Trade Liberalization and the Skill Premium in Developing Economies

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(Received June 5, 2002; Revised June 9, 2003; Accepted June 2, 2004)

Abstract

Empirical evidence shows that while the skill premium narrowed in some developing countries following trade liberalization, it widened in others, or even exhibited non-monotonic behavior. This paper studies a simple dynamic general equilibrium trade model in which differences in initial conditions across developing countries play a key role in explaining the variety of skill premium behaviors. Differences in initial conditions in terms of skilled labor and physical capital emerge in the model due to differences in trade policies. The model can generate non-monotonic behavior for the skill premium following trade liberalization.

Key Words: Trade Liberalization, Dynamic Models of Trade, Skill Premium, Developing Economies, Factor Endowments

JEL Classification: F11; F43; O11; O15; O41

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This paper is a revised version of one chapter of my dissertation at the University of Rochester. I thank Eric Bond, Daniele Coen-Pirani, Alan Deardorff, David DeJong, Ron Jones, Per Krusell, and participants to seminars at the University of Michigan, Penn State University and the University of Rochester for helpful comments. I also thank Richard Rogerson and an anonimous referee for very useful suggestions. The usual disclaimer applies.

1 Introduction

The impact of trade liberalization on income distribution has received wide attention in recent years. One of the puzzling questions in this literature is that while the standard Stolper-Samuelson theorem predicts that the skill premium should decrease in developing countries following trade liberalization, the empirical evidence is mixed. In fact, referring to these empirical studies, Wood (1997) asserts that "it is hard to avoid the conclusion that there is a genuine conflict of evidence: in some *developing* countries and periods, increased openness does appear to have caused a narrowing of skill *wage* differentials, but in others the opposite seems to have happened (even allowing for influences other than trade)."[p. 45][2] Similarly, in a study of nineteen countries, Michaely, Papageorgiu and Choksi (1991) find that measures of income inequality during the course of trade liberalization either decreased, widened, or displayed non-monotonic dynamics.[3]

How can we explain such different outcomes across developing economies? The standard 2×2 Heckscher-Ohlin model has been modified in various ways to generate predictions contrary to the Stolper-Samuelson result: key modifications include the addition of nontraded goods, and more factors of production (Wood, 1997). These modifications are ultimately designed to render factor price equalization invalid. However, most of this analysis has been conducted in static models in which factor supplies are fixed. This framework seems inappropriate once factor price equalization is abandoned because in this case the evolution of the skill premium following trade liberalization will be affected by the endogenous changes in factor supplies.

This paper studies a simple dynamic general equilibrium trade model in order to understand the behavior of the skill premium in developing economies following trade liberalization. The model fea-

[2]Italics are mine. Citing Robbins (1996), Wood (1997) documents a narrowing of the skill premium following trade liberalization in Korea, Taiwan, Singapore and Malaysia. In contrast, the skill premium widened in Hong Kong, Argentina, Chile, Colombia, Costa Rica, Uruguay and Mexico. Moreover, for countries such as the Philippines, the skill premium first widened and then narrowed.

[3]Following trade liberalization, income inequality decreased in Colombia, Greece and Indonesia, but widened in Argentina, Chile and Israel. On the other hand, Singapore experienced decreased inequality first, followed by widened inequality. The opposite is documented for Sri Lanka.

tures a combination of two-period overlapping generations with a two-sector specific factors setting. Young agents, who differ from each other in terms of skill-acquisition cost, decide whether to pay this cost or to remain unskilled. Skilled workers are the specific factor in the production of a traded investment good, while unskilled workers are specific to the traded consumption good. Capital is mobile across the two sectors of production. At given world prices, all developing economies export the consumption good and import the investment good. However, before trade liberalization, these economies differ in their trade policies, i.e., in terms of import tariffs, export subsidies, and export duties. These different distortions are mapped into different "initial conditions" in terms of skill and capital accumulation at the time of trade liberalization. Thus, in this paper, we go beyond the common "North-South" distinction, and focus on heterogeneity across countries in the "South".

The analysis yields three main results. The first result is that initial conditions matter. In particular, I show that different initial conditions at the time of trade liberalization imply different transitional dynamics for factor prices, as well as human and physical capital; thus, differences in initial conditions generate a variety of skill premium paths. Given the class of trade policies considered, there are two key cases. The first, Case A, corresponds to developing economies that start off with a relatively high ratio of skilled to unskilled workers, and relatively low physical capital. Relative abundance in this dynamic model is measured in comparison to the open-economy steady state (i.e., the tariff-free steady state). Case-A countries start with a relatively high skill premium and end up with a lower premium after liberalization. The opposite occurs in the second key case: Case-B developing countries start with a relatively low ratio of skilled to unskilled workers, a low skill premium, and high physical capital, and end up with a higher skill premium after liberalization. The reason why Case-B countries have initially low ratios of skilled to unskilled workers and also have low skill premia is that in this model, the lower the skill premium, the smaller the mass of young agents who can afford to pay the cost of becoming skilled.

The second key finding is that the model can generate non-monotonic behavior for the skill premium following trade liberalization, as documented in the empirical literature. In particular, the dynamic path of the skill premium is non-monotonic when the share of physical capital in the production of the investment good is larger than this share for the consumption good. In the context of this specific factors model, this is equivalent to the investment good being "capital intensive". In this instance, Case-A countries experience a decrease of the skill premium during the period in which trade barriers are removed, but a subsequent increase in this premium along the rest of the transition path. The opposite occurs to Case-B countries: the skill premium first increases and then decreases.

The third result is that static models of trade featuring fixed factor supplies may overestimate the quantitative impact of trade liberalization on the skill premium. As indicated above, in a dynamic model in which the supplies of skilled workers and physical capital change, the dynamic path of the skill premium is non-monotonic when the investment good is capital intensive. This non-monotonicity may significantly dampen the predicted change in the skill premium when trade distortions are removed. This sheds light on why some empirical studies have found a quantitatively small impact of trade liberalization on the skill premium.

This paper is related to Davis (1996), who introduces the concept of "local factor abundance" to explain the variety of income-distribution outcomes observed across developing countries following trade liberalization. The idea is that while developing countries are relatively abundant in unskilled workers when compared to the "global economy", some of them are abundant in skilled workers in a "local sense", i.e., when compared with countries with similar endowment proportions that produce the same range of goods. However, while Davis looks at local abundance in order to reinterpret Stolper-Samuelson in the context of a static model, here "local" differences are treated as different initial conditions in the context of a dynamic model in which Stolper-Samuelson effects are absent. The nature of the model studied here allows for an analysis of the full dynamic path of relative wages following increased openness.

In another related paper, Ruffin (2001) builds a static model that exhibits either Heckscher-Ohlin or specific factors properties in order to explain why the skill premium can move in different directions across countries. In his model, physical capital is mobile across two sectors while labor is a quasi-specific factor. Depending on relative good prices, Stolper-Samuelson effects may be present or absent. Again, here I not only consider and emphasize the dynamic channel, but I also restrict attention to a specific factors model in which Stolper-Samuelson effects are absent.

A few other papers have introduced endogenous changes in factor supplies in the analysis of factor prices. First, Findlay (1995) discusses human capital, wage differentials and trade patterns in a model with human capital accumulation. Trade across two countries occurs due to differences in the rate of time preference. A comparative statics analysis is used to compare autarky and free trade. Here, I depart from this analysis by using a simple overlapping generations model and solving for the transitional dynamics in order to characterize the full path of adjustment of prices and factor supplies following trade liberalization. Second, the effects of international trade on the accumulation of factors of production has been formalized by Bond and Trask (1997) in the context of an endogenous growth model with physical and human capital. The model studied here differs in that human capital accumulation is along the extensive, rather than the intensive margin; i.e., here there is a distinction between skilled and unskilled workers which allows for an analysis of the skill premium.

The remainder of this paper is organized as follows. Section 2 presents the model. In Section 3 I map differences in trade policies across developing countries into different initial conditions at the time of trade liberalization. Section 4 discusses the transitional dynamics of a developing country after trade liberalization, and it compares the qualitative and quantitative differences between static and dynamic models. Section 5 presents numerical examples to illustrate the transitional dynamics of the model, and Section 6 concludes.

2 The model

The model presented here combines the two-sector specific factors framework in Jones (1971), with a dynamic two-period overlapping generations model in which young agents can decide whether to become skilled or remain unskilled.

2.1 Production

In order to study the behavior of the skill premium in a dynamic model, the simplest possible setting consists of a minimum of two tradable goods and three factors of production. Unlike the standard 2×2 Heckscher-Ohlin model, factor price equalization does not hold in this case, thus changes in the supply of factors of production are relevant to determine factor prices. Obviously, two of the factors of production to consider are skilled H and unskilled L workers. I choose capital K to be the third factor in order to make the production structure consistent with a two-period overlapping generations model in which the young save in order to consume when old.

Consider the following two tradable goods: a consumption good Z, and an investment good X, which is used to accumulate physical capital.[4] Assume both goods are produced using K, but H and L are specific to sectors according to the following constant-returns to scale production functions:

$$Z = F_z(K_z, L_z),$$

$$X = F_x(K_x, H_x).$$

Thus skilled workers are used in the production of the investment good, and unskilled in the production of the consumption good.[5] As will become clear below, even though H and L are specific factors, there is certain "mobility" of workers across sectors because each new generation of young agents endogenously decides the supply of H and L. Thus, this setting does not allow for the perfect mobility of factors of the Heckscher-Ohlin model, but its dynamic component makes it less rigid than the static specific factors model.

[4] An alternative model would be one in which capital is non-reproducible, and the investment good is replaced by a second consumption good. Such a model is not interesting for dynamic analysis because it does not feature a transition: the model instantly jumps from one steady state to another.

[5] The choice of K as the mobile factor has been recently used by Ruffin (2001). He introduces skilled and unskilled workers as "quasi-specific" factors to two different sectors. An alternative to the specification chosen here would be to assume that all factors are used in all sectors, but in different proportions. However, this alternative complicates the analytical solution of the model without adding much insight.

Let the world price of Z be the numeraire and let p be the price of good X. Since one can think of a developing economy as "small", the world price of X can be taken as exogenously given by $p = \overline{p}$. In order to study the effects of trade liberalization, I introduce exports subsidies or duties, and import tariffs. I define developing countries as those producing and exporting good Z, and producing but importing good X, even though they do so in different volumes.[6] Thus, the local price of good Z is $(1 + \tau_z)$, with $\tau_z \gtreqless 0$, and that of good X is $\overline{p}(1 + \tau_x)$, with $\tau_x > 0$.

Let r be the rental price of capital; w^H and w^L wages for skilled and unskilled workers, all measured in terms of good Z. In order to derive analytical results, assume that technology is Cobb-Douglas in both sectors, with physical capital shares of α_z and α_x for the consumption and the investment goods. Then, optimality conditions for local producers imply

$$r_t = (1 + \tau_z)\, \alpha_z K_{zt}^{\alpha_z - 1} L_{zt}^{1-\alpha_z}, \tag{1}$$

$$r_t = \overline{p}\,(1 + \tau_x)\, \alpha_x K_{xt}^{\alpha_x - 1} H_{xt}^{1-\alpha_x}, \tag{2}$$

$$w_t^L = (1 + \tau_z)\,(1 - \alpha_z)\, K_{zt}^{\alpha_z} L_{zt}^{-\alpha_z}, \tag{3}$$

$$w_t^H = \overline{p}\,(1 + \tau_x)\,(1 - \alpha_x)\, K_{xt}^{\alpha_x} H_{xt}^{-\alpha_x}, \tag{4}$$

where (1) and (2) jointly guarantee equalization of the return for the mobile factor K.[7] Finally, full employment of capital implies

$$K_{zt} + K_{xt} = K_t, \tag{5}$$

while $H_{xt} = H_t$ and $L_{zt} = L_t$ guarantee full employment of both types of workers.

[6] As will become clear below, what makes developing economies different in this model are their factor supplies, not the types of goods they import. This enables an analysis of the impact of endogenous changes in factor supplies on the skill premium.

[7] The efficiency parameter in the production function is normalized to one for both sectors.

2.2 Households

Consider an overlapping generations economy in which agents live two periods: as young and old. Total population is constant and the mass of young is normalized to 1. As in Caselli (1999), when born, agents differ in the cost of becoming skilled; denote this cost by $\pi_i > 0$, which is given in terms of good Z. Let $\Phi(\pi)$ be the exogenously given probability distribution of π over the support $[\underline{\pi}, \overline{\pi}]$, $\overline{\pi} > \underline{\pi} > 0$. For simplicity, I assume a uniform distribution. Once agents are born, they observe their π_i and instantly decide whether or not to become skilled or remain unskilled. As is standard, young agents work, consume c^y, and save s; while old agents retire and consume c^o out of saving.[8]

Each young agent i decides whether or not to become skilled by maximizing his net income when young. Denote the latter by $y_{it} \equiv \max\{w_t^H - \pi_i, w_t^L\}$. It is easy to see that there exists a cut-off value π_t^* that would make an agent indifferent between paying the cost of becoming skilled, or remaining unskilled:

$$\pi_t^* = w_t^H - w_t^L, \tag{6}$$

where $0 < \underline{\pi} < \pi_t^* < \overline{\pi}$.[9] The lifetime utility of an agent of type i is

$$u(c_{it}^y) + \beta u(c_{it+1}^o), \tag{7}$$

[8]Notice that since in this model agents instantly decide whether or not to become skilled or remain unskilled, H and L are control rather than state variables. As will become clear below, having H and L as control variables allows for a cleaner analysis on how different factors of production affect the skill premium. In particular, H and L will change immediately when trade liberalization occurs, while K will only react later. In order to make H and L state variables, one can introduce a third period of life, say childhood, in which the agent either spends time becoming skilled, or stays at home if he is to remain unskilled. In order to simplify the solution of such a model, one would need to introduce further assumptions: e.g., there is no consumption during childhood, and agents pay for education in the second period of life (when they are young and work) at no interest. These asssumptions, although restricitive, avoid the need to introduce bequests as a source of income to finance consumption and education during childhood. I have solved such a version of the model, but it does not change the qualitative conclusions on the skill premium presented below.

[9]Here I assume an interior solution in order to focus on the case in which both sectors operate.

where $u(.)$ is strictly concave and $0 < \beta < 1$. Agent i maximizes (7) subject to budget constraints when young y and old o

$$c_{it}^{y} = y_{it} - s_{it},$$

$$c_{it+1}^{0} = \left[1 + \frac{r_{t+1}}{\overline{p}(1+\tau_x)} - \delta\right] s_{it},$$

where $\frac{r_{t+1}}{\overline{p}(1+\tau_x)}$ is the rate of return on saving. I assume that government lump-sum transfers are "thrown to the ocean."[10] The optimality condition for an interior solution is

$$u'(c_{it}^{y}) = \beta u'(c_{it+1}^{o})\left[1 + \frac{r_{t+1}}{\overline{p}(1+\tau_x)} - \delta\right].$$

In order to simplify the solution, I use logarithmic utility. In this case, we obtain the following familiar conditions

$$s_{it} = \frac{\beta}{1+\beta} y_{it}, \tag{8}$$

$$c_{it}^{y} = \frac{1}{1+\beta} y_{it}, \tag{9}$$

$$c_{it}^{o} = \left[1 + \frac{r_t}{\overline{p}(1+\tau_x)} - \delta\right] \frac{\beta}{1+\beta} y_{it}. \tag{10}$$

Finally, notice that at each point in time the supply of skilled and unskilled workers is given by

$$H_t = \Phi(\pi_t^*) = \frac{\pi_t^* - \underline{\pi}}{\overline{\pi} - \underline{\pi}}, \tag{11}$$

$$L_t = 1 - \Phi(\pi_t^*) = \frac{\overline{\pi} - \pi_t^*}{\overline{\pi} - \underline{\pi}}. \tag{12}$$

[10]This is a world with heterogeneous agents, thus the way the government distributes lump-sum transfers affects the income and wealth distributions, which impacts welfare calculations. Since here I do not study welfare effects, I simply consider the case in which no lump-sum transfers are made.

2.3 Aggregate constraints

The market clearing condition for the consumption good market is[11]

$$(1+\tau_z)\,Z_t-(1+\tau_z)\,T_{zt}=C_t^y+C_t^o+E_t, \tag{13}$$

where T_{zt} stands for net exports of good Z, and capital letter variables C_t^y, C_t^o represent the aggregate counterpart of individual variables.[12] Also, E_t stands for education expenditures, i.e., what is spent to make workers skilled, and is given by

$$E_t=\int_{\underline{\pi}}^{\pi_t^*}\pi_i d\Phi(\pi)=\frac{\pi_t^{*2}-\underline{\pi}^2}{2(\overline{\pi}-\underline{\pi})}.$$

Similarly, the market clearing condition for investment goods reads

$$X_t-T_{xt}=K_{t+1}-(1-\delta)K_t=\frac{1}{\overline{p}\,(1+\tau_x)}S_t-(1-\delta)K_t, \tag{14}$$

where δ is physical capital depreciation, S_t is the aggregate saving of the young, and $(1-\delta)K_t$ the dissaving of the old. Thus, using (8), the law of motion of capital reads

$$K_{t+1}=\frac{1}{\overline{p}\,(1+\tau_x)}S_t=\frac{1}{\overline{p}\,(1+\tau_x)}\frac{\beta}{1+\beta}\left[H_t w_t^H+L_t w_t^L-E_t\right]. \tag{15}$$

Finally, since there is no borrowing and lending, trade must be balanced in every period

$$(1+\tau_z)\,T_{zt}+\overline{p}\,(1+\tau_x)\,T_{xt}=0.$$

The competitive equilibrium of this economy is then characterized by the following nine equations: (1) through (5), (6) through (12), and (15). By Walras' law, one does not need to consider

[11]Notice that in equation (13), C_t^y, C_t^o and E_t are measured in terms of the world numeraire. In contrast, Z_t and T_{zt} are measured in units of local good Z; i.e., one needs to adjust by $(1+\tau_z)$ in order to express Z_t and T_{zt} in terms of the world numeraire.

[12]Notice that in this economy goods will either be imported or exported.

the balanced-trade condition. The nine equations above solve for nine unknowns: r_t, w_t^H, w_t^L, K_{zt}, K_{xt}, K_t, π_t^*, H_t, L_t.

3 Before trade liberalization

I now analyze the effect of trade liberalization on the skill premium in developing economies. The simplest way to proceed is to assume that the country is at a distorted steady state prior to liberalization, i.e., there are trade barriers in place. Thus, the effects of trade liberalization can be seen as a "change in regime" that takes the economy from a distorted steady state to an open-economy steady state. The idea of this exercise is not only to compare initial and final steady states, but also to study transitional dynamics. This allows for a characterization of the different skill-premium patterns that may arise, depending on how the supplies of K, H, and L evolve. I adopt a posture similar to Davis (1996) in that trade liberalizations in practice have limited scope, and in principle do not fundamentally alter the sectors of production that are active, but they do affect their levels of output.

I now describe the distorted steady state for developing economies. Recall that these economies are homogeneous in that at some given world price $\overline{p}$, they produce and export good Z, and produce but import good X. What makes developing countries heterogeneous in this model is that they differ in their trade policies before trade liberalization, i.e., they start from different distorted steady states. Here, I map these different trade policies into different initial conditions at the time of trade liberalization. This story seems a plausible one, as differences in tariff structure, and more generally in development strategies, have been widely documented (see Wood, 1997).

Given the class of distortions considered here, there are two key cases. In Case A, the local relative price of good X is higher than the world price $\overline{p}$ (i.e., higher than it would be if there were no distortions). This can be the case when there are import tariffs $\tau_x > 0$, or export duties $\tau_z < 0$, or even export subsidies coupled with relatively higher import tariffs, i.e., $\tau_x > \tau_z > 0$. In Case B, the local relative price of good X is lower than the world price $\overline{p}$. This emerges with export subsidies alone, or even with export subsidies that are relatively higher than import tariffs; i.e.,

$\tau_z > \tau_x > 0$.

Let r, w^H, w^L, K_z, K_x, K, π^*, H, L be the open-economy steady state variables, and let subscripts A and B be associated with Case-A and Case-B distorted steady states. Notice that for each pair of policies (τ_z, τ_x) there exists a unique steady state.[13] I now discuss how the diverse trade policies generate different initial factor endowments across developing countries. The following result summarizes the differences in factor endowments associated to distorted steady states A and B.

Distorted steady states. *The class of distortions considered here generate two key cases: (1) Case A:* $\tau_x > \tau_z > 0$*, which implies that the developing economy produces more* X *and less* Z *relative to free trade, and so distorted steady state A is characterized by* $H_A > H$*,* $L_A < L$ *and* $K_A < K$*; (2) Case B:* $\tau_z > \tau_x > 0$*, which implies that* $H_B < H$*,* $L_B > L$ *and* $K_B > K$*.*

The intuition for these results is simple. In Case A, since the relative price of the investment good is higher than in the open economy, and H is the specific factor in this sector, the skill premium must also be higher than in the open economy. This in turn implies a higher cut-off value π^*, a higher supply of H, and a lower supply of L, i.e., $H_A > H$ and $L_A < L$. In other words, in this economy, the higher skill premium allows a larger mass of young agents to become skilled. On the other hand, a higher relative price of the investment good implies that the saving of the young can now buy less claims on capital goods, and so the capital stock is lower than in the open economy, i.e., $K_A < K$. The opposite intuition applies for Case B.

Figure 1 illustrates distorted steady states A and B. It highlights the idea that at the time of trade liberalization, developing economies differ in their initial conditions due to different trade policies. Notice that in a three-factor model, the standard concept of factor abundance becomes more difficult to express. However, in this model, since all skills are accumulated on the extensive margin and so $H = 1 - L$, then just knowing H immediately determines L. Thus, a natural choice is to portray H/L against K, as Figure 1 does.

[13] As indicated above, the vector of nine variables (r, w^H, w^L, K_z, K_x, K, π^*, H, L) can be uniquely solved for by using the steady-state version of the nine equations that characterize the competitive equilibrium.

FIGURE 1. HERE

In this dynamic framework, one can think of "factor abundance" as how initial conditions $(H_A/L_A, K_A)$ and $(H_B/L_B, K_B)$ compare to the open-economy pair $(H/L, K)$. Recall that in this model, developing economies will converge to $(H/L, K)$ after trade liberalization. Figure 1 illustrates the idea that countries in the "South" are heterogeneous or are "locally" different in initial conditions, depending on how they implement trade policy. This local heterogeneity is important to explain the different behavior of the skill premium following trade liberalization. As was argued above, a developing country that before liberalization is at $(H_A/L_A, K_A)$ starts off with a skill premium higher than that in the open-economy, i.e., $sp_A > sp$. Similarly, $sp_B < sp$ for the developing economy with initial condition at $(H_B/L_B, K_B)$. Thus, along the transition the behavior of the skill premium will differ across these two economies as H_i/L_i and K_i change and finally converge to $(H/L, K)$.

How does the skill premium evolve in the two types of developing countries after trade liberalization? Is the transition monotonic, or do the endogenous changes in the supply of H, L, and K generate some non-monotonicity? These questions are addressed next section.

4 Transitional dynamics

This section discusses the transitional dynamics of a developing country after trade liberalization, and it compares the qualitative and quantitative differences between static and dynamic models. In what follows I focus mainly on the skill premium, as it is the variable of interest for this paper. Next section I use numerical examples to illustrate the dynamics of other variables.

I discuss transitional dynamics in three steps. First, I analyze the predictions of a static version of the model presented above, i.e., a model in which factor supplies do not change. I show that even this static version would predict changes in the skill premium that are different from the standard Heckscher-Ohlin model. Second, I analyze what occurs in the first period of trade liberalization under the dynamic model. This "first-period effect" can be compared to the predictions of the "static effect": under very general conditions, the static model overestimates the change in the skill premium. Finally, I describe what occurs along the rest of the transition in the dynamic setting. This "transitional-dynamics effect" highlights the potential of the model to generate non-monotonic behavior of the skill premium. This non-monotonicity is consistent with some of the empirical evidence documented above. Moreover, non-monotonicity implies not only qualitative but also quantitative differences between the static and dynamic models.

Recall that trade liberalization is defined as the removal of all trade distortions. For the purpose of comparison it is useful to start off by analyzing the behavior of the skill premium that would be predicted by a static model in which factor supplies are constant.

Static effect. *The static model with fixed factor supplies predicts a once-and-for-all decrease in the skill premium following trade liberalization for Case-A economies. In contrast, the skill premium increases for Case-B economies.*

To understand this static effect, starting from a distorted steady state, assume that import tariffs and export subsidies are eliminated. Totally differentiating zero-profit conditions for both sectors of production, along with full employment of capital yields

$$-\tau_z = \alpha_z \widehat{r} + (1-\alpha_z)\,\widehat{w}^L, \tag{16}$$

$$-\tau_x = \alpha_x \widehat{r} + (1-\alpha_x)\,\widehat{w}^H, \tag{17}$$

and

$$\widehat{K} = \frac{K_z}{K}\left(\widehat{L} + \widehat{w}^L\right) + \frac{K_x}{K}\left(\widehat{H} + \widehat{w}^H\right) - \widehat{r}. \tag{18}$$

Using the equations above together with the fact that $\widehat{L} = -\frac{H}{L}\widehat{H}$, the percentage change in the skill premium sp is given by

$$\widehat{sp} = \widehat{w}^H - \widehat{w}^L = \frac{1}{\Theta}\frac{1}{(1-\alpha_z)(1-\alpha_x)}\left[(\tau_z - \tau_x) + (\alpha_x - \alpha_z)\left(\widehat{K} - \frac{H}{K}\left(\frac{K_x}{H} - \frac{K_z}{L}\right)\widehat{H}\right)\right], \tag{19}$$

where

$$\Theta = \frac{1}{(1-\alpha_x)}\frac{K_x}{K} + \frac{1}{(1-\alpha_z)}\frac{K_z}{K} > 0.$$

In a static framework in which $\widehat{K} = \widehat{H} = \widehat{L} = 0$ there are no factor-supply effects on the skill premium. Thus, the only effect of trade liberalization on the skill premium comes from the change in the relative price of goods:

$$\widehat{sp}_{static} = \frac{1}{\Theta}\frac{1}{(1-\alpha_z)(1-\alpha_x)}\left[\tau_z - \tau_x\right]. \tag{20}$$

For Case-A economies, where $\tau_x > \tau_z$, then $\widehat{sp}_{static} < 0$: the skill premium decreases. The opposite occurs in Case-B economies. Notice how these findings depart from the standard Heckscher-Ohlin result regarding skilled-abundant countries. In the model presented here, the "relatively skilled-abundant" country experiences a decrease in the skill premium following trade liberalization.

In contrast to the static setting with fixed factor supplies, the predictions of a dynamic model can be decomposed in two effects: there is a "first-period effect," which occurs during the period when tariffs and subsidies are eliminated, and reflects both the change in relative prices of goods, and also changes in H and L.[14] Recall that while these two variables are controls, K is a state variable and will not change on the first period. Following the first-period effect, once prices in the small open developing country are equalized to world prices, there is a "transitional-dynamics effect" that involves changes in the supplies of K, H and L until the country converges to the open-economy steady state. One can think of the first-period effect as a short run effect, and of transitional dynamics as a longer run effect.

I now analyze the first-period and the transitional-dynamics effects. As will become clear below, the predictions regarding these two effects depend on: *(i)* whether or not $\alpha_x > \alpha_z$; and *(ii)* whether or not $\frac{K_x}{H} > \frac{K_z}{L}$. Recall that α_x and α_z represent the share of capital in the production

[14] In this model, for simplicity, we assume that tariffs and subsidies are completely eliminated in one step. In practice, the "first-period effect" is more complicated because reduction of tariffs usually occurs gradually. However, one may calibrate this model to make a period equivalent to, for instance, ten years.

of the investment and consumption goods respectively. Then, $\alpha_x > \alpha_z$ can be interpreted as the investment good being capital intensive from the "income-distribution" point of view. On the other hand, $\frac{K_x}{H} > \frac{K_z}{L}$ would correspond to the more standard "physical" definition of the investment good being capital intensive. Although in principle $\frac{K_x}{H}$ and $\frac{K_z}{L}$ are not comparable because H and L are two different factors, in the model studied here one can think of them as "efficiency- adjusted" capital-labor ratios.[15] I now compare the first-period effect with the static effect described above.[16]

First-period effect. *If either $\alpha_x > \alpha_z$ and $\frac{K_x}{H} > \frac{K_z}{L}$, or $\alpha_x < \alpha_z$ and $\frac{K_x}{H} < \frac{K_z}{L}$, then the "first-period effect" of trade liberalization on the skill premium is quantitatively smaller than the one predicted by a static model with fixed factor supplies. In particular, during the first period in which trade barriers are eliminated, Case-A economies experience a decrease in the skill premium smaller than that predicted by the static effect. Similarly, Case-B economies display an increase in the skill premium smaller than the static effect.*

To understand the first-period effect, notice that from (19) that

$$\widehat{sp}_{first-period} = \frac{1}{\Theta} \frac{1}{(1-\alpha_z)(1-\alpha_x)} \left[(\tau_z - \tau_x) - (\alpha_x - \alpha_z) \frac{H}{K} \left(\frac{K_x}{H} - \frac{K_z}{L} \right) \widehat{H}_{t=1} \right], \tag{21}$$

which shows that there are two channels affecting $\widehat{sp}_{first-period}$: first, $\tau_z - \tau_x$, which corresponds to the static effect analyzed above, and second, $\widehat{H}_{t=1}$, which is a factor-supply effect. Consider Case-A economies. We know in this case $\tau_z - \tau_x < 0$, and as predicted by the static effect, the skill premium decreases. In turn, this static effect decreases the supply of skilled workers, i.e., $\widehat{H}_{t=1} < 0$.

[15] Unlike the standard, constant-returns to scale 2 x 2 Heckscher-Ohlin model, in the specific factor model the relative sizes of $\frac{K_x}{H}$ and $\frac{K_z}{L}$ are not uniquely determined by α_x and α_z. I used numerical simulations for a large range of parameters to see whether $\alpha_x > \alpha_z$ could imply $\frac{K_x}{H} < \frac{K_z}{L}$, but I could not find any instances. It was always the case that $\alpha_x \gtrless \alpha_z$ implied $\frac{K_x}{H} \gtrless \frac{K_z}{L}$.

[16] Recall that while the first-period effect reflects changes in relative prices of goods, H and L, the static effect only captures changes in prices. In principle, given that H and L are control variables, one could also allow for a static framework to consider changes in both these variables. However, the point of this paper is to consider a static model where the supplies of H, L and K do not change, which is the model that has been traditionally used in analyzing trade and factor prices.

It is easy to see from the equation above that if either $\alpha_x > \alpha_z$ and $\frac{K_x}{H} > \frac{K_z}{L}$, or $\alpha_x < \alpha_z$ and $\frac{K_x}{H} < \frac{K_z}{L}$, then $\widehat{H}_{t=1} < 0$ would partially offset the static effect $\widehat{sp}_{static} < 0$.[17] Thus the static model with fixed factor supplies overestimates the effect of trade liberalization on the skill premium.

What are the mechanisms and the intuition behind this result? The key to understand why factor-supply changes may partially offset the standard static effect is that both H and L are specific factors. In this model, starting from distorted steady state A, $\widehat{H}_{t=1} < 0$ also implies that the supply of unskilled workers increases, i.e., $\widehat{L}_{t=1} > 0$. These two supply changes act in opposite direction. First, since H is a specific factor, the reduction in H decreases the return to the mobile factor r because it lowers the marginal product of capital in the investment sector. In contrast, the increase in L raises r because it increases the marginal product of capital in the consumption sector. Which of the two effects dominates in equilibrium depends on whether $\frac{K_x}{H} > \frac{K_z}{L}$. If this is the case, then the decrease in r due to the smaller supply of H dominates the increase in r due to the larger supply of L. This is so because when the efficiency-adjusted capital-labor ratio in the consumption sector is relatively small, an increase in L will not raise the return to the mobile factor r by much.

Now since r decreases, the return to both of the specific factors must increase, i.e., both w^H and w^L increase. This is so because now that tariffs have been removed, and local prices equal world prices, (16) reads $\alpha_z \widehat{r}_t + (1 - \alpha_z)\,\widehat{w}_t^L = 0$, and (17) reads $\alpha_x \widehat{r}_t + (1 - \alpha_x)\,\widehat{w}_t^H = 0$. These two equations imply that if $\alpha_x > \alpha_z$, then w^H must increase by more than w^L. Thus the decrease in the supply of skilled workers $\widehat{H}_{t=1} < 0$ acts in the opposite direction of the static effect: it increases the skill premium. In conclusion, as shown in the equation above, if $\alpha_x > \alpha_z$ and $\frac{K_x}{H} > \frac{K_z}{L}$ then the lower supply of H would partially offset the static effect. Thus, for those economies starting at distorted steady state A, $\widehat{sp}_{first-period} < 0$, and conversely, for Case-B countries, $\widehat{sp}_{first-period} > 0$. Moreover, in both cases, $\left|\widehat{sp}_{first-period}\right| < |\widehat{sp}_{static}|$.

[17] In general, for given K in the first period, one should not expect $\widehat{H}_{t=1} < 0$ to fully offset the static effect, i.e., starting from distorted steady state A, one should not expect $\widehat{sp}_{first-period} > 0$. This is so because $\widehat{H}_{t=1} < 0$ obtains as an indirect effect from the elimination of trade barriers, and in equilibrium, $\widehat{H}_{t=1} < 0$ is consistent with $\widehat{sp}_{first-period} < 0$.

I now analyze the "transitional-dynamics effect". Following this first-period effect, the behavior of the skill premium along the rest of the transition depends on the dynamics of K, H, and L. Unlike the first-period effect, the supply of K also changes. This is important because it may generate non-monotonic dynamics for the skill premium. In fact, an interesting property of the model is that if the investment good is capital intensive, i.e., if $\alpha_z > \alpha_x$, the behavior of the skill premium is non-monotonic, matching some of the empirical evidence documented above. The following result focuses on Case-A economies; an analogous argument holds for Case-B economies.

Transitional-dynamics effect. *Case-A economies experience a monotonic increase of capital K along the transition, and a decrease in skilled workers H that may or may not be monotonic. Suppose H decreases monotonically. If $\alpha_x > \alpha_z$ and $\frac{K_x}{H} > \frac{K_z}{L}$, i.e., if the investment good is capital intensive, then the skill premium exhibits a non-monotonic behavior: it declines on the first period, i.e., $\widehat{sp}_{first-period} < 0$, but then it increases for the rest of the transition.*

Following the first-period effect and along the rest of the transition, the dynamics of the skill premium are given by

$$\widehat{sp}_{transition} = \frac{1}{\Theta} \frac{(\alpha_x - \alpha_z)}{(1-\alpha_z)(1-\alpha_x)} \left[\widehat{K}_t - \frac{H}{K} \left(\frac{K_x}{H} - \frac{K_z}{L} \right) \widehat{H}_t \right]. \tag{22}$$

In Case-A economies, K_t increases monotonically along the transition because $K_A < K$, and saving are increasing in K.[18] It is easy to see from the equation above that if H_t decreases after the first period, and if $\alpha_x > \alpha_z$ and $\frac{K_x}{H} > \frac{K_z}{L}$, the skill premium increases along the transition.[19] Since, as shown above, for these economies $\widehat{sp}_{first-period} < 0$, then the skill premium displays non-

[18] To verify this claim, one needs to use the law of motion of capital as given by (15), and check whether the derivative of $K_{t+1} = \frac{1}{p} S_t$ with respect to K_t is positive. Using the definition of S_t, this derivative evaluated at the steady state can be reduced to $\frac{\partial S_t}{\partial K_t} = \frac{\beta}{1+\beta} \left[H \frac{\partial w_t^H}{\partial K_t} + L \frac{\partial w_t^L}{\partial K_t} \right] > 0$ where both $\frac{\partial w_t^H}{\partial K_t}$ and $\frac{\partial w_t^L}{\partial K_t}$ are positive because, as in any specific factors model, since K is the mobile factor, an increase in its supply rises the return to both specific factors.

[19] Notice that even though the skill premium increases along the transition, it will never surpass the initial premium. Recall from the discussion above that $sp_A > sp$.

monotonic dynamics: it first decreases and then increases.[20] In other words, if the investment good is capital intensive, there is longer run complementarity between physical capital and skilled labor.

Still considering a Case-A country, if $\alpha_x < \alpha_z$ and $\frac{K_x}{H} < \frac{K_z}{L}$, i.e., if the consumption good is capital intensive, then (22) does not provide an unambiguous prediction for the behavior of the skill premium. However, it can be verified that the skill premium will most likely decrease along the transition.[21] In other words, the skill premium exhibits a monotonic behavior: it declines on the first period, i.e., $\widehat{sp}_{first-period} < 0$, and it then continues to decrease for the rest of the transition.

What is most interesting about the transitional-dynamics effect is the possibility of a non-monotonic behavior of the skill premium when the investment good is capital intensive. This non-monotonicity emphasizes both qualitative and quantitative differences between static and dynamic models. The key intuition behind the non-monotonicity is that K is a mobile factor. Consider Case-A economies. As K_t grows along the transition and r_t falls, since good prices are constant at world levels, then the return to both of the specific factors w_t^H and w_t^L must increase. As explained above, with $\alpha_x > \alpha_z$ it then must be the case that w_t^H increases by more than w_t^L, and so the skill premium increases. This effect creates the possibility of a non-monotonic behavior because in going from distorted steady state A to the open-economy steady state, the skill premium overall *decreases*.

One important implication of the transitional-dynamics effect is that if the investment good is capital intensive, then the static model overstates the impact of trade liberalization on the skill premium because it does not account for the endogenous changes in the supply of factors of production. In particular, the larger α_x is compared to α_z, the more the static model overestimates the reaction of the skill premium. Whether or not $\alpha_x > \alpha_z$ is an empirical question, but in

[20]It is not possible to analytically determine what happens if H_t is non-monotonic and *increases* after the first period. It turns out that in numerical simulations, one still gets a non-monotonic skill premium. See numerical examples in Section 5.

[21]To see this, notice that in equation (22), $\left|\frac{H}{K}\left(\frac{K_x}{H} - \frac{K_z}{L}\right)\right| = \left|\frac{K_x}{K} - \frac{H}{L}\frac{K_z}{K}\right| < 1$ because $\frac{K_x}{K} < 1$, $\frac{K_z}{K} < 1$ and $\frac{H}{L} < 1$ (the latter follows because developing economies export the consumption good and import the investment good). Thus, for a case-A developing economy, $\widehat{K}_t > 0$ will most likely dominate $\widehat{H}_t < 0$. Since $\alpha_x < \alpha_z$, then equation (22) implies a decreasing skill premium. For numerical verification see Section 5 below.

principle, it is not unreasonable to expect the investment good to be capital-intensive. This result sheds light on why trade liberalization, once endogenous changes in the supply of factors are taken into account, may have a quantitatively small impact on the skill premium.

5 Numerical examples

This section uses numerical examples to illustrate the transitional dynamics from distorted to open steady states. Given the distorted physical capital stock, equations (1) through (5), and (6) through (12) solve for r_t, w_t^H, w_t^L, K_{zt}, K_{xt}, π_t^*, H_t, L_t at the period in which trade liberalization occurs. Finally, (15) solves for K_{t+1}.[22] The following parameters are used in the examples: $\beta = 0.9$, $\underline{\pi} = 0.01$, $\overline{\pi} = 1$, $\delta = 0.5$. The examples presented below are robust to the choice of these parameters. Values for α_z, α_x, τ_z and τ_x vary across the examples in order to illustrate the different cases discussed above.

Figure 2 displays the transition for Case-A economies. In the figure, the investment good is capital intensive, i.e., $\alpha_x > \alpha_z$, and $\tau_x > \tau_z$. In particular, $\alpha_z = 0.1$, $\alpha_x = 0.5$, $\tau_x = 1\%$ and $\tau_z = 0\%$. Variables are measured as percentage deviations from the distorted steady state. The dotted lines correspond to the predictions of a static model with fixed factor supplies, while the solid lines represent the dynamic model.

FIGURE 2. HERE

As observed in Figure 2, Case-A economies will see K grow along the transition. As K grows, w^H increases by more than the increase in w^L, and so π^* rises. Accordingly, starting at $t = 2$, H increases and L decreases. Notice the non-monotonic behavior of the skill premium predicted for the case in which the investment good is capital intensive, i.e., $\alpha_x > \alpha_z$. The skill premium declines on the first period, but it then increases along the transition. Notice also the quantitative differences between the static and the dynamic models: in this numerical example, while the static

[22] A natural question at this point is whether or not this model exhibits stable dynamics. In order for the system to be stable, we need to guarantee that $\frac{dK_{t+1}}{dK_t} = \frac{1}{p}\frac{\partial S_t}{\partial K_t} < 1$. Since it is not possible to check for this analytically, we do so numerically.

model predicts that an elimination of a 1% tariff on imports of X would reduce the skill premium by 1.5%, the dynamic model shows that once the transition is completed the reduction would only be in the order of 0.25%. Finally, since there is more openness, both exports and imports increase.

Figure 3 displays the transition for Case-B economies. In the figure, the investment good is capital intensive as in Figure 2, but now, $\tau_x < \tau_z$. In particular, $\alpha_z = 0.1$, $\alpha_x = 0.5$, $\tau_z = 2\%$ and $\tau_x = 1\%$. This figure is almost a mirror image of Figure 2. In this case, the skill premium first increases and then decreases. It is interesting to notice that in both Figure 2 and 3 the dynamic paths for π_t^*, H_t and L_t are also non-monotonic.

FIGURE 3. HERE

Finally, Figure 4 repeats the case of Figure 2 but when the consumption good is capital intensive, i.e., $\alpha_x < \alpha_z$. In the figure, $\alpha_z = 0.4$, and $\alpha_x = 0.3$. As predicted above, the non-monotonic behavior of the skill premium is lost. Notice also that the paths of H_t, L_t and π_t^* are monotonic. In this case, the static model underestimates the reduction in the skill premium by a small percentage. As shown above, the magnitude of this percentage depends on $|\alpha_x - \alpha_z|$, which in this case is smaller than in Figure 2.[23]

FIGURE 4. HERE

6 Concluding comments

This paper offers an explanation for the fact that while the skilled premium increased in some developing countries following trade liberalization, it decreased in others, or even displayed non-monotonic behavior. Unlike other papers in the literature, this is done here using a model in which the transitional dynamics induced by trade liberalization can vary across countries with different initial conditions. In the model, trade liberalization not only changes the relative demand of

[23] I do not include a figure for a Case-B economy when the consumption good is capital intensive. This ommited figure is just a mirror image of Figure 4.

skilled workers, as emphasized in the Stolper-Samuelson result, but it also changes the endogenous accumulation of factors of production.

Developing countries are generally treated as homogeneous in the sense that they export a low-skill good and import a high-skill good. In contrast, one of the main ideas of the paper is that within a dynamic setting, developing countries may actually be heterogeneous: some of them are relatively abundant either in physical capital, or in the ratio of skilled to unskilled workers. The concept of "abundance" in this case is relative to a common open-economy steady-state equilibrium. These differences in factor endowments are attributed to diverse trade policies. For instance, some countries may have generated a large ratio of skilled to unskilled workers by artificially protecting the sector that uses skilled workers as a specific factor. Instead, some other countries may have generated excess physical capital by lowering the relative price of the investment good.

The main finding is that the skill premium will fall with trade liberalization when the developing country is initially abundant in the ratio of skilled to unskilled workers and scarce in physical capital. Notice that this finding departs from the standard Heckscher-Ohlin result regarding skilled-abundant countries. Moreover, in the model studied here the behavior of the skill premium may be non-monotonic when the investment good is capital intensive. One of the implications of this non-monotonicity is that there may be significant qualitative and quantitative differences between the predictions of the static and dynamic models.

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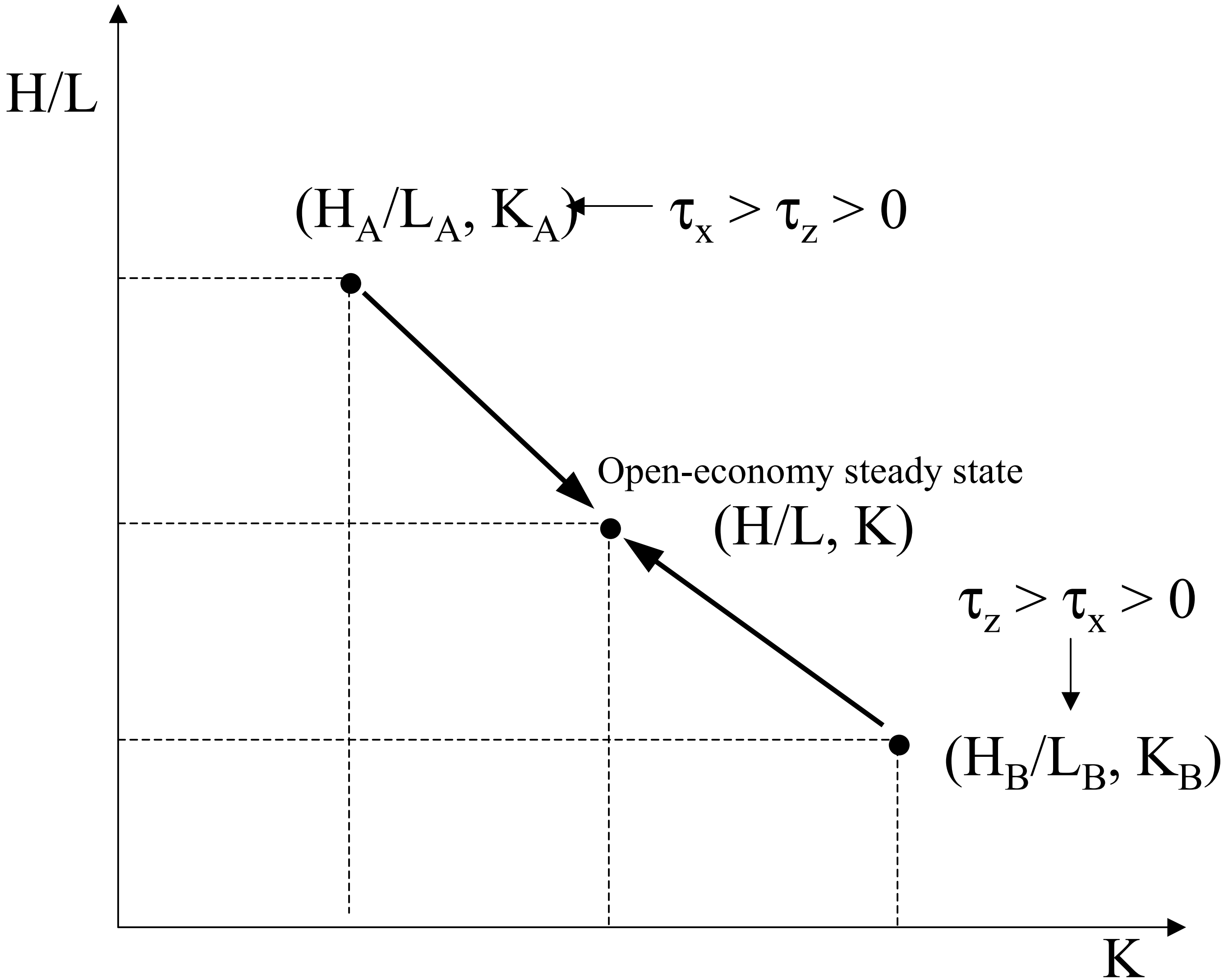

Figure 1: Distorted steady states: two key cases

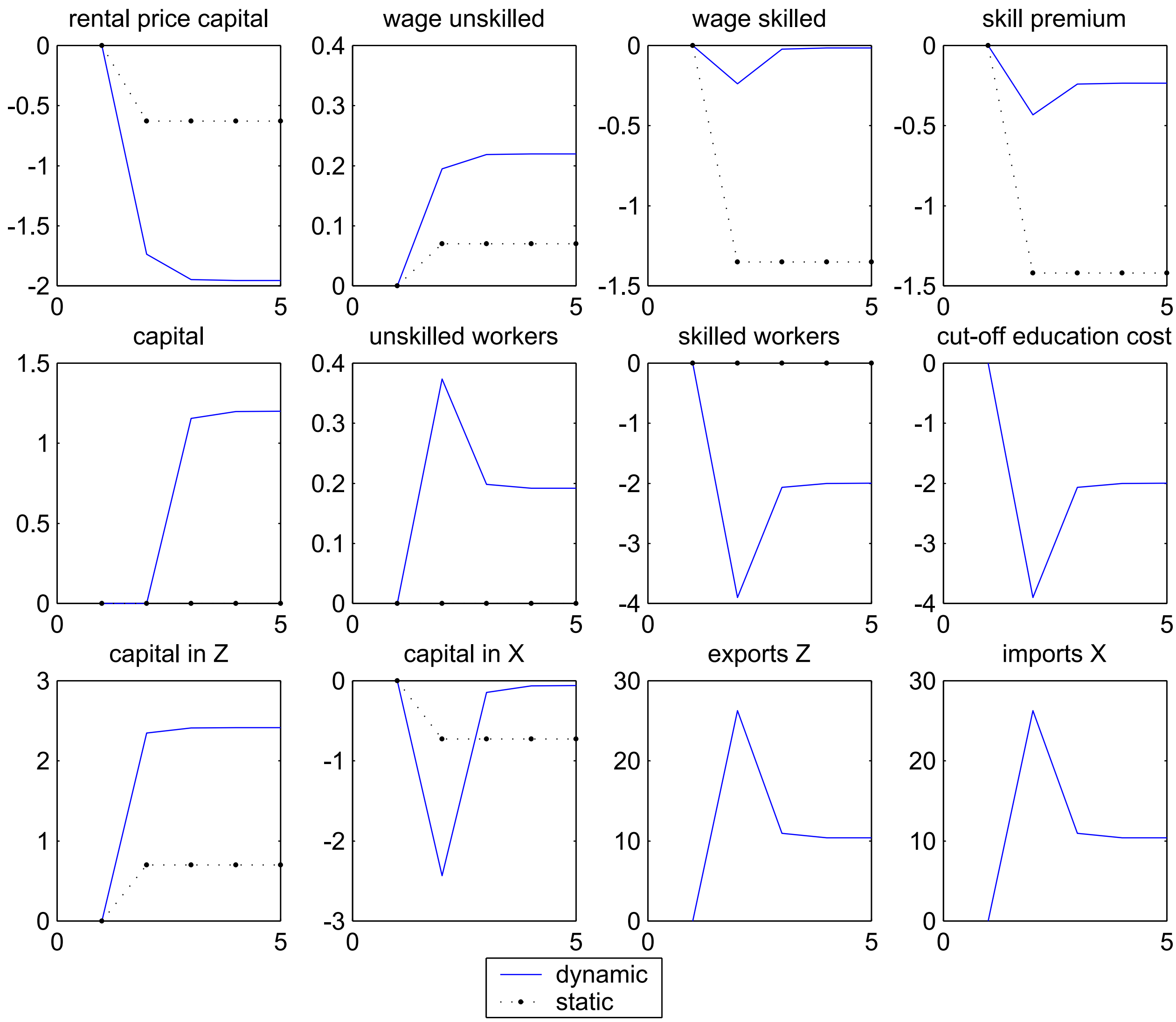

Figure 2: Transition from distorted steady state A - Investment good capital intensive

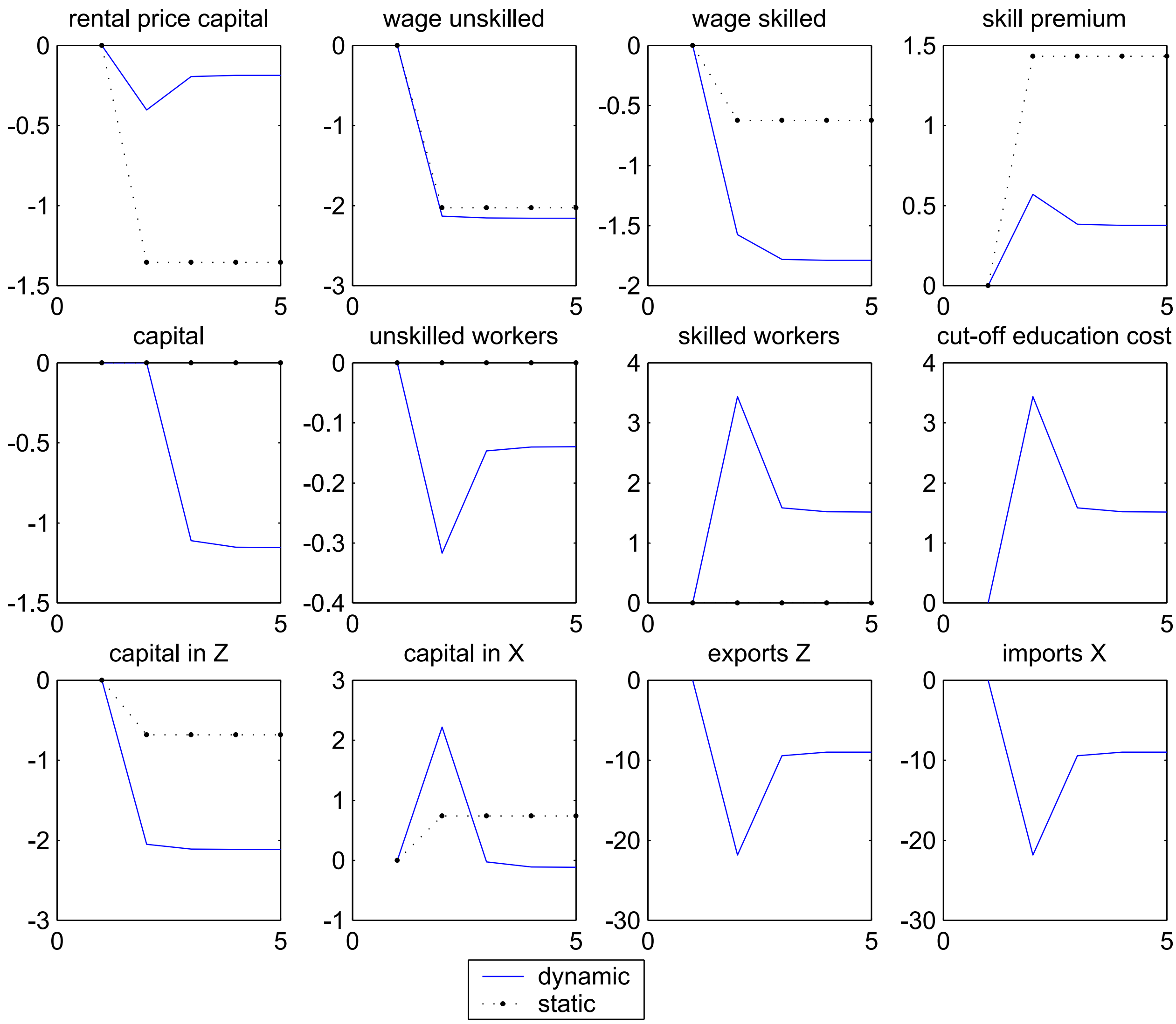

Figure 3: Transition from distorted steady state B - Investment good capital intensive

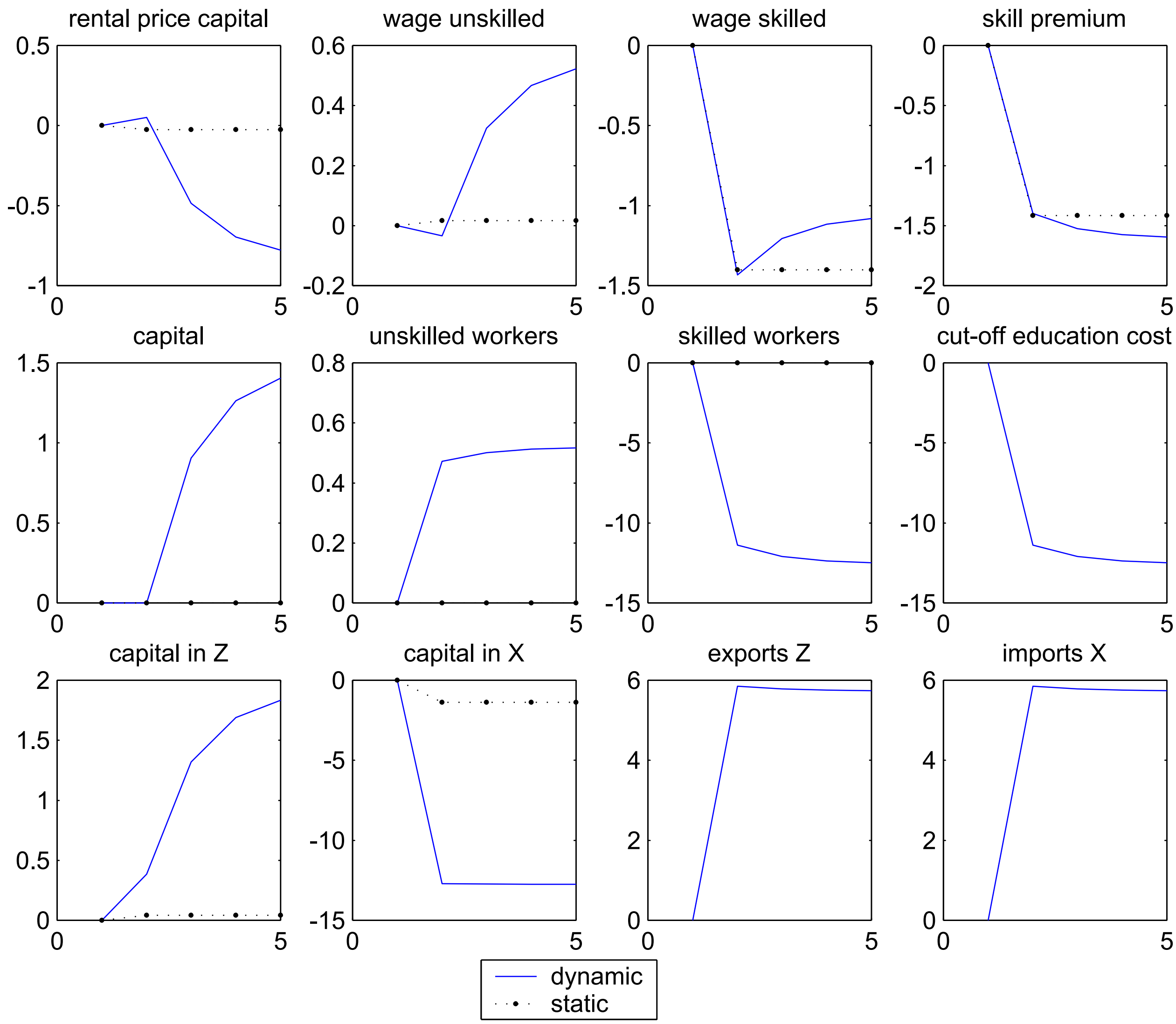

Figure 4: Transition from distorted steady state A - Consumption good capital intensive