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A model of unbalanced sectorial growth with application to transition economies

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Abstract This paper studies the implications of a dynamic general equilibrium model with three production sectors, which are agriculture, industry and services. Due to the assumption of increasing returns, our model has multiple equilibria. There are two stable equilibria: one, in which a country produces only agricultural goods and converges to a steady state, and the other, in which a country operates all three sectors and has positive unbalanced long-run growth with contracting agriculture and expanding industry and services. These predictions agree well with the real-world development experiences of rich and poor countries. In the context of our model, we also investigate the evolution of the sectorial composition in the transition countries and find that such countries move to the rich rather than to the poor world.

Keywords Growth model · Increasing returns to scale · Agriculture · Industry · Services · Multiple equilibria · Transition economies

JEL Classification F10 · F12 · O13 · O30 · O41

1 Introduction

In this paper, we consider a multi-sector dynamic general equilibrium model with the aim of explaining the evolution of the sectorial composition in rich and poor countries, and in particular, in transition countries. There are three sectors in the

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model: agriculture, industry and services. Industry is assumed to have increasing returns to scale, which leads to multiplicity of equilibria. The stable equilibria are two. In the first equilibrium, a country opens only the agricultural sector and converges to a steady state with zero long-run growth. In the second equilibrium, a country opens all the sectors and converges to an unbalanced long-run growth path with contracting agriculture and expanding industry and services.

The consumer's side of our economy is standard: a representative consumer solves an intertemporal utility-maximization problem subject to a capital-accumulation constraint. Concerning the producer's side, we assume that the three sectors produce the same output commodity by using different technologies.[1] Agriculture uses both capital and labor inputs; industry uses only capital input; and services uses only labor input. There are positive spillovers across firms in the sense of Romer (1986). Spillovers have the largest effect on the productivity of industry, they have more modest effect on the productivity of services and they have no affect on the productivity of agriculture. If no firm invests in industry, the productivity of industry and service sectors is zero, so that no individual firm has incentives to invest there, unless sufficiently many other firms do so. This is precisely the feature of the model that produces multiplicity of equilibria: countries whose producers manage to coordinate on opening industry and services become rich, whereas those whose producers did not succeed in doing so remain poor.

There is a body of literature based on multi-sector models with increasing returns to scale, e.g., Murphy et al. (1989), Kemp and Schweinberger (1991), Matsuyama (1991, 1992) and Rodrik (1996).[2] This literature explains the differences in patterns of economic development across countries by multiplicity of equilibria: rich countries are those that are situated in high-income equilibria, while poor countries are those that stick to low-income equilibria.[3] Three recent contributions to this literature are Eswaran and Kotwal (2002), Graham and Temple (2006), and Kylymnyk et al. (2007). The first paper extends the standard setup with two sectors, industry and agriculture, to include a third sector, services, and studies the role of the service sector in the process of industrialization. The second paper calibrates a two-sector model with economies of scale to the data and establishes whether each considered country is situated in a low-income or a high-income equilibrium. Finally, the last paper constructs a two sector model that has non-vanishing economic growth in a good equilibrium, as opposed to a bad equilibrium, in which there is no long-run growth.[4]

[1] In this assumption, we follow Hansen and Prescott (2002) who assume that the manufactured and agricultural goods are perfect substitutes.

[2] See also Choi and Yu (2002) for a review of the international-trade literature that employes the assumption of increasing returns to scale.

[3] A review of the literature on coordination can be found in Rodrik (2005).

[4] Other related literature can be classified in two groups. One group includes multi-sector neoclassical growth models, which focus on explaining the time-series behavior of the sectorial composition of one given country (Hansen and Prescott 2002; Kongsamut et al. 2001); in the absence of a permanent cross-country heterogeneity, these models do not account for the cross-country differences since the equilibrium in a neoclassical growth model is unique. The other group includes dynamic Heckscher–Ohlin models of comparative advantage, which explain the cross-country differences by heterogeneity in preferences and technology (Ventura 1997), timing of development (Atkeson and Kehoe 2000), endowment of natural resources (Guilló and Pérez 2007).

In the present paper, we adopt assumptions that lead to non-vanishing economic growth in a good equilibrium, as in Kylymnyk et al. (2007), however, there are important differences between the two papers. In the present paper, we focus on a closed economy with three sectors (agriculture, industry and services), whose inputs are capital and labor, and whose products are perfect substitutes. In the previous paper, we consider an open economy of international trade with two sectors (primitive and sophisticated), where primitive production requires capital and land, and where the sophisticated production requires capital and primitive goods, and where only output of the sophisticated (but not the primitive) sector can be consumed. We differ from Eswaran and Kotwal (2002) in that we augment the standard two-sector model to include the service sector in a dynamic context, which allows us to focus on time-series patterns of the economic development, while Eswaran and Kotwal (2002) study the role of the service sector in a static context. We differ from Graham and Temple (2006) in that our model predicts non-vanishing economic growth in a good equilibrium and can account for arbitrary large income differences between rich and poor countries, whereas a calibrated variant of a two-steady-state model considered in Graham and Temple (2006) produces too small income differences relative to the data. Finally, unlike the previous literature, we test the model's predictions by looking not only at evidence from the developed and the developing countries but also at recent evidence from the transition countries.

The transition economies are currently undertaking a transformation to market economies, however, it is not clear yet whether they will be transformed to rich or poor market economies. In particular, this is not clear because the transition process was initially accompanied by a severe economic crisis and a dramatic reduction in the living standards. It is therefore an open question where the transition countries transit. Our model predicts multiple solutions and thus, it does not allow us to answer this question on purely theoretical grounds: the transition countries can end up either rich or poor depending on the equilibrium selected. Nonetheless, our model allows us to get the answer on empirical grounds, specifically, we can characterize the good and bad equilibria in the model and check which of them fits the development experiences of the transition countries.

In order to establish an equilibrium prevailing in the transition economies, we trace out the sectorial adjustments taking place in these economies along the transition process. Initially, the transition countries had a large agricultural and industrial sectors, and they had a small service sector compared to the corresponding sectors in the developed countries. Therefore, if the transition countries are in the good equilibrium, we should observe an expansion of the service sector and a contraction of the agricultural and the industrial sectors. In turn, if they are in the bad equilibrium, we should see agricultural growth at expanse of the other two sectors. We find that during the 1990–1999 period, the average output shares of agriculture and industry in the transition group of countries had reduced from 20.0% to 17.0% and from 44.3% to 31.1%, respectively, and the average output share of services had increased from 35.7% to 51.9%. We therefore conclude that on average, the transition economies are in the good equilibrium. The good-equilibrium pattern is particularly pronounced for the most developed transition countries such as Czech Republic, Estonia, Lithuania, Hungary, Poland and Slovak Republic. For less developed transition countries, the development patterns are not entirely clear. In particular, such countries as Albania, Armenia, Azerbaijan, Kyrgyz Republic, Moldova, Romania, Tajikistan and Uzbekistan had experienced an increase in the output share of agriculture, which corresponds to the bad equilibrium.

The rest of the paper is organized as follows. Section 2 develops the model and defines the equilibrium. Section 3 discusses the model's implications. Section 4 tests the empirical relevance of the model, and finally, Sect. 5 concludes.

2 The model

In this section, we develop a model and describe the corresponding equilibrium conditions. Time is continuous, and the horizon is infinite, $t \in [0, \infty)$. The consumer's side of the economy consists of a continuum of identical infinitely-lived agents, and the producer's side consists of a continuum of identical production firms. Both the agents and the firms have their names uniformly distributed on a unit interval [0,1], which ensures that variables of the representative agent and the representative firm coincide with the corresponding aggregates.

A representative agent has a period utility function of the Cobb–Douglas type that depends on consumption. The agent does not value leisure, so she inelastically supplies all her time endowment to the market. For the sake of convenience, we normalize the time endowment to one.

Thus, the agent solves the standard intertemporal utility-maximization problem:

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

subject to

$$\dot{K}_t = (r_t - \delta) K_t + w_t - c_t, \tag{2}$$

$$\lim_{t \to \infty} \left[K_t e^{-\int_0^t r_v dv} \right] \geq 0, \tag{3}$$

where $K_0 > 0$ is given. Here, c_t is consumption; w_t is real wage; K_t and r_t are the capital stock and the interest rate, respectively; $\rho > 0$ is the discount rate; $\gamma > 0$ is the utility function parameter; $\delta \in (0, 1]$ is the depreciation rate of capital; and finally, (3) is a no Ponzi game condition. Dot over K_t represents differentiation with respect to time.

A representative firm is composed of three production units, the agricultural, the industrial and the service ones, which we denote by superscripts "a", "i" and "s", respectively.[5] All three units produce the same output commodity but use different

[5] The assumption that each firm can operate in all three sectors is convenient because it allows us to explicitly separate the intertertemporal decision about the total capital stock and the intratemporal decisions about the distribution of the total capital stock across sectors. It can be shown that our setup is equivalent to the one where firms can operate only in one sector and where all investment decisions are made by the consumer.

technologies. There are two production inputs capital, k_t, and labor, n_t. Therefore, the level of output depends on how the firm distributes capital and labor across its production units. As in Romer (1986), we allow for the presence of learning-by-doing spillovers in the production function. As a result, output of each individual firm also depends on how capital is distributed across the agricultural, industrial and service sectors at the aggregate level. Thus, the production function of each firm is

$$F\left(k_t^a, k_t^i, k_t^s, n_t^a, n_t^i, n_t^s, \Phi_t\right), \tag{4}$$

where $k_t^a, k_t^i, k_t^s \geq 0$ and $n_t^a, n_t^i, n_t^s \geq 0$ are the capital and labor inputs of the agricultural, industrial and service units, respectively; and Φ_t is a set of aggregate variables, which represent spillovers (externalities). For example, Φ_t can be composed of aggregate capital stocks of the three sectors. We assume that the production function (4) exhibits constant returns to scale in private inputs and that it is continuous, differentiable and strictly concave.

The firm maximizes the period-by-period profit taking Φ_t, r_t and w_t as given

$$\pi_t = \max_{k_t^a k_t^i k_t^s n_t^a n_t^i n_t^s} \left\{F\left(k_t^a, k_t^i, k_t^s, n_t^a, n_t^i, n_t^s, \Phi_t\right) - r_t k_t - w_t n_t\right\}, \tag{5}$$

subject to

$$k_t^a + k_t^i + k_t^s = k_t, \tag{6}$$

$$n_t^a + n_t^i + n_t^s = 1. \tag{7}$$

Definition An equilibrium in the economy (1)–(7) is defined as a sequence for the agent's allocation $\{c_t, K_{t+1}\}_{t=0}^{\infty}$, for prices $\{r_t, w_t\}_{t=0}^{\infty}$ and for the firm's allocation $\left\{k_t, k_t^a, k_t^i, k_t^s, n_t^a, n_t^i, n_t^s\right\}_{t=0}^{\infty}$ such that given the prices:

(i) $\{c_t, K_{t+1}\}_{t=0}^{\infty}$ solves the utility-maximization problem (1)–(3);
(ii) $\left\{k_t, k_t^a, k_t^i, k_t^s, n_t^a, n_t^i, n_t^s\right\}_{t=0}^{\infty}$ solves the profit-maximization problem (5)–(7);
(iii) the representative firm's variables coincide with the corresponding aggregates;
(iv) all markets clear and the non-negatity constraints are satisfied.

It follows from the utility maximization problem (1)–(3) that the agent's optimal choice satisfies the standard Euler equation

$$\rho + \gamma \frac{\dot{c}_t}{c_t} = [r_t - \delta]. \tag{8}$$

Further, the profit-maximization conditions of the firm (5)–(7) are described by the following Kuhn–Tucker conditions:

$$\left(\frac{\partial F}{\partial k_t^x} - r_t\right) k_t^x = 0, \qquad k_t^x \geq 0 \ \text{ for } x \in \{a, i, s\}, \tag{9}$$

$$\left(\frac{\partial F}{\partial n_t^x} - w_t\right) n_t^x = 0, \qquad n_t^x \geq 0 \ \text{ for } x \in \{a, i, s\}. \tag{10}$$

In particular, conditions (9) implies that if the firm has no capital in some sector, this is because such a sector has a rate of return, which is lower than r_t. Also, this condition implies that all sectors, in which the amount of capital is positive, have the same rate of return, equal to r_t. Condition (10) has similar implications with respect to labor and wage.

3 The model's implications

In this section, we study the implications of the model of Sect. 2 under particular assumptions about the production function. We specifically assume that (4) takes the form:

$$A\left(k_t^a\right)^{\beta}\left(n_t^a\right)^{1-\beta}+\varphi_t^i\left(k_t^i\right)^{\beta}+\varphi_t^s\left(n_t^s\right)^{1-\beta}, \tag{11}$$

where $A > 1$, $\beta \in (0,1)$ and φ_t^i, φ_t^s are spillovers affecting productivity of industry and services such that:

$$\varphi_t^i = \varphi^i\left(k_t^i\right) = \left(k_t^i\right)^{2-2\beta} \text{ and } \varphi_t^s = \varphi^s\left(k_t^i\right) = \left(k_t^i\right)^{\beta}. \tag{12}$$

This specification is based on several simplifying assumptions that later allow us to obtain a closed-form expression for intratemporal choice. First, agriculture uses both capital and labor inputs; industry uses only capital input; and services uses only labor input. Second, only the industry sector creates externalities. Third, externalities have the largest effect on the productivity of industry, they have more modest effect on the productivity of services and they have no affect on the productivity of agriculture. While these assumptions are very special and should be treated with caution, they still allow us to capture an important feature of actual economies, namely, that capital labor ratios are the largest in industry and the smallest in services, see Eswaran and Kotwal (2002) for a discussion.

Let us characterize the optimal distribution of capital and labor across sectors under the production function (11). As a first step, we shall compute the marginal productivities of capital and labor:

$$r_t^a = \beta A\left(k_t^a\right)^{\beta-1}\left(n_t^a\right)^{1-\beta}, \tag{13}$$

$$r_t^i = \beta\varphi_t^i\left(k_t^i\right)^{\beta-1} = \beta\left(k_t^i\right)^{1-\beta}, \tag{14}$$

$$w_t^a = (1-\beta)A\left(k_t^a\right)^{\beta}\left(n_t^a\right)^{-\beta}, \tag{15}$$

$$w_t^s = (1-\beta)\varphi_t^s\left(n_t^s\right)^{-\beta} = (1-\beta)\left(k_t^i\right)^{\beta}\left(n_t^s\right)^{-\beta}, \tag{16}$$

where the second parts of equalities (14) and (16) follow by assumption (12).

Notice that the assumption of decreasing returns to scale in the agricultural sector ensures that output of this sector is always strictly positive. In fact, at low levels of development, $k_t \to 0$, the marginal productivity of capital in agriculture is higher than that in industry, i.e.,

$$\lim_{k_t\to 0} r_t^a = \infty, \text{ and } \lim_{k_t\to 0} r_t^i = 0, \tag{17}$$

for all $k_t^a, k_t^i \geq 0$ satisfying $k_t^a + k_t^i = k_t$. Thus, agriculture attracts all capital, while industry is not developed at all, i.e., $k_t^a = k_t$ and $k_t^i = 0$. However, given that industry is not operating, from (16) we have that the rate of return on labor in services is zero, so that the service sector is also closed, $n_t^a = 1$ and $n_t^s = 0$. Thus, at low levels of development we have a corner solution where only agriculture sector is operating.

When the aggregate capital stock becomes large enough, in addition to the corner solution, there is an interior solution, where the aggregate capital is split between the agriculture and industry sectors, so that both of them have the same marginal productivity of capital, $r_t^a = r_t^i$,

$$n_t^a = A^{\frac{1}{\beta-1}} k_t^i k_t^a. \tag{18}$$

Furthermore, it follows from (16) that once industry is opened, the firm will also open the service sector, so that agriculture and services must have the same productivity of labor, $w_t^a = w_t^s$,

$$A\left(k_t^a\right)^{\beta}\left(n_t^a\right)^{-\beta} = \left(k_t^i\right)^{\beta}\left(n_t^s\right)^{-\beta}. \tag{19}$$

By substituting (18) into (19) and re-arranging the terms, we obtain

$$n_t^s = A^{\frac{1}{\beta(\beta-1)}}\left(k_t^i\right)^2. \tag{20}$$

Let us compute a threshold level of the aggregate capital under which the industry and the service sectors can be opened. By combining restrictions $n_t^a + n_t^s = 1$ and $k_t^a + k_t^i = k_t$ with conditions (18) and (20), we can write

$$\left(1 - A^{-\frac{1}{\beta}}\right)\left(k_t^i\right)^2 - k_t^i k_t + 1 = 0. \tag{21}$$

By solving for k_t^i from (21), we have

$$k_t^i = \frac{k_t \pm \sqrt{k_t^2 - 4\left(1 - A^{-\frac{1}{\beta}}\right)}}{2}. \tag{22}$$

Thus, the minimum aggregate capital stock under which industry can be opened, $\overline{k}$, satisfies $k_t^2 - 4\left(1 - A^{-\frac{1}{\beta}}\right) = 0$, and is given by which implies

$$\overline{k} = 2\sqrt{1 - A^{-\frac{1}{\beta}}}, \tag{23}$$

in which case, according to (22), a half of capital is transferred from agriculture to industry and services, i.e., $\overline{k}^a = \overline{k}^i = \frac{1}{2}\overline{k}$. Under any $k_t > \overline{k}$, Eq. 21 has two different solutions, which are given by (22).

Summarizing, the equilibrium dynamics of our economy are described by the following system of two differential equations:

$$\dot{c}_t = \frac{c_t}{\gamma}\left[\beta A\left(k_t^a\right)^{\beta-1}\left(n_t^a\right)^{1-\beta} - \delta - \rho\right], \tag{24}$$

$$\dot{k}_t = \left(\beta A\left(k_t^a\right)^{\beta-1}\left(n_t^a\right)^{1-\beta} - \delta\right)k_t + (1-\beta)A\left(k_t^a\right)^{\beta}\left(n_t^a\right)^{-\beta} - c_t, \tag{25}$$

where we can have either corner solution $k_t^a = k_t$ or one of the interior solution given by (22). Assuming that the economy sticks to the same solution during all its life, we obtain the following possible equilibria.

Equilibrium I (E_I) All production is concentrated in agriculture, and the production of industry and services is zero. The economy converges to a steady state E_I^* with a zero growth rate,

$$k_I^{a*} = \left(\frac{\delta + \rho}{A\beta}\right)^{\frac{1}{\beta - 1}}, \quad k_I^{i*} = 0, \tag{26}$$
$$n_I^{a*} = 1, \quad n_I^{s*} = 0,$$

where variables with stars and without time subscripts denote steady state values. The result (26) follows directly from the Euler Eq. 24 evaluated in the steady state.

Equilibrium II (E_{II}) All sectors produce non-zero output. The economy converges to a steady state E_{II}^* with a zero growth rate,

$$k_{II}^{a*} = \left(\frac{\delta + \rho}{A\beta}\right)^{\frac{1}{\beta - 1}} n_{II}^{a*}, \quad k_{II}^{i*} = \left(\frac{\delta + \rho}{\beta}\right)^{\frac{1}{1-\beta}}, \tag{27}$$
$$n_{II}^{a*} = 1 - n_{II}^{s*}, \quad n_{II}^{s*} = A^{\frac{1}{\beta(\beta-1)}}\left(\frac{\delta + \rho}{\beta}\right)^{\frac{2}{1-\beta}}.$$

To compute the above values, we first substitute n_t^a from (18) into the Euler Eq. 24 and evaluate the resulting expression in the steady state to get k_{II}^{i*}. We next compute the steady state values of n_{II}^{s*} from (20), and we restore n_{II}^{a*} from the restriction $n_{II}^{a*} + n_{II}^{s*} = 1$. We finally compute k_{II}^{a*} by using the obtained value n_{II}^{a*} and Eq. 18.

Equilibrium III (E_{III}) All sectors produce non-zero output, except of the limiting case $t \to \infty$, when the agricultural sector is closed down. The economy grows at an increasing growth rate, so that in the limit, we have[6]

$$k_{III}^{a*} = 0, \quad k_{III}^{i*} = \infty, \tag{28}$$
$$n_{III}^{a*} = 0, \quad n_{III}^{s*} = 1.$$

The three equilibria constructed are shown in Fig. 1. In the figure, the curves $r^a\left(k_t^a\right)$ and $r^i\left(k_t^i\right) = r^i\left(k_t - k_t^a\right)$ represent the marginal productivities of capital in agriculture and industry (services), respectively. The tangency point of $r^a\left(k_t^a\right)$ and $r^i\left(\overline{k} - k_t^a\right)$ identifies the threshold level (23). Finally, the intersection of $r^a\left(k_t^a\right)$ and $r^i\left(k_{II}^* - k_t^a\right)$ determines the steady state levels of Equilibria I and II.

In fact, Equilibrium II is unstable to deviations that affect prices. This can be shown by means of the Marshallian tatonnement argument, which is as follows.[7]

[6] Instead of an increasing growth rate, we can obtain an asymptotically constant growth rate by assuming different functions for externalities, ones that satisfy $\lim_{k \to \infty} \varphi'(k) = 1$.

[7] See Matsuyama (1991) for a discussion.

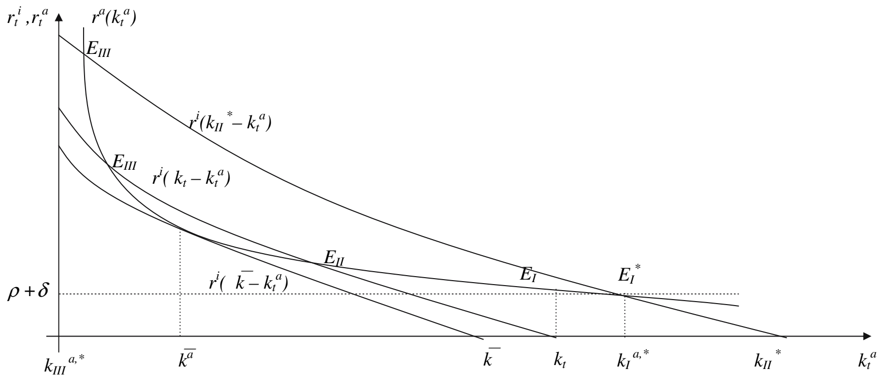

Fig. 1 Equilibria I, II and III and threshold value $\bar{k}$

Suppose that all firms are situated in Equilibrium II but a coalition of firms with a positive measure deviates by investing more capital in agriculture than that implied by the Equilibrium II strategy. Then, as is seen in Fig. 1, the marginal productivity of capital in agriculture becomes larger than that in industry, $r_t^a > r_t^i$, so that other firms start shifting capital from industry and services to agriculture until the economy ends up in Equilibrium I. Alternatively, if a group of firms with a positive measure deviates by investing more capital in industry than that implied by the Equilibrium II strategy, we have $r_t^i > r_t^a$, and all firms re-allocate capital from agriculture to industry and services until the economy ends up in Equilibrium III.[8] In contrast, Equilibria I and III are stable to deviations. Consider, for example, Equilibrium I. If nobody invests in industry, according to (14), the marginal productivity of these sectors is zero, $r_t^i = 0$. Hence, $r_t^a > r_t^i$, and no firm has incentives to deviate from the equilibrium strategy, which is to invest all capital in agriculture. The same type of reasoning can be used to show the stability of Equilibrium III.

Thus, according to our model, each country can become either rich or poor depending on which equilibrium it coordinates on.[9] Poor and slow-growing countries are those that are situated in Equilibrium I; such countries produce exclusively agricultural products. In turn, rich and fast-growing countries are those that are situated in Equilibrium III; such countries produce all kinds of products;

[8] One can advocate Equilibrium II by arguing that it is stable under deviations that do not affect prices, i.e., deviations of one firm or a group of firms with a zero measure. It is also possible to make Equilibrium II stable to the price-affecting deviations by introducing adjustment costs as in Graham and Temple (2006). In this paper, we do not consider Equilibrium II as it is not relevant for the empirical issues we focus on.

[9] The fact that the equilibria in our model can be Pareto ranked does not imply that the coordination problem is simple to resolve: it is a dominant strategy for each agent to stick to the bad equilibrium as long as all agents do so. It is an open question how to get poor countries to coordinate on the good equilibrium.

they have low and decreasing with time shares of agriculture (in terms of labor, capital and output) and they have high and increasing with time shares of industry (in terms of capital and output) and services (in terms of labor and output).

4 Where do transition countries transit?

One of the key implications of our model is that a country can switch from one equilibrium to the other at any point in time. In particular, the country can reach the "agriculture only" Equilibrium I even when, initially, the country is in a good Equilibrium III where industry and services represent a major fraction of the country's production. Such an equilibrium switch occurs when for whatever reason, producers become pessimistic and start believing that the economy moves to the bad "agriculture only" Equilibrium I. Then, the optimal strategy of each individual producer will be to reallocate all capital from industry and services to agriculture. Those producers who fail to do so will incur losses since a massive reallocation of capital to agriculture drives the rate of return on capital in industry and services to zero, as Eq. 14 shows.

Therefore, there is one question concerning transition countries, which is of interest to address in the context of our model, namely: "Where do transition countries transit now, to rich or poor countries?" When the Soviet system had been broken down and transition to market economy began, the former Soviet countries were roughly in the middle between rich and poor countries in terms of their per-capita income. Regarding the sectorial composition of transition economies, it was artificially created by the Soviet central-planning system, and it was not typical for either rich or poor market economies. Namely, at the beginning of transition, an average transition country had a very large industrial sector, a relatively small service sector and a medium agricultural sector. Our model predicts multiple equilibria and thus, does not allow us to tell where transition countries transit on purely theoretical grounds: such countries can end up either being rich or poor depending on the equilibrium selected. Nonetheless, the model allows us to answer this question on empirical grounds, specifically, given a characterization of the good and the bad equilibria in the model, we can determine which of the two equilibria fits the development experiences of transition countries.

We therefore investigate the empirical relationship between the countries' sectorial composition and their economic performance. Our data come from the World Development Indicators CD-ROM (2000) data set. We distinguish the groups of 10 richest and 10 poorest countries in the sample by the level of GDP in 1999 and the group of 26 transition countries. (The countries entering each group are listed in the note "b" of Table 1). In Fig. 2, we plot the evolution of the GDP levels, and the GDP and labor shares of agriculture, industry and services over the 1990–1999 period for the three groups distinguished, and in Figs. 3–5, we plot the same time series for each of the transition countries considered. In Table 1, we provide the corresponding groups' statistics. To check the robustness of tendencies observed, in

Table 1 The GDP level, and the GDP and labor shares of industry, agriculture and services: their evolution in the 26 transition countries and their averages in the 10 richest and the 10 poorest countries over 1990–1999

		% of GDP			% of labor		
	GDP $\times$ 10^3, 1995US$	Agriculture	Industry	Services	Agriculture	Industry	Services
The sample averages over 1990–1999 (transition countries excluded)							
10 richest countries	32.8795 (7.1379)	3.8391 (2.6883)	27.8950 (5.4049)	68.2658 (4.9883)	5.5808 (2.1626)	27.9353 (3.8329)	66.4839 (4.7026)
20 richest countries	27.3603 (7.9113)	3.1229 (2.3510)	27.7279 (4.6484)	69.1610 (5.0275)	4.9998 (2.9741)	28.2050 (3.4645)	66.7952 (4.4666)
10 poorest countries	0.2091 (0.0379)	40.7081 (6.7741)	22.0963 (9.4452)	37.1956 (9.5694)	64.3617 (24.4727)	12.7633 (13.2761)	22.8750 (14.7131)
20 poorest countries	0.2797 (0.0855)	37.1963 (7.8396)	22.4435 (8.2681)	40.3602 (8.6807)	63.4070 (23.0161)	11.8202 (10.3214)	24.7728 (15.5285)
Sample average	7.8920 (10.9282)	17.0064 (13.7608)	29.7128 (9.1682)	53.2914 (12.6647)	28.3387 (26.4523)	22.3810 (9.4071)	49.4266 (19.4702)
Transition countries							
1990	2.9327 (1.9869)	19.9569 (9.4173)	44.3294 (8.1943)	35.7137 (8.7523)	25.6625 (16.0007)	34.7783 (9.6604)	42.0130 (8.9955)
1991	2.6428 (1.7830)	19.9753 (11.8047)	43.1016 (7.3116)	36.9230 (10.6059)	21.2042 (11.0089)	35.8350 (10.4385)	42.9608 (8.7966)
1992	2.3251 (1.7268)	20.2679 (14.2351)	39.9956 (6.5374)	39.7364 (12.7310)	21.5719 (12.0169)	33.8684 (10.4514)	44.5596 (8.9684)
1993	2.2260 (1.7946)	18.7006 (14.5371)	38.2851 (8.3876)	43.0142 (12.7510)	22.0684 (13.0334)	33.3684 (9.0204)	44.5632 (7.3505)
1994	2.1068 (1.9042)	19.9789 (14.7155)	35.2500 (7.0487)	44.7710 (13.4273)	22.7158 (13.7967)	31.9491 (8.9616)	45.3351 (8.0711)
1995	2.0155 (1.9829)	20.6106 (15.2225)	34.0167 (8.8889)	45.3728 (13.0781)	24.0559 (15.4856)	29.6833 (8.9327)	46.2608 (9.0788)
1996	2.0928 (2.0626)	19.3007 (14.2974)	33.3734 (10.0355)	47.3261 (13.0308)	24.6875 (15.5073)	28.6529 (9.3386)	46.9000 (9.0647)
1997	2.1828 (2.1621)	18.7555 (13.7277)	32.3009 (7.9561)	48.9438 (11.7312)	23.5813 (13.8756)	28.3294 (9.2467)	48.2500 (7.7793)
1998	2.2549 (2.2399)	17.3462 (13.3492)	31.7343 (7.6277)	50.9196 (11.5368)	23.2500 (13.5619)	27.7643 (9.1741)	48.9857 (7.8726)
1999	2.3139 (2.3236)	16.9974 (12.9314)	31.1167 (7.4356)	51.8860 (11.9705)	–	–	–

Notes: [a] Source: World Development Indicators CD ROM (2000)

[b] The 10 richest countries are Switzerland, Denmark, Japan, Luxemburg, U.S., Netherlands, Norway, Iceland, Belgium and Austria (in a descending order). The 10 poorest countries are Burkina Faso, Madagascar, Rwanda, Chad, Nepal, Niger, Sierra Leona, Malawi, Burundi and Democratic Republic of Congo (in a descending order). The 26 transition countries are Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan (in an alphabetic order)

[c] Numbers in the table are the sample averages and standard deviations of the corresponding variables

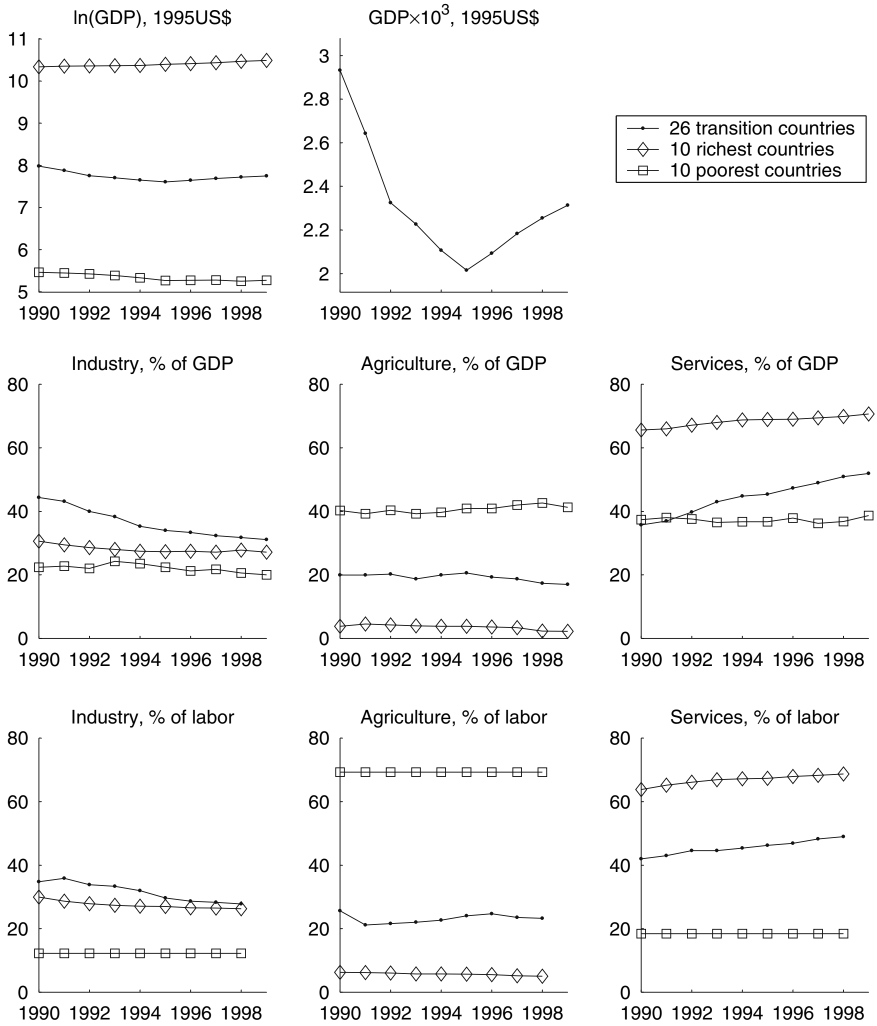

Fig. 2 The GDP level, and the GDP and the labor shares of industry, agriculture and services: their evolution in 26 transition, 10 richest and 10 poorest countries over 1990–1999. *Note*: For the 10 poorest countries, the labor shares are the averages of the corresponding variables over 1990–1999

Table 1, we also report statistics for the groups of 20 richest and 20 poorest countries in the sample.

The evidence about the development experience of rich and poor countries is well-known in the literature, see Kongsamut et al. (1997), Hansen and Prescott (2002), Eswaran and Kotwal (2002), and Kylymnyk et al. (2007). Table 1 illustrates the key tendencies. First, we have an enormous gap in the level of economic development between the groups of rich and poor countries, whose per-capita GDPs differ by a factor of more than 150. Further, we observe a striking difference in the sectorial compositions between rich and poor economies. Rich countries have a

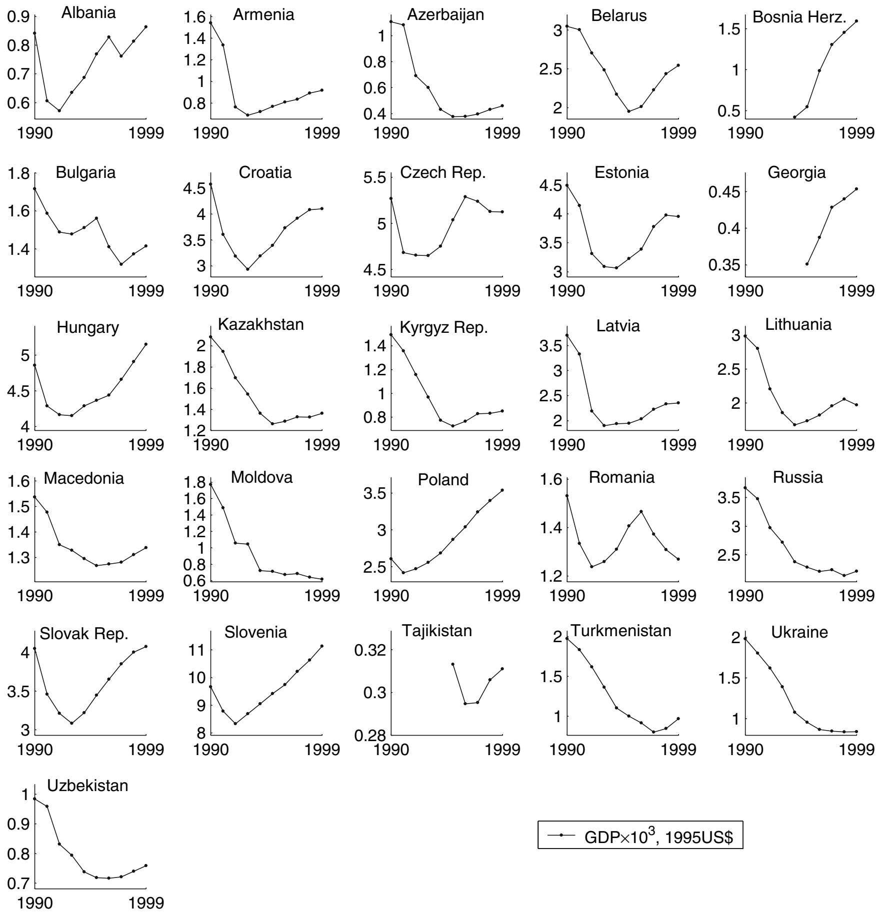

Fig. 3 The evolution of GDP in the transition countries over 1990–1999

small agricultural sector and a large industrial and service sectors, while poor countries have a large agricultural sector and a small industrial and service sectors. As far as the evolution of the sectorial composition is concerned, the currently rich countries have experienced a dramatic decline in the output share of agriculture and an increase in the output shares of industry and services over the process of economic development. In contrast, the sectorial composition of the currently poor countries have been stable during a relatively long period. Our model is consistent with all the above facts: it can account both for the differences in the development patterns observed across rich and poor countries and for time-series patterns of economic development of rich and poor countries.

We shall now turn to transition countries, which are the main subject of our investigation. The tendencies about the output dynamics in the transition countries do not reveal us whether the good or the bad equilibrium is selected. Most of the transition countries experienced a *J*-curve output pattern over the 1990–1999

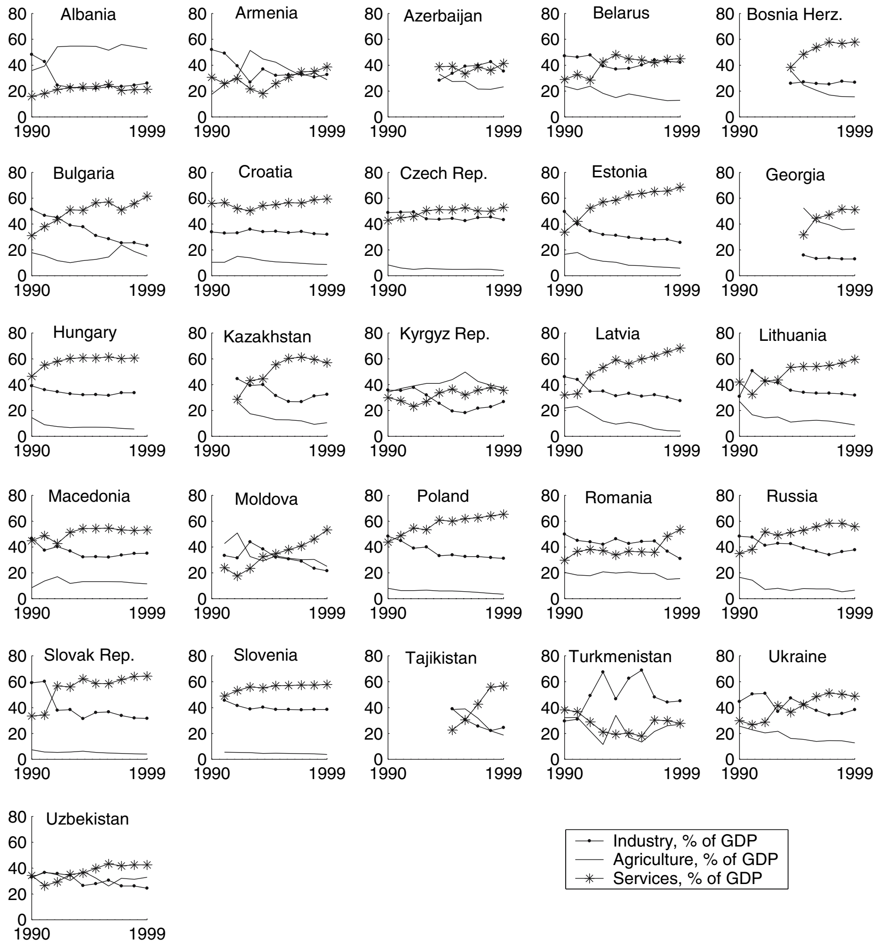

Fig. 4 The evolution of the GDP shares of industry, agriculture and services in the transition countries over 1990–1999

period: in 1990, the average per-capita GDP of the transition countries expressed in constant 1995 $US was 2932.7; in 1995, it reached a minimum of 2015.5; and in 1999, it rose to 2313.9. Although during the last years, the transition countries exhibit an upward trend in the per-capita GDP, it is not yet clear whether such a trend is a result of a recovery after the crisis or it is an indication of having jumped to a stable growth path. In fact, most of the transition countries still have not reached the output level which they had at the beginning of transition; see Table 1 and Figs. 2 and 3.

We therefore analyze the sectorial composition of transition economies and its evolution over the transition period, and we compare it with the sectorial compositions of rich and poor economies. As is seen from Table 1, during the

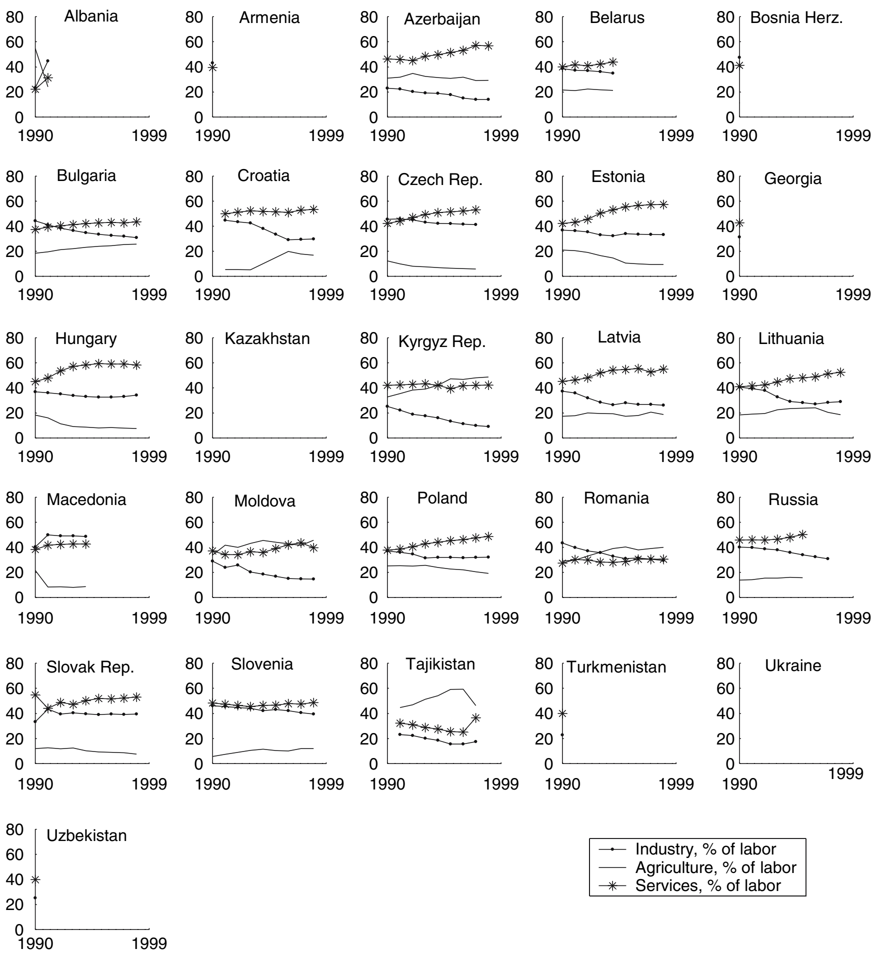

Fig. 5 The evolution of the labor shares of industry, agriculture and services in the transition countries over 1990–1999

1990–1999 period, the output shares of the industrial and the agricultural sectors in the transition countries decreased from 44.3% to 31.1% and from 20.0% to 17.0%, respectively, and the output share of the service sector increased from 35.7% to 51.9%. Similar regularities hold for the changes in the distribution of the labor force across sectors: the labor shares of the industrial and the agricultural sectors decreased from 34.8% to 27.8% and from 25.7% to 23.2%, respectively, while the labor share of the service sector went up from 42.0% to 49.0%. For the 10 world richest countries, the output (labor) shares of agriculture, industry and services are 3.6% (5.1%), 27.9% (28.3%) and 68.5% (66.7%), respectively, whereas for the 10 poorest world countries, the corresponding output shares are 41.1% (69.2%), 19.7% (12.2%) and 39.2% (18.6%). Thus, there is strong evidence that the sectorial composition of the transition countries, as a group, converges to that of rich rather than poor countries.[10]

We also look at the evolution of the sectorial composition for each individual country in the transition group. Notice that the sectorial output shares in Fig. 4 do not always expose the same tendencies as do the sectorial labor shares in Fig. 5, which is because the former shares are influenced by changes in the relative productivity of sectors. Nonetheless, for such countries as Czech Republic, Estonia, Lithuania, Hungary, Poland and Slovak Republic, the pattern implied by Equilibrium III is well seen for both output and the labor shares, and their sectorial composition currently approaches the one of the 10 richest countries. In fact, these transition countries are ones that do best in economic terms. On the contrary, the transition countries doing poorly have experienced the changes in their sectorial composition that put them closer to poor than to rich countries. According to the output-shares figure, Albania significantly increased the agricultural sector; Turkmenistan both increased the industrial sector and decreased the service sector; and such countries as Armenia, Azerbaijan, Kyrgyz Republic and Uzbekistan exhibited changes in their sectorial composition that lack a definite pattern. In turn, as follows from the labor-shares figure, such countries as Bulgaria, Croatia, Kyrgyz Republic, Moldova, Romania and Tajikistan expanded their agricultural sectors. In the case of Bulgaria and Croatia, we also observe an expansion of the service sector but such an expansion is not sufficient to absorb all labor exiting the industrial sector. The agricultural growth in Kyrgyz Republic, Moldova, Romania and Tajikistan is more worrying in a sense that it was not accompanied by visible growth of the service sector and hence, it may indicate that those countries move to the bad equilibrium.

5 Conclusion

This paper presents a general equilibrium three-sector growth model, in which the industrial sector has an increasing returns to scale. The presence of economies of scale in our model leads to multiplicity of equilibrium. Our model predicts that rich and fast-growing countries are ones that are situated in the good equilibrium: such countries experience non-vanishing growth, they reduce agriculture and increase industry and services over time. In turn, poor and stagnating countries are ones that are situated in the bad equilibrium: they have no long-run growth and specialize in producing agricultural goods. In our setup, each country can become rich and fast-growing if economic agents manage to coordinate on the good equilibrium.

Our model provides a framework for analyzing the development experience of the transition countries. It predicts that if the transition countries move to the rich world, we should see a reallocation of resources from industry and agriculture to services, whereas, if they move to the poor world, we must observe an expansion of

[10] A decrease in the share of industry in the transition countries is consistent with Equilibrium III of our model. Given that the former Soviet countries artificially overinvested into industry at expense of services, we should expect the size of industry relative to services to decrease to the level, which is optimal for market economy.

agriculture. Our empirical analysis suggests that overall, the transition countries move to the good equilibrium. This is undoubtfully true for the most developed countries in the transition sample (such as Czech Republic, Estonia, Lithuania, Hungary, Poland and Slovak Republic), whose sectorial composition is now close to that of the world richest countries. However, for less developed transition countries, the development pattern is not entirely clear. In particular, such countries as Albania, Armenia, Azerbaijan, Kyrgyz Republic, Moldova, Romania, Tajikistan and Uzbekistan, have experienced growth of the agricultural sector, which can be viewed as an indication of being in the bad equilibrium.

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