \tag{5}$$

where Q is total output, M is the imported input, K is the "capital" input, and $\hat{L}$ is the "effective" labor input. The effective labor input is assumed to increase over time at the rate of exogenous technological progress x and the population growth rate n:

$$\hat{L}_t = L_t e^{(x+n)t}, \quad \text{for } x > 0. \tag{6}$$

The production function in equation (5) is assumed to exhibit diminishing marginal returns to each input and constant returns to scale for both inputs.

Define $\hat{q} = Q/\hat{L}$; $\hat{m} = M/\hat{L}$; $\hat{k} = K/\hat{L}$; and $z = \hat{m}/\hat{k}^{\alpha}$. The production function is rewritten as

$$\hat{q} = \hat{k}^{\alpha} h(z), \quad \text{for } h_z > 0 \text{ and } h_{zz} < 0. \tag{7}$$

First-order conditions for firms' profit maximization under perfect competition imply that

$$r_t = V - \delta = \alpha\hat{k}^{\alpha-1}/[(1-\psi)h(z)]^{1/\sigma} - \delta, \tag{8}$$

$$p_t = [\psi h(z)z^{-1}]^{1/\sigma}, \tag{9}$$

$$w_t = [\hat{q}_t - \hat{k}_t V - p_t\hat{m}_t]e^{xt}, \tag{10}$$

where $\psi = \gamma_2^{\sigma}$, $1 - \psi = \gamma_1^{\sigma}$, and σ denotes the elasticity between domestic inputs and imported inputs, $\sigma = 1/(1 - \mu)$. The variable V denotes the marginal productivity of capital, and δ denotes the rate of depreciation, $0 < \delta < 1$. The relative price of the foreign good in terms of the domestic good is denoted by p_t. Under the small-country assumption, p_t is determined by world market conditions. In free trade, the price of the foreign good is assumed to equal the price of domestic output, that is, $p = 1$. Let ψ denote the share of imported inputs in total output under a free trade regime. Equation (9) can be solved for equilibrium z, and thereby $h(z)$:

$$\bar{z} = \bar{z}(p) = (1 - \psi)^{1/(\sigma - 1)}\psi[p^{\sigma - 1} - \psi]^{\sigma/(1-\sigma)}, \quad \text{for } z_p \leq 0; \quad (11)$$

$$h(\bar{z}) = (1 - \psi)^{1/(\sigma - 1)}[1 - p^{1-\sigma}\psi]^{\sigma/(1-\sigma)}, \quad \text{for } h_p \leq 0. \quad (12)$$

By combining the behavior of households and firms, the model is solved for a unique competitive market equilibrium. In equilibrium, the assets per household, a, equal the capital per worker, k. Substituting equations (8) through (12) into equation (3) gives the resource constraint for the economy,

$$\dot{\hat{k}} = \hat{k}^{\alpha}[1 - p^{1-\sigma}\psi]h(\bar{z}) - \hat{c} - (x + n + \delta)\hat{k}, \quad (13)$$

where $\hat{c} = ce^{-xt}$ and $k(0)$ is given.

The growth rate of consumption per effective worker is solved by substituting the real interest rate in equation (8) into equation (4).

$$\dot{\hat{c}}/\hat{c} = (1/\theta)\{\alpha\hat{k}^{\alpha-1}[(1 - \psi)h(\bar{z})]^{1/\sigma} - \delta - \rho - \theta x\}. \quad (14)$$

Equations (13) and (14) and a transversality condition determine the time paths of $\hat{k}$ and $\hat{c}$ in this economy. As is well known, in the steady state of the neoclassical model, consumption, investment, capital stock, and output all grow at the exogenously given rate of technological progress (see Barro and Sala-i-Martin (1991b, chapter 1)). Therefore, the other parameters do not matter for the steady-state growth rates, although they change the steady-state values of $\hat{k}$ and $\hat{c}$. With constant p and thereby constant $\bar{z}$, this open economy exhibits the same dynamics as the closed economy does: the economy converges to the steady state at a decreasing rate, and in the steady state all quantities grow at the exogenously given rate of technological progress.

Free Trade Steady-State Equilibrium

Suppose that the price of foreign goods equals the price of domestic goods in the world market as the economy follows a policy of free trade. Equations (11) and (12) simplify to

$$\bar{z} = (1 - \psi)^{-1}\psi; \tag{11'}$$

$$h(\bar{z}) = (1 - \psi)^{-1}. \tag{12'}$$

And equations (13) and (14) are rewritten as

$$\dot{\hat{k}} = \hat{k}^{\alpha} - c - (x + n + \delta)\hat{k}; \tag{13'}$$

$$\dot{\hat{c}}/\hat{c} = 1/\theta(\alpha k^{\alpha - 1} - \delta - \rho - \theta x). \tag{14'}$$

Thus, the free trade steady state has values of capital stock and income per effective worker as follows:

$$\hat{k}^* = [\alpha(\delta + \rho + \theta x)^{-1}]^{1/(1-\alpha)}, \tag{15}$$

$$\hat{y}^* = \hat{k}^{*\alpha} = [\alpha(\delta + \rho + \theta x)^{-1}]^{\alpha/(1-\alpha)}, \tag{16}$$

where $\hat{k}^*$ denotes the free trade steady-state capital stock per effective worker, and $\hat{y}^*$ the free trade steady-state income per effective worker. Note that when the economy is engaged in free trade, the size of imported inputs in total output (ψ) does not matter for steady-state income in this model. In other words, what really matters for the steady-state income is free trade policy not the import share itself. For example, a large country that can acquire most of its intermediate inputs domestically, and consequently has a low ψ, goes to the same steady-state income as does a small country that may depend more on foreign intermediate inputs and consequently will have a high ψ. This makes sense because there is no technological difference between either domestic or imported inputs. However, once trade is distorted, the size of the import share matters and determines the effects of trade distortions on income. Suppose that this economy cuts off foreign transactions ($M = 0$), then the autarkic output and income become

$$\hat{q}^* = 0, \quad \text{if } \sigma < 1; \quad \text{and}$$

$$\hat{q}^* = (1 - \psi)^{1/(\sigma - 1)}\hat{k}^{*\alpha}, \quad \text{if } \sigma > 1. \tag{17}$$

Not surprisingly, when the imported input is essential in the production of domestic goods ($\sigma < 1$), the autarkic economy exhibits no output growth over time. Unless the domestic and the imported inputs are perfect substitutes ($\sigma = \infty$), the autarkic steady-state values of the capital stock, consumption, and income per capita are lower than their free trade values. And as ψ becomes larger, output is lower when the economy is autarkic. The parameter ψ, which denotes the steady-state share of imports in total output, may depend on the resource endowments of the economy, as will be discussed later. Therefore, implementing a free trade policy may be more important for a smaller country than a larger country.

The steady-state gross saving rate is given by

$$s^* = \frac{(x+\delta)\hat{k}^*}{\hat{y}^*} = \frac{(x+\delta)\alpha}{f_k^*} = \frac{(x+\delta)\alpha}{(\rho+\delta+\theta x)}. \qquad (18)$$

Thus, import share does not matter for the steady-state saving rate.

Transitional Dynamics and Economic Growth

The steady state in the neoclassical model, where the growth rate is given by the exogenous technological progress x, does not provide any interesting implications for economic growth. The explanation that observed variations in cross-country growth rates are only the result of different rates of exogenous technological progress is not very convincing. As a result, much attention has been given to the process of transitional dynamics.

During the transitional period in which the economy approaches the steady state from a low initial level of capital stock, $\hat{k}$ and $\hat{c}$ rise monotonically toward their steady-state values but at decreasing rates (see Barro and Sala-i-Martin (1991b, chapter 1)). In the neoclassical model, the length of the transitional period can be examined by a log-linearized version of equations (13′) and (14′) around the steady state. Following Sala-i-Martin (1990a), the average growth rate of per capita income, y, over a period from initial time 0 to any future time $T > 0$ is given by

$$(1/T)\log[y(T)/y(0)] = x + \frac{(1-e^{-\beta T})}{T}[\log(\hat{y}^*/\hat{y}(0))], \qquad (19)$$

where $\hat{y}^*$ denotes the steady-state level of income per effective worker. "The speed of convergence" is β, with $\beta > 0$. Various empirical studies show that the estimates for the convergence speed, β, are roughly about 2 percent a year (Barro and Sala-i-Martin (1991a) and Mankiw, Romer, and Weil (1992)). This predicted coefficient implies a lengthy convergence period: about 35 years to move half the distance between the initial per capita income figure and the steady state, and more than 100 years to move 90 percent of the distance. In a special Solow case, in which the saving rate is always constant over time, the convergence speed simplifies to

$$\beta = (1-\alpha)(\delta + n + x). \qquad (20)$$

Then the empirical estimate for β, roughly 0.02 per year, requires a value for α of around 0.75 with the other parameter values on the order of $\delta = 0.04$, $x = 0.02$, and $n = 0.02$. Therefore, in these types of neoclassical models, α, the share of "broad capital," must be well above the conventional value of one-third.

Equation (19) shows that the economy exhibits growth rates exceeding

x, the exogenously given rate of technological progress, during the transitional period. If the last term of equation (19) is large, transitional dynamics may explain a significant part of the growth rate, and hence play a larger role in explaining differences in growth rates than that played by the exogenously given rate of technological progress. If this is the case, trade policies, which change the steady-state level of income, may have long-run effects on economic growth in the neoclassical model.

II. Trade Distortions and Economic Growth

In the open economy model presented above, any trade distortions that restrict the availability of foreign goods lower steady-state income and consumption per capita.

Effects of Trade Distortions

Suppose that the government intervenes in foreign transactions by imposing a tariff τ on the imports of foreign goods so that the price paid by the domestic purchaser is $(1 + \tau)$ times the price received by foreign exporters.[2] Thus,

$$p = (1 + \tau), \quad \text{for } \tau \geq 0, \tag{21}$$

where p is the relative price of the foreign good in terms of domestic goods.[3]

Government is assumed to transfer tariff revenues to the public.[4] The lump-sum transfer directly increases private sector income. Therefore, the tariff has two effects on the economy, namely the distortion of resource allocation and the transfer of revenue. Tariff revenue is given by

$$\hat{G} = \tau \hat{m}, \tag{22}$$

where $\hat{G}$ is the tariff revenue per effective worker.

Solving the equilibrium z and $h(z)$ by substituting equation (21) into

[2] Quantitative restrictions on imports can also be considered to increase the domestic price of foreign inputs equivalently.

[3] If consumer goods are imported and trade distortions are imposed on the imports of both consumer and producer goods, a change in p can be smaller than τ with the increase in the domestic price of output, which depends on the substitutability between foreign and domestic consumer goods.

[4] The role of government expenditure as a productive input for private production is considered later in this section. Barro (1990, section 4) considers the case where government provides services that directly increase households' utility. For small tariff rates, assumptions about tariff revenue make little difference.

equations (11) and (12), and then using equations (13) and (14), gives the time path of the economy when trade distortions are imposed:

$$\dot{\hat{k}} = \hat{k}^{\alpha}\Phi - \hat{c} - (x + n + \delta)\hat{k} + \hat{G}, \tag{23}$$

$$\dot{\hat{c}}/\hat{c} = (1/\theta)[(\alpha\hat{k}^{\alpha-1}\Phi) - \delta - \rho - \theta x], \tag{24}$$

where $\Phi = [(1 - \psi)h(\bar{z})]^{1/\sigma} = [(1 + \pi) - \pi(1 + \tau)^{1-\sigma}]^{1/(1-\sigma)}$. The parameter π, which is $\psi/(1 - \psi)$, denotes the share of imported inputs in the value added in trade. The parameter π, which denotes free trade openness, may depend on structural features of the economy, such as factor endowments and natural trade barriers.

Equation (24) can be solved for the steady-state capital stock per effective worker:

$$\hat{k}^* = [\alpha(\delta + \rho + \theta x)^{-1}\Phi]^{1/(1-\alpha)}. \tag{25}$$

Since $\Phi_{\tau} < 0$, the steady-state capital stock decreases with the tariff. Steady-state income is given by

$$\begin{aligned}\hat{y}^* &= \hat{k}^{\alpha}\Phi + \hat{G}^* = (1 + \hat{g}^*)\hat{k}^{\alpha}\Phi \\ &= [\alpha(\delta + \rho + \theta x)^{-1}]^{\alpha/(1-\alpha)}(1 + \hat{g}^*)\Phi^{1/(1-\alpha)},\end{aligned} \tag{26}$$

where $\hat{g}^*$ is the proportion of tariff revenue in private income, that is, income excluding government transfers. Equation (26) shows that the effects of trade distortions on the steady-state income consist of two components: the distortion and the revenue effect. Without the transfer of tariff revenue, $\hat{g}^*$ will be zero and there is no revenue effect. Equations (25) and (26) imply that the distortionary effect of tariffs always decreases the steady-state levels of the capital stock, output, and thus consumption.

Effects of trade distortions on the steady-state gross saving rate depend entirely on the revenue effect. The steady-state gross saving rate is given by

$$s^* = \frac{(x + n + \delta)\hat{k}^*}{\hat{y}^*} = \frac{(x + n + \delta)\alpha^{-1}}{(\rho + \delta + \theta x)}(1 + \hat{g}^*)^{-1}. \tag{27}$$

Trade Distortions and Growth

As shown in equation (19), the effects of the trade distortions depend on the change in steady-state income and the convergence speed. The convergence speed, β, is not changed if a constant saving rate over time is assumed. For the Solow case, in which the saving rate is constant, equation (27) is rewritten as follows:

$$\dot{\hat{k}} = s(1 + \hat{g}^*)\hat{k}^{\alpha}\Phi - (x + n + \delta)\hat{k}. \tag{28}$$

The log linearization of this equation around the steady state gives the same convergence speed, β, as in equation (21). Thus, during the transitional period, the effects of trade distortions depend entirely on the change in the steady-state income. Substituting equation (26) into equation (19) gives the growth rate in the transitional period:[5]

$$(1/T)\log[y(T)/y(0)] = \frac{(1-e^{\beta T})}{T}\alpha(1-\alpha)^{-1}\log[\alpha(\delta + \mathrm{p} + \theta x)^{-1}] - \frac{(1-e^{-\beta T})}{T}\log[\hat{y}(0)] + \frac{(1-e^{-\beta T})}{T}\log(1+\hat{g}) + \frac{(1-e^{-\beta T})}{T}(1-\alpha)^{-1}\log\Phi + x. \quad (29)$$

The effects of trade distortions on the growth rate in the transitional period hinge on the last two components—revenue and the distortion effect. If the Cobb-Douglas combination of domestic inputs and foreign goods is assumed, the distortionary effect is simplified to[6]

$$-\frac{(1-e^{-\beta T})}{T}(1-\alpha)^{-1}\pi\log(1+\tau). \quad (30)$$

Thus, the distortionary effects of tariffs on the growth rate evidently hinge on free trade openness: the level of openness magnifies the distortionary effect multiplicatively. Thus, the same trade distortion decreases the growth rate more in an economy that has a high π. Therefore, free trade is more important in a small, resource-scarce economy, which would become more open in the steady state, than in a large, resource-abundant economy.

Expression (30) gives more insights on the effects of trade distortions if one considers a special case in which the saving rate is constant over time and T is small. As T approaches 0, the value of $(1-e^{-\beta T})/T$ approaches β. In this case, equation (30), the distortionary effect, is simplified to

$$-(x + n + \delta)\pi\log(1+\tau). \quad (31)$$

Thus, the value of the capital share, α, does not matter for the determination of the tariff effect.

[5] It is assumed that initial income is not plagued by the same trade distortion that influences the steady-state income. If the same distortionary trade policy has prevailed over the whole period, its effects on the transitional growth rates become smaller by a factor of α and the revenue effect disappears.

[6] This result is obtained by taking the limit of the last log term in equation (29) and using l'Hopital's rule.

Effects of Trade Distortions in a Model Economy

The effects of trade distortions in a representative economy are now considered. Equation (29) implies that the tariff rate τ decreases the growth rate in the transitional period by about $100(x + n + \delta)(\log \Phi)$ percent if the saving rate is constant. Here, the values of plausible parameters are considered to be $\delta = 0.04$, $n = 0.02$, and $x = 0.02$. The selection of the parameter value for free trade openness π is obviously critical in determining the effects of the trade restrictions. For the numerical example, two cases are considered—$\pi = 0.4$ and $\pi = 0.2$. These figures are chosen by considering the average share of total imports in GDP in a large sample of countries from various data sources.[7]

Table 1 shows the effect of tariffs on growth rates with various elasticities of substitution in production (still assuming a constant saving rate). The results show that trade distortions caused by tariffs decrease the growth rate of per capita income depending on the degree of free trade openness and on the elasticities. As the level of openness rises, the effects of trade distortions increase almost proportionally, given a particular level of substitutability between inputs. Given the openness, the elasticity of substitution between domestic and imported inputs becomes a crucial determinant of the distortionary effects. With a lower elasticity, which implies that imported goods are more essential for production, growth rates decrease more quickly as trade restrictions increase. When both inputs increase in substitutability ($\sigma > 1$), trade distortions are less damaging to the economy. However, for a moderate increase in the tariff rate, the role of substitutability between domestic inputs and foreign goods is less influential than is the openness of trade.

This numerical example illustrates that the effects of trade distortions on growth rates are quite significant. For example, in a country where π is 0.4 percent, a tariff rate of 20 percent, which roughly corresponds to the difference between the average tariff rates of the OECD countries and developing countries, reduces the growth rate of per capita income by about 0.5 percent or 0.6 percent depending on the elasticity of substitution in the country concerned.

[7] In 1988, the average import share in GDP was 0.37 in the World Bank (1990) *World Tables*, but was 0.20 in 1985 for all countries in Summers and Heston (1991). When total imports for each country are disaggregated at the five-digit SITC level according to the United Nations' (1976) "Classification by Broad Economic Categories," imports of capital goods and of intermediate goods were 73 percent of total imports on average in 1988. It was assumed that under free trade the import shares would be higher than these figures.

Table 1. *Effects of Tariffs on Growth Rates in the Transitional Period*
(Change of growth rate in percent)

	$\sigma = 2.0$		$\sigma = 1.0$		$\sigma = 0.5$	
Tariff rate in percent	Tariff effect	With transfer	Tariff effect	With transfer	Tariff effect	With transfer
When $\pi = 0.4$						
0	0.00	0.00	0.00	0.00	0.00	0.00
10	−0.29	−0.22	−0.31	−0.23	−0.32	−0.24
20	−0.52	−0.41	−0.58	−0.45	−0.62	−0.48
30	−0.71	−0.58	−0.84	−0.66	−0.92	−0.71
40	−0.87	−0.72	−1.08	−0.86	−1.22	−0.95
50	−1.00	−0.85	−1.30	−1.05	−1.51	−1.18
60	−1.12	−0.96	−1.50	−1.22	−1.79	−1.41
70	−1.22	−1.06	−1.70	−1.39	−2.07	−1.64
80	−1.31	−1.15	−1.88	−1.55	−2.35	−1.86
90	−1.39	−1.23	−2.05	−1.71	−2.63	−2.09
100	−1.46	−1.30	−2.22	−1.85	−2.90	−2.31
110	−1.52	−1.36	−2.38	−1.99	−3.17	−2.54
120	−1.58	−1.42	−2.52	−2.13	−3.44	−2.76
When $\pi = 0.2$						
0	0.00	0.00	0.00	0.00	0.00	0.00
10	−0.14	−0.11	−0.15	−0.12	−0.16	−0.12
20	−0.26	−0.21	−0.29	−0.23	−0.31	−0.24
30	−0.36	−0.29	−0.42	−0.33	−0.45	−0.35
40	−0.44	−0.37	−0.54	−0.43	−0.60	−0.46
50	−0.52	−0.43	−0.65	−0.52	−0.74	−0.57
60	−0.58	−0.49	−0.75	−0.61	−0.87	−0.68
70	−0.63	−0.55	−0.85	−0.69	−1.00	−0.79
80	−0.68	−0.59	−0.94	−0.77	−1.13	−0.89
90	−0.72	−0.64	−1.03	−0.85	−1.26	−0.99
100	−0.76	−0.67	−1.11	−0.92	−1.38	−1.10
110	−0.80	−0.71	−1.19	−0.99	−1.51	−1.20
120	−0.83	−0.74	−1.26	−1.05	−1.63	−1.30

Notes: π denotes the share of imported inputs in value added in free trade. σ is the elasticity of substitution between domestic inputs and foreign inputs. Pure distortion effects of the tariff and the total effect with a lump-sum transfer of revenue are presented.

Table 1 also reports the additional revenue effect of tariffs on the growth rate. The lump-sum transfer of tariff revenue, by increasing steady-state income in the private sector, offsets the negative effects of a tariff, though to a limited degree. The strong distortionary effect with low substitutability is most affected since the lower elasticity of substitution between domestic and imported inputs raises tariff revenue.

Public Investment and Growth

Until now, it has been assumed that government transfers the tariff revenues to the public and that the lump-sum transfer partially offsets the distortionary effect of the tariff by increasing steady-state income in the private sector. This section considers the role of government spending as an input to private production along the lines of Barro (1990). Under this approach, government provides a public input to the production of private goods, which is financed by tariffs. Assume that public inputs are combined with the foreign inputs in a Cobb-Douglas production function for the private good:[8]

$$Q = [\gamma_1(K^{\alpha}\hat{L}^{1-\alpha})^{\mu} + \gamma_2(M^{1-\chi}G^{\chi})^{\mu}]^{1/\mu}, \quad \text{for } 1 > \chi > 0. \tag{32}$$

Public inputs are interpreted as "publicly provided private goods," which are "rival" and "excludable."[9] Thus, each producer has a property right to the quantity of the public input that is provided by the government. This equation is rewritten in terms of the effective worker:

$$\hat{q} = \hat{k}^{\alpha} h(z\tau^{\chi}), \tag{33}$$

where a balanced government budget is assumed. The equation shows that the tariff has a positive effect on the production of the private good. Hence, tariff revenue used for the production of private goods diminishes the distortionary effect on the growth rate. If the Cobb-Douglas combination of $(K^{\alpha}\hat{L}^{1-\alpha})$ and $(M^{1-\chi}G^{\chi})$ is assumed, the total growth effect of tariffs is simplified to

$$-\frac{(1-e^{-\beta T})}{T}(1-\alpha)^{-1}\pi(1-\chi)\log\tau^{-\chi}(1+\tau). \tag{34}$$

Thus, the net effect of the tariff on the growth rate is determined as follows:

$$\partial \log[y(T)/y(0)]/\partial\tau > 0, \quad \text{if } (1-\chi)\chi^{-1}\tau < 1,$$

and

$$\partial \log[y(T)/y(0)]/\partial\tau < 0, \quad \text{if } (1-\chi)\chi^{-1}\tau < 1. \tag{35}$$

[8] It is assumed that the government purchases private output and then makes it available as inputs to producers in the private sector.

[9] "Rival" means that no person can enjoy the good without decreasing another person's enjoyment, and "excludable" means that it is possible to exclude a person from the enjoyment of the good if he is not willing to pay the price. For the case of public goods, which are nonrival or nonexcludable, see Barro and Sala-i-Martin (1990).

The expression shows that, even if the government uses all tariff revenue for its most productive use, a high tariff will eventually reduce the growth rate. If one assumes that the share of imported inputs in value added is around 0.3 and the share of total public investment in value added is around 0.033 (which is the 1960–85 average for all countries in Barro (1991)), then tariff rates above 11 percent always lower the growth rate.

The result shows that the relation between tariffs and growth rates is negative except with a very low tariff rate—the distortionary effect of which can be superceded by the stimulating effect of public investment financed by the tariff revenue. This finding that the distortionary effect usually overshadows the productive revenue effect matches the results in Barro (1990) and Easterly (1990). Since the marginal productivity of public investment is very high when the size of public investment is small, the effect of an increase in public input may dominate the distortionary effect of the tariff and create a net positive effect on growth. However, when the tariff rates are high enough, the productivity of public input diminishes; thus, higher tariffs always lead to lower growth rates.

Real Interest Rate Puzzle

One criticism of the neoclassical model is that it predicts an unreasonably wide range of values for the marginal productivity of capital and hence for real interest rates. This prediction apparently contradicts the observed lack of capital flowing from rich countries to poor ones (King and Rebelo (1989)). The open economy model considered here may provide an answer to this contradiction. With trade distortions, the systematic negative relation between per capita income and the marginal productivity of capital (V) no longer holds. Trade restrictions may lower the marginal productivity of capital, and thus the real interest rate, enough to prevent capital from flowing to poor countries. From equations (25) and (26), V can be written as a function of income and the tariff:

$$V = \alpha \hat{y}^{(\alpha - 1)/\alpha} \Phi^{1/\alpha}. \tag{36}$$

To simplify the discussion, tariff revenues are ignored. The result shows that trade distortions affect V more significantly than the difference in income. It is very plausible, therefore, that V is higher in a high-income, low-distortion country than it is in a low-income, high-distortion country.

Table 2 shows the extent to which V is lower in a tariff-ridden economy than in a free trade one, when both countries have the same income. Assuming the conventional value for the capital share ($\alpha = 1/3$), the numerical results show that a tariff rate of about 30 percent reduces V

Table 2. *Marginal Productivity of Capital in a Tariff-Ridden Economy*
(Index, zero tariffs equal unity)

Tariff rate in percent	$\pi = 0.4$			$\pi = 0.2$		
	$\sigma = 2.0$	$\sigma = 1.0$	$\sigma = 0.5$	$\sigma = 2.0$	$\sigma = 1.0$	$\sigma = 0.5$
0	1.00	1.00	1.00	1.00	1.00	1.00
10	0.90	0.89	0.89	0.95	0.94	0.94
20	0.82	0.80	0.79	0.91	0.90	0.89
30	0.77	0.73	0.70	0.87	0.85	0.84
40	0.72	0.67	0.63	0.85	0.82	0.80
50	0.68	0.61	0.57	0.82	0.78	0.76
60	0.65	0.57	0.51	0.80	0.75	0.72
70	0.63	0.53	0.46	0.79	0.72	0.68
80	0.61	0.49	0.41	0.77	0.70	0.65
90	0.59	0.46	0.37	0.76	0.68	0.62
100	0.58	0.43	0.33	0.75	0.66	0.59
110	0.56	0.41	0.30	0.74	0.64	0.57
120	0.55	0.38	0.27	0.73	0.62	0.54

Notes: π denotes the share of imported inputs in value added in free trade. σ is the elasticity of substitution between domestic inputs and foreign inputs. Marginal productivity of capital under free trade is normalized to 1.0.

to about two-thirds of its free trade value when π is equal to 0.4. A simple calculation shows that a 30 percent tariff rate offsets about 20 percent of the income differential, thus leaving V the same. Therefore, trade restrictions are crucial in determining real interest rates, and thereby the capital flow.

III. Trade Distortions in an Endogenous Growth Model

In this section, a simple endogenous growth model is considered by assuming that production requires no fixed labor input. The production function is constant returns to scale in both capital and imported inputs. Thus, it is a variant of the "AK" model (Rebelo (1991)). Because the economy is assumed to be small in the world market, foreign inputs are a reproducible factor. Using a similar framework, Easterly (1990) shows that a tariff on imported capital decreases the growth rate by reducing the marginal productivity of capital in a country.

This production technology implies that α equals 1 in equation (7). Defining $Z = M/K$, the production function is written as a type of "AK":

$$Q = AKh(Z), \quad \text{for } A > 0, \tag{37}$$

where A is a constant. This production function gives the real interest rate, which is substituted into equation (4) and yields

$$\dot{c}/c = (1/\theta)[A\Phi - \delta - \rho], \tag{38}$$

where Φ is $[(1 + \pi) - \pi(1 + \tau)^{1-\sigma}]^{1/(1-\sigma)}$, as in the preceding section. The resource constraint in the economy is given by

$$\dot{\hat{k}} = A\hat{k}\Phi - \hat{c} - (x + n + \delta)\hat{k} + \hat{G}. \tag{39}$$

Equation (38) shows the common growth rate of consumption, output, and capital in this economy. The economy has no transitional dynamics and all quantities grow at the same rate. (See Sala-i-Martin (1990b) for a rigorous proof.) Equation (38) shows that trade distortions always decrease income growth rates. In the endogenous growth model, tariff revenue does not affect the growth rate, though it is important for welfare. To predict the effects of trade distortions, this endogenous growth model can be considered as a limiting case of a neoclassical model with an infinite convergence period. Thus, this simple case gives a striking result: distortionary effects are the *same* in both exogenous and endogenous growth models when the saving rates are constant. In the constant saving case, the effect of trade distortions was simplified to approximately $[(x + n + \delta)\pi \log(1 + \tau)]$ in equation (31). Therefore, as already noted, the capital share does not change the effects of trade distortions. If the saving rate can change, however, the effects of trade distortions are different. In the endogenous growth model, an increase in the tariff may raise or lower the saving rate:

$$\begin{aligned} s &= (\dot{K} + \delta K)/y = (1 + g)^{-1}\Phi^{-1}[\delta + (\dot{K}/K)] \\ &= (1 + g)^{-1}\{(1/\theta) + \Phi^{-1}[(\delta/A) + (1/\theta)(-\delta - \rho)]\}. \end{aligned} \tag{40}$$

Therefore, the effect of a tariff on the saving rate depends on the sign of the last bracketed expression and on the tariff revenue.

To see the total effects of trade distortions in the endogenous growth model, an economy with the parameter values—$\delta = 0.04$ and $x = 0.02$—is considered. Two different values for free trade openness are considered: $\pi = 0.4$ or $\pi = 0.2$. Momentary utility is taken to be logarithmic ($\theta = 1$) and the time discount rate ρ is assumed to be 0.05. The value of A is 0.04 in order for the steady-state growth rate to be 3 percent under free trade, which corresponds to the average growth rate of the OECD countries during 1960–85.

Table 3 shows that the size of free trade openness is central to the determination of distortionary effects, as in the exogenous growth model.

Table 3. *Effects of Tariffs on Growth Rates: Endogenous Growth Model*
(Change of growth rate in percent)

Tariff rate in percent	$\pi = 0.4$			$\pi = 0.2$		
	$\sigma = 2.0$	$\sigma = 1.0$	$\sigma = 0.5$	$\sigma = 2.0$	$\sigma = 1.0$	$\sigma = 0.5$
0	0.00	0.00	0.00	0.00	0.00	0.00
10	−0.42	−0.45	−0.46	−0.21	−0.23	−0.23
20	−0.75	−0.84	−0.90	−0.39	−0.43	−0.45
30	−1.01	−1.20	−1.31	−0.53	−0.61	−0.66
40	−1.23	−1.51	−1.69	−0.65	−0.78	−0.86
50	−1.41	−1.80	−2.06	−0.75	−0.93	−1.05
60	−1.57	−2.06	−2.41	−0.84	−1.08	−1.24
70	−1.70	−2.30	−2.74	−0.91	−1.21	−1.41
80	−1.81	−2.52	−3.06	−0.98	−1.33	−1.58
90	−1.91	−2.72	−3.36	−1.04	−1.45	−1.75
100	−2.00	−2.91	−3.65	−1.09	−1.55	−1.91
110	−2.08	−3.08	−3.92	−1.14	−1.66	−2.06
120	−2.15	−3.25	−4.00	−1.18	−1.75	−2.21

Notes: π denotes the share of imported inputs in value added in the free trade. σ is the elasticity of substitution between domestic inputs and foreign inputs.

Also the elasticity of substitution between domestic and foreign inputs is important. With low substitutability, the tariff decreases the growth rate more significantly.[10] The effects of a 20 percent tariff rate on the growth rate are more pronounced than in the exogenous growth model: the economy's growth rate falls by about 0.75 percent to 0.9 percent when π equals 0.4. If the same values of A and δ are assumed in the two countries, the endogenous growth model predicts that capital must flow from a low-distortion country to a high-distortion country since an increase in trade distortions decreases the marginal productivity of capital and thereby real interest rates.

IV. Exchange Controls and Economic Growth

Another important trade policy–induced distortion occurs with foreign exchange controls. Exchange controls have been prevalent, especially in developing countries where high fiscal deficits and a consequent high rate of money creation have posed problems for the maintenance of a "predetermined" nominal exchange rate. As fiscal imbalances and an overval-

[10]The lowest growth rate is bounded by $-\delta$, assuming that investment is irreversible.

ued exchange rate drain foreign exchange reserves, the authorities typically try to protect the depleted reserves by imposing quantitative exchange controls in the official exchange market. Under such a regime, the official market does not clear at the overvalued official exchange rate. As a result, as long as the costs of engaging in illegal transactions are not prohibitive, an illegal black market in exchange arises in response to the excess demand for foreign exchange. In the black market, the exchange rate floats freely to an equilibrium that is higher than the official rate.

In this section, a simple scheme of exchange controls is assumed. Exporters are legally obligated to surrender all export earnings to the central bank. The central bank then sells foreign exchange to importers. Exchange controls are enforced: the government restricts the availability of foreign exchange for the purchase of imported goods and services and prohibits the private sector from holding or transacting in foreign currency abroad. These binding restrictions on the availability of foreign exchange in the official market bring about an exchange premium in the black market.[11] In this economy, the domestic price of imports reflects the black market premium: imported inputs, obtained at the official exchange rate, are resold to the producers of export goods with the premium accruing to the importers. By contrast, despite the possibility of smuggling or underinvoicing, exporters will surrender all export proceeds to the authorities at the official rate. This follows from the assumption that the marginal cost of the exporters' illegal transactions is large enough to prevent illegal behavior.[12]

Suppose that world prices are equal to unity. Letting ϕ denote the black market premium,

$$p = 1 + \omega\phi. \tag{41}$$

The domestic price of imported goods increases by a proportion ω of the black market premium. The associated black market premium, $\omega\phi$, plays exactly the same role as an import tariff. The distortion that arises from foreign exchange controls always increases the price of the imported inputs and thereby lowers steady-state income, and consequently growth rates in the transitional period. The rent on the importers $\omega\phi M$ plays the same role as the tariff revenue, although it may not be counted in the official national income accounts.

[11] Many studies on the black market show this result in a general equilibrium framework (see, for example, Nowak (1984)).

[12] If the illegal transactions cost is not prohibitive, or if exporters have to surrender only a portion of their export proceeds, the marginal rate for exporters will be a weighted average between the official and the black market rate.

V. Empirical Implementation of the Model

It has been shown that distortionary trade policies such as trade restrictions and exchange controls have negative effects on the growth rate in the transitional period. To explore empirically the predictions of the model, the significance of tariff rates and black market premia for cross-country differences in growth is examined.

Specification of Empirical Equation

Equation (29) shows that the growth rate is a function of initial income and of trade distortions. Assuming a short time period and the Cobb-Douglas technology between domestic and foreign inputs, this equation is rewritten as

$$(1/T)\log[y(T)/y(0)] = \text{Constant} - \beta\log[\hat{y}(0)] + \beta\log(1+g) + \beta(1-\alpha)^{-1}\cdot\pi\log(1+\tau) + \beta(1-\alpha)^{-1}\pi\log(1+\omega\phi) + \epsilon, \quad (42)$$

where Constant $= x + \beta(1-\alpha)^{-1}\log[\alpha(\delta+\rho+\theta x)^{-1}]$.

The trade and the exchange rate distortions are represented by the tariff rate and the black market premium. This equation shows how the growth rate of per capita income depends on initial income and the existing distortions. One potential problem with estimating equation (42) is that the error term ϵ may be correlated with other independent variables. Any correlation between the error term (for example, an omitted saving variable) and the variables representing the distortions gives biased estimates. This potential bias may be partially corrected by including the saving rate in the equation. By assuming the constant saving rate, the growth equation (42) is rewritten as follows:

$$(1/T)\log[y(T)/y(0)] = \text{Constant}' - (1-\alpha)(x+n+\delta)\log[\hat{y}(0)] + \alpha_k(x+n+\delta)\log S_k + \alpha_h(x+n+\delta)\log S_h + (x+n+\delta)\log(1+g) - (x+n+\delta)\cdot\pi\log(1+\tau) - (x+n+\delta)\pi\log(1+\omega\phi) + \epsilon', \quad (43)$$

where Constant$' = x - \alpha(x+n+\delta)\log(x+n+\delta)$.

The saving rates of physical capital and human capital are included separately. Therefore α_k and α_h denote the share of each capital input in the value added. The tariff revenue is ignored in the estimation since cross-country data are not widely available. As discussed earlier, omission of the revenue variable would little bias the estimation anyway.

Data

For the regressions, most of the data are from Barro's (1991) data set, which in turn draws primarily on the Summers and Heston (1988) data set. Here, the annual growth rate of per capita real GDP during 1960-85 is used as a dependent variable for all regressions. The variable S_k is measured as the average share of real investment (including government investment) in real GDP. The secondary school enrollment ratio in 1960 is used as a proxy for the saving rate of human capital (S_h).

Data on black market premia are assembled from the Levine and Renelt (1990) data set and from Wood (1988), which originally come from *Pick's Currency Yearbook*. The variable used is the average of black market exchange rate premia from 1960 to 1987. The data are available for 102 countries. Data on tariff rates on imported inputs—intermediate and capital goods—have been assembled for 108 countries from various sources: Lee and Swagel (1992) for 96 countries, and General Agreement on Tariffs and Trade (1980) and Greenaway (1983) for six OECD countries.[13] Lee and Swagel (1992) report an import-weighted average of ad valorem import charges on consumer, intermediate, and capital goods using tariff rates at the most detailed level of the Customs Cooperation Council Nomenclature (CCCN), which are collected by the United Nations from country sources. Although this is one of the most extensive measures for trade restrictions available, a number of reservations must be considered when making cross-country comparisons of trade restrictions on its basis. First, these data do not reflect nontariff barriers (NTBs), such as quantitative import restrictions and voluntary export restraints. Studies show that NTBs cover a significant fraction of import categories in most countries (see Pritchett (1990) and Lee and Swagel (1992)). Although some measures of the frequency of NTBs are available, they do not accurately measure the intensity of NTBs. The black

[13] For those six OECD countries—Austria, Finland, Norway, Sweden, Switzerland, and New Zealand—an import-weighted average tariff rate on imports of semimanufactures is used.

market premium, however, might partially reflect the intensity of the quantitative restrictions in the economy. A second reservation with the CCCN numbers is that the data refer to various years in the 1980s. Thus, it may not stand for the degree of trade distortion in the full sample period. This problem will be less significant if the tariff structure across countries has not varied much over the period.[14] Third, tariff rates for each country are weighted by their own import value. Thus, an import-weighted average of sectoral tariff rates has a problem of downward bias because imports become smaller in a sector with a higher tariff rate.

To construct a measure of free trade openness, the ratio of total imports to GDP in 1985 is obtained from Summers and Heston (1991).[15] Because this measure of the import share has been influenced by existing trade distortions, the measure of free trade openness is constructed by using instrumental variables. Assume that the import share is determined only by structural features of the economy, such as natural resource endowments and the natural trade barriers to free trade, and that total natural resources relate to the geographical size of each country. Thus, a larger country is assumed to be more self-sufficient under free trade than a smaller country. The distance to major world exporters is used in each country as a proxy for natural trade barriers, such as transportation and other transaction costs. The distances from the national capitals of the top 20 exporters are weighted by the bilateral import values in 1985.[16] Using geographical size, distance to foreign markets, and trade distortion measures as independent variables and the share of imports in GDP as the dependent variable, the following regression is estimated:[17]

$$\text{Import share} = \underset{(0.042)}{0.528} - \underset{(0.006)}{0.026} \log(area) - \underset{(0.023)}{0.095} \log(dist)$$

[14] In most of the countries, the tariff rate has been reduced over the sample period. However, I suspect that the ranking in tariff rates has not varied much among the countries.

[15] In previous versions of this paper data from the World Bank's (1990) *World Tables* are used. The following basic regression results do not depend on the measure of the import share. Conceptually, the import share from Summers and Heston seems to be a correct measure, considering that the growth rate of income comes from the same source.

[16] Distance data are taken from Fitzpatrick and Modlin (1986) and the bilateral import data come from the IMF's *Direction of Trade Statistics*.

[17] There are a number of studies that emphasize natural resource endowments and distances to determine trade volumes in free trade: for example, Bergsten and Cline (1985), Bergstrand (1985, 1989), and Lawrence (1987). Leamer (1984, 1988) presents various measures of trade volume under free trade, based on a Heckscher-Ohlin model at the three-digit SI C level. Unfortunately the number of countries included in his studies is too small to use in this study.

$$- \underset{(0.090)}{0.248} \log(1 + \textit{tariff}) - \underset{(0.034)}{0.075} \log(1 + BMP),$$

$$\bar{R}^2 = 0.585, \quad n = 79, \tag{44}$$

where standard errors are in parentheses. *Area* is the size of land in terms of millions of square kilometers and *dist* is an import-weighted distance in terms of 1,000 kilometers. The average black market premium over the period 1960 to 1987 is denoted *BMP*. By replacing coefficients on trade distortions—the tariff and the black market premium—with zeros in the estimated equation, the fitted values for the dependent variable are taken as a measure of free trade openness, π:

$$\pi = 0.528 - 0.026 \log(\textit{area}) - 0.095 \log(\textit{dist}). \tag{45}$$

Table 4 summarizes the assembled data set of 81 countries.[18] It shows that trade and exchange restrictions have been extensive in developing countries. Black market premia prevail in developing countries where exchange controls also predominate. By contrast, in the OECD during the sample period, a black market exchange premium existed in only Greece, Portugal, and Turkey. Tariff rates have also been much higher in developing countries. In the sample, tariffs of developing countries were, on average, 22.3 percent, compared with 4.4 percent for the developed countries. This reflects a gradual reduction of tariff barriers in the developed countries through seven rounds of multilateral trade negotiations under the GATT. Because of the severe trade restrictions in developing countries, the import share is far smaller than the corresponding free trade level. By contrast, the gap between the prevailing import shares and the free trade shares is, on average, negligible in the OECD countries.

Basic Results

Table 5 presents estimation results of equation (43). The first two columns report regressions of the rate of economic growth on tariff rates.[19] The results show that the negative relation between tariffs and growth is significant when initial income and saving rates are controlled. Inclusion of a dummy for sub-Saharan Africa strengthens the negative relationships. Regression of the growth rates on black market premia

[18]The data for individual countries are presented in Lee (1992).
[19]The population growth variable, $x + n + \delta$, has been dropped as it is insignificant and does not change any of the following conclusions.

Table 4. *Summary of Country Indicators*

Variable	All countries ($n = 81$) Mean	All countries ($n = 81$) Std. deviation	Industrial (OECD) countries ($n = 21$) Mean	Industrial (OECD) countries ($n = 21$) Std. deviation	Developing countries ($n = 60$) Mean	Developing countries ($n = 60$) Std. deviation
Real GDP, per capita (Y)	1.977	1.826	4.181	1.763	1.205	1.064
School enrollment (Sch)	0.223	0.220	0.509	0.200	0.123	0.112
Growth of real GDP, per capita	0.020	0.019	0.031	0.009	0.016	0.020
Domestic investment (Inv)	0.180	0.080	0.256	0.049	0.153	0.072
Tariff (Tar)	0.176	0.174	0.044	0.040	0.223	0.179
Black market premium (BMP)	0.389	0.597	0.016	0.053	0.519	0.644
Actual trade openness	0.162	0.130	0.275	0.129	0.120	0.104
Free trade openness (π)	0.222	0.074	0.280	0.080	0.201	0.061

Notes: Real per capita GDP in 1960 in thousands of 1980 dollars; Secondary school enrollment rate in 1960; Growth rate of real per capita GDP from 1960 to 1985; Ratio of real domestic investment to real GDP, average from 1960 to 1985; Import-weighted average tar ff rate on imports of intermediate and capital goods; Black market exchange rate premium relative to the official exchange rate, average from 1960 to 1987; Share of total imports in GDP; Estimate of the openness in free trade.

Table 5. *Regressions of Growth on Trade Distortions and Economic Variables in 81 Countries, 1960–85*

	Regression					
Independent variable	1	2	3	4	5	6
Constant	0.0848	0.0820	0.0800	0.0766	0.0828	0.0801
	(0.0076)	(0.0073)	(0.0071)	(0.0068)	(0.0073)	(0.0069)
Log(Y)	−0.0136	−0.0144	−0.0135	−0.0137	−0.0146	−0.0153
	(0.0028)	(0.0026)	(0.0025)	(0.0024)	(0.0026)	(0.0025)
Log(Sch)	0.0100	0.0053	0.0098	0.0056	0.0101	0.0055
	(0.0021)	(0.0024)	(0.0020)	(0.0024)	(0.0020)	(0.0023)
Log(Inv)	0.0194	0.0201	0.0170	0.0179	0.0164	0.0171
	(0.0040)	(0.0037)	(0.0039)	(0.0037)	(0.0039)	(0.0036)
π log(1 + Tar)	−0.1500	−0.1950	...	...	−0.1134	−0.1584
	(0.0789)	(0.0758)			(0.0757)	(0.0723)
π log(1 + BMP)	...	...	−0.0891	−0.0899	−0.0829	−0.0813
			(0.0266)	(0.0254)	(0.0267)	(0.0250)
Sub-Saharan Africa	...	−0.0171	...	−0.0148	...	−0.0169
		(0.0054)		(0.0051)		(0.0051)
$\bar{R}^2$	0.527	0.578	0.568	0.607	0.575	0.626
Standard error of estimate	0.0132	0.0125	0.0126	0.0121	0.0125	0.0118

Notes: The dependent variable is the growth of real GDP per capita, 1960–85. Standard errors of coefficients are in parentheses. See Table 4 for definitions of variables.

Table 6. *Regressions of Growth and Investment on Trade Distortions and Economic Variables in 81 Countries, 1960–85*

	Growth rate			Investment		
Independent variable	1	2	3	1	2	3
Constant	0.0593	0.0570	0.0621	0.2695	0.2491	0.2747
	(0.0064)	(0.0053)	(0.0059)	(0.0252)	(0.0226)	(0.0251)
Log(Y)	−0.0122	−0.0122	−0.0138	0.0084	0.0133	0.0053
	(0.0031)	(0.0028)	(0.0029)	(0.0123)	(0.0120)	(0.0123)
Log(Sch)	0.0140	0.0130	0.0133	0.0310	0.0283	0.0298
	(0.0022)	(0.0020)	(0.0020)	(0.0086)	(0.0087)	(0.0085)
π log(1 + Tar)	−0.2142	...	−0.1517	−0.8783	...	−0.7622
	(0.0886)		(0.0830)	(0.3491)		(0.3515)
π log(1 + BMP)	...	−0.1213	−0.1112	...	−0.2573	−0.2067
		(0.0284)	(0.0285)		(0.1214)	(0.1208)
$\bar{R}^2$	0.386	0.465	0.481	0.453	0.440	0.466
Standard error of estimate	0.0158	0.0141	0.0139	0.0593	0.0600	0.0586

Notes: The dependent variables are the growth of real GDP per capita and domestic investment as a share of GDP. Standard errors of coefficients are in parentheses. See Table 4 for definitions of variables.

shows that the premia are also strongly and negatively related to the cross-country growth rate.[20] The last two equations show that when the tariff rate and the black market premium are included together, the two variables still have independent effects on growth rates. The estimated coefficients on tariff rates are close to the magnitudes predicted by the model. The result in regression 5 suggests that, on average, in a developing country with an import share about 0.20 under a free trade regime, distortionary trade policies, such as a 25 percent tariff and a 50 percent black market premium, have decreased the growth rate by about 1.4 percent a year during the sample period.

The fact that tariff rates and black market premia negatively affect growth rates (after controlling for the investment rate) suggests that they do so by decreasing the productivity of capital. But trade restrictions and exchange controls may diminish capital accumulation itself, and thereby lower the growth rate. Table 6 supports this suspicion. The results show that trade distortions have decreased both the growth rate and the investment rate. Thus, distortionary trade policies influence growth rates negatively by decreasing both the rate of capital accumulation and its efficiency.[21]

VI. Concluding Remarks

This paper shows that trade policy generates cross-country divergences in growth rates of per capita income. In a neoclassical model of an open economy in which domestic production requires domestic and imported inputs, trade distortions caused by government policies of tariffs and exchange controls lower growth rates significantly over a long transitional period because they impede the supplies of imported inputs, thereby decreasing the productivity of capital accumulation. Thus, the well-known idea that trade and payments regimes are associated with growth rates through efficiency is confirmed.

The neoclassical open economy model considered here presents several implications. First, trade distortions are more harmful in a country that would import relatively more under a free trade regime: therefore

[20]This result contradicts empirical findings by Levine and Renelt (1990) and Fischer (1991) that the black market premium is always insignificantly related to the growth rate, when the investment rate is controlled. However, they have used the premium itself in the estimation as well as smaller samples of countries.

[21]Another interesting experiment is to test the significance of trade distortions alone, without interaction with π, as in equation (43). Unfortunately, high correlations between independent variables, such as $(1 + tariff)$ and $\pi(1 + tariff)$, make it impracticable.

a free trade policy is more important in a small, resource-scarce country than in a large, resource-rich country. Second, if saving rates are constant over time, trade distortions affect growth rates similarly in both the endogenous growth model with no fixed inputs and the usual neoclassical model with diminishing returns. Third, distortions substantially lower the marginal productivity of capital, causing capital to flow out of highly distorted low-income countries to high-income countries with low distortions.

The empirical results confirm that tariff rates and black market premia, interacting with the estimate of free trade imports, have significant negative effects on the growth rate of per capita income across countries in the sizes predicted by the model. Although in theory protecting specific sectors with scale economies can lead to higher efficiency and thus to higher growth, the empirical results, using cross-country data, do not support this speculation. Restrictive trade policies and exchange controls have made growth rates and economic well-being significantly lower than they otherwise would be.

REFERENCES

Agarwala, Ramgopal, "Price Distortions and Growth in Developing Countries," World Bank Staff Working Paper No. 575 (Washington: World Bank, 1983).

Backus, David, Patrick J. Kehoe, and Timothy Kehoe, "In Search of Scale Effects in Trade and Growth," Working Paper 451 (Minneapolis: Federal Reserve Bank of Minneapolis, 1990).

Bhagwati, Jagdish, "Export-Promoting Trade Strategy: Issues and Evidence," *The World Bank Research Observer* 3 (Washington: World Bank, January 1988), pp. 27–57.

Baranson, Jack, *Automotive Industries in Developing Countries*, World Bank Staff Occasional Papers No. 8 (Baltimore: The Johns Hopkins University Press, 1969).

Barro, Robert J., "Are Government Bonds Net Wealth?" *Journal of Political Economy*, Vol. 82 (1974), pp. 1095–1117.

———, "Government Spending in a Simple Model of Endogenous Growth," *Journal of Political Economy*, Vol. 98 (October 1990), S1 pp. 103–125.

———, "Economic Growth in a Cross Section of Countries," *Quarterly Journal of Economics*, Vol. 106 (May 1991), pp. 407–43.

Barro, Robert J., and Xavier Sala-i-Martin, "Public Finance in Models of Economic Growth," NBER Working Paper No. 3362 (Cambridge, Mass.: National Bureau of Economic Research, 1990).

——— (1991a), "Convergence Across States and Regions," *Brookings Papers on Economic Activity* 1 (1991), pp. 107–58.

——— (1991b), *Economic Growth* (unpublished, 1991).

Bergsten, Fred C., and William R. Cline, *The United States—Japan Economic Problem* (Washington: Institute for International Economics, 1985).

Bergstrand, Jeffrey H., "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence," *Review of Economics and Statistics*, Vol. 67 (August 1985), pp. 474–81.

———, "The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade," *Review of Economics and Statistics*, Vol. 71 (February 1989), pp. 143–53.

Easterly, William, "Endogenous Growth in Developing Countries with Government Induced Distortions" (unpublished; Washington: World Bank, 1990).

Edwards, Sebastian, "Openness, Outward Orientation, Trade Liberalization and Economic Performance in Developing Countries," NBER Working Paper No. 2908 (Cambridge, Mass.: National Bureau of Economic Research, 1989).

Fitzpatrick, Gary L., and Marilyn J. Modlin, *Direct-Line Distances: International Edition* (Metuchen, N.J.: Scarecrow Press, 1986).

General Agreement on Tariffs and Trade, *The Tokyo Round of Multilateral Trade Negotiations*, Vol. 2 (Geneva: GATT, 1980).

Greenaway, David, *Trade Policy and the New Protectionism* (New York: St. Martin's Press, 1983).

Grossman, Gene, and Elhanan Helpman, "Comparative Advantage and Long Run Growth," *American Economic Review*, Vol. 80 (September 1990), pp. 796–815.

Harrison, Ann, "Openness and Growth: A Time-Series, Cross-Country Analysis for Developing Countries" (unpublished; Washington: World Bank, 1991).

Havrylyshyn, Oli, "Trade Policy and Productivity Gains in Developing Countries: A Survey of the Literature," *The World Bank Research Observer*, Vol. 5 (1990), pp. 1–24.

Jung, W., and P. Marshall, "Exports, Growth and Causality in Developing Countries," *Journal of Development Economics*, Vol. 18 (1985), pp. 1–12.

King, Robert, and Sergio Rebelo, "Transitional Dynamics and Economic Growth in the Neoclassical Model," NBER Working Paper No. 3185 (Cambridge, Mass.: National Bureau of Economic Research, 1989).

Kruger, Anne, "Trade Policy as an Input to Development," *American Economic Review*, Vol. 70 (May 1980), pp. 288–92.

Krugman, Paul, "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher: Notes on Trade in the Presence of Dynamic Scale Economies," *Journal of Development Economics*, Vol. 27 (1987), pp. 41–55.

Lawrence, Robert Z., "Imports in Japan: Closed Markets or Minds?" *Brookings Papers on Economic Activity* 2:1987, pp. 517–54.

Leamer, Edward E., *Sources of International Comparative Advantage Theory and Evidence* (Cambridge, Mass.: MIT Press, 1984).

———, "Measures of Openness," in *Trade Policy Issues and Empirical Analysis*, ed. by Robert Baldwin (Chicago: University of Chicago Press, 1988), pp. 147–200.

Lee, Jong-Wha, "International Trade, Distortions, and Long-Run Economic Growth," IMF Working Paper 92/90 (Washington: International Monetary Fund, 1992).

Lee, Jong-Wha, and Phil Swagel, "Measuring Trade Distortions" (unpublished; Harvard University, 1992).

Levine, Ross, and David Renelt, "A Sensitivity Analysis of Cross-Country Growth Regressions" (unpublished; Washington: World Bank, 1990).

Lucas, Robert, "On the Mechanics of Economic Development," *Journal of Monetary Economics*, Vol. 22 (July 1988), pp. 3–42.

Mankiw, Gregory, David Romer, and David Weil, "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, Vol. 107 (May 1992), pp. 407–37.

Nowak, Michael, "Quantitative Controls and Unofficial Markets in Foreign Exchange," *Staff Papers*, International Monetary Fund (June 1984), pp. 404–31.

Pritchett, Lant, "Measuring Outward-Orientation in LDCs: Can it be Done?" (unpublished; Washington: World Bank, 1990).

Rebelo, Sergio, "Long Run Policy Analysis and Long Run Growth," *Journal of Political Economy*, Vol. 99 (June 1991), pp. 500–21.

Rivera-Batiz, L., and P. Romer, "International Trade with Endogenous Technological Change," *Quarterly Journal of Economics* (May 1991), pp. 531–556.

Romer, Paul M., "Endogenous Technological Change," *Journal of Political Economy*, Vol. 98 (October 1990), pp. S71–S102.

Sala-i-Martin, Xavier (1990a), "Lecture Notes on Economic Growth (I)," NBER Working Paper No. 3563 (Cambridge, Mass.: National Bureau of Economic Research, 1990).

——— (1990b), "Lecture Notes on Economic Growth (II)," NBER Working Paper No. 3564 (Cambridge, Mass.: National Bureau of Economic Research, 1990).

Summers, Robert, and Alan Heston, "A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950–85," *Review of Income and Wealth*, Vol. 34 (1988), pp. 1–25.

———, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–1988," *Quarterly Journal of Economics*, Vol. 106 (May 1991), pp. 327–68.

United Nations, "Classification by Broad Economic Categories Defined in Terms of SITC Rev 2," *Statistical Papers Series M*, No. 53, Rev. 1 (New York: United Nations, 1976).

World Bank, *World Tables* (London: Oxford University Press, 1990).

Wood, Adrian, "Global Trends in Real Exchange Rates 1960 to 1984." World Bank Discussion Paper 35 (Washington: World Bank, 1988).

Young, Alwyn, "Learning by Doing and the Dynamic Effects of International Trade," *Quarterly Journal of Economics*, Vol. 106 (May 1991), pp. 369–405.