The B.E. Journal of Macroeconomics

Topics

Volume 7, *Issue* 1 2007 *Article* 20

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Recommended Citation
Dmytro Kylymnyuk, Lilia Maliar, and Serguei Maliar (2007) "Rich, Poor and Growth-Miracle Nations: Multiple Equilibria Revisited," *The B.E. Journal of Macroeconomics*: Vol. 7: Iss. 1 (Topics), Article 20.
Available at: http://www.bepress.com/bejm/vol7/iss1/art20

Rich, Poor and Growth-Miracle Nations: Multiple Equilibria Revisited*

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Abstract

This paper presents a two-sector growth model of international trade that can account for the key features of the postwar world development experience. Two sectors represent traditional primitive production and modern sophisticated production. Due to increasing returns in the modern sector, the open-economy version of our model gives rise to three different equilibria: one in which the country produces only primitive goods and converges to a low-income steady state; another in which it produces both primitive and sophisticated goods and converges to the world-average steady state; and a third in which it specializes in the production of sophisticated goods and converges to a balanced growth path. We argue that the development experiences of poor, rich and growth-miracle countries are well described by these three equilibria.

KEYWORDS: international trade, small-open economy, multiple equilibria, poverty trap, growth miracles, coordination problem

*We thank two anonymous referees and editor Charles I. Jones for many valuable suggestions. We also benefited from the comments of Lola Guilló and Fidel Pérez. This research was supported by the Instituto Valenciano de Investigaciones Económicas, the Economics Education & Research Consortium (EERC) at the National University "Kyiv-Mohyla Academy" (NaUKMA), the Generalitat valenciana, and the Ministerio de Ciencia y Tecnología de España under the Ramón y Cajal program and BEC 2001-0535. Correspondence to: Lilia Maliar, Departamento de Fundamentos del Análisis Económico, Universidad de Alicante, Campus San Vicente del Raspeig, Ap. Correos 99, 03080 Alicante, Spain. E-mail: maliarl@merlin.fae.ua.es

1 Introduction

In this paper, we attempt to develop a unified theory that accounts for the main features of the postwar world development experience. The regularities that we observe in the data and that we try to reproduce are as follows: The typical rich country has a relatively large industrial sector and a relatively small agricultural sector, a sectoral composition that becomes stable over time. Rich countries have generally been rich for quite a long time and now continue to grow at relatively moderate rates. Some rich countries are large while others are small. The typical poor country, on the other hand, specializes in primitive natural-resource-based production and exchanges its primitive products (agriculture, food, fuel, ore, etc.) for more sophisticated products (manufactured goods) on the international market. Most of the poor countries have been poor for a long time and continue to have small positive or even negative growth rates. However, some of the countries that were poor in 1950s have started to grow at very high rates. The period of fast growth in such growth-miracle countries has been accompanied by a dramatic increase in the share of their industrial sectors (especially, in machinery and high-tech) relative to that of agriculture. Over the postwar period, the growth-miracle countries changed their international specialization, becoming importers of primitive goods and large-scale exporters of manufactured goods of increasing sophistication.

Our theory, aimed at explaining the above empirical regularities, is built around a dynamic two-sector growth model of international trade. The first sector produces a primitive commodity by using a constant returns-to-scale technology with two inputs, capital and natural resources, with the latter input being available at a fixed level. The second sector produces a sophisticated commodity from capital and primitive commodities; its technology has increasing returns in the early development stages (due to learning-by-doing and knowledge externalities), and it has constant returns in its later development stages (due to bounded externalities). Only sophisticated commodities can be used for consumption and investment. We consider two different versions of our economy, the autarkic and the open-economy versions. In the latter case, we assume that both primitive and sophisticated goods are tradable on the international market and that the economy is small in economic terms, so that it does not affect world prices.

In the autarkic version of our economy, long-run growth is impossible. Since the amount of natural resources is fixed, there are decreasing returns to scale in the production of primitive goods, and since primitive goods are used as an input for producing sophisticated goods, there are also asymptotically decreasing returns to scale in the production of sophisticated goods, which implies that the autarkic economy converges to a steady state.

The open-economy version of our model gives rise to three different equilibria, which are referred to here as the "poverty-trap", the "autarky-like" and the "growth-miracle" equilibria. In the poverty-trap equilibrium, the country produces only primitive goods and trades them for sophisticated goods on international market; it converges to a steady state with consumption (welfare), which is lower than that of the autarkic economy. Furthermore, in the autarky-like equilibrium, the open economy produces both primitive and sophisticated commodities; it mimics the behavior of the autarkic economy and converges to the same steady state as the autarkic economy does. Finally, in the growth-miracle equilibrium, the country produces mainly sophisticated goods and trades them for primitive goods on international market; it converges to a balanced growth path with an asymptotically constant growth rate. Long-run growth is possible for a small open economy because it can buy primitive goods at a constant world price and thus, has constant returns to the production of sophisticated goods. We argue that the postwar development experience of poor, rich and fast-growing countries is well described by the three equilibria we have constructed.[1]

When choosing from among equilibria, the agents face a coordination problem. Specifically, the production of sophisticated goods would be unprofitable for an individual investor if no other investors enter this sector, but it would be profitable if enough investors do so.[2] Therefore, according to our theory, countries that perform well are those that succeed in coordinating on a good equilibrium. We show that a larger capital endowment or richer natural resources can facilitate convergence to a good equilibrium. However, even under the most favorable initial conditions, a country can get stuck in a bad equilibrium forever. We argue that the government is the natural candidate for the task of coordination. In fact, empirical evidence indicates

[1] The presence of multiple equilibria has long been used in the literature to explain wide income differences across countries. As was advocated by Lucas (1993, p. 269), "If our objective is to understand a world in which similarly situated economies follow very different paths, these theoretical features [multiplicities] are advantageous".

[2] A similar mechanism can be found in the model of industrialization by Murphy, Shleifer and Vishny (1989). See also Rodrik (2003) for a discussion of the literature where coordination failures are induced by increasing returns to scale, as is in our case.

that government policies inducing simultaneous entry of producers into the sophisticated-good sector, played a crucial role in the economic success of the actual growth-miracle countries.

Our model combines several features that have been repeatedly referred to in the literature as being important in explaining the determinants of the economic growth and prosperity of nations. First of all, our model is similar to Variable-Returns-to Scale (VRS) models of international trade, in its assumption of increasing returns to scale in one of the two production sectors.[3] This assumption leads to multiple solutions in our model, as it does in the typical VRS setup.[4] Our model is particularly close to the one in Matsuyama (1992), however, there is an important difference between the two models: we explicitly consider intertemporal capital accumulation, whereas Matsuyama (1992) assumes that the capital input is fixed.[5] Thus, unlike the previous VRS models, which either have no engine of long-run growth and predict convergence to a steady state (as in, e.g., Graham and Temple, 2006) or have an exogenous engine of long-run growth (as in Matsuyama, 1992), our model can generate balanced endogenous long-run growth.[6]

Furthermore, in the growth-miracle equilibrium, our economy is similar to Hansen and Prescott's (2002) economy which evolves from agriculture, with a decreasing-returns-to-scale technology, to industry with AK technology. We differ from Hansen and Prescott (2002) in several respects. They focus on the closed-economy case, assume that the goods produced by the two sectors are perfect substitutes and do not consider externalities, which implies that there is a unique equilibrium where industry is always opened as soon as enough capital is accumulated. In contrast, we concentrate mainly on the open-economy case, assume that the output of one sector is used as the input for the other, and we have multiple equilibria, due to the presence of externalities, which implies that opening of the sophisticated-good sector is not guaranteed in general.

[3] See Choi and Yu (2002) for a review of the VRS trade literature.

[4] See Kemp and Schweinberger (1991) for a discussion on the multiplicity of equilibria in the VRS class of models.

[5] Matsuyama (1992, p. 330) admits that neglecting capital accumulation is "probably the most serious omission" of his analysis.

[6] Our model is also related to closed-economy models of industrialization in which there exist multiple equilibria due to increasing returns in the industrial sector; see, e.g., Murphy, Shleifer and Vishny (1989), Matsuyama (1991). However, those models do not generate endogenous long-run growth either.

Finally, our model is closely related to the dynamic neoclassical Heckscher-Ohlin models of comparative advantage, considered in Ventura (1997) and Atkeson and Kehoe (2000). We share with Ventura (1997) the mechanism for making a miracle, i.e., the implication that a small open economy that faces constant world prices can behave as if it had a linear technology. However, in contrast to Ventura (1997), who generates differing economic performance of simultaneously developing countries by assuming ex-ante heterogeneity (in, e.g., rental rates, relative productivities of sectors, subjective rates of preferences across countries), we have cross-country differences due to the multiplicity of equilibria, even if all of the countries are ex-ante identical. We share with Atkeson and Kehoe (2000) the assumption that countries differ in their timing of development. To be more specific, we assume that a small open economy begins to develop when the rest of the world has already developed. However, our conclusions regarding the destiny of a small late-blooming country is different from that of Atkeson and Kehoe (2000): their model predicts that late-blooming countries necessarily converge to a lower level of output per capita than early-blooming countries do, while our analysis suggests that late-blooming countries can converge either to a steady state with lower output than early-blooming countries do, or to a steady state with the same output as early-blooming countries do, or to a balanced growth path.

The plan of the paper is as follows: In Section 2, we present the model and characterize its implications. In Section 3, we describe the empirical relationship between the sectorial composition, international trade and economic growth, and we argue that the model can account for the key features of the postwar world development experience. In Section 4, we discuss some factors that determine the equilibrium choice, and finally, in Section 5, we conclude.

2 The model

In this section, we describe a two-sector economy and derive the equilibrium conditions. Subsequently, we consider two different versions of our economy, the autarkic and the open-economy.

2.1 A two-sector economy

Time is continuous, and the horizon is infinite. The consumer side of the economy consists of a continuum of infinitely-lived agents with their names on a closed interval $[0, 1]$. As a result, average and aggregate quantities coincide in our model.

An agent owns capital and natural resources and rents them to the production firms. Natural resources do not depreciate and stay constant over time. The capital stock depreciates at the rate $\delta \in (0, 1]$. The agent spends the period's income on consumption and investment. Hence, the agent faces the following constraints:

$$c_t + x_t = r_t k_t + q_t N, \tag{1}$$

$$\dot{k}_t = x_t - \delta k_t, \tag{2}$$

where c_t is consumption; x_t, k_t, r_t, are, respectively, investment, capital and interest rate; N and q_t denote natural resources and their price, respectively. Dot over k_t represents differentiation with respect to time.

The consumer has a period utility function of the Constant Relative Risk Aversion (CRRA) type and solves the following intertemporal utility-maximization problem:

$$\max_{\{c_t, k_t\}} \int_0^\infty e^{-\rho t} \left[\frac{c_t^{1-\sigma} - 1}{1-\sigma} \right] dt \tag{3}$$

subject to

$$\dot{k}_t = (r_t - \delta) k_t + q_t N - c_t, \tag{4}$$

$$\lim_{t \to \infty} \left[k_t e^{-\int_0^t r_v dv} \right] \geqslant 0, \tag{5}$$

with the initial value of the capital stock, k_0, being given. Here, $\rho > 0$ is the discount rate; $\sigma > 0$ is the utility function parameter; budget constraint (4) follows from (1) – (2); and finally, (5) is a no-Ponzi game condition that precludes the consumer from infinite borrowing.

The production side of the economy consists of a representative firm that buys its inputs and sells its output on perfectly competitive markets. The firm has two production units which correspond to two sectors of the economy: primitive-good and sophisticated-good sectors denoted by superscripts "p" and "s", respectively.

The production of primitive goods can be interpreted as traditional production which depends heavily on natural resources (such as land, sea, ore, etc.); and where the transformation of initial inputs is relatively small and does not make use of a complicated technological process. This sector has a constant return-to-scale production technology, characterized by a Cobb-Douglas production function:

$$y_t^p = (k_t^p)^\beta N^{1-\beta}, \tag{6}$$

where $\beta \in (0,1)$. We think of primitive goods as intermediate products (or raw materials) which should be further transformed by the sophisticated-good sector into the final consumption or investment goods.[7]

The sophisticated-good sector employs a production technology that has constant returns to scale in private inputs and is subject to learning-by-doing and knowledge spillovers as in Romer (1986),

$$y_t^s = \varphi_t (k_t^s)^\alpha z_t^{1-\alpha}, \tag{7}$$

where φ_t is the spillover level; z_t is the amount of the primitive good; and $\alpha \in (0,1)$.

We assume that the size of spillovers φ_t is determined by the sector's cumulative production experience, measured by its capital stock, i.e., $\varphi_t \equiv \varphi(k_t^s)$. If nobody in the economy produces sophisticated goods, the productivity of the sophisticated-good sector is zero. When the sector develops, its productivity increases. We assume that the function φ satisfies the following properties: $\varphi(0) = 0$, $\lim_{k\to\infty} \varphi(k) = B$, $\varphi'(k) > 0$ and $\lim_{k\to 0} \varphi'(0) = \infty$, where $B > 0$ is a constant.[8]

Let us normalize the price of the sophisticated good to one, and denote by p_t the price of the primitive good in terms of the sophisticated good.[9] The representative firm buys natural resources and capital from the consumer and

[7] We use a two-sector model as a convenient approximation of the modern economies where the final consumption is usually preceded by non-trivial transformation process which can also include infrastructure, transportation, storing, selling etc.

[8] The assumption that learning-by-doing spillovers are limited by national borders (national spillovers) is also adopted in, e.g., Bardhan (1970), Krugman (1987), Lucas (1988). The models of international trade and endogenous growth that use the assumption of boundedness of learning-by-doing opportunities include, e.g., Stokey (1991), Young (1991), Maliar, Maliar and Pérez (2007). See also Grossman and Helpman (2003) for a discussion of models of international trade with learning-by-doing.

[9] Such normalization is always valid since in a competitive n-good economy, only n-1

allocates capital between the two sectors to maximize its period-by-period profit in both sectors by taking φ_t, r_t and p_t as given:

$$\pi_t = \max_{k_t^p, k_t^s, z_t, N} p_t \left(k_t^p\right)^\beta N^{1-\beta} + \varphi_t \left(k_t^s\right)^\alpha z_t^{1-\alpha} - r_t k_t - p_t z_t - q_t N \qquad (8)$$

subject to

$$k_t^p + k_t^s = k_t, \qquad (9)$$

$$k_t^p \geq 0, k_t^s \geq 0, z_t \geq 0, \qquad (10)$$

where (9) is the total capital constraint and (10) contains non-negativity restrictions.

2.2 Equilibrium conditions

Definition: An equilibrium in the economy $(3)-(10)$ is defined as a sequence of the individual quantities $\{c_t, k_t\}_{t=0}^{\infty}$, of the prices $\{r_t, p_t, q_t\}_{t=0}^{\infty}$ and of the production inputs $\{k_t^p, k_t^s, z_t, N\}_{t=0}^{\infty}$ such that given the prices

(i) $\{c_t, k_t,\}_{t=0}^{\infty}$ solves the utility-maximization problem $(3)-(5)$;

(ii) $\{k^p, k_t^s, z_t, N\}_{t=0}^{\infty}$ solves the profit-maximization problem $(8)-(10)$;

(iii) markets clear and the economy's resource constraint is satisfied.

It follows from $(3)-(5)$ that the agent's optimal choice satisfies the Euler equation

$$\frac{\dot{c}_t}{c_t} = \frac{1}{\sigma}\left[r_t - \delta - \rho\right], \qquad (11)$$

which allows for a standard interpretation: return from today's investment is equal to return from today's consumption, $r_t - \delta = \frac{\dot{c}_t}{c_t}\sigma + \rho$.

Furthermore, according to $(8)-(10)$, the firm's optimal decisions are described by the following Kuhn-Tucker conditions

$$\left(p_t \beta \left(k_t^p\right)^{\beta-1} N^{1-\beta} - r_t\right) k_t^p = 0, \qquad k_t^p \geq 0, \qquad (12)$$

$$\left(\varphi\left(k_t^s\right) \alpha \left(k_t^s\right)^{\alpha-1} z_t^{1-\alpha} - r_t\right) k_t^s = 0, \qquad k_t^s \geq 0, \qquad (13)$$

$$\left(p_t\left(1-\beta\right)\left(k_t^p\right)^\beta N^{-\beta} - q_t\right) N = 0, \qquad N \geq 0, \qquad (14)$$

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prices can be determined in equilibrium. Here we take sophisticated good as a numeraire and normalize its price to one, which is equivalent to saying that all prices in our economy are expressed in terms of the sophisticated good.

$$\left(\varphi\left(k_t^s\right)(1-\alpha)\left(k_t^s\right)^{\alpha} z_t^{-\alpha}-p_t\right) z_t=0, \qquad z_t \geq 0. \tag{15}$$

That is, the price of an input in each sector should be equal to its marginal revenue which is the marginal productivity multiplied by the output price. Corner solutions occur when the firm decides to operate only one of the two production units. It can be seen from (12) and (13) that since capital has the same value in both the primitive and sophisticated-good sectors, the firm will simultaneously keep both units open if and only if the marginal productivities of capital in the two sectors are equal. Otherwise, it would be optimal to transfer the whole capital stock to a sector with a higher rate of return. Thus, the optimal allocation of capital between the sector may take one of the three forms:

$$r_t=p_t\beta\left(k_t^p\right)^{\beta-1} N^{1-\beta}, \qquad k_t^p=k_t, \qquad k_t^s=0, \tag{16}$$

$$r_t=\varphi\left(k_t^s\right)\alpha\left(k_t^s\right)^{\alpha-1} z_t^{1-\alpha}, \qquad k_t^s=k_t, \qquad k_t^p=0, \tag{17}$$

$$r_t=p_t\beta\left(k_t^p\right)^{\beta-1} N^{1-\beta}=\varphi\left(k_t^s\right)\alpha\left(k_t^s\right)^{\alpha-1} z_t^{1-\alpha}, \qquad k_t^p+k_t^s=k_t, \tag{18}$$

which correspond to the two corner and one interior solutions, respectively.

Furthermore, it follows from (14) and (15) that if the solutions for natural resources and the primitive-good production inputs are interior, $N>0$ and $z_t>0$, their respective prices are given by

$$q_t=p_t(1-\beta)\left(k_t^p\right)^{\beta} N^{-\beta}, \tag{19}$$

$$p_t=\varphi\left(k_t^s\right)(1-\alpha)\left(k_t^s\right)^{\alpha} z_t^{-\alpha}. \tag{20}$$

Under our assumption of constant returns to scale in production, the equilibrium profits of the firm is equal to zero, $\pi_t=0$.

Market clearing conditions depend on whether the economy is closed or open; we will specify them separately. However, we can derive a version of the resource constraint that describes both the closed-economy and the open-economy cases. Given that the term $r_t^p k_t^p+r_t^s k_t^s$ is equal to $r_t k_t$ both under interior solution (18) and under corner solutions (16), (17), we can represent budget constraint (4) in the form

$$\dot{k}_t=\left(r_t^p k_t^p+q_t N+r_t^s k_t^s+p_t z_t\right)-p_t z_t-\delta k_t-c_t. \tag{21}$$

It follows from equations $(16)-(20)$ that the terms $r_t^p k_t^p+q_t N$ and $r_t^s k_t^s+p_t z_t$ are equal to the value of output produced by the primitive-good and the sophisticated-good sectors, (6) and (7), respectively, so that we re-write (21) as

$$\dot{k}_t = \varphi\left(k_t^s\right)\left(k_t^s\right)^{\alpha} z_t^{1-\alpha} + p_t\left(\left(k_t^p\right)^{\beta} N^{1-\beta} - z_t\right) - \delta k_t - c_t. \tag{22}$$

The term $p_t z_t$ is subtracted from the total output because it does not go to consumer but is used as an intermediate input in production.

2.3 An autarkic economy

If an economy is in autarky, it can trade neither primitive nor sophisticated goods on the international market. Thus, sophisticated goods in the autarkic economy can only be produced from its home-made primitive goods. According to (6) and (7), we have

$$z_t = y_t^p = \left(k_t^p\right)^{\beta} N^{1-\beta} \quad \text{and} \quad y_t^s = \varphi\left(k_t^s\right)\left(k_t^s\right)^{\alpha}\left[\left(k_t^p\right)^{\beta} N^{1-\beta}\right]^{1-\alpha}. \tag{23}$$

Since agents can consume only sophisticated goods, and these cannot be bought on the international market, sophisticated-good production is non-zero, $k_t^s \neq 0$. Furthermore, since the production of sophisticated goods requires the use of primitive goods as an input, primitive-good production is also non-zero, $k_t^p \neq 0$. Thus, the optimal allocation is interior in autarky, and both sectors are developed from the beginning.

According to (18), in the interior equilibrium, the rate of return of capital in both sectors is equal, i.e.,

$$\varphi\left(k_t^s\right)(1-\alpha)\left(k_t^s\right)^{\alpha}\left[\left(k_t - k_t^s\right)^{\beta} N^{1-\beta}\right]^{-\alpha} \beta\left(k_t - k_t^s\right)^{\beta-1} N^{1-\beta} = \varphi\left(k_t^s\right)\alpha\left(k_t^s\right)^{\alpha-1}\left[\left(k_t - k_t^s\right)^{\beta} N^{1-\beta}\right]^{1-\alpha}. \tag{24}$$

Condition (24) yields the following relationship between k_t^p, k_t^s and k_t

$$k_t^p = \frac{\beta - \beta\alpha}{\beta - \beta\alpha + \alpha} k_t \qquad \text{and} \qquad k_t^s = \frac{\alpha}{\beta - \beta\alpha + \alpha} k_t. \tag{25}$$

That is, both types of capital, k_t^p and k_t^s, are in fixed proportions to total capital, k_t. With this result, we can write the interest rate as

$$r_t \equiv r\left(k_t\right) = \theta\varphi\left(\frac{\alpha}{\beta - \beta\alpha + \alpha} k_t\right) k_t^{-(1-\beta)(1-\alpha)}, \tag{26}$$

where

$$\theta \equiv N^{(1-\beta)(1-\alpha)} \frac{\alpha^{\alpha} \left[\beta (1-\alpha)\right]^{\beta(1-\alpha)}}{(\beta - \beta\alpha + \alpha)^{-(1-\beta)(1-\alpha)}}. \tag{27}$$

By substituting the equilibrium interest rate (26) in the Euler equation (11), and by substituting the result (23) and the formulas for k_t^p and k_t^s from (25) into the resource constraint (22), we obtain

$$\dot{c}_t = \frac{c_t}{\sigma} \left[\theta \varphi \left(\frac{\alpha}{\beta - \beta\alpha + \alpha} k_t \right) k_t^{-(1-\beta)(1-\alpha)} - \delta - \rho \right], \tag{28}$$

$$\dot{k}_t = \frac{\theta}{\beta - \beta\alpha + \alpha} \varphi \left(\frac{\alpha}{\beta - \beta\alpha + \alpha} k_t \right) k_t^{\alpha + \beta(1-\alpha)} - \delta k_t - c_t. \tag{29}$$

The above system describes the transitional dynamics of the autarkic economy.

A steady state is defined as a situation in which all the model's variables have constant values. In the steady state, we have $\dot{c}_t = 0$ and $\dot{k}_t = 0$, so that conditions (28) and (29) imply, respectively,

$$\varphi \left(\frac{\alpha}{\beta - \beta\alpha + \alpha} k_t \right) k_t^{-(1-\beta)(1-\alpha)} = \frac{\rho + \delta}{\theta}, \tag{30}$$

$$c_t = \frac{\theta}{\beta - \beta\alpha + \alpha} \varphi \left(\frac{\alpha}{\beta - \beta\alpha + \alpha} k_t \right) k_t^{\alpha + \beta(1-\alpha)} - \delta k_t. \tag{31}$$

Due to the presence of externalities, equation (30) can have multiple solutions; thus, our economy can have multiple steady states. Also, steady states can be unstable. In this paper, we however restrict our attention to the case when the dynamic system (28) and (29) is saddle path stable and hence, the steady state is unique. Below, we provide an example of a function φ that leads to saddle-path stability.

Example 1 Assume that $\varphi(k) = k^{\gamma}$ with $0 < \gamma < (1-\beta)(1-\alpha)$. Then, (28) and (29) become

$$\dot{c}_t = \frac{c_t}{\sigma} \left[\theta \left(\frac{\alpha}{\beta - \beta\alpha + \alpha} \right)^{\gamma} k_t^{\gamma - (1-\beta)(1-\alpha)} - \delta - \rho \right], \tag{32}$$

$$\dot{k}_t = \frac{\theta \alpha^{\gamma}}{(\beta - \beta\alpha + \alpha)^{1+\gamma}} k_t^{\gamma + \alpha + \beta(1-\alpha)} - \delta k_t - c_t. \tag{33}$$

There is a unique steady state associated with (32) and (33), which is given by

$$k^* = \left[\frac{(\delta + \rho)(\beta - \beta\alpha + \alpha)^\gamma}{\theta\alpha^\gamma} \right]^{1/[\gamma-(1-\beta)(1-\alpha)]}, \tag{34}$$

$$c^* = \frac{\theta\alpha^\gamma}{(\beta - \beta\alpha + \alpha)^{1+\gamma}} (k^*)^{\gamma+\alpha+\beta(1-\alpha)} - \delta k^*. \tag{35}$$

Furthermore, the dynamic system (32) and (33) is saddle-path stable. This can be shown by drawing a phase diagram: it is qualitatively the same as the one in the standard neoclassical growth (Ramsey) model. Thus, our example-economy has a unique equilibrium path which asymptotically converges to the steady state (34) and (35). ||

The function $\varphi(k) = k^\gamma$ does not, however, satisfy the assumption of Section 2.1. of boundedness from above, $\lim_{k\to\infty} \varphi(k) = B$. In an open-economy version of the model, such a function leads to a counterfactual growth implication that the economy's growth rate increases over time. In contrast, the assumption of bounded externalities $\lim_{k\to\infty} \varphi(k) = B$ prevents this undesirable outcome and leads to a balanced growth pattern with an asymptotically constant growth rate. A function $\varphi(k)$ that is consistent with all our assumptions would be one that behaves similarly to $\varphi(k) = k^\gamma$ at low levels of capital and that converges to B at high levels of capital. Furthermore, in order to ensure saddle-path stability, we shall assume that externalities are not excessively large, so that the effective production function in the system (28) and (29),

$$F(k_t) \equiv \varphi\left(\frac{\alpha}{\beta - \beta\alpha + \alpha} k_t \right) k_t^{\alpha+\beta(1-\alpha)}, \tag{36}$$

has the standard properties, $F'(k) > 0$, $F''(k) < 0$, $F(0) = 0$, $\lim_{k\to 0} F'(k) = \infty$ and $\lim_{k\to\infty} F'(k) = 0$. (This was the case in our Example 1). However, we were not able to find an analytical example of the function $\varphi(k)$ that fulfills all the above requirements.

We shall summarize the equilibrium properties in the autarkic economy with the following proposition:

Proposition 1 *(a) If an equilibrium in the autarkic economy exists, then such an equilibrium is interior, i.e., both the primitive- and sophisticated-good sectors are developed from the beginning.*

(b) If the function $\varphi(k)$ is such that $F(k_t)$ defined in (36) *has the properties of the neoclassical production function, then the dynamic system described in* (28) *and* (29) *is saddle-path stable and the equilibrium is unique.*

In order to make a comparison between the closed- and the open-economy versions of the model, it is convenient to characterize a steady state in the autarkic economy in terms of the relative price. A steady state value of a variable x in the autarkic economy is denoted by x_A^*. Let us assume that this steady state is unique. Then, the steady state price p_A^* is also unique. Given that the steady state interest rate is equal to $\delta+\rho$, formula (16) determines the capital stock of the primitive-good sector $k_A^{p,*}$, and formulas (16) and (20) determine the capital stock of the sophisticated-good sector $k_A^{s,*}$,

$$k_A^{p,*}=\left(\frac{\delta+\rho}{p_A^*\beta}\right)^{1/(\beta-1)}N \qquad \text{and} \qquad k_A^{s,*}=\varphi^{-1}\left[\frac{(\delta+\rho)^{\alpha}\left(p_A^*\right)^{1-\alpha}}{\alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}}\right]. \tag{37}$$

The steady state values of the remaining variables can be recovered by direct calculations.

2.4 An open economy

If an economy is open, it need not consume all of the domestically produced goods but can trade some of them on the international market. We shall assume that the domestic country is small, so that its trade has no effect on the world price, and that the world price is constant, $p_t=p$ for all t. Furthermore, we shall assume that capital is immobile, so that there is no international borrowing and lending.

We can establish the country's international specialization by looking at conditions (6) and (20), which yields the amount of primitive goods used for production of sophisticated goods and the amount of primitive goods produced, respectively,

$$z_t=\left(p^{-1}\varphi\left(k_t^s\right)(1-\alpha)\right)^{1/\alpha}k_t^s \quad \text{and} \quad y_t^p=\left(k_t^p\right)^{\beta}N^{1-\beta}. \tag{38}$$

If $z_t<y_t^p$, then the country produces mostly primitive goods and exchange them in the amount of $(y_t^p-z_t)$ for sophisticated goods. If, on the other hand, $z_t>y_t^p$, then the country produces mostly sophisticated goods. Finally, if $z_t=y_t^p$, the country does not trade goods on the international market.

According to conditions $(16)-(18)$, the country chooses from three different international specializations, namely, to produce either only sophisticated goods, or only primitive goods or both kinds of goods, with the aggregate capital stock being distributed to satisfy $r^p\left(k_t^p\right)=r^s\left(k_t^s\right)$, where

$$r^p\left(k_t^p\right) \equiv p\beta\left(k_t^p\right)^{\beta-1} N^{1-\beta}, \tag{39}$$

$$r^s\left(k_t^s\right) \equiv \varphi\left(k_t^s\right)^{1/\alpha} \alpha\left(p^{-1}(1-\alpha)\right)^{(1-\alpha)/\alpha}. \tag{40}$$

Condition (40) follows after substituting z_t from (38) into (17).

Note that the corner solution, to produce only sophisticated goods, is not an equilibrium. Indeed, if all capital is concentrated in the sophisticated-good sector, we have $r^s\left(k_t\right)<\infty$ and $\lim_{k_t^p \to 0} r^p\left(k_t^p\right)=\infty$, so that a price-taking agent can increase the period's capital income by re-investing from the sophisticated-good to primitive-good sector, which means that the strategy $k_t^p=0$ is not utility-maximizing. In contrast, the other corner solution, to produce only primitive goods, is an equilibrium. To see this, note that if all capital is invested in the primitive-good sector, we have $r^s(0)=0$, so that a unilateral deviation of a price-taking agent from the equilibrium strategy $k_t^s=0$ reduces the agent's period capital income. Finally, note that any interior solution is an equilibrium because we have $r^p\left(k_t^p\right)=r^s\left(k_t^s\right)$, and thus, any distribution of capital between the sectors, leading to equal interest rates in both sectors, is consistent with the utility-maximization of a price-taking agent.

The dynamic behavior of our open economy can be described by the following system of differential equations:

$$\dot{c}_t=\frac{c_t}{\sigma}\left[p\beta\left(k_t^p\right)^{\beta-1} N^{1-\beta}-\delta-\rho\right], \tag{41}$$

$$\dot{k}_t=\alpha\left(\frac{1-\alpha}{p}\right)^{\frac{1-\alpha}{\alpha}} \varphi\left(k_t^s\right)^{1/\alpha} k_t^s+p\left(k_t^p\right)^\beta N^{1-\beta}-\delta k_t-c_t. \tag{42}$$

Equation (41) follows by substituting the interest rate $r^p\left(k_t^p\right)$ from (39) into the Euler equation (11) and equation (42) follows by substituting z_t from (38) into the budget constraint (22). Notice that the above system of equations describes all possible equilibria in the open economy. Indeed, the corner solution $k_t^p=k_t$ is described by setting $k_t^s=0$ in (42), and the interior solutions are described by (41), (42) under the restriction that $r^p\left(k_t^p\right)=$

$r^s(k_t^s)$. The corner solution $k_t^s = k_t$ is not possible in our model, as we argued above.

At low levels of economic development, an interior solution is not feasible since the rate of return on capital in the primitive-good sector is higher than the one in the sophisticated-good sector, independently of how the total capital is split between the sectors (in the limit, we have $\lim_{k_t \to 0} r^p(k_t^p) = \infty$ and $\lim_{k_t \to 0} r^s(k_t - k_t^p) = 0$ for all $k_t^p \in (0, k_t]$). Hence, a low-capital country produces only primitive goods.

When the country accumulates a sufficiently large capital stock, it may switch to the interior solution (18). Let us establish a minimal value for aggregate capital stock, $\overline{k}$, for which the interior solution is feasible. The equality of the sectoral interest rates, together with (39) and (40), determines the optimal distribution of aggregate capital between the sectors, according to

$$\varphi(k_t - k_t^p)^{1/\alpha}(k_t^p)^{1-\beta} = \frac{p\beta N^{1-\beta}}{\alpha\left[p^{-1}(1-\alpha)\right]^{(1-\alpha)/\alpha}} \equiv \xi. \tag{43}$$

We define $\Im(k_t)$ as the maximum value that the left side of (43) can achieve for a given value of k_t, i.e.,

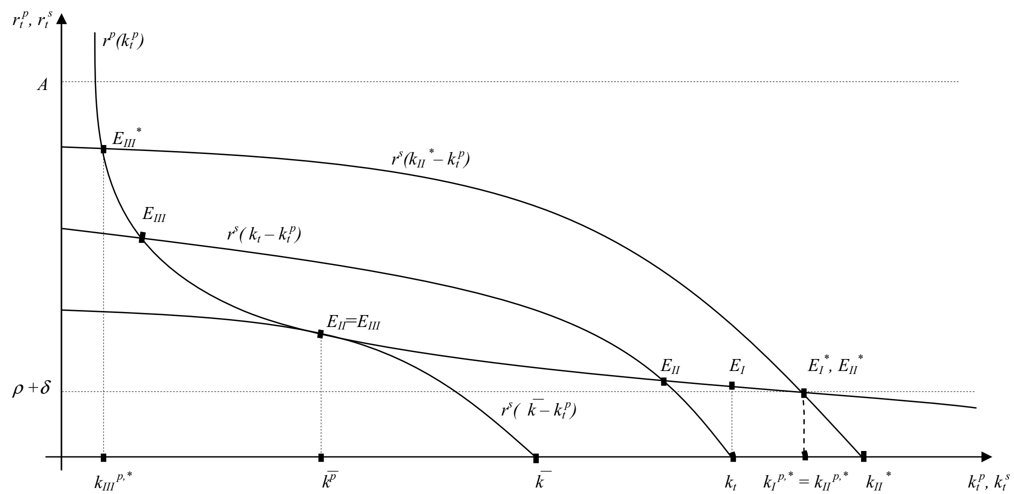
$$\Im(k_t) \equiv \max_{k_t^p}\left\{\varphi(k_t - k_t^p)^{1/\alpha}(k_t^p)^{1-\beta}\right\}. \tag{44}$$

Given that $\Im$ is a strictly increasing, continuous function with $\Im(0) = 0$ and that $\lim_{k_t \to \infty} \Im(k_t) = \infty$, we conclude that there exists a unique threshold value for the aggregate capital stock $\overline{k}$ satisfying $\Im\left(\overline{k}\right) = \xi$. As the equilibrium is interior by assumption, we can characterize the threshold value by means of the first-order condition of (44),

$$\frac{\varphi'(k_t - k_t^p)\,k_t^p}{\varphi(k_t - k_t^p)} = (1-\beta)\,\alpha. \tag{45}$$

By solving the system of two equations, (43) and (45), with respect to two unknowns, k_t and k_t^p, we obtain the threshold aggregate capital stock, $\overline{k}$, and the optimal size of the primitive-good sector, $\overline{k}^p$. The solution is found at the point where $r^p(k_t^p)$ and $r^s(k_t - k_t^p)$ are tangent, which is illustrated in *Diagram 1.*

Diagram 1. Equilibria I, II and III and threshold value $\bar{k}$ in the open economy.



Finally, when the country develops beyond the threshold level, $k_t > \overline{k}$, there are two different interior solutions to equation (43). Thus, at high levels of development, the country has to choose among three alternatives, namely, one corner solution and two interior solutions (see *Diagram 1*).

Below, we provide an example where the threshold point and the optimal distribution of capital between sectors can be characterized explicitly.

Example 2 Assume that $\varphi(k) = k^{\gamma}$ with $\gamma = (1-\beta)\alpha$. Then, equation (43) becomes

$$(k_t - k_t^p)^{1-\beta} (k_t^p)^{(1-\beta)} = \xi. \tag{46}$$

By solving this equation, we obtain two real solutions for k_t^p,

$$k_t^p = \frac{k_t \pm \sqrt{k_t^2 - 4\xi^{\frac{1}{1-\beta}}}}{2}, \tag{47}$$

provided that $k_t^2 - 4\xi^{\frac{1}{1-\beta}} > 0$. To obtain the threshold point, we use (45),

$$\frac{(1-\beta)\alpha (k_t - k_t^p)^{(1-\beta)\alpha - 1} k_t^p}{(k_t - k_t^p)^{(1-\beta)\alpha}} = (1-\beta)\alpha \qquad \Longrightarrow \qquad k_t^p = \frac{k_t}{2}. \tag{48}$$

By substituting this result into (43), we get the threshold point at which the sophisticated-good sector can be opened, $\overline{k} = 2\xi^{\frac{1}{2(1-\beta)}}$. (Notice that this is precisely the point where the expression $k_t^2 - 4\xi^{\frac{1}{1-\beta}}$ in (47) is equal to zero).

The capital stock of the sophisticated-good sector corresponding to (47) is given by

$$k_t^s = k_t - k_t^p = \frac{k_t \mp \sqrt{k_t^2 - 4\xi^{\frac{1}{1-\beta}}}}{2}. \tag{49}$$

Thus, in one interior equilibrium, the primitive-good sectors expands over time while the sophisticated-good sector contracts, while in the other interior equilibrium, the opposite happens.

In addition to the two interior solutions, there is a corner solution $k_t^p = k_t$. This solution occurs if agents fail to coordinate on massive re-allocation of capital from the primitive-good to the sophisticated-good sector. Recall that with our assumption on spillovers, an output of each given small firm that switches to the sophisticated-good production would be zero if no other firm produces sophisticated-good. ‖

Due to the presence of multiple solutions, our open economy has indeterminacy of equilibrium, in the sense that it can switch between the three solutions in an arbitrary manner at any point of time. We must emphasize, however, that switching among solutions is not a fundamental property of our model, but rather, a result of our simplifying assumption that capital can be costlessly and instantaneously transferred from one sector to another. We would not have switching between solutions in a more realistic environment, in which the re-allocation of capital between sectors is costly.[10] We therefore restrict our attention to a case in which the economy sticks to the same solution until a coordinating agent, e.g., government, induces a switch to another solution.

We are particularly interested in the case where the price p in the open economy is equal to the steady state price p_A^* in the autarkic economy considered in Section 2.3. This assumption allows us to compare some steady states of the autarkic and the open economies. We refer to the equilibrium dynamic paths corresponding to the corner and two interior solutions as Equilibria I, II, III, respectively. Steady state values of a variable x in Equilibria I, II, III are denoted by x_I^*, x_{II}^*, x_{III}^*, respectively. Below, we establish some properties of the three equilibria in the open economy.

Equilibrium I *(Poverty-trap equilibrium).* This is a corner solution where the country produces only primitive goods and trades them for sophisticated goods. As such, its dynamic behavior is described by the Euler equation (41) and budget constraint (42) under the restriction $k_t^p = k_t$ and $k_t^s = 0$. Note that this dynamic system is equivalent to the one of the standard neoclassical growth (Ramsey) model: it is saddle-path stable, so that the economy converges to a steady state with a zero growth rate,

$$k_I^{p,*} = \left(\frac{\delta + \rho}{p\beta}\right)^{1/(\beta-1)} N \qquad \text{and} \qquad k_I^{s,*} = 0. \tag{50}$$

Comparing the poverty-trap steady state in the open economy (50) with the steady state of the autarkic economy (37), we observe that given an

[10]In an important paper of Evans, Honkapohja and Romer (1998), switching between high- and low-growth states also takes place. In their model, multiplicity of equilibria is due to the assumptions of monopolistic competition and complementarity between different types of capital goods. Switching between equilibria occurs because of self-fulfilling shifts in expectations about the returns to investment.

identical relative price, $p = p_A^*$, both economies produce the same amount of primitive-good, but unlike the autarkic economy, the open economy produces no sophisticated goods.

We refer to this equilibrium as the "poverty-trap" because a low developed country, that only produces primitive goods, might be unable to accumulate the threshold capital stock, $\overline{k}$, necessary for opening the sophisticated-good sector, thus, remaining poor forever. Alternatively, a country might have accumulated the threshold capital stock, $\overline{k}$, but agents fail to coordinate on opening the sophisticated-good sector.

Equilibrium II *(Autarky-like equilibrium).* This is an interior equilibrium where the country produces both kinds of goods; it expands its primitive-good sector and contracts its sophisticated-good sector in the process of economic development. The dynamic behavior of such an economy is described by the Euler equation (41) and the budget constraint (42) under the assumption of an interior solution to (43) such that primitive production grows over time.

In this case, apart from decreasing returns to capital in the primitive-good sector $y_t^p = p\left(k_t^p\right)^\beta N^{1-\beta}$, there are also decreasing returns to capital in the sophisticated-good sector $y_t^s = \alpha\left(\frac{1-\alpha}{p}\right)^{\frac{1-\alpha}{\alpha}} \varphi\left(k_t^s\right)^{1/\alpha} k_t^s$ because we select a solution to (43) such that the size of the sophisticated-good sector and its marginal productivity of capital decreases over time . The decreasing returns to capital in both sectors imply that the phase diagram in terms of c_t and k_t is again qualitatively similar to the one produced by the standard neoclassical growth (Ramsey) model, so that this system is also saddle-path stable.

As follows from the Euler equation (41), in the limit, the economy reaches a steady state with the same size of the primitive-good sector as in Equilibrium I (i.e., $k_{II}^{p,*} = k_I^{p,*}$), and formula (40) together with the fact that the the steady state interest rate is equal to $\delta + \rho$ determines the capital stock of the sophisticated-good sector, $k_{II}^{s,*}$,

$$k_{II}^{p,*} = \left(\frac{\delta+\rho}{p\beta}\right)^{1/(\beta-1)} N \qquad \text{and} \qquad k_{II}^{s,*} = \varphi^{-1}\left[\frac{(\delta+\rho)^\alpha p^{1-\alpha}}{\alpha^\alpha (1-\alpha)^{1-\alpha}}\right]. \quad (51)$$

We call this equilibrium "autarky-like", because a comparison of (37) and (51) shows that under $p = p_A^*$, the open economy has the same steady state as does the autarkic economy.[11]

[11] In spite of having the same steady state, the autarkic economy and the open econ-

Equilibrium III *(Growth-miracle equilibrium).* This is another interior equilibrium where the country produces both kinds of goods but now it contracts its primitive-good sector and it expands its sophisticated-good sector over time. The dynamics of such an economy is described by the Euler equation (41) and the budget constraint (42) under the assumption of an interior solution to (43) such that primitive production decreases over time.

Asymptotically, the model converges to the standard AK-model where "A" is defined by

$$\lim_{k_t\to\infty} r^s\left(k_t^s\right) = \alpha B^{1/\alpha}\left[p^{-1}\left(1-\alpha\right)\right]^{(1-\alpha)/\alpha} \equiv A. \tag{52}$$

Under $p = p_A^*$, the growth rate of consumption, following from the Euler equation (11), is positive, $\gamma_{III}^* \equiv \left(\frac{\dot{c}_t}{c_t}\right)^* = \frac{1}{\sigma}\left[A-\delta-\rho\right] > 0$. (To see this, note that according to (40) and (52), in the autarky-like steady state, we have that $A\left[\frac{\varphi\left(k_A^{*,s}\right)}{B}\right]^{1/\alpha} = \delta+\rho$ and given that $\lim_{k\to\infty}\varphi\left(k\right) = B$ and $\varphi'\left(k\right) > 0$, we have that $A > \delta+\rho$). Therefore, the economy asymptotically converges to a balanced growth path, in which, according to (43), the capital stock of the primitive-good sector is constant, while that of the sophisticated-good sector grows at the same rate as consumption does,

$$k_{III}^{p,*} = \xi^{1/(1-\beta)} \qquad \text{and} \qquad \left(\frac{\dot{k}_t^s}{k_t^s}\right)^* = \gamma_{III}^*. \tag{53}$$

With the term "growth-miracle" that we employ for this equilibrium, we emphasize that it is possible to have eternal growth in the open economy, in contrast to the autarkic economy, where long-run growth is not feasible.

The results obtained for the open economy are summarized below:

Proposition 2 *Let $\overline{k}$ be the threshold capital stock of the open economy defined by* (43), (45)*.*
(a) Under $k_t < \overline{k}$, the economy produces only primitive goods.
(b) Under $k_t = \overline{k}$, the sophisticated-good sector can be opened. If so, $\overline{k}^s = \overline{k} - \overline{k}^p$ is transferred to the sophisticated-good sector and $\overline{k}^p$ is left in the primitive-good sector, where $\overline{k}^p$ is determined by (45)*.*

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omy in Equilibrium II have different equilibrium dynamics. In particular, in the autarkic economy, the price changes with time, whereas in the open economy, it is constant.

(c) Under $k_t > \overline{k}$, there are three different equilibria.
Eq. I. The economy only has a primitive-good sector and it asymptotically converges to the steady state (50)*.*
Eq. II. The economy expands the primitive-good sector and diminishes the sophisticated-good sector; it asymptotically converges to the steady state (51)*.*
Eq. III. The economy expands the sophisticated-good and reduces the primitive-good sector; it asymptotically converges to a balanced growth path (53)*.*

Equilibria I, II, III can be ranked by welfare. For any given initial capital $k_0 \geq \overline{k}$, we have that the interest rate in Equilibrium III is larger than the one in Equilibrium II, which in turn, is larger than the one in Equilibrium I, for all t. According to the Euler equation, a larger interest rate implies a larger consumption growth rate. Hence, Equilibrium III dominates Equilibrium II, which in turn, dominates Equilibrium I in the level of utility.[12]

3 Accounting for the stylized facts

In this section, we investigate the relationship between sectoral composition, international trade and economic growth by performing a cross-country comparison. We use the World Development Indicators CD-ROM (2000) data set, which contains relevant information for the period 1960-1999. For our study, we select a sample of 100 countries for which the data on GDP are available for at least the entire period 1965-1994. In the ranges 1960-1964 and 1995-1999, several values were missing for the GDP of such countries as Canada, Malta, Oman, Puerto Rico and Congo D. R. We constructed the missing values by a linear extrapolation of a logged GDP on a constant and time trend. We provide a list of the countries in our sample in *Table 1*. Furthermore, for both the first year, 1960, and the last year, 1999, we report each country's size (defined as its share of the total GDP of the sample), its GDP per capita and its rank according to GDP per capita. Finally, we provide each country's cumulative GDP growth rate over the 1960-1999 period

[12] As far the issue of stability is concerned, all our equilibria are stable to deviations of one agent from the equilibrium strategy, as such deviations have no effect on prices. If we consider deviations that affect prices, Equilibrium II will be unstable because of the Marshallian tatonnement argument (see Matsuyama, 1991). One can make Equilibrium II stable in the latter sense by introducing adjustment costs as in Graham and Temple (2006).

(defined as the ratio of GDP in 1999 to that in 1960) and its rank according to the cumulative growth rate of the GDP.

We use the constructed rankings to distinguish three groups of countries: a group of "rich" countries which is composed of the top ten countries in the sample by the level of GDP in 1999 (Luxembourg, Switzerland, Japan, Norway, Denmark, Austria, US, Iceland, Netherlands and Finland); the group of "fast-growing" countries which includes the top ten countries in the cumulative GDP growth over the 1960-1999 period (Botswana, Singapore, South Korea, Malta, Oman, Hong Kong, China, Thailand, Japan and Malaysia) and the group of "poor" countries which consists of the bottom ten countries in the level of GDP for 1999 (Nigeria, Madagascar, Rwanda, Chad, Nepal, Niger, Malawi, Sierra Leone, Burundi and Congo D.R.). Given that six out of the ten poorest countries belong to the group of the ten slowest-growing countries, (specifically, Madagascar, Rwanda, Chad, Niger, Sierra Leone and Congo D.R.), we shall not distinguish between the groups of poor and slow-growing countries, but rather focus exclusively on the former group. In *Table 2*, we report the key statistics on the GDP and export for our three groups of countries as well as for the whole sample (the shares are the averages over the 1990-1999 period and the growth rates are the averages for 1960-1999). As a test for robustness, we also report the same set of statistics by increasing the size of the rich, fast-growing and poor groups from ten to twenty. In *Table 3*, we provide evidence on the composition of international trade, by products, for our set of countries obtained from the World Factbook (2002). In *Figures 1, 2* and *3*, we draw, respectively, the shares of industry and agriculture in GDP, the sectoral composition of manufacturing and the sectoral composition of export, for the three groups of countries.[13]

[13] Whenever data for a country is unavailable, we replace such a country in *Figures 1-3* with its nearest out-of-group neighbor for which data is available. As a result, in some figures, we have the series for Belgium, Finland and Burkina Faso, which according to GDP in 1999, occupy the 11th, 12th and 90th places, respectively. Furthermore, given that Japan enters both the rich and the fast-growing groups, we replace it with Indonesia, which is the 13th fast-growing country.

Table 1. Rankings of countries by GDP per capita in 1960 and in 1999 and by GDP growth over 1960-1999.

Country	Year 1960			Year 1999			GDP growth over 1960-1999[b]	Rank by GDP growth over 1960-1999
	Size	GDP per capita[a]	Rank by GDP	Size	GDP per capita[a]	Rank by GDP		
Botswana	0.0025	343.57	82	0.0207	3611.00	45	10.5102	1
Singapore	0.0669	2698.90	33	0.3583	25297.00	14	9.3731	2
South Korea	0.4764	1255.60	47	1.8748	11022.00	28	8.7783	3
Malta	0.0059	1177.30	48	0.0137	9759.50	29	8.2897	4
Oman	0.0059	696.31	60	0.0575	5704.19	35	8.1920	5
Hong Kong, China	0.1398	3007.60	29	0.5308	21801.00	17	7.2486	6
China	1.1310	111.73	99	3.2980	724.73	72	6.4864	7
Thailand	0.1866	465.92	73	0.5758	2628.50	50	5.6415	8
Japan	11.7274	8213.50	17	19.5822	42285.00	3	5.1482	9
Malaysia	0.1204	975.00	53	0.3559	4379.90	41	4.4922	10
Portugal	0.3715	2737.30	32	0.4373	11976.00	27	4.3751	11
Ireland	0.2347	5461.90	20	0.3149	23154.00	15	4.2392	12
Indonesia	0.3556	249.34	87	0.7272	974.63	66	3.9088	13
Greece	0.4257	3368.70	27	0.4726	12269.00	25	3.6421	14
Mauritius	0.0112	1122.20	50	0.0171	4034.50	42	3.5952	15
Puerto Rico	0.1204	3364.00	28	0.1701	12008.95	26	3.5698	16
Spain	2.1352	4620.40	23	2.3642	16391.00	23	3.5475	17
Norway	0.6117	11256.00	7	0.6016	37053.00	4	3.2918	18
Hungary	0.2293	1513.60	42	0.1818	4907.80	37	3.2425	19
Egypt, Arab Rep.	0.1415	359.67	79	0.2578	1143.60	63	3.1796	20
Luxembourg	0.0754	15772.00	3	0.0775	49620.00	1	3.1461	21
Israel	0.1686	5256.30	22	0.3597	16466.00	22	3.1326	22
Lesotho	0.0022	168.47	96	0.0039	511.66	77	3.0371	23
Italy	5.0629	6646.50	19	4.2005	19911.00	20	2.9957	24
Finland	0.6646	9886.80	14	0.5523	29257.00	10	2.9592	25
Iceland	0.0271	10135.00	12	0.0299	29809.00	8	2.9412	26
Austria	1.1417	10675.00	9	0.9163	30962.00	6	2.9004	27
Sri Lanka	0.0412	274.83	86	0.0543	789.30	70	2.8720	28
Belice	0.0013	976.90	52	0.0024	2742.30	49	2.8071	29
Seychelles	0.0016	2563.00	34	0.0021	7176.50	32	2.8000	30
Pakistan	0.1257	180.66	94	0.2412	500.38	78	2.7697	31
Belgium	1.4854	10735.00	8	1.0846	29016.00	11	2.7029	32
Barbados	0.0102	2923.90	30	0.0077	7895.00	31	2.7002	33
Chile	0.2272	1968.00	35	0.2849	5246.60	36	2.6660	34
France	7.3557	10611.00	10	6.0421	28243.00	13	2.6617	35
Dominican Rep.	0.0335	682.56	61	0.0545	1801.70	54	2.6396	36
Gabon	0.0134	1810.70	39	0.0206	4768.10	38	2.6333	37
Brazil	1.9228	1741.50	40	2.7340	4500.80	40	2.5844	38
Syrian Arab Rep.	0.0329	475.16	72	0.0677	1206.60	62	2.5394	39
Trinidad and Tobago	0.0242	1890.90	37	0.0219	4651.00	39	2.4597	40
Netherland	2.0916	11999.00	6	1.6846	29293.00	9	2.4413	41
India	1.2080	183.07	93	1.5449	430.46	81	2.3513	42
Australia	1.5416	9887.20	13	1.5677	22821.00	16	2.3081	43
United States	36.4050	13279.00	5	30.3477	30135.00	7	2.2694	44
Denmark	1.1322	16287.00	2	0.7159	36864.00	5	2.2634	45
Canada	2.5668	9329.94	16	2.3232	20967.00	18	2.2473	46
Panama	0.0250	1462.50	43	0.0325	3206.10	48	2.1922	47
United Kingdom	7.5467	9495.90	15	4.4976	20718.00	19	2.1818	48
Colombia	0.2825	1104.20	51	0.3594	2404.40	52	2.1775	49
Mexico	0.9189	1639.00	41	1.2352	3539.90	46	2.1598	50
Sweden	1.5199	13390.00	4	0.9338	28796.00	12	2.1506	51
Paraguay	0.0249	889.58	55	0.0342	1787.20	55	2.0090	52
Ecuador	0.0523	776.68	57	0.0696	1559.80	58	2.0083	53
Morocco	0.1229	696.40	59	0.1416	1391.80	61	1.9986	54
Costa Rica	0.0344	1934.60	36	0.0486	3765.40	44	1.9463	55
Saudi Arabia	0.2330	3767.70	25	0.4952	6866.00	33	1.8223	56
Fiji	0.0084	1400.40	44	0.0072	2475.90	51	1.7680	57
Papua New Guinea	0.0165	565.15	67	0.0168	998.59	65	1.7669	58

Switzerland	2.1355	26245.00	1	1.1718	44988.00	2	1.7142	59
Kenya	0.0254	201.20	92	0.0358	339.48	88	1.6873	60
Uruguay	0.1492	3873.00	24	0.0778	6460.90	34	1.6682	61
Guatemala	0.0558	928.30	54	0.0606	1531.10	60	1.6494	62
Mauritania	0.0044	293.87	83	0.0044	476.87	79	1.6227	63
Bahamas, The	0.0134	7842.40	18	0.0137	12696.00	24	1.6189	64
Bangladesh	0.1697	217.46	91	0.1613	350.38	86	1.6112	65
New Zealand	0.3728	10356.00	11	0.2301	16564.00	21	1.5995	66
Congo, Rep.	0.0084	557.32	68	0.0091	889.85	68	1.5967	67
Philippines	0.2975	711.40	58	0.3000	1123.80	64	1.5797	68
Malawi	0.0052	97.79	100	0.0059	154.09	97	1.5757	69
Zimbabwe	0.0264	455.59	75	0.0306	715.34	74	1.5701	70
Argentina	1.6965	5423.20	21	1.1214	8473.60	30	1.5625	71
Burkina Faso	0.0119	169.13	95	0.0102	258.66	90	1.5294	72
Nepal	0.0208	147.66	97	0.0183	218.79	95	1.4817	73
Togo	0.0053	230.20	88	0.0054	328.11	89	1.4253	74
Honduras	0.0147	513.17	71	0.0163	721.70	73	1.4064	75
South Africa	0.7472	2830.60	31	0.5948	3921.80	43	1.3855	76
Algeria	0.1876	1145.00	49	0.1667	1541.80	59	1.3466	77
Cote d'Ivoire	0.0337	587.02	66	0.0436	786.45	71	1.3397	78
El Salvador	0.0513	1310.40	46	0.0382	1727.40	56	1.3182	79
Peru	0.2823	1873.10	38	0.2139	2353.70	53	1.2566	80
Cameroon	0.0416	518.24	70	0.0338	645.53	75	1.2456	81
Jamaica	0.0346	1398.00	45	0.0162	1712.00	57	1.2246	82
Guyana	0.0058	676.95	62	0.0026	824.44	69	1.2179	83
Bolivia	0.0420	826.66	56	0.0283	972.24	67	1.1761	84
Burundi	0.0057	128.09	98	0.0035	147.25	99	1.1496	85
Nigeria	0.1385	223.53	89	0.1123	253.70	91	1.1350	86
Benin	0.0109	350.65	80	0.0086	393.90	83	1.1233	87
Venezuela	0.4279	3720.50	26	0.3006	3531.00	47	0.9491	88
Ghana	0.0462	449.53	76	0.0270	401.28	82	0.8927	89
Senegal	0.0324	670.38	63	0.0191	577.51	76	0.8615	90
Rwanda	0.0115	276.28	85	0.0067	226.94	93	0.8214	91
Chad	0.0135	289.63	84	0.0060	225.51	94	0.7786	92
Central African Rep.	0.0106	457.45	74	0.0043	341.20	87	0.7459	93
Sierra Leone	0.0075	219.33	90	0.0027	153.08	98	0.6979	94
Nicaragua	0.0153	655.54	64	0.0079	452.22	80	0.6898	95
Haiti	0.0316	546.91	69	0.0104	369.96	85	0.6765	96
Madagascar	0.0312	382.67	78	0.0127	238.40	92	0.6230	97
Zambia	0.0309	647.79	65	0.0137	387.92	84	0.5988	98
Niger	0.0186	405.33	77	0.0081	217.52	96	0.5366	99
Congo, Dem. Rep.	0.0813	349.56	81	0.0193	112.66	100	0.3223	100

Note: [a] GDP per capita is expressed in 1995US$.
[b] GDP growth over 1960-1999 is defined as the ratio of GDP per capita in 1999 to GDP per capita in 1960.

Table 2. Selected statistics on GDP, its components and export for different groups of countries.

	Ranked by GDP per capita in 1999				Ranked by GDP growth over 1960-1999				All countries
	Top 10%	Top 20%	Bottom 10%	Bottom 20%	Top 10%	Top 20%	Bottom 10%	Bottom 20%	
GDP in 1960	13.375	10.751	0.252	0.299	1.895	2.650	0.423	0.660	3.257
	(5.195)	(5.092)	(0.108)	(0.147)	(2.419)	(2.901)	(0.153)	(4.650)	(4.650)
GDP in 1999	36.027	30.050	0.195	0.278	12.721	12.556	0.273	0.609	8.630
	(7.425)	(8.342)	(0.048)	(0.097)	(13.224)	(11.915)	(0.110)	(11.963)	(11.963)
GDP growth	1.028	1.030	0.997	1.001	1.055	1.045	0.990	0.997	1.021
rate, 1960-1999	(0.008)	(0.012)	(0.013)	(0.013)	(0.009)	(0.012)	(0.008)	(0.018)	(0.018)
Industry									
Labor share, %,	27.935	28.205	12.763	11.820	28.581	28.242	14.050	14.975	22.381
1990-1999	(3.833)	(3.465)	(13.28)	(10.32)	(6.070)	(6.685)	(14.43)	(11.20)	(9.407)
Output share, %,	27.895	27.728	22.096	22.444	40.526	36.445	21.126	24.595	29.713
1990-1999	(5.405)	(4.648)	(9.445)	(8.268)	(9.625)	(8.840)	(7.669)	(10.18)	(9.168)
Output growth	1.025	1.023	1.008	1.009	1.071	1.055	0.993	1.003	1.0240
rate, 1960-1999	(0.016)	(0.019)	(0.034)	(0.027)	(0.015)	(0.023)	(0.024)	(0.024)	(0.027)
Agriculture									
Labor share, %,	5.581	5.000	64.362	63.407	20.536	19.212	62.778	51.042	28.339
1990-1999	(2.163)	(2.974)	(24.47)	(23.02)	(22.23)	(18.28)	(30.38)	(29.23)	(26.45)
Output share, %,	3.839	3.123	40.708	37.196	6.791	7.619	37.548	33.021	17.006
1990-1999	(2.688)	(2.351)	(6.774)	(7.840)	(6.969)	(6.26)	(8.19)	(12.66)	(13.76)
Output growth	1.007	1.007	0.998	1.000	1.007	1.012	0.994	0.999	1.005
rate, 1960-1999	(0.016)	(0.014)	(0.010)	(0.009)	(0.017)	(0.021)	(0.011)	(0.010)	(0.014)
Sectorial output, % of GDP, 1990-1999									
Machinery	5.488	6.098	0.372	0.837	9.765	6.824	0.398	0.499	2.998
	(2.377)	(3.443)	(0.284)	(1.142)	(2.462)	(4.331)	(0.290)	(0.460)	(3.271)
Food	3.030	2.643	3.716	3.703	3.657	3.999	4.745	4.700	4.365
	(0.547)	(0.816)	(2.540)	(1.827)	(2.920)	(2.419)	(1.215)	(1.851)	(2.121)
Chemicals	1.931	1.905	1.090	1.309	2.424	2.059	0.979	1.108	1.812
	(0.453)	(0.533)	(1.406)	(0.987)	(1.193)	(1.051)	(0.286)	(0.837)	(0.925)
Textile	0.747	0.989	2.044	1.744	2.333	3.045	0.469	0.740	1.878
	(0.304)	(0.665)	(1.559)	(1.564)	(1.900)	(2.706)	(0.496)	(0.428)	(1.734)
Sectorial growth rate, 1960-1999									
Machinery	1.030	1.038	1.124	1.085	1.183	1.155	1.083	1.072	1.072
	(0.019)	(0.042)	(0.047)	(0.064)	(0.131)	(0.117)	(0.054)	(0.062)	(0.083)
Food	1.020	1.019	1.052	1.033	1.057	1.057	1.035	1.038	1.028
	(0.022)	(0.017)	(0.113)	(0.076)	(0.055)	(0.046)	(0.052)	(0.072)	(0.047)
Chemicals	1.033	1.039	1.061	1.083	1.145	1.120	1.148	1.091	1.070
	(0.013)	(0.030)	(0.114)	(0.099)	(0.117)	(0.098)	(0.103)	(0.097)	(0.078)
Textile	0.983	0.997	1.114	0.873	1.096	1.0920	0.496	0.817	0.981
	(0.029)	(0.032)	(0.150)	(0.819)	(0.159)	(0.130)	(1.434)	(0.838)	(0.390)
Net export, % of GDP, 1990-1999									
Manufacturing	-2.298	-0.704	-17.152	-15.011	-0.054	-3.249	-15.951	-15.752	-9.639
	(8.104)	(7.238)	(13.22)	(11.29)	(6.059)	(7.035)	(12.11)	(8.816)	(9.675)
Fuel	0.596	0.015	7.695	0.076	-0.730	0.156	-3.488	3.009	1.193
	(4.761)	(3.486)	(22.43)	(13.97)	(3.043)	(4.544)	(2.250)	(14.07)	(10.43)
Ores	0.259	0.158	1.810	3.860	-0.827	-0.354	9.312	4.143	1.326
	(0.930)	(0.922)	(5.092)	(8.093)	(0.428)	(0.604)	(11.99)	(7.488)	(4.543)
Food	2.458	1.392	3.147	1.400	0.472	0.782	3.315	0.669	2.419
	(5.798)	(4.618)	(11.51)	(8.247)	(3.397)	(3.284)	(7.215)	(5.767)	(6.042)
Agriculture	0.187	0.151	-0.265	1.775	0.105	-0.139	0.300	2.039	0.727
	(0.654)	(0.921)	(0.779)	(4.721)	(2.167)	(1.352)	(0.919)	(4.647)	(2.302)
Fuel+Ores+Foo	3.500	1.716	10.848	6.920	-0.981	0.445	9.438	9.859	5.791
d+Agriculture	(7.560)	(6.558)	(15.12)	(12.01)	(7.129)	(6.497)	(8.880)	(11.29)	(11.33)
Gross export, % of GDP, 1990-1999									
HiTech	2.782	3.834	0.044	0.116	7.584	4.948	0.095	0.185	1.787
	(1.913)	(4.543)	(0.046)	(0.145)	(9.046)	(7.753)	(0.073)	(0.275)	(3.928)

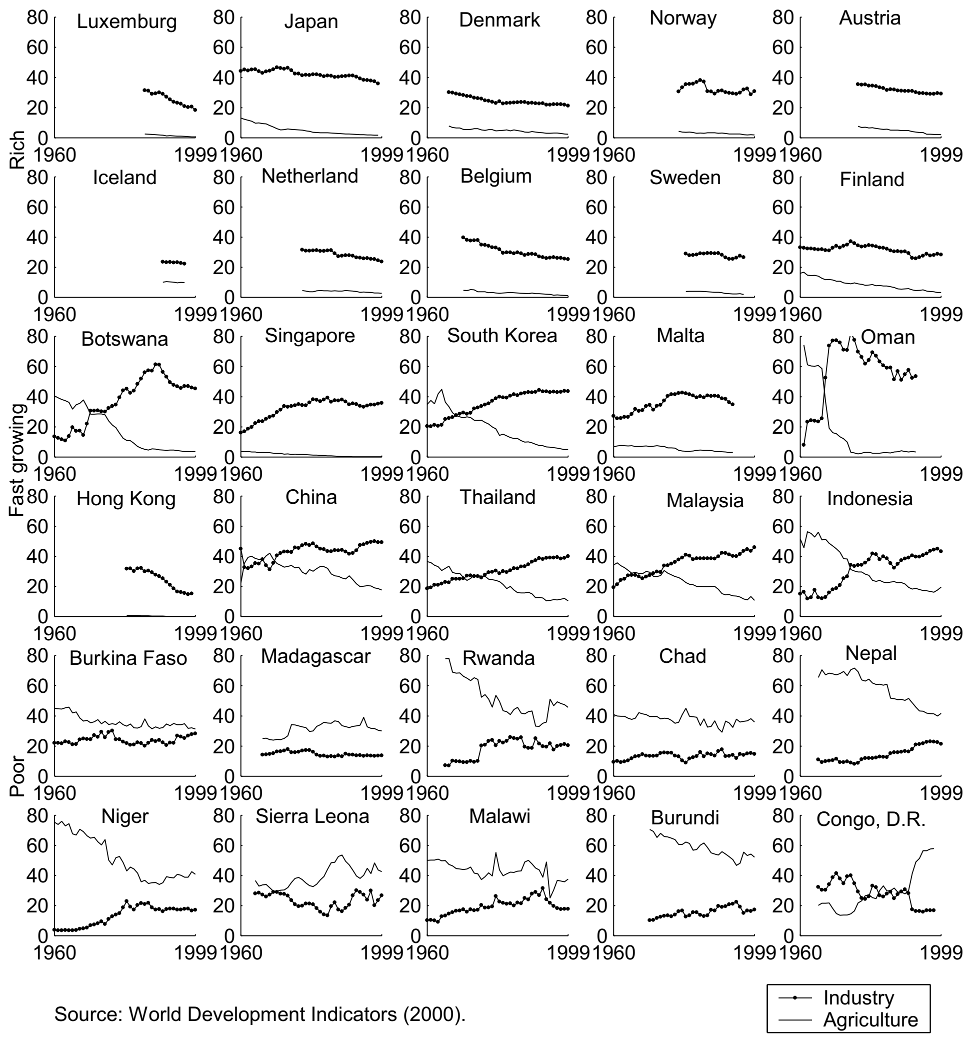
Note: Numbers in each column are the group-averages and numbers in parenthesis are the group-standard deviations of the corresponding statistics.

Table 3. The main exported and imported products for the three groups of countries.

Country	Export	Import
The rich group		
Luxembourg	machinery and equipment, steel products, chemicals, rubber products, glass	minerals, metals, foodstuffs, quality consumer goods
Switzerland	machinery, chemicals, metals, watches, agricultural products	machinery, chemicals, vehicles, metals; agricultural products, textiles
Japan	motor vehicles, semiconductors, office machinery, chemicals	machinery and equipment, fuels, foodstuffs, chemicals, textiles, raw materials (2001)
Norway	petroleum and petroleum products, machinery and equipment, metals, chemicals, ships, fish	machinery and equipment, chemicals, metals, foodstuffs
Denmark	machinery and instruments, meat and meat products, dairy products, fish, chemicals, furniture, ships, windmills	machinery and equipment, raw materials and semimanufactures for industry, chemicals, grain and foodstuffs, consumer goods
Austria	machinery and equipment, motor vehicles and parts, paper and paperboard, metal goods, chemicals, iron and steel; textiles, foodstuffs	machinery and equipment, motor vehicles, chemicals, metal goods, oil and oil products; foodstuffs
United States	capital goods, automobiles, industrial supplies and raw materials, consumer goods, agricultural products	crude oil and refined petroleum products, machinery, automobiles, consumer goods, industrial raw materials, food and beverages
Iceland	fish and fish products 70%, animal products, aluminum, diatomite, ferrosilicon	machinery and equipment, petroleum products; foodstuffs, textiles
Netherland	machinery and equipment, chemicals, fuels; foodstuffs	machinery and transport equipment, chemicals, fuels; foodstuffs, clothing
Finland	machinery and equipment, chemicals, metals; timber, paper, pulp (1999)	foodstuffs, petroleum and petroleum products, chemicals, transport equipment, iron and steel, machinery, textile yarn and fabrics, grains (1999)
The fast-growing group		
Botswana	diamonds 90%, copper, nickel, soda ash, meat, textiles	foodstuffs, machinery, electrical goods, transport equipment, textiles, fuel and petroleum products, wood and paper products, metal and metal products
Singapore	machinery and equipment (including electronics), consumer goods, chemicals, mineral fuels	machinery and equipment, mineral fuels, chemicals, foodstuffs
South Korea	electronic products, machinery and equipment, motor vehicles, steel, ships; textiles, clothing, footwear; fish	machinery, electronics and electronic equipment, oil, steel, transport equipment, textiles, organic chemicals, grains
Malta	machinery and transport equipment, manufactures	machinery and transport equipment, manufactured and semi-manufactured goods; food, drink, and tobacco
Oman	petroleum, reexports, fish, metals, textiles	machinery and transport equipment, manufactured goods, food, livestock, lubricants
Hong Kong	electrical machinery and appliances, textiles, apparel, footwear, watches and clocks, toys, plastics, precious stones	foodstuffs, transport equipment, raw materials, semimanufactures, petroleum, plastics, machinery, electrical equipment; a large share is reexported
China	machinery and equipment; textiles and clothing, footwear, toys and sporting goods; mineral fuels	machinery and equipment, mineral fuels, plastics, iron and steel, chemicals
Thailand	computers, transistors, seafood, clothing, rice (2000)	capital goods, intermediate goods and raw materials, consumer goods, fuels (2000)
Malaysia	electronic equipment, petroleum and liquefied natural gas, wood and wood products, palm oil, rubber, textiles, chemicals (2000)	electronics, machinery, petroleum products, plastics, vehicles, iron and steel products, chemicals (2000)
The poor group		
Nigeria	petroleum and petroleum products 95%, cocoa, rubber	machinery, chemicals, transport equipment, manufactured goods, food and live animals
Madagascar	coffee, vanilla, shellfish, sugar; cotton cloth, chromite, petroleum products	capital goods, petroleum, consumer goods, food
Rwanda	coffee, tea, hides, tin ore	foodstuffs, machinery and equipment, steel, petroleum products, cement and construction material
Chad	cotton, cattle, gum arabic	machinery and transportation equipment, industrial goods, petroleum products, foodstuffs, textiles
Nepal	carpets, clothing, leather goods, jute goods, grain	gold, machinery and equipment, petroleum products, fertilizer
Níger	uranium ore, livestock, cowpeas, onions	foodstuffs, machinery, vehicles and parts, petroleum, cereals
Malawi	tobacco 60%, tea, sugar, cotton, coffee, peanuts, wood products, apparel	food, petroleum products, semimanufactures, consumer goods, transportation equipment
Sierra Leone	diamonds, rutile, cocoa, coffee, fish (1999)	foodstuffs, machinery and equipment, fuels and lubricants, chemicals (1995)
Burundi	coffee, tea, sugar, cotton, hides	capital goods, petroleum products, foodstuffs
Congo, D. R.	diamonds, copper, crude oil, coffee, cobalt	foodstuffs, mining and other machinery, transport equipment, fuels

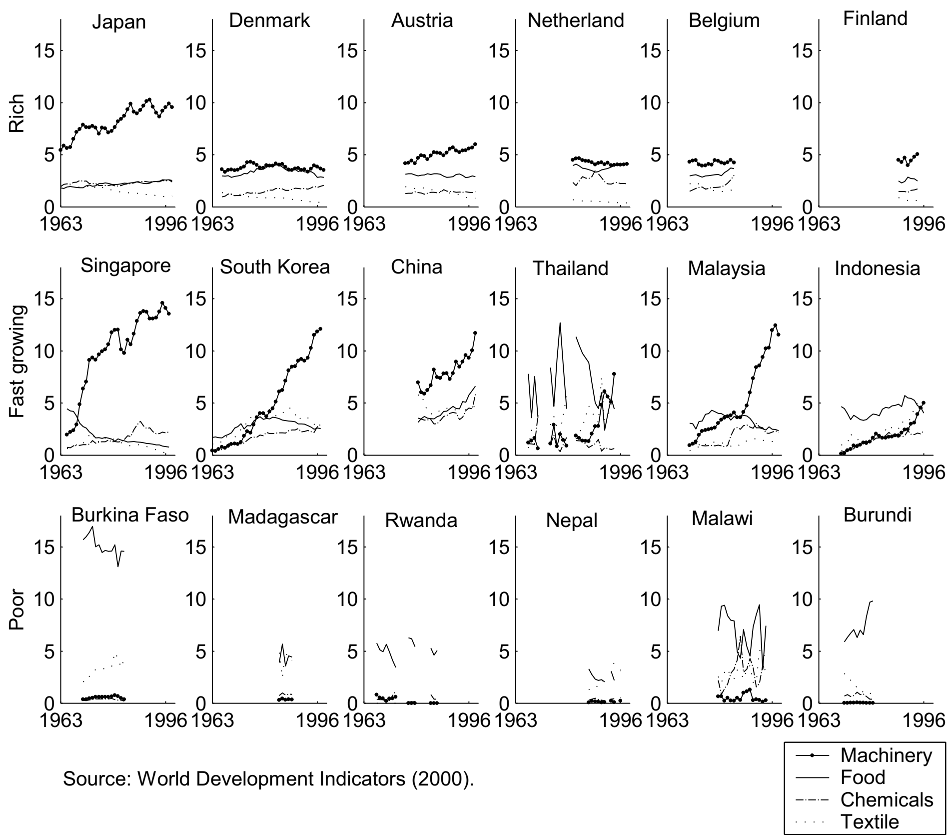
Note: Exported and imported are provided starting from the most important.

Figure 1. Shares of industry and agriculture in GDP for three groups of countries.



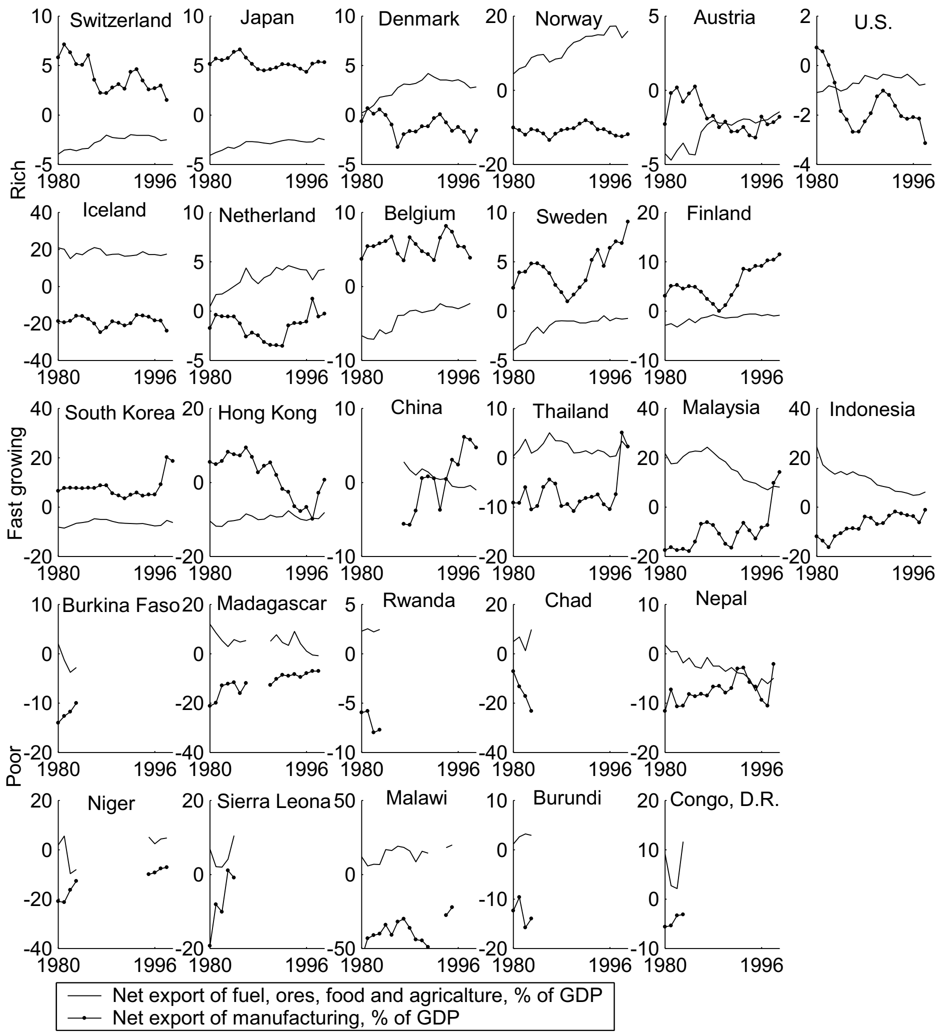
Source: World Development Indicators (2000).

Figure 2. Sectorial composition of GDP for three groups of countries.



Source: World Development Indicators (2000).

Figure 3. Sectorial composition of net export for three groups of countries.



Source: World Development Indicators (2000).

We summarize the tendencies observed in the data below.

1. The richest countries are not the ones with the highest growth rates, and the fast-growing countries are not particularly rich.

2. In general, fast-growing countries are small. Rich countries may be either large or small.

3. The rich countries have large industrial sectors and small agricultural sectors, and the poor countries have large agricultural sectors and small industrial sectors. The shares of industry and agriculture in both the rich and poor countries are stable over time. The fast-growing countries first had large agricultural sectors and small industrial sectors, as the poor countries do. Over the subsequent period of fast growth, the fast-growing countries experienced a dramatic reduction of their agricultural sectors and a great expansion of their industrial sectors.

4. For the rich countries, the largest component of manufacturing is machinery, whereas for the poor countries, it is food (and the smallest component is machinery). For the fast-growing countries, the share of machinery in manufacturing was initially small but increased dramatically over the period of fast growth.

5. The poor countries are heavy net exporters of primary products (i.e., fuel, ore, food and agriculture) and net importers of highly elaborated products (manufacturing). The rich countries do not have a pronounced pattern of international trade. The fast-growing countries increase the share of manufacturing in their net exports over the period of fast growth. In particular, the fast-growing countries have the highest share of high-tech export in GDP.

Let us discuss the above stylized facts in greater detail. As far as *Fact 1* is concerned, the growth-rates ranking among the ten richest countries are 21, 59, 9, 18, 45, 27, 44, 26, 41 and 25, respectively (see *Table 1*). The average growth rate of the rich group is 2.78%, which is much lower than the growth rate of the fast-growing group, 5.52% (see *Table 2*). In turn, the ranks by GDP per capita in 1999 of the ten fast-growing countries are 45, 14, 28, 29, 35, 17, 72, 50, 3 and 41, respectively. In 1960, the GDP per capita of the fast-growing group was about twice as low as the sample average and more than six times as low as that of the rich group. As a result of their continuous fast growth, in 1999, the GDP per capita of the fast-growing group surpasses that of the sample average, but is still about three times as low as that of the rich group. In fact, there is only one country, Japan, which belongs to both the rich and the fast-growing groups.

As regards *Fact 2*, the sizes of seven out of ten fast-growing countries, such as Botswana, Singapore, Malta, Oman, Hong Kong, Thailand, and Malaysia were less than 20% of the sample average in 1960, and remain far below the sample average in 1999 in spite of their continued economic growth (see *Table 1*). South Korea and China had initial sizes comparable to the sample average (48% and 113%, respectively) and increased their sizes to 187% and 330%, respectively, in 1999. Japan is the only serious exception to the general rule: it was about ten times larger than the sample average in 1960, and it almost doubles its relative size in 1999. Furthermore, our rich group is composed of six countries whose sizes are about average in both 1960 and 1999 (Norway, Finland, Austria, Netherlands, Denmark, Switzerland), of two very large countries (Japan and the U.S.), and of two very small countries (Luxembourg and Iceland). Thus, the size of the typical fast-growing country is significantly smaller than that of the typical rich country.

The tendencies listed in *Fact 3* are illustrated in *Figure 1* and are quantified in *Table 2*. As can be seen from the table, the shares of industry in GDP for the rich, fast-growing and poor groups are about 27.9%, 40.5% and 22.1%, respectively, while the shares of agriculture in GDP for these groups are about 3.8%, 6.8% and 37.2%, respectively. (The figures for the shares of labor employed in industry and in agriculture are quite similar). Furthermore, in the fast-growing countries, the growth rate for industry is 7.7%, which is remarkably higher than it is for either the rich or the poor countries, 2.2% and 0.9%, respectively. The growth rates for agriculture are, in general, low and do not differ substantially among the fast-growing, rich or poor groups, amounting to 0.7%, 0.7% and 0%, respectively. In *Figure 1*, we observe few exceptions to the regularities in *Fact 3*. Specifically, for such fast-growing countries as Singapore, Malta and Hong-Kong, the agricultural sector had always been nearly zero because of their poor endowment of land. In Congo D.R., although the share of agriculture was initially smaller than that of industry, it increased over the last decade and currently exceeds the share of industry.

The regularities in *Fact 4* can be readily seen from *Figure 2* and *Table 2*. In particular, it follows from the table that the growth rate of machinery in the fast-growing countries was 18.3%, which is much higher than that in the rich countries, where it is 3.0%. Currently, the share of machinery in GDP in the fast-growing countries is almost twice as much as it is in the rich countries. In the poor group, machinery was also growing at a high rate of 12.4%. However, given that, initially, this sector was almost non-existent, its share in GDP still represents just 0.8%. It is interesting to note that the evolution of machinery in Japan is quite characteristic for both rich and fast-growing countries: machinery was the largest part of manufacturing sector in Japan, as it is in the rich countries, and it has been growing rapidly, as it is in the fast-growing countries. This substantiates the fact that Japan belongs to both the rich and the fast-growing groups.

To appreciate the composition of the exports and imports of the different countries listed in *Fact 5*, we shall look at *Figure 3, Table 2* and *Table 3*. Regarding the rich group, we observe that some countries, like Luxembourg, Switzerland, Japan and Finland are net exporters of manufactured goods and importers of primary goods; other countries that are particularly rich in certain primary goods, like Denmark (fish, meat), Norway (petroleum), Iceland (fish) and Netherlands (food), are importers of manufactured goods and exporters of primary goods; finally, Austria and the U.S. are currently importers of both primary and manufactured goods (see *Figure 3* and *Table 3*). The fact that the fast-growing countries experienced a large expansion in the export of manufactured goods over the last two decades can be observed from *Figure 3*: initially, such countries as China, Thailand, Malaysia and Indonesia were importers of manufactured goods and are now net exporters; and South Korea increased its share of net exports of manufactured goods in its GDP, from 7% to 20%. In particular, the gross export of high-tech products in the fast-growing group is 7.58% of their GDP, which is much higher than the respective numbers for the rich and the poor groups, 2.78% and 0.04%, respectively. (Unfortunately, we do not have data on net export of high-tech products). Finally, there is a very clear pattern of international trade for the poor countries, which export such primary goods as cotton, livestock, coffee, tea, carpets, tobacco, sugar, peanuts, petroleum or diamonds in exchange for capital goods, machinery, equipment and foodstuffs (see *Table 3*). The quantitative expression of the tendency is well-illustrated by the figures shown in *Table 2*: the poor group has net import of manufacturing as over 17% of their GDP and net export of primary goods as 10%.

Some of these empirical facts have been documented in previous development literature. For example, Chari, Kehoe and McGrattan (1996) consider the ten fastest-growers and the ten slowest-growers and analyze their growth rates relative to the average during the 1960-1985 period. Further, Kongsamut, Rebelo and Xie (2001) focus on the effect of structural change on economic dynamics in 123 countries in the period 1970-1989 and find that an increase in per capita income leads to a decrease in the share of agricultural output and to an increase in the share of manufactured output in total GDP.

We shall argue that our model is largely consistent with the stylized facts documented above. We shall start by presenting the view of the postwar worldwide economic development, as our model suggests. Following Atkeson and Kehoe (2000), we assume that different countries begin their economic development at different dates. To be specific, we consider the world as being composed of two groups of countries: i.e., the early-blooming group, consisting of both autarkic and open economies that have reached the autarky-like steady state (51) and the late-blooming group, consisting of open economies that have just begin to develop. We assume that the late-blooming group is small, relative to the early-blooming group, so that the choices of the late-bloomers do not affect the world price, which is equal to the steady state price in the early-blooming countries p_A^*.

For the world economy, the implications of our model are the same as for the autarkic economy in Section 2.3. In particular, we have that long-run growth is impossible at the world level. Indeed, there are decreasing returns to primitive-good production because the available amount of one of the production factors, natural resources, is fixed. Given that primitive goods are used as inputs for producing sophisticated goods, in equilibrium, we also have (asymptotically) decreasing returns to sophisticated-good production, as formula (23) shows. Hence, nearly all the world economies end up in an autarky-like steady state, as our early-blooming group does.

According to our model, a small open economy does not necessarily share a common destiny: it can do either worse than, as well as, or better than the world in general does, depending on the sort of equilibrium it has. Below, we argue that the three groups of countries defined in at the beginning of this section, namely, the poor, rich and fast-growing groups, can be viewed as being in Equilibria I, II, and III, respectively.

First, as follows from our model, being a small open economy is a curse if the poverty-trap equilibrium (Equilibrium I) is chosen. Such an economy produces only primitive goods and exchanges them for sophisticated goods on the international market, and it converges to the poverty-trap steady state with a lower consumption (welfare) than the world's average. The features of ten late-blooming African countries from our poor group seem to fit the above description.

Secondly, our model predicts that a small open economy can reach the world's average if it mimics the behavior of the autarkic economy by choosing Equilibrium II. Such an economy produces both primitive and sophisticated commodities, and it converges to the autarky-like steady state with no trade on the international market.[14] The above description seems to suit the rich early-blooming countries in the data. Note that our rich group includes both large developed economies (like the U.S., Japan, Canada) and small developed economies (like Luxembourg, Iceland, Norway, Denmark). In fact, our model is consistent with this empirical observation: one can view large developed economies as being in autarky, and one can view small developed economies as open economies being in Equilibrium II.

Finally, according to our model, being a small open economy becomes a blessing if it produces mostly sophisticated goods (Equilibrium III), and exchanges them for primitive goods on the international market. Such an economy has positive long-run growth, i.e., it becomes a growth-miracle. Eternal growth is possible for a small open economy because it can buy primitive goods used in the production of sophisticated goods at a constant world price p, and hence, has constant returns to scale in the production of sophisticated goods. A distinctive property of Equilibrium III is that the country's share of primitive-good production decreases and that of its sophisticated-good production increases over time. The above features are indeed characteristic of the fast-growing countries in the data.[15]

Given the close relation with the paper of Atkeson and Kehoe (2000), we finish this section by comparing our results to theirs. Specifically, they

[14] To be precise, in the autarky-like steady state, there is no trade of primitive goods for sophisticated goods or vise versa. Note that exchange of one primitive (sophisticated) good for another primitive (sophisticated) good is not considered to be "trade" in our model, as we do not have different primitive (sophisticated) goods. Hence, our model is consistent with the observation that the developed countries are both importers and exporters of sophisticated goods (see *Table 3*) as long as their net export (import) is zero.

[15] In addition, the prediction of our model, that the fast-growing countries would have increasing returns to scale in the early stages of development and constant returns to scale in recent years, is consistent with the empirical evidence on the East Asian economies, documented by Park and Ryu (2006). Furthermore, this study finds that the East Asian economic growth was due to the accumulation of physical capital, and not to technical progress, which is also in agreement with our model.

show that the rate of economic growth is independent of the time of development but consumption is permanently lower in a country that starts developing later, whereas our analysis implies that a small country may do worse, as good as, or better than the rest of the world in terms of economic growth and welfare, depending on a specialization selected. This difference in growth implications is due to the assumptions made about the two sectors of the economy. In their model, two sectors differ in capital intensity: late-booming countries start the process of development with a lower level of capital and, therefore, should specialize in production of labor-intensive goods, which makes them earn a lower income compared to early-blooming countries. In our model, an important difference between the two sectors is returns to scale: a small country can enjoy increasing returns to scale if it selects a right specialization. Note also that in Atkeson and Kehoe's (2000) model, where production functions have constant returns to scale, equilibrium is always unique and, therefore, countries cannot select a specialization; on the contrary, we obtain multiple equilibria and a possibility to select a specialization due to increasing returns to scale in one of the sectors.

4 Making a miracle

According to our theory, different countries show distinct types of economic performance because they have selected different types of equilibria. In this section, we analyze three factors that are important for the choice of a given type of equilibrium, specifically: endowment of capital, endowment of natural resources and government economic policy. We argue that these factors are indeed relevant in explaining the different development experiences of actual economies.

4.1 Escaping the poverty trap

In the absence of externalities, $\varphi(k) = 1$ for all k, a small open economy has an AK-type of technology for producing sophisticated goods. As there are decreasing returns to the primitive-good production, such an economy will open the sophisticated-good sector once the marginal productivity of capital in the primitive-good sector reaches the constant productivity of the sophisticated-good sector. Starting from this point, we have a constant size of the primitive-good sector and an increasing size of the sophisticated-good sector, so that asymptotically, we obtain an AK model.[16]

With externalities, it might be that the economy never accumulates sufficient capital to open a sophisticated-good sector. Indeed, it could be that the steady state capital stock of the economy producing only primitive goods, $k_I^{p,*}$, is lower than the required threshold capital, $\overline{k}$, which was shown to be necessary for launching a sophisticated-good sector. If this is so, the economy is caught in the poverty trap forever, producing only primitive goods. This is presumably what happens to the countries in our poor group.

To escape the poverty trap, a developing country should adopt different policies to help it reach the threshold level $\overline{k}$. One possibility would be to ask for international aid, and/or, to attract foreign investment. Another possibility would be to reduce the threshold level $\overline{k}$ by employing an appropriate fiscal policy. For example, the government can tax primitive-good producers and subsidize sophisticated-good producers: the former policy pushes $r^p\left(k_t^p\right)$ down in (39) and the latter one pushes $r^s\left(k_t^s\right)$ up in (40), so that their intersection, $\overline{k}$, is reduced.[17]

There are examples of developing countries that have benefited from such policies. Foreign aid boosted the development of the two growth-miracles of South Korea and Thailand. The discriminatory tax-subsidy schemes were crucial for promoting export-oriented industries in South Korea and Japan. However, there are also numerous examples of developing countries (especially, in Latin America) that received significant foreign help and did very poorly afterwards. Our model suggests the following explanation to this phenomenon: in order to become a growth miracle, a country should not only accumulate the threshold amount of capital but should also choose the right equilibrium. We discuss this issue in Section 4.3.

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[16] As was mentioned in the introduction, this implication is parallel to the one obtained in Hansen and Prescott (2002).

[17] An economy ruled by a benevolent central planner (dictator) has a greater chance of escaping the poverty trap than a market economy does. First, the planner internalizes externalities and, thus, faces a lower threshold $\overline{k}$, and secondly, the planner can adopt development strategies that are not feasible in a market economy, such as developing its sophisticated-good sector when it is still unprofitable or to go beyond the (poverty-trap) steady state of the primitive-good sector.

4.2 Natural resources

We shall now analyze the role of natural resources in economic development. From (43) and (45) and from (50), we obtain, respectively:

$$\frac{d\log \overline{k}}{d\log N} = \frac{\overline{k}^p}{\overline{k}} < 1 \qquad \text{and} \qquad \frac{d\log k_I^{p,*}}{d\log N} = 1. \tag{54}$$

That is, as the amount of natural resources, N, increases, both the steady-state capital stock in Equilibrium I, $k_I^{*,p}$, and the threshold capital stock, $\overline{k}$, increase, but the former grows faster than the latter does. Hence, under a sufficiently large N, we have $k_I^{*,p} > \overline{k}$, which implies that a country with abundant natural resources is able to accumulate enough capital in the primitive-good sector to launch the sophisticated-good sector. The converse is also true: a country with scarce natural resources is never able to reach the threshold necessary for launching a sophisticated-good sector. Thus, in the absence of international aid, only countries that are rich in natural resources have any chance of developing.

If international aid is available but limited, abundant natural resources could become an obstacle for growth. Indeed, as follows from (54), the threshold capital stock, $\overline{k}$, for countries with abundant natural resources is larger than that for countries with scarce natural resources. In particular, in the limit, we have $\lim_{N\to 0} \overline{k} \to 0$. Therefore, a country with few natural resources can reach its threshold level $\overline{k}$ with little international aid, as opposed to a country with great natural resources, which needs relatively more international aid to do so.

Consequently, the effect of natural resources on growth, in our model, is dual: on the one hand, the richness in natural resources increases the production possibilities of the country, but, on the other hand, it leads to excessive production of primitive goods and distracts the economic agents from more sophisticated and more efficient production alternatives. These predictions of our model are similar to those of Matsuyama's (1992) model if variations in the agricultural productivity in the latter model are interpreted as variations in the endowment of natural resources in our model.[18]

[18]The dual role of natural resources in economic development is also emphasized in Guilló and Pérez (2007) in the context of the standard neoclassical two-sector growth model with fixed sector-specific inputs.

The model's implication about the dual role of natural resources in economic growth appears to be in agreement with the data.[19] The fast-growing countries are generally short of natural resources. This is particularly true for the Four East Asian dragons (Singapore, South Korea, Hong Kong, Taiwan) and Malta. The most outstanding of them, Singapore, started with greater adversities than the other three, and is now the most developed country among them. Malta has no rivers, no minerals, no domestic energy sources and poor soil. As reported in Gylfason and Zoega (2006), in Japan, Thailand, China, Malaysia, Indonesia, natural resources make up 0.8%, 6.5%, 7.2%, 8.6%, 12.4% of national wealth, respectively, which also points to the fact that the fast-growers are resource-poor. (For the other fast-growers, the corresponding reliable data are not available). The above countries, however, managed to overcome their resource constraints by developing large export-oriented manufacturing sectors. In contrast, the poor slow-growing countries identified earlier are very rich in terms of natural resources: in all these countries, natural resources represent more than 15% of their national wealth (an exception is Malawi, where this figure is slightly lower); remarkably, in Sierra Leone, Chad, Madagascar and Niger, natural resources represent 28%, 37%, 42% and 54% of national wealth, respectively; see Gylfason and Zoega (2001). These resource-rich countries export raw materials and agricultural products in exchange for more sophisticated manufactured goods, so that their own production of sophisticated goods remains underdeveloped. At the same time, the example of Oman and Botswana, demonstrates that abundant natural resources can be a boost rather than an obstacle to growth. (Oman and Botswana are exceptionally rich in fuel and diamonds, respectively). The success of these two countries is explained by their strategy of investing income from the exportation of natural resources to initiate industrialization.

4.3 The coordinating role of government

The key implication of our model is that the economic performance of a small open economy depends crucially on which type of equilibrium it selects. As we argued in Sections 4.1 and 4.2, some countries can converge more easily to a good equilibrium than others, because of their larger capital endowment or their greater wealth in natural resources. However, even the most favorable

[19] The empirical literature that studies the relationship between the richness in natural resources and economic growth includes, e.g., Sachs and Warner (1995), Gylfason, Herbertsson and Zoega (1999), Gylfason and Zoega (2006).

initial conditions do not guarantee that a country will become a growth miracle. Only those countries that manage to coordinate on the growth-miracle equilibrium will do so.

The government is a natural candidate for performing the coordinating role. The importance of the government's policy on economic development can be seen clearly by looking at the experience of the fast-growing countries. In *Singapore*, the basic industrialization program was initiated and managed by the government; in particular, the government consulted a UN development expert, who recommended the rapid build up of the manufacturing sector. In *South Korea*, with the military takeover in 1961, economic policy changed from reconstruction and import substitution to the aggressive promotion of exportation. The economic expansion of *Malaysia* was encouraged by the government in the late 1960s, by initiating its import-substitution industrialization program in heavy industry. The *Japanese* government played an important coordinating role in overcoming the market failures that inhibited the economy's structural transformation.[20] *Malta* has based its economic growth on the promotion of the exportation of manufactured goods (as well as tourism). In the case of *Botswana*, the source of its growth was mineral wealth, which Botswana's government was able to transform into long-term growth by channelling funds into the development of manufacturing. Another fast-growing country with rich natural resources, *Oman*, has had a similar experience: income generated from the exportation of natural resources was used for the development of physical and social infrastructure.

A crucial role of government in the process of economic development can be also appreciated by comparing the experience of Botswana with that of Sierra Leone, another African country that exports diamonds. As was discussed above, Botswana now has a high-performance economy because its government was able to take advantage of its wealth in diamonds by implementing the adequate economic policy. In contrast, Sierra Leone is one of the poorest countries in the world, mainly because its government was unable to stop a domestic conflict that is linked its rich diamond supply and which destroyed the country's infrastructure and social institutions.

[20] Rodrik (1996, p.19) also emphasizes the importance of the governments' coordination for successful economic performance of the fast-growing East Asian countries: "... the governments of Japan, South Korea, and Taiwan played an active role in coordinating, subsidizing, and guiding private investment decisions. This active role was implemented through the governments' control over the allocation of credit, through tax and other incentives, administrative guidance, and when all else failed, public enterprises".

China is another example of a government that played a key role in initiating and promoting economic development. The Chinese government implemented a gradual transition from a command economy to a market economy, generally maintaining its old institutions and slowly reshaping them to meet the needs of its market economy. In particular, as a first step, the government introduced market forces in agriculture and only after agriculture had been sufficiently developed, began the necessary reforms in industry. In fact, this development strategy is precisely what leads to a growth-miracle equilibrium in our model: It, first, accumulates the threshold amount of capital in the primitive-good sector and then, it switches to a growth-miracle equilibrium by shifting the resources to the sophisticated-good sector.

5 Conclusion

This paper develops a two-sector model of international trade and economic growth with the aim of explaining postwar international growth experiences. The open-economy version of our model has multiple equilibria because one of the production sectors has increasing returns to scale. Depending on the equilibrium chosen, a small open economy can do either worse, as well as, or better than the world average. These implications are consistent with the tendencies that we observe in the data since 1950s , namely, that the initially rich nations have remained rich, most of the poor nations have remained poor and some of the poor nations have become growth miracles. We emphasize the importance of government interventions in a country's successful economic performance by arguing that an appropriate policy can help the economy coordinate on a superior equilibrium.

As a final comment, we should point out one important limitation to our analysis. We take a rather simplified view of the world economy by assuming that it is composed of developed autarkic economies which determine world prices and of small developing open economies which have no effect on world prices. In reality, world prices arise as an outcome of the interactions among all countries, and, in particular, are affected by the actions of developing countries. This fact is potentially important for the properties of equilibrium in the world economy. One implication of our model that will not survive the introduction of fully endogenous price determination is that a small open economy can grow forever. Indeed, eternal growth is possible for a small open economy because it faces constant prices. However, as such an economy grows larger, it starts affecting world prices, so that its growth must slow down. (Presumably, this effect accounts for the slow-down in the Japanese growth rate during the last decade). To address this and other similar issues, one has to set up a multi-country general equilibrium model of international trade and economic growth. Characterization of equilibrium in such a model is, in general, a difficult task. One possible way of proceeding in this direction would be to employ the aggregation theory, see, e.g., Caselli and Ventura (2000), and Maliar and Maliar (2003).

References

[1] Atkeson, A., Kehoe, P., 2000. Paths of development for early- and late-bloomers in a dynamic Heckscher-Ohlin model, Federal Reserve Bank of Minneapolis, Research Department Staff Report 256.

[2] Bardhan, P., 1970. Economic growth, development and foreign trade, John Wiley and Sons, New York.

[3] Caselli, F., Ventura, J., 2000. A representative consumer theory of distribution, American Economic Review 90, 909-926.

[4] Chari, V., Kehoe, P., McGrattan, E., 1996. The poverty of nations: a quantitative exploration, NBER Working Paper 5414.

[5] Choi, J., Yu, E., 2002. External economies in the international trade theory: a survey, Review of International Economics 10, 708-728.

[6] Evans, J.W., Honkapohja, S., Romer, P., 1998. Growth Cycles, American Economic Review 88, 495-515.

[7] Gylfason, T., Herbertsson, T., Zoega, G., 1999. A mixed blessing: natural resources and economic growth, Macroeconomic Dynamics 3, 204-225.

[8] Gylfason, T., Zoega, G., 2006. Natural resources and economic growth: the role of investments, The World Economy 29 (8), 1091–1115.

[9] Graham, B., Temple, J., 2006. Rich nations, poor nations: How much can multiple equilibria explain?, Journal of Economic Growth 11(1), 5-41.

[10] Grossman, G., Helpman, E., 2003. Technology and trade. In: Grossman, G., Rogoff, K., Eds., Handbook of International Economics, North-Holland, Volume 3, Chapter 25.

[11] Guilló, M., Pérez, F., 2007. The curse and blessing of fixed specific factors in small open economies, Journal of Development Economics 82(1), 58-78.

[12] Hansen, G., Prescott, E., 2002. Malthus to Solow, American Economic Review 60, 895-911.

[13] Kemp, M., Schweinberger, A., 1991. Variable returns to scale, non-uniqueness of equilibrium and the gains from international trade, Review of Economic Studies 58, 807-816.

[14] Kongsamut, P., Rebelo, S., Xie, D., 2001. Beyond balanced growth, Review of Economic Studies 68(4), 869-82.

[15] Krugman, P., 1987. The narrow moving band, the dutch desease, and the competitive consequences of Mrs. Thatcher: Notes on trade in the presence of dynamic scale economics, Journal of Development Economics 27, 41-55.

[16] Lucas, R., 1988. On the mechanics of economic development. Journal of Monetary Economics 22, 3-42.

[17] Lucas, R., 1993. Making a miracle, Econometrica 61, 251-272.

[18] Maliar, L., Maliar, S., 2003. The representative consumer in the neoclassical growth model with idiosyncratic shocks, Review of Economic Dynamics 6, 362-380.

[19] Maliar, L., Maliar, S., Pérez, F., 2007. Sovereign Risk, FDI Spillovers, and Economic Growth, Review of International Economics, forthcoming.

[20] Matsuyama, K., 1991. Increasing returns, industrialization and indeterminacy of equilibrium, Quarterly Journal of Economics 106, 617-650.

[21] Matsuyama, K., 1992. Agricultural productivity, comparative advantage, and economic growth, Journal of Economic Theory 58, 317-334.

[22] Murphy, K., Schleifer, A., Vishny, R., 1989. Industrialization and the big push, Journal of Political Economy 97, 1003-1026.

[23] Park, J., Ryu, H., 2006. Accumulation, Technical Progress, and Increasing Returns in the Economic Growth of East Asia, Journal of Productivity Analysis 25(3), 243-255.

[24] Rodrik, D., 1996. Coordination failures and government policy: a model with application to East Asia and Eastern Europe, Journal of International Economics 40, 1-22.

[25] Rodrik, D., 2003. Growth strategies, In: P. Aghion and S. Durlauf, Eds., Handbook of Economic Growth, North-Holland, Volume 3, Chapter 5.

[26] Romer, P., 1986. Increasing returns and long-run growth, Journal of Political Economy 94, 1002-1037.

[27] Sachs, J., Warner, A., 1995. Natural resource abundance and economic growth, NBER working paper 5398.

[28] Stokey, N., 1991, Human capital, product quality, and growth. Quarterly Journal of Economics 425, 587-616.

[29] Ventura, J., 1997. Growth and interdependence, Quarterly Journal of Economics 112, 57-84.

[30] Young, A., 1991. Learning by doing and the dynamic effects of international trade, Quarterly Journal of Economics 105, 369-405.