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International capital mobility and structural transformation

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Abstract:
This study examines the role of international capital mobility in shaping the relation between economic growth and structural transformation. We build a small open economy Ramsey model with two goods, tradables and nontradables. We show that if the long-run autarky interest rate of a small open economy is higher than the world interest rate, the employment and value-added shares of the tradables sector will rise over time. In the opposite case, the shares will fall. Because the autarky interest rate increases with the rate of technological progress, our result suggests that cross-country differences in the rate of technological progress may be a significant factor in accounting for diverse patterns of structural changes among countries.

Keywords: capital mobility, financial integration, industrialization, structural transformation, trade imbalance

JEL classification: O41, F43, F21

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1 Introduction

Recently, there has been a surge of research on structural transformation: the situation in which a few broad sectors of the economy are growing at unequal rates. As a survey by Herrendorf, Rogerson, and Valentinyi (2013) documents, most advanced economies have experienced falling agriculture shares and rising manufacturing and services shares in an earlier phase of development, and after agriculture shares drop sufficiently, they experience falling manufacturing shares and fast rising services shares. Developing countries also seem to be following a similar pattern, although their experiences are more varied.

Structural transformation has long been an integral part of research on the growth process (e.g. Clark 1940; Chenery 1960; Kuznets 1966; Syrquin 1988). Recent research based on the neoclassical growth theory largely follows two lines of research. One line, inspired by Engel's law of consumption, attempts to explain unequal sectoral growth rates based on different income elasticities across consumption goods. Echevarria (1997), Kongsamut, Rebelo, and Xie (2001), and Foellmi and Zweimüller (2008) fall under this strand of research. Another line of research has been formed on the prediction by Baumol (1967) that the relative price and the employment share of services, whose productivity growth is slower than that of manufacturing, would rise indefinitely. In these studies, unbalanced growth is driven by differential rates of technological progress across sectors. Ngai and Pissarides (2007) and Acemoglu and Guerrieri (2008) are notable examples. A related study is Duarte and Restuccia (2010), who found that differences in the levels and growth rates of productivity between rich and poor countries are greater in agriculture and services than in manufacturing. They show that the reallocation of labor between sectors during structural transformation can lead to endogenous changes in the growth rate of aggregate productivity, even though productivity growth rates at the sectoral level remain constant.

This paper attempts to add an international dimension to the growing literature on structural transformation. We build a Ramsey model with two goods, in line with Ngai and Pissarides (2007). One sector produces tradables and the other sector nontradables. We open up the economy by allowing it to export or import tradables, and borrow or lend at a given world interest rate. We find that if the long-run autarky rate of the small open economy is higher than the world interest rate, the employment and output shares of the tradables sector will increase over time. The opposite holds if the autarky interest rate is lower. Because the autarky interest rate increases with the rate of technological progress, our result implies that economies with faster technological progress will be highly industrialized in the long run, while those with slower progress will experience severe deindustrialization.

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Trade economists have long noted the possibility that a sector with faster technological progress is relatively expanding rather than shrinking, contrary to Baumol's prediction (e.g. Findlay and Grubert 1959). A sector with faster technological progress acquires comparative advantages and draws resources for exports from technologically stagnant sectors. Matsuyama (1992), 2009) is among the first to model this phenomenon in a neoclassical growth framework. Sposi (2011), Teignier (2009), and Uy, Yi, and Zhang (2013) simulate multi-sector models with international trade to explain quantitatively the fast and sustained expansion of manufacturing share in Korea.

While our model emphasizes interdependence among countries as a source of structural change, the underlying mechanism is distinct from that of models based on comparative advantage. Our result does not depend on differential rates of productivity growth between sectors and inter-sectoral trade between agriculture and manufacturing. In our model, international capital mobility and intertemporal substitution drive structural change through overall trade imbalance. When the autarky interest rate is higher than the world interest rate, capital market opening tilts the consumption path flatter such that current consumption rises relative to future consumption. In addition, investment surges with a lower interest rate. This development causes the economy to borrow heavily in the early years of opening, and to service foreign debt by running trade surpluses later. To do so, the tradables sector should grow faster than the nontradables sector in the long run. Furthermore, if the initial rise of consumption expenditure is big enough, an industrialization cycle can emerge. A consumption boom in initial periods reallocates labor from the tradables sector to the nontradables sector, and leads to deindustrialization, as in a Dutch disease model. As the consumption boom subsides in later periods, industrialization follows.

Our analysis is closely linked to the large body of literature on financial integration and growth. Because the aggregate dynamics of our economy is derived from the standard Ramsey model, the aggregate response of the economy to capital market liberalization is essentially identical to that of the standard neoclassical economy, as analyzed by Gourinchas and Jeanne (2006, 2013). A departure from their model, apart from the fact that we examine a two-sector extension, is that we do not adopt their assumption on the convergence of technology across countries. We assume that the growth rate of total factor productivity in each sector is constant, and does not converge to the growth rate in the frontier country.[1] While the convergence hypothesis is partly supported by data and is theoretically attractive, the productivity of many developing economies kept growing much faster or slower than in the US economy for the past half century. Thus, our assumption on technology could be a relevant approximation of reality as well as serving to simplify the analysis.

Antunes and Cavalcanti (2013) introduce borrowing constraints and uninsurable idiosyncratic shocks to income in the standard neoclassical model. In contrast to the small welfare gains found by Gourinchas and Jeanne (2006) in the standard model, they show that financial liberalization can generate considerable welfare gains by reducing borrowing costs and loosening borrowing constraints for poor households. Financial friction and the heterogeneity of households are ignored in our study. A related limitation of the current research is that, as an extended Ramsey model, our model inherits the shortcomings of the standard neoclassical model. Gourinchas and Jeanne (2013) show that the standard neoclassical model predicts that countries with faster productivity growth should attract more foreign capital, but in reality the opposite holds. In our model as well, capital flows into countries with faster technological progress. To match theory with data, we need to augment our model in various dimensions.

An extensive body of literature exists on evaluating the growth effect of capital account liberalization (e.g. Eichengreen 2001; Kose et al. 2009; Obstfeld 2009; and Rodrik and Subramanian 2009). Many authors find that correlation between long-run economic growth and capital account liberalization is elusive to establish. Our results might be related to the weak growth performances of some developing countries after capital account liberalization, as stressed by Rodrik and Subramanian (2009). We show that a country with slow productivity growth may suffer from capital outflows and deindustrialization after opening capital markets. Our study also shows that even a country with a strong growth potential may have to go through an extended period of trade deficits and debt accumulation before it becomes a highly industrialized economy. Given the volatility of international financial markets, this could be a difficult task, as the Asian Crisis suggests. To support our model, we have to search for evidence that the relation between growth and industrialization is altered with open capital markets.[2] This would be a difficult task given the difficulty of finding empirical links between growth and capital account liberalization. We leave our empirical investigation to future research.

This paper is organized as follows. Section 2 sets up the model and derives equilibrium in autarky. Section 3 examines the dynamic behavior of a small open economy. Section 4 concludes the paper with some remarks.

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2 The model and autarky equilibrium

We use a standard Ramsey-Cass-Koopmans model extended to accommodate two sectors. To highlight the main point, we investigate the model under the simplest parametric configuration. Most of our results do not depend on the simplification, and results for more general cases will be discussed later in the concluding section.

All markets in the economy are competitive. The representative household solves the following problem.

$$Max \int_0^\infty \log \tilde{c} \ \exp[-(\theta - n)\, t]\, dt$$

$$s.t\ \dot{\tilde{a}} = (r-n)\,\tilde{a} + W - \tilde{e}\,,$$

$$\lim_{t\to\infty} \tilde{a} \exp[-\int_0^t (r(s)-n)ds] \geq 0. \tag{1}$$

$$\tilde{c} = \tilde{c}_T^{1-\sigma}\tilde{c}_N^{\sigma}. \tag{2}$$

$$\tilde{e} = p_T\, \tilde{c}_T + p_N\, \tilde{c}_N. \tag{3}$$

$\tilde{c}$ denotes the consumption per capita of a composite consumption good. The composite consumption good is produced by combining a tradable good T and a nontrable good N with the Cobb-Douglas production function in (2). $\tilde{c}_i$ (i =T or N) denotes the consumption per capita of good i, and p_i its price. $\tilde{e}$ is consumption expenditure per capita. We use r for the interest rate, and W for the wage rate. $\tilde{a}$ represents asset holdings per capita. Assets are entirely composed of physical capital in autarky, but they can include foreign bonds when the economy is open. θ is the subjective discount rate, and n is a constant rate of population growth. We assume that $\theta > n$. The time dependence of variables is omitted for simplicity.

We take the tradable good as the numeraire, and fix p_T to be equal to unity. We can show that the necessary and sufficient conditions for optimal consumption are:

$$\dot{\tilde{e}} = (r-\theta)\ \tilde{e}, \tag{4}$$

$$\dot{\tilde{a}} = (r-n)\,\tilde{a} + W - \tilde{e}\,, \tag{5}$$

$$\lim_{t\to\infty} \tilde{a} \exp[-\int_0^t (r(s)-n)ds] = 0. \tag{6}$$

In addition, from the Cobb-Douglas preferences in (2), $\tilde{c}_T = (1-\sigma)\tilde{e}$ and $p_N\, \tilde{c}_N = \sigma\, \tilde{e}$.

Equilibrium in goods markets requires that

$$Q_T = (A_T L_T)^{1-\alpha} K_T^{\alpha} = \tilde{c}_T\, L + \dot{K} + X, \tag{7}$$

$$Q_N = (A_N L_N)^{1-\alpha}\, K_N^{\alpha} = \tilde{c}_N\, L. \tag{8}$$

Q_i denotes the production of good i, and L_i and K_i denote labor and capital employed in sector i. Both goods are produced by Cobb-Douglas production functions. They are identical except in the level of productivity. K is aggregate capital, and we assume that there is no depreciation of capital. L is aggregate labor supply, which also is equal to population. Thus, $\dot{L}/L = n$. The resources constraints require that $K_T + K_N = K$, and $L_T + L_N = L$.

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X is equal to total exports. Let g_i be the rate of labor-augmenting technological progress in sector i: $g_T = \dot{A}_T / A_T$, and $g_N = \dot{A}_N / A_N$. We assume that they are constant and identical: $g_T = g_N = g$.

Equations (7) and (8) contain an important restriction: tradables are used for both consumption and investment, but nontradables are used only for consumption. Ngai and Pissarides (2007) adopt a similar structure in their multi-sector closed economy. They assume that manufacturing produces goods used both for consumption and investment, while the other sectors produce only consumption goods. Herrendorf, Rogerson, and Valentinyi (2013) criticize this assumption on the ground that services (especially software and industrial design) have become increasingly important in investment. However, this observation does not conflict with the setup of our model if investment-related services are included in tradables. When we open up the economy, our model becomes a dependent economy model with capital accumulation. In this literature, the assumption that investment needs only tradables is popular, as exemplified by Razin (1984), Engel and Kletzer (1989), and Obstfeld and Rogoff (1996). However, as Brock and Turnovsky (1994) stress, structure investment requires hard-to-trade services like construction. We adopt the assumption that investment needs only tradables because it greatly simplifies our analysis below.

When the tradable good is produced, its price should be equal to its unit cost.

$$1 = \phi\, A_T^{-(1-\alpha)}\, W^{1-\alpha}\, r^{\alpha}, \tag{9}$$

ϕ is a constant equal to $\alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$. Likewise, if the nontradable good is produced,

$$p_N = \phi\, A_N^{-(1-\alpha)} W^{1-\alpha}\, r^{\alpha}. \tag{10}$$

The capital intensities of two sectors are identical, and are given by the following.

$$\frac{K}{L} = \frac{K_T}{L_T} = \frac{K_N}{L_N} = \frac{\alpha}{1-\alpha}\frac{W}{r}. \tag{11}$$

Because the capital intensities of two sectors are identical, they also are equal to the capital-labor ratio of the entire economy.

The following normalization of variables is useful in the analysis below.

$$e \equiv \tilde{e}/A_T, c_T \equiv \tilde{c}_T/A_T, c_N \equiv \tilde{c}_N/A_T, c \equiv \tilde{c}/A_T, a \equiv \tilde{a}/A_T, w \equiv W/A_T,$$

$$k \equiv K/(L\,A_T)\ , k_T \equiv K_T/(L_T A_T), k_N \equiv K_N/(L_N A_T), x \equiv X/(L\,A_T).$$

In terms of normalized variables, equations (4) through (6) can be written as:

$$\dot{e} = (r - \theta - g)\ e, \tag{12}$$

$$\dot{a} = (r - n - g)\,a + w - e, \tag{13}$$

$$\lim_{t\to\infty} a \exp[-\int_0^t (r(s) - n - g)ds] = 0. \tag{14}$$

Using the three equations, we can show that

$$e(0) = (\theta - n)\ \left(a(0) + \int_0^{\infty} w(t) \exp\left[-\int_0^t (r(s) - n - g)ds\right] dt \right). \tag{15}$$

This equation derives from the fact that the present value of consumption expenditure should be equal to total wealth, the sum of financial wealth and the present value of wages. With the logarithmic utility function, the marginal propensity to consume out of total wealth is constant and equal to the subjective discount rate $\theta - n$.

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Let $\lambda = L_N/L$, the employment share of the nontradables sector. Using normalized variables, (7) and (8) can be written as:

$$\frac{Q_T}{L\,A_T} = (1-\lambda)\,k_T^{\alpha} = (1-\sigma)\,e + \dot{k} + (n+g)\,k + x, \tag{16}$$

$$\frac{p_N Q_N}{L\,A_T} = \lambda\,p_N\left(\frac{A_T}{A_N}\right)^{-(1-\alpha)} k_N^{\alpha} = \sigma\,e. \tag{17}$$

Equations (9) through (11) become:

$$1 = \phi\,w^{1-\alpha}\,r^{\alpha}, \tag{18}$$

$$p_N = \left(\frac{A_T}{A_N}\right)^{1-\alpha} \phi\,w^{1-\alpha}\,r^{\alpha}, \tag{19}$$

$$k = k_T = k_N = \frac{\alpha}{1-\alpha}\frac{w}{r}. \tag{20}$$

It is worthwhile to emphasize at this point that (19) must always hold, while (18) may not hold in an open economy. Given the Cobb-Douglas preferences in (2), the marginal utility of each good goes to infinity when its consumption goes to zero. Thus, the consumption of each good is always strictly positive. This means that the nontradable good should always be produced. However, the tradable good can be imported and consumed without any domestic production. Thus, (18) may not hold in an open economy equilibrium.

Suppose that both goods are produced. Then, (18) and (19) simultaneously hold. It follows that $p_N = (A_T/A_N)^{1-\alpha}$, and it is constant with the assumption that A_T and A_N grow at the same rate. Thus, when both goods are produced, (17) becomes

$$\frac{p_N Q_N}{L\,A_T} = \lambda\,k_N^{\alpha} = \sigma\,e\,. \tag{21}$$

Adding (16) and (21),

$$y \equiv \frac{Q_T + p_N Q_N}{L\,A_T} = k^{\alpha} = e + \dot{k} + (n+g)\,k + x. \tag{22}$$

y is ouput per effective worker, and k^{α} can be considered as an aggregate production function. By (21) and (22), $\lambda = \frac{p_N Q_N}{Q_T + p_N Q_N}$. Thus, λ is both the output and employment share of the nontradables sector. From (18) and (20), it follows that

$$\alpha\,k^{\alpha-1} = r. \tag{23}$$

The marginal product of capital in the tradables sector should be equal to the interest rate when tradables are produced.

We now solve for an equilibrium path in an autarky. In our model, the autarkic nature of the economy is imposed by three conditions. r is endogenously determined, $a = k$, and $x = 0$. In addition, both the tradable good and the nontradable good should be produced in equilibrium. Then, using (23), (12) and (13) can be written as:

$$\dot{e} = \left(\alpha\,k^{\alpha-1} - \theta - g\right)\,e, \tag{24}$$

$$\dot{k} = k^{\alpha} - (n+g)\,k - e. \tag{25}$$

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Thus, in terms of e and k, our closed economy behaves like the standard one-sector Ramsey model. A unique stable balanced growth path exists, and it can be obtained by putting $\dot{e} = \dot{k} = 0$ in (24) and (25). On the path, r (= $\alpha k^{\alpha-1}$) is equal to $\theta + g$, and e and k are constant. The transversality condition in (14) is satisfied with $\theta > n$. Because $c_T = (1 - \sigma)e$, and $p_N c_N = \sigma e$, and $c = c_T^{1-\sigma} c_N^{\sigma}$, c_T, c_N, and c are all constant. The constancy of λ, $Q_T/L A_T$, and $p_N Q_N/LA_N$ immediately follows from (16) and (21). The value of λ can be explicitly calculated using (15) and (21). We obtain Proposition 1.

Proposition 1

The economy converges to a unique balanced growth path in autarky. On the path, $r = \theta + g$, and Q_T, Q_N, K, K_T, K_N all grow at the rate of $n + g$. Aggregate consumption expenditure ($\tilde{e} L$), and the aggregate consumption of the tradable good, the nontradable good, and the composite consumption good also grow at the rate of $n + g$. L_T and L_N grow at the same rate of n. The output and employment share of the nontradable sector remains constant, and is given by $\lambda = \sigma \frac{\theta + g - \alpha(n+g)}{\theta + g} \in (0, 1)$.

3 Dynamics in a small open economy

In this section, we investigate the dynamic behavior of our economy when its capital markets are unexpectedly opened while it is in the autarky balanced growth path. When it is open, the economy can trade good T and bonds with the world. We assume that the economy is so small that the price of the tradable good is unilaterally determined by the world market price, which is equal to 1. The domestic interest rate is also determined by the world rate r_f, which is constant. However, the price of the nontradable good p_N is internally determined.

Let us denote the autarky interest rate on the balanced growth path by $r_a = \theta + g$. We start with the case $r_a > r_f > n + g$. The world interest rate is lower than the autarky interest rate, and thus the interest rate permanently falls with open capital markets. The second inequality is necessary to satisfy the transversality condition. We will restrict our attention on an equilibrium path where both goods are produced.

The responses of capital stock and consumption expenditure to a capital market opening are identical to those to a lower interest rate in a standard one-sector Ramsey model. At time 0, the moment of opening, capital stock jumps up. Consumption expenditure instantly jumps up, but grows at a lower rate than in autarky. We can confirm these responses as follows. By (23), k should jump up at time 0, and stay at the higher level forever with a lower and constant r. That e should jump up at time 0 can be confirmed from (15). $a(0)$ cannot jump, tied to the level of k in autakry. However, the present value of wages jumps up with the combination of a lower interest rate and a higher wage rate. That the wage rate goes up with a lower interest rate follows from (18): the unit cost of the tradable good should be equal to 1 as long as it is domestically produced. After the initial upward jump, e starts declining as its growth rate falls with a lower interest rate. The rate of decline can be obtained from (12).

$$\dot{e} = -\left(r_a - r_f\right) e. \tag{26}$$

Because e declines at a fixed rate of $r_a - r_f$ after time 0, it converges to zero as the time goes to infinity.

Given the paths of k and e that have been determined above, the path of sectoral labor allocation can be calculated from (21), the clearing condition for the nontradables market: $\lambda k^{\alpha}{}_N = \sigma e$. λ (=L_N/L) can jump up or down at the moment of opening markets. On the one hand, as e jumps up at time zero, the demand for nontradables increases on the right side. At the same time, the capital intensity of the nontradables sector increases with a lower interest rate, as we saw before. Thus, the initial impact of capital market opening on λ is theoretically ambiguous. However, when α is small, as commonly assumed in simulation exercises, the demand side effect through e is likely to dominate. In this case, λ jumps up at time zero. The employment and output shares of the nontradables sector rise on impact. A capital market opening generates a symptom similar to Dutch disease. A consumption boom moves labor from the tradables sector to the nontradables sector.

After time 0, the path of λ mimics that of e because $\lambda k^{\alpha}{}_N = \sigma e$, and k_N remains constant after time 0. λ declines at the same rate as e during transition. In addition, as e converges to zero, λ also follows. The relative size of the nontradables sector shrinks to zero as time goes to infinity. Thus, in a case where λ jumps up at time zero, big de-industrialization at the initial moments will be followed by complete industrialization in the long run.

The behavior of exports can be traced by (22), which can be written as $x = k^{\alpha} - (n + g)k - e$. Because both k and e jump up at time zero, x can either jump up or down depending on which effect dominates. When the effect of consumption expenditures dominates that of capital inflows, x jumps down at time zero. The economy starts as an importer because of a consumption boom. After time 0, x must be increasing during transition, because k is constant, but e keeps on declining. In a finite time, the economy starts exporting, and its exports keep on growing.

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Recall that $a = k + b$ in an open economy, where b is net foreign assets per effective labor ($A_T L$). a cannot jump, but k jumps up at the moment of opening. Therefore, b turns negative at time zero. The economy finances the jump of capital stock by heavy borrowing from abroad. Equation (15) and the constancy of w imply that $e = (\theta - n)\ (a + w/(r_f - n - g))$. As e keeps on declining, a must too. Because k is constant, b also declines during the entire period of transition. The economy starts as a big borrower, and it keeps on borrowing. After opening capital markets, the economy experiences capital inflows in both the short and long runs. The current account is always in deficit.

Which long run equilibrium is the economy heading for? As we saw, after making an initial jump, λ (= L_N/L) continually decreases at the constant rate of $r_a - r_f$, converging to zero in the long run. Thus, $\dot{L_N}/L_N = n - \left(r_a - r_f\right)$, and from (21), $\dot{Q_N}/Q_N = n + g - \left(r_a - r_f\right)$ after time 0. In contrast, L_T/L converges to 1, and thus the growth rate of L_T converges to n. In (16), $Q_T/(LA_T)$ converges to a constant equal to k_T^{α}, and therefore Q_T grows asymptotically at the rate of $n + g$. Therefore, L_N and L_T grow at asymptotically different rates, as Q_N and Q_T do. Note also that λ converges to zero, but the economy cannot be exactly in the state where $\lambda = 0$. The economy should consume a strictly positive amount of nontradables, and λ, however small it is, should be strictly positive all the time. Therefore, the growth rate of L_T and Q_T cannot be exactly constant. A balanced growth path where all major quantity variables grow at a constant and identical rate does not exist in our open economy. To characterize the economy under perpetual structural transformation, we have to resort to the concept of approximate generalized balanced growth path, using the terminology of Herrendorf, Rogerson, and Valentinyi (2013). They call the state where major quantity variables grow at constant, but possibly different rates as "generalized balanced growth path." In addition, an economy can go infinitely close to a generalized balanced growth path, but it may never be exactly on the path. Then, we can say that the economy goes to an "approximate generalized balanced growth path." Our economy satisfies the enlarged definition of balanced growth path.

The long run values of assets, net foreign assets, and exports can be obtained as follows. $e = (\theta - n)\ (a + w/(r_f - n - g))$, and e converges to zero. Thus, a must converge to a negative constant equal to $-w/(r_f - n - g)$. Then, b converges to $-(k + w/(r_f - n - g))$. The economy becomes a debtor in the long run, and total debt grows asymptotically at the rate of $n + g$. Furthermore, the level of foreign debt grows so high that it approaches the value of entire capital stock plus the present value of wages. The economy will borrow against the entire value of physical capital and human wealth. Because $\dot{k} = 0$ and e goes to zero in (22), x converges to kα−(n+g)k$k^{\alpha} - (n + g)\,k$. Because α kα−1=rf>n+g$\alpha\ k^{\alpha-1} = r_f > n + g$, $k^{\alpha} - (n + g)\,k = k\left(r_f/\alpha - (n + g)\right) > 0$. Therefore, the economy becomes an exporter in the long run, and total exports grow asymptotically at the rate of $n + g$.

Denoting the growth rate of z by g_z, and the asymptotic value of v by v^*, we summarize our long-run results in Proposition 2.

Proposition 2

When the world interest rate is given by $r_f \in (n + g,\ r_a)$, the small open economy goes to a unique approximate general balanced growth path on which the economy produces both goods. On the path, the following holds:

i. $r = r_f$,

ii. $\lambda^* = 0$,

iii. $g^*_{L_T} = n, g_{L_N} = n - \left(r_a - r_f\right)$,

iv. $g^*_{Q_T} = n + g, g_{p_N Q_N} = n + g - \left(r_a - r_f\right)$,

v. $g_K = g^*_{K_T} = n + g, g_{K_N} = n + g - \left(r_a - r_f\right)$,

vi. $g_{\tilde{e}L} = g_{\tilde{c}L} = g_{\tilde{c}_T L} = g_{\tilde{c}_N L} = n + g - (r_a - r_f)$.

In addition, the economy becomes an exporter and a debtor in the long run, and exports and foreign debt grow asymptotically at the rate of $n + g$.

Figure 1 shows the results of a simulation exercise. For this exercise, we assumed that $\theta = 0.04$, $n = 0.01$, $\sigma = 0.6$, $\alpha = 0.3$, and $g = 0.03$. Assuming that the world has an identical subjective discount rate, and its (labor-augmenting) productivity grows at the rate of 0.015, r_f is given by 0.055. The number 0.03 is roughly equal to the top 20% of the average productivity growth rates of 102 countries between 1970 and 2010.[3] The number 0.015 is equal to the average productivity growth rate of the U.S. economy. Our economy experiences a permanent fall of the interest rate from 7% to 5.5% when it opens capital markets. Figure 1 shows that λ jumps up from the autarky level of 0.5 to 0.9 at time 0. The ratio of exports to GDP ($= x/k^{\alpha}$) jumps to −0.7.[4] After an initial big upward jump, λ gradually declines toward 0. The figure shows that the decline is slow, and it takes more than 200 years for λ to go down close to zero. The ratio of exports to GDP, after an initial jump down, increases all

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the way during transition. The figure illustrates that in 44 years, exports turn positive, and keep on growing toward their limit value. Changing parameter values in the neighborhood of those chosen for Figure 1 does not qualitatively change the results.

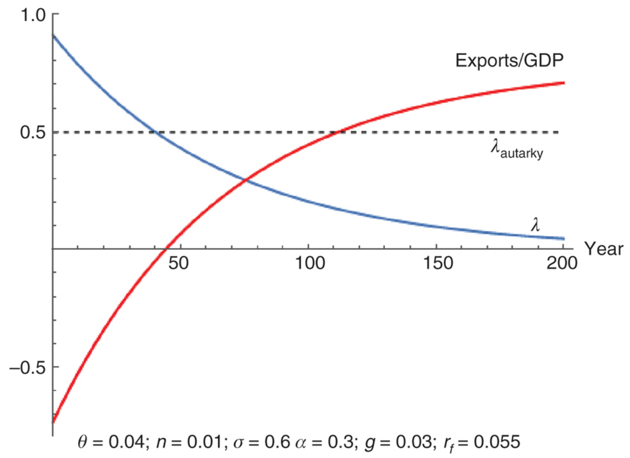

Figure 1: Share of nontradables and total exports when the world interest rate is lower.

Now we turn to the case $r_f > r_a$. With a higher world interest rate, the behaviors of key variables are just opposite to those that we obtained for a lower world interest rate. However, an important analytical difference arises. In this case, a long-run equilibrium where the economy produces both goods is impossible. To see why, recall that (21) holds as long as the economy produces both goods: $\lambda k_N^{\alpha} = \sigma e$. The right side of the equation increases at the rate of $r_f - r_a$ by (26), while k_N^{α} on the left side remains constant with a constant interest rate. Therefore, while the economy produces both goods, λ keeps on increasing at the fixed rate of $r_f - r_a$. λ will reach the value of 1 in a finite time.

After λ hits the value of 1, the economy stops producing tradables. The economy should be governed by different dynamics. Let T denote the time when λ hits the value of 1. Even after T, e keeps on increasing. Thus, the price of nontradables should go up, or their production should go up, or both. The Appendix shows that both should happen, and w increases at the constant rate of $r_f - r_a$ for all $t \geq T$. Because w keeps on increasing while r is constant, the cost of producing the tradable good exceeds 1 after T. The economy loses international competitiveness, and cannot produce any tradable good. By (19) and (20), p_N rises at the rate of $(1 - \alpha)\left(r_f - r_a\right)$, and k increases at the rate of $r_f - r_a$ when w increases after T.

Using this information, the Appendix shows that how we pin down the value of T. It also shows that a and b are positive and proportional to e after T. Thus, both of them grow at the rate of $r_f - r_a$ for all $t \geq T$. Because the economy does not produce any tradable good, it has to import all it needs. Using (16) and the fact that $\dot{k} = \left(r_f - r_a\right) k$, we can obtain that $-x = (1 - \sigma)e + \left(n + g + r_f - r_a\right) k$. Thus, imports are always positive, and $-x$ grows at the rate of $r_f - r_a$ for all $t \geq T$. Proposition 3 summarizes our results of the long run equilibrium.

Proposition 3

When the world interest rate is given by $r^f > r_a$, the small open economy goes to a unique generalized balanced growth path. On the path, the economy produces only the nontradable good, and the following equations hold.

i. $r = r_f$,

ii. $g_{p_N} = (1 - \alpha)\left(r_f - r_a\right)$,

iii. $g_{p_N Q_N} = g_{K_N} = n + g + r_f - r_a$,

iv. $g_{\tilde{e}L} = g_{\tilde{c}_T L} = n + g + r_f - r_a$,

v. $g_{Q_N} = g_{\tilde{c}_N L} = n + g + \alpha(r_f - r_a)$.

In addition, the economy becomes an importer and a creditor in the long run, and imports and foreign assets grow asymptotically at the rate of $n + g + r_f - r_a$.

We can obtain the behaviors of variables between time 0 and T as follows. The response of labor allocation at the moment of opening is again theoretically ambiguous. e jumps down with a higher interest rate, decreasing the demand for nontradables. At the same time, k_N jumps down, decreasing the capital intensity of nontradables. λ can go down or up depending on which effect dominates. Again, with plausible parameter values, it is more likely that the effect of consumption expenditure dominates, and λ jumps down at time 0. The depression

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of consumption caused by a higher interest rate leads the nontradables sector to release labor to the tradables sector. A reverse Dutch disease develops.

With a big jump down of e, x is likely to turn positive at time 0, and the economy starts as an exporter, as we can see from (22). Because k jumps down while a is tied to the level of k in autarky, b turns positive on time 0. Big capital outflows occur at the moment of a capital market opening.

After an initial jump down, e keeps on growing at the positive rate of $r_f - r_a$ until it hits the value of 1. k, after an initial jump down, stays constant until time T. Therefore, in the equation $\lambda k^{\alpha} = \sigma e$, λ keeps on increasing at the rate of $r_f - r_a$ until it reaches the value of 1 at time T. By (22), with e rising and k constant, x continually decline and turn negative in a finite time. Again, the short and long run responses of employment and trade can be quite different. A capital market opening can engineer a big industrialization followed by a complete deindustrialization later.

The simulation result reported in Figure 2 confirms our reasoning. Parameter values used are identical to those in Figure 1. The only difference is that now the domestic productivity growth rate is set equal to 0.003. The number belongs to the bottom 20% of the average productivity growth rates of 102 countries for the last 40 years. In this case, the interest rate permanently rises from 0.043 to 0.055 when the economy opens up capital markets. Figure 2 shows that λ jumps down from the autarky level of 0.54 to 0.47 at time 0.[5] The ratio of exports to GDP jumps to 0.18. After an initial jump down, λ rises toward unity. The figure shows that it takes 67 years for the economy to reach the specialization point. The ratio of exports to GDP, after an initial jump up, keeps on falling while the economy produces both goods. Exports turn negative after 19 years. Again, simulation results are not sensitive to small changes in parameter values.

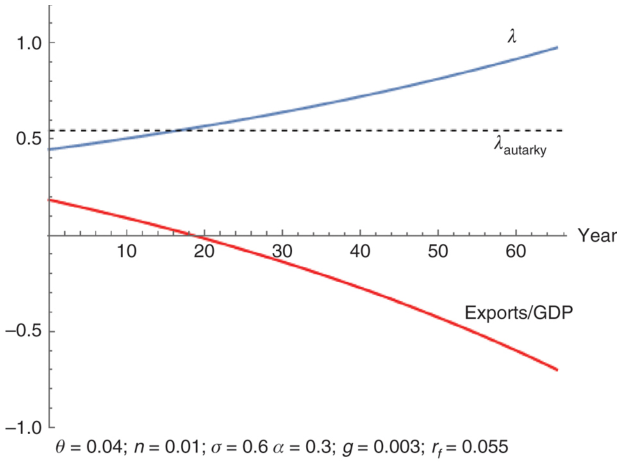

Figure 2: Share of nontradables and total exports when the world interest rate is higher.

4 Remarks and conclusion

The short run responses of the economy can be significantly altered with a nonunitary intertemporal rate of substitution. We can allow the intertemporal rate of the substitution to vary by replacing the logarithmic utility function by $\frac{1}{1-\gamma}\tilde{c}^{1-\gamma}$, where $\frac{1}{\gamma}$ is the intertemporal rate of substitution. The logarithmic utility function corresponds to the case where $\gamma = 1$. Though we do not report simulation results here, we can show that the extreme short run responses in Figure 1 can be dampened by raising the value of γ. This can be expected because with a lower intertemporal rate of substitution, the response of consumption expenditure to a change in the interest rate is moderated. When we raise the value of γ to 3, keeping the other parameters unchanged, the amounts of jumps in the share of nontradables and the share of exports are reduced almost to zero. With $\gamma = 4$, the directions of jumps at the initial moment are reversed. The share of nontradables jumps down on impact, while the ratio of exports to GDP turns positive from the start. The contrast between the short and long run responses disappears.

Other parameter values can be relaxed, too. Kim, Oh, and Song (2016) deal with a more general case: the utility function has the intertemporal rate of substitution less than 1, the composite consumption good is produced by a CES function with the elasticity of substitution between tradables and nontradables less than 1, technology improves faster in the tradables sector than in the nontradables sector, and the capital intensity is higher in the tradables sector. In this model, Baumol's cost disease (Nordhaus 2008) develops: the relative price of nontradables and their share in consumption expenditure rise indefinitely. Despite this, we show that the

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long run effects of opening capital markets identified in this paper still survive. A country whose autarky interest rate is higher than the world rate will experience the rising employment and output shares of the tradables sector, while a country whose autarky interest rate is lower will experience falling shares.

Although our model serves to highlight the role of international capital mobility and intertemporal substitution in structural transformation, its extreme predictions about long run equilibrium need to be moderated to match with reality. They could be made less extreme by introducing omitted factors, such as the convergence of productivity among countries, constraints in international borrowing, or the life cycle consumption of households. Incorporating these elements to bring the model closer to reality should be our future task.

This study shows that the relationship between growth and industrialization should be altered with financial integration. However, we fail to provide any empirical support. This lack should also be remedied in future research.

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Appendix Specialization Dynamics

Let T denote the time when λ hits the value of 1. Using (17) , (19), and the fact that λ is fixed to 1, for all $t \geq T$.

$$\phi\, w^{1-\alpha}\, r^{\alpha} k_N^{\alpha} = \sigma\, e. \tag{27}$$

On the left side, r is constant. By (20), $k_N = (\alpha/(1-\alpha))\, w/r$, and grows at the same rate as w. Thus, denoting the growth rate of w by g_w, the left side of the equation grows at the rate of g_w. Because the growth rate of e is equal to $r_f - r_a$, $g_w = r_f - r_a$. By (19), $g_{P_N} = (1-\alpha)\,(r_f - r_a)$ for all $t \geq T$.

For $t \in [0, T]$, (18) holds, and the wage rate is determined by the equation: $1 = \phi\, w^{1-\alpha}\, r_F^{\alpha}$. Let this value of w be $\overline{w}$. Because $g_w = r_f - r_a$ after T, $w\,(t) = \overline{w}\, \exp[\left(r_f - r_a\right)(t - T)]$ for $t \geq T$. Likewise, $k = k_N$ is constant at $\overline{k} = \alpha/(1-\alpha)\ \overline{w}/r_f$ for $t \in [0, T]$, and $k\,(t) = \overline{k}\, \exp[\left(r_f - r_a\right)(t - T)]$ for $t \geq T$. Using (15),

$$e\,(0) = (\theta - n)\,\frac{\alpha}{1-\alpha}\,\frac{\overline{w}}{r_a} + \frac{\overline{w}}{r_f - r_a + \theta - n}\left(\theta - n + \left(r_f - r_a\right)\exp\left[-\left(r_f - r_a + \theta - n\right)T\right]\right) \tag{28}$$

Because $\lambda\,(T) = 1$, by (21), $e\,(T) = (1/\sigma)\overline{k}^{\alpha} = e\,(0)\exp\left[\left(r_f - r_a\right)T\right]$. Using this equation and (28), we can calculate the value of T.

By (15), $e\,(t) = (\theta - n)\ a\,(t) + \overline{w}\exp\left[\left(r_f - r_a\right)(t - T)\right] = e\,(T)\exp\left[\left(r_f - r_a\right)(t - T)\right]$ for $t \geq T$. In addition, we can show that $\overline{w} = \sigma(1-\alpha)e(T)$. Therefore, for $t \geq T$,

$$a\,(t) = \frac{1 - \sigma(1-\alpha)}{\theta - n}\, e(t). \tag{29}$$

Thus, using the fact that $\overline{k} = (\sigma\alpha/r_f)\ e(T)$ and $k\,(t) = \overline{k}\, \exp[\left(r_f - r_a\right)(t - T)]$ for $t \geq T$,

$$b\,(t) = a\,(t) - k\,(t) = \frac{r_f\,(1-\sigma) + \sigma\alpha\left(n + g_T + r_f - r_a\right)}{r_f\,(\theta - n)}\, e(t). \tag{30}$$

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Notes

1 Duarte and Restuccia (2010) also assume that each sector's productivity growth rate is constant, and permanently different from other countries'.
2 Furthermore, as we illustrate below, our model predicts that the relation can be reversed in the short and long runs.
3 We used the Penn World Table 9.0. We assumed that labor input is equal to the number of employees, and all countries have the same value of $\alpha = 0.3$ to calculate the level of productivity.
4 Both jumps are far too dramatic to be observed in reality. As the next section discusses, we can easily dampen initial jumps if we reduce the intertemporal rate of substitution, which is assumed to be equal to 1 in Figure 1.
5 The absolute amount of the jump is smaller in this case because consumption expenditure jumps down by a smaller amount. This is because the normalized wage keeps on increasing after T even though its level goes down between time 0 and T.

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