The Real Exchange Rate in Transition Economies

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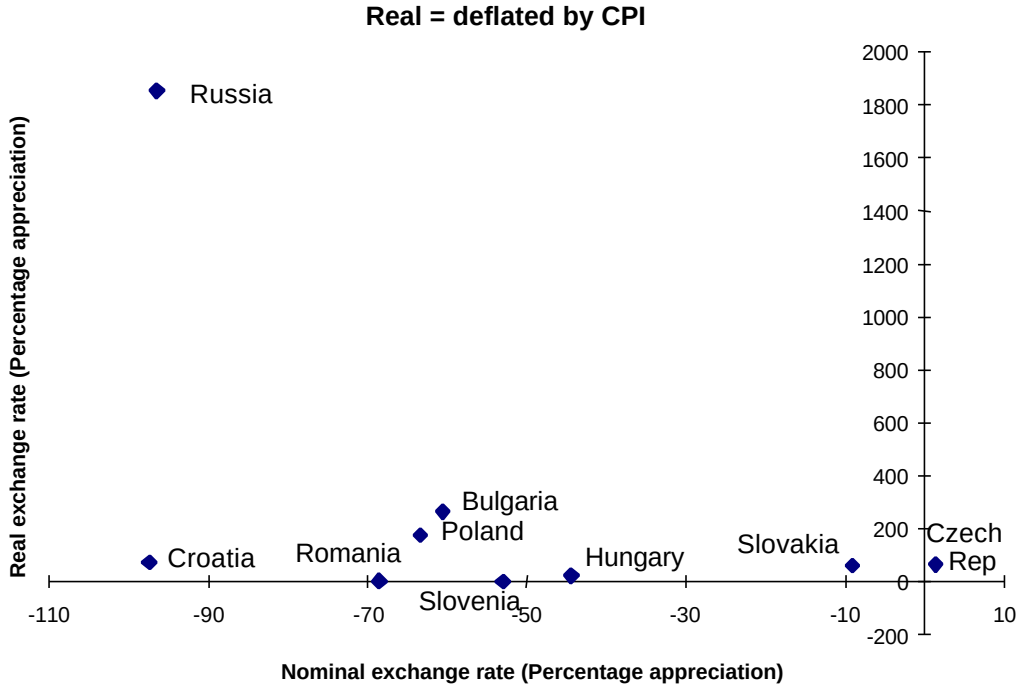
1. Introduction

The role of the exchange rate in the early phase of transition remains a source of debate among analysts and policymakers. At stake are important issues like the need to peg the exchange rate as a nominal anchor to control inflation, the risk of overvaluation, the effect of a real appreciation on structural changes, the proper evolution of the current account, the reaction to capital inflows, speculative attacks and, more generally, the conduct of monetary policy. Most analyses used in these debates are based, explicitly or implicitly, on theories developed for non-transition economies. Some argue that the relevant framework should be based on the experience in developing countries which have in common with transition fairly underdeveloped financial markets and trade barriers. Others observe that capital mobility is *de facto* quite high and trade barriers quite low, so that the proper reference must be based on theories that fit developed economies. Yet, the behavior of the exchange rate in transition economies exhibits some unique features which warrant separate theorizing.

In particular the transition process presents two original characteristics. First, quite independently of the chosen exchange rate regime the real exchange rate steadily appreciates once the economy is liberalized (Halpern and Wyplosz, 1997). Second, there is no apparent link between the evolution of the nominal and real exchange rates. Figure 1 shows cumulated nominal and real appreciations for nine countries for which data is available. Russian nominal (3000%) and real appreciation (1800%) dwarfs the other observations, but the conclusion stands: excluding Russia the coefficient of partial correlation between the nominal and real exchange rates depicted on Figure 1 is -0.15. This observation is not sensitive to the choice of real exchange rate. When the real exchange rate is defined as the ratio of the CPI to the PPI (meant to be a proxy for the non-traded to traded good price ratio) correlation is also -0.15 and it is 0.03 when we use the average dollar wage. Taken together, these two characteristics make the transition countries stand apart.

Developed countries do not exhibit trend appreciation. Fast growing developing countries do tend to have an appreciating real exchange rate, which is often seen as a manifestation of the Balassa-Samuelson effect (Balassa, 1964) which occurs in presence of rapid productivity gains. When the gains are higher in the traded good than in the non-traded good sector, and if wages are equalized across sectors, the real exchange rate appreciates. Yet, if transition, indeed, is largely a story of accelerated productivity gains, the Balassa-Samuelson effect does not look like a promising start. Support for this effect is not readily found in the data for a good reason: productivity gains in the non-traded good sector must have been very large since services were non-existent or very underdeveloped under central planning, while the traded good sector has undergone a collapse in output with only limited labor shedding.

Figure 1
The Real and Nominal Appreciation



Source: IMF
Note: Equally weighted averages of exchange rates vis-à-vis the US dollar and the DM. The real exchange rate is computed using CPI indices. The period of observation is chosen for each country to start at the time of the last large devaluation, and it extends as far as possible:

	Beginning	End		Beginning	End
Bulgaria	Feb 91	Sep 94	Romania	Jul 93	Dec 95
Croatia	May 92	Aug 94	Russia	Jan 92	Dec 96
Czech.	Jan 91	Dec 95	Slovakia	Jan 91	Dec 95
Hungary	Jan 91	Apr 95	Slovenia	Jan 92	Aug 94
Poland	Jan 90	May 95			

The absence of any link between nominal and real exchange rate changes stands in sharp contrast with the evolution observed in most non-transition economies. 'Normal' countries typically display very high short-term correlations between the nominal and real exchange rates. This is commonly understood as an indication of price stickiness.[1] In high inflation countries prices are known to be quite flexible but the nominal exchange rate depreciates roughly at the speed of inflation so that the real exchange rate changes little. This is not the experience of transition countries, even those that have suffered high inflation.

In transition economies there seems to be enough price flexibility to cut the link between nominal and real changes. Consequently, the real exchange rate can be largely seen as a variable in its own right. Halpern and Wyplosz (1997) show that, to some extent, the real appreciation corresponds to a correction following the initial excessive nominal and real depreciation which accompanied the launch of most price liberalization programs. This effect is not enough, however, to fully explain the observed behavior. Their results point to the role of various structural factors. What these factors are, and how they operate, remains largely

[1] This result is standard textbook wisdom, see e.g. Obstfeld and Rogoff (1996).

unexplained at this stage.

As far as we know, there is not yet any paper which proposes a theory of the real exchange rate in transition economies. Such a theory must start form the defining characteristics of the transition process. We have already mentioned a high degree of price flexibility — and this concerns wages too — so that we need to focus on real shocks and/or market imperfections to explain movements in the real exchange rate. The persistence of an unproductive state sector is a primary suspect. In addition, much recent evidence shows that the expansion of private activity in Eastern Europe is less impaired by labor market frictions than by a shortage of capital (OECD, 1995; Konings et al., 1996) and that budget constraints remain quite soft (EBRD, 1995; Cornelli et al., 1996). Case studies confirm that investment is almost entirely financed out of retained earnings (Aghion and Blanchard, 1994; Cornelli et al., 1996).

The theory that we propose here must be considered as a first exploratory step. We focus exclusively on the real side of the economy and abstract from any non-neutralities which could contribute to explaining the evolution of the real exchange rate. This may be too strong an assumption but it allows us to explore the two-way linkages between structural changes and the real exchange rate. Our simple model is designed to capture the transformation process as initially described by Aghion and Blanchard (1994), Blanchard (1997) and Kehoe and Atkinson (1993). It emphasizes the role of the old and inefficient state sector as well as the lack of adequate financing for the emerging modern corporate.

Traded goods are initially produced by a state sector meant to capture the large manufacturing base that most transition countries inherited. This sector is gradually replaced by a new private sector that is slowed down in its emergence by a financing constraint. To keep the model tractable we assume full employment. As the old state sector gradually declines, it relinquishes labor which can flow into new more productive activities. Although the new sector is more productive, it cannot immediately absorb all workers from the old sector, because capital accumulation is financially restricted. To that effect, we assume that financial markets are absent so that investment has to be financed by current profits. The real exchange rate is defined as the relative price of non-traded and traded goods. We take the extreme view that the non-traded good sector only requires labor as factor input. This sector did not exist beforehand; as it does not need to accumulate capital, it can jump into existence at the start of the reform process. The relative price of traded and non-traded goods turns out to be directly related to the real wage. For this reason it controls the speed and the success of the transition process described as the gradual elimination of the state sector and its replacement by the new traded and non-traded good sectors.

The next section presents the model. Section 3 looks at the behavior of the real exchange rate at the outset of liberalization, assuming an instantaneous big-bang. Section 4 explores the subsequent evolution, from big-bang to the steady-state which is described in Section 5. The last section concludes.

2. The Model

We consider an economy with three sectors: i) the old state sector that produces an internationally tradable good; ii) a modern private sector that also produces an internationally tradable good; iii) a modern private sector that produces not internationally tradable services.

2.1 The State Sector

A common inheritance of all transition countries is a large, often inefficient, industrial sector. The technology used in the sector is mostly outdated and inefficient compared to modern equipment from abroad. The countries were either financially unable enough to import western technology or restricted from doing so because of cold war politics (restrictions on technology transfer etc.). Furthermore marginal products of labor and capital vary a lot across and within industries because the market forces that usually equate them under perfect capital and labor mobility were not allowed (Castanheira and Roland, 1996). We model this fact explicitly as follows. The old state sector comprises a continuum of firms which operate under a Leontief technology:

$$y^S(j) = \min (a_1 K^S(j), a_2(j) L^S(j)) \qquad (1)$$

i.e. capital is specific to each production line j and allows different levels of output per worker. Since competitive forces were not at work prior to transition, there is no reason to believe that even companies that produced identical goods were equally productive. We order the production lines such that labor productivity is rising in j, i.e. we assume:

$$j_a > j_b \Rightarrow a_2(j_a) > a_2(j_b)$$

State firms only take the decision to operate a production line, setting $a_2(j)L^S(j) = a_1K^S(j)$, or to abandon it. The assumption that capital productivity a_1 is the same across firms plays no role in what follows as we will consider that capital is redundant in this sector so that effectively $y^S(j) = a_2(j) L^S(j)$. Employment L(j) is assumed to be uniformly distributed over $[0, a_{2\ max}]$ i.e. production lines are all of the same size.

We capture the continuing existence of soft budget constraints in the state sector by assuming that profitable firms subsidize those which face losses.[2] As a whole, therefore, the state sector just breaks even. Post-redistribution, profit is exactly nil in all state firms and there is no further investment. Inherited capital is just a sunk cost so that the only cost to the state firms are labor costs. Workers are homogeneous and wages are taken to be the same throughout the sector. This assumption is natural given the system of cross subsidies in firms steeped in the equalitarian tradition of the communist regime, but is not essential to the analysis. It implies that the wage is equal to average labor productivity in the state sector.

We further assume the existence of non pecuniary benefits in the state sector (e.g. low effort) as well as the opportunity costs of leaving the sector (harder effort, relocation, loss of state employment privileges such as tenure, social services, housing, etc.). The resulting fixed cost F of moving out of the state sector drives a wedge between wages there and the modern sector. Such a limit to labor mobility is often blamed for the slow emergence of a private

[2] We present in the appendix a model with subsidies.

sector (Burda, 1993; Aghion and Blanchard, 1994). This assumption is not essential for the dynamics of the model but it allows for interesting comparative static results.

2.2 The New Sectors

The two other sectors did not exist under central planning. They become latent at the outset of transformation. The traded good sector produces industrial goods with a Leontief technology as well:[3]

$$y^T = \min (b_1 K^T, b_2 L^T) \tag{2}$$

To capture the fact that the new modern sector is more efficient than the state sector we assume that the most efficient state firm is just as efficient as firms in the new sector:

$$a_{2\,max} = b_2 \tag{3}$$

The non-traded good sector uses only labor. The extreme assumption that no capital is needed in the production of non-traded goods could be relaxed, but the model would be much less tractable. The only assumption that is really needed for the effect we want to study is that the production of non-traded goods is less capital intensive than the production of industrial output, which is less controversial:

$$y^N = cL^N \tag{4}$$

All technical coefficients are constant. This assumption permits us to limit the sources of growth to just two factors: i) the accumulation of capital in the traded good sector; ii) sectoral adjustment as workers from the non-traded sector into the traded sector. Adding technological progress would certainly improve the realism of the model but is not needed for our purposes. We already know that technological progress affects the real exchange rate if it is biased towards a particular sector along the lines of the Balassa-Samuelson effect. Since such a channel is well-known and is not specific to transition economies, we simply acknowledge its existence and look for *other* sources of real exchange rate changes.

2.3 Labor Market

Free entry into the non-traded good sector implies that firms in that sector earn zero profits. Wages are then set to be:

$$w^N = cp \tag{5}$$

where p is the relative price of non-traded goods in terms of traded goods ($p = P^N/P^T$) and w^N is the real wage in terms of the traded good price. Throughout the paper p is our definition of the real exchange rate (and increases when there is real appreciation).

With perfect labor mobility across sectors, wages are equalized up to the fixed cost F

[3] Allowing for factor substitutability would not change the results but greatly complicate the formulation.

of leaving the state sector:

$$w^T = w^N = w^S + F \tag{6}$$

With wages flexible and free entry into the non-traded sector, there is no open unemployment.[4] Therefore the total labor force is:

$$\underline{L} = L^S + L^T + L^N \tag{7}$$

2.4 Financial Markets

When transformation starts unexpectedly, all labor is in the state sector. The service sector starts to operate immediately since no prior capital accumulation is required. In contrast the modern traded good sector needs first to invest in physical capital, which raises the issue of financial markets.

With very few exceptions, firms have not been able to raise outside money. Banks typically do not lend to firms, and stock markets have yet to provide capital for more than a few blue chips (EBRD, 1995). This motivates our simple assumption that neither firms nor households have access to financial markets. Investment is entirely financed through retained earnings. If w^T is the real (in terms of traded goods) wage in the traded good sector, investment is therefore:

$$dK^T/dt = y^T - w^T L^T, \text{ if} > 0, \qquad dK^T/dt = 0 \text{ otherwise} \tag{8}$$

The same could apply to the state sector but our assumption that it does not operate profitably implies that it will not invest.[5] Note that, for simplicity, there is no depreciation of capital. Capital keeps its value forever unless it is abandoned, as will be the case in the state sector. When capital is abandoned its value drops immediately to zero. The emerging modern private industrial sector can be seen as growing out of new greenfield investment projects, a feature that does not appear too far from the truth.

2.5 Goods Market

Consumers consider the traded good — itself perfectly substitutable with foreign goods — and the state sector good as perfect substitutes. This assumption is not realistic as state goods are mostly of very low quality but we keep it because it makes the solution more tractable. None of the substantial results are affected by this assumption even though imperfect substitutability allows for some further results mentioned in the last section.

Consumers have Cobb-Douglas type preferences over the two categories of goods, traded plus state sector goods, and non-traded. Personal disposable income is labor income $w^T y^T + w^S y^S + w^N y^N = cp\underline{L} - FL^S$, plus net transfers from abroad Z:

[4] Alternatively, there can be labor hoarding. The model allows for redundant labor in the state sector.

[5] Alternatively one could argue that the corporate governance structure of state firms does not allow for retained earnings. Profits could only be accumulated by abandoning more production lines and laying off more workers than necessary to break even in the short run, a decision which is very difficult to push through under an diffuse ownership structure.

$$C^T = \alpha\,(cp\underline{L} - FL^S + Z) \tag{9a}$$

$$pC^N = (1 - \alpha)\,(cp\underline{L} - FL^S + Z) \tag{9b}$$

Profits are not distributed to shareholders, rather they are entirely used to finance productive investment and therefore do not affect spending. Note that the fixed costs of moving out of the state sector F reduce disposable income. This formulation clearly embodies the efficiency costs of maintaining the state sector, measured by the opportunity cost FL^S of moving workers to the modern sector.

With little commercial lending, residents are not able to use the current account to smooth out spending. Furthermore, in the early phase of transition, private capital inflows are predominantly loans and transfers from institutional lenders and direct inflows, most of them associated with privatizations (Calvo et al.,1995). The proper description of the situation would probably involve credit rationing for households and firms. We take a shortcut: financing is only made possible through foreign transfers. The amount Z of foreign transfers is exogenously set and remains fixed forever. Unless the transfer is a grant, and grants do not last forever, this formulation violates the country's intertemporal budget constraint. This is the price to be paid to avoid a more complex model.

The two good market equilibrium conditions are:

$$Z + y^T + y^S = C^T + dK^T/dt \tag{10a}$$

$$pC^N = pY^N \tag{10b}$$

where we assume that investment goods are the same as traded goods. Obviously, one of these two equations is redundant because of Walras' law.

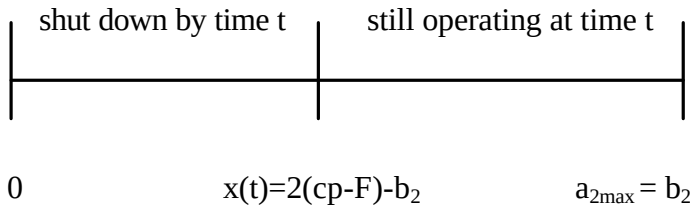
2.6 Emergence and Growth of the Modern Sectors

Economic transformation is described as the development of the modern traded and non-traded good sectors described by (2), (4) and (8). Given the full-employment assumption (7), the other side of the coin is the decline of the state sector. Which production lines are closed first? The new sectors will be drawing workers out of the state sector by offering them continuously growing wages. This will be made possible through capital accumulation in the traded good sector and by rising relative prices in the non-traded good sector, which brings us back to the setting of wages in the old state sector. Labor market equilibrium (6) requires that wages also grow in the state sector. For this reason, productivity must also rise in the state sector and this implies closing down the least efficient production lines first.

We have already made the following assumptions: workers are identical but production lines in the state sector, while of the same size, are heterogeneous and ranked by labor productivity. The state does not claim dividends and profitable firms subsidize loss-making firms with the state sector just breaking even as a whole. This set of assumptions determine the size of the state sector since it implies that the wage is equal to average labor productivity. Let x(t) be the productivity of the marginal production line still in operation at time t, as shown in Figure 2. Average productivity is $\tilde{a}_2(t) = (b_2 + x(t))/2$ and $w^S = \tilde{a}_2(t)$. By closing down the least productive lines, average productivity increases over time as x(t) rises and more workers

switch to the two new sectors.

Figure 2
Productivities in the State Sector



The labor market equilibrium condition (6) along with (5) implies:

$$(b_2 + x(t))/2 = c\,p(t) - F,$$

which gives:

$$x = 2(cp - F) - b_2 \qquad (11)$$

where we have dropped the time subscript. The low productivity state sector shrinks when the real exchange rate, henceforth defined as the ratio of non-traded to traded good prices p, appreciates.

This feature can be seen as a Balassa-Samuelson effect in reverse. The standard Balassa-Samuelson effect is driven by the supply side (Obstfeld and Rogoff, 1996). Here it is driven by the demand side. In order to meet higher demand for its output, the under-developed non-traded good sector must raise its relative price to raise wages and attract workers. The state sector works under an aggregate budget constraint; in order to maintain its labor force, it must improve its aggregate productivity which is achieved by closing down the least efficient units. Over time there could be investment in modern equipment. While this is entirely possible, we assume that state firms which invest are reclassified in the new traded good sector, and offer the correspondingly higher wage. Allowing state firms to invest would not change the results. Note that the higher is the wage gap F the larger is the state sector.

Employment and output in the state sector are:

$$L^S = \underline{L}\,(b_2 - x)/b_2 \qquad (12)$$

$$y^S = \tilde{a}_2\, L^S = 2\,(cp - F)(b_2 - cp + F)\underline{L}\,/b_2, \qquad (13)$$

Quite clearly $y^S \geq 0$ since the fixed cost F cannot exceed the real wage in the new sector $w^T = w^N = cp$. Otherwise transition never takes off. As long as $b_2 \geq cp$ equations (2), (6) and (8) along with the assumption that the traded good sector is run efficiently (no redundant capital or labor) imply that:

$$dK^T/dt = (b_2 - cp)\,L^T \qquad (14)$$

As the modern traded good sector accumulates capital, it can expand and hire workers away

from the state sector. Since (2) implies that $y^T = b_1K^T = b_2L^T$, we have:

$$dL^T/dt = (b_1/b_2)\,(b_2 - cp)\,L^T. \qquad (15)$$

Hiring in the new sector depends negatively on the real exchange rate. When employment in the new sector is low, i.e. at the outset of reform, a successful transition can only occur if the real exchange rate is sufficiently low.

3. Big Bang

We now characterize the situation on day one of the transition. We assume a big-bang policy which instantaneously establishes market conditions, frees prices, wages and trade, and allows firms to be created. The only remaining legacy of central planning is an inefficient state sector which continues to operate with soft budget constraints even though there are no net subsidies from the rest of the economy. Initially, there is no capital in the new sectors. The tradable sector first has to invest and cannot immediately produce goods. The non-traded good sector, which does not need capital, immediately starts to produce. Its size is determined by demand. The initial situation is described as follows:

$$L^T = 0; \qquad b_2 L^S = 2\,(b_2 - cp + F)\underline{L}\,; \qquad L^N = \underline{L} - L^S \qquad (16)$$

$$cp = (1 - \alpha)\,(Z - FL^S) / (\alpha\underline{L} - L^S) \qquad (17)$$

The link between employment (or output) in the state sector and the real exchange rate is represented in Figure 3, with two possible configurations. In both cases, the LL line which describes the labor market conditions (16) is downward sloping. It corresponds to the reverse Balassa-Samuelson effect discussed above: to hire more workers from the state sector the non-traded good sector must raise the real wage and therefore its relative price p.

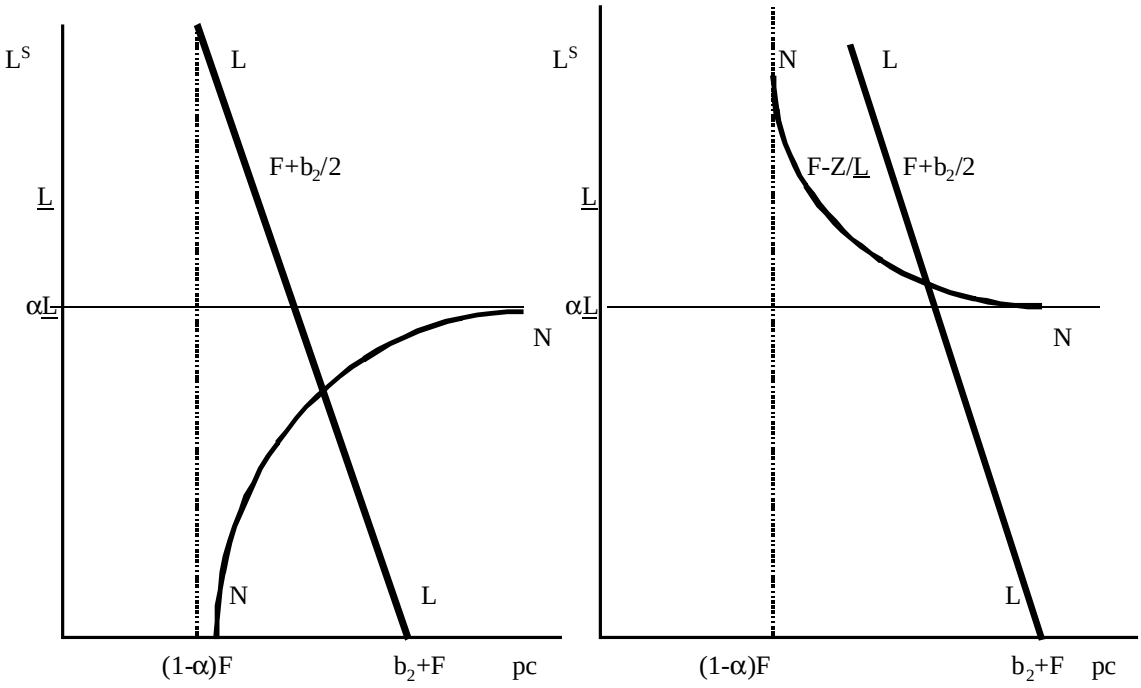
The curve NN represents the good market equilibrium condition (17). When $Z > \alpha F\underline{L}$ the NN schedule is upward sloping: the real exchange rate increases with the size of the state sector. Indeed a large state sector implies that output in the non-traded good sector is in short supply. For a given level of demand, a reduced supply translates into a higher relative price. The level of demand, however, is also affected by the size of the state sector because of larger efficiency losses which depress disposable income and demand. When the inefficiency associated with the wage gap F is large enough (i.e. when $\alpha F\underline{L} > Z$), this second effect dominates and the NN schedule is downward sloping.

The situation at the time of big bang (t = 0) is at the intersection of the two schedules.[6] Figure 3 shows the instantaneous birth of the non-traded good sector. Employment in the state sector (L^S) falls below its initial value $\underline{L}$ which makes room for employment in the non-traded good sector ($L^N > 0$). Pent-up demand for the non-traded goods that were not provided by the old state sector is instantaneously satisfied. This is a standard feature of the early days of

[6] The NN schedule admits another branch corresponding to $cp < (1- \alpha)\,F$ which is not shown in Figure 3. Appendix 1 shows formally that there is no admissible solution on this branch. The appendix also rules out a second solution with lower value of p than the one shown in the case $F\underline{L}\alpha > Z$. Graphically this second solution corresponds to the other intersection (not shown) further up along the NN schedule on the right hand-side panel, where $LS > \underline{L}$, which is impossible, of course.

transition when kiosks, snack bars and other trades suddenly appeared along the streets of many Eastern European cities.

Figure 3
The situation after big-bang



Case $\alpha F\underline{L} < Z$ Case $\alpha F\underline{L} > Z$

Figure 3 also helps to understand the role of the economy's structure and of exogenous factors. Only two productivity factors matter. First, the higher is labor productivity in the non-traded good sector (c) the less the real exchange rate (p) appreciates.[7] This illustrates the main feature of the model embodied in (5) and (6): the function of the real exchange rate is to determine the real wage and therefore the size of the state sector. The higher is the real wage the more productive must the state sector be in aggregate, and therefore the more it must shrink under the assumption that the least productive product lines are first closed down. To achieve a given size, the non-traded good sector must offer the corresponding real wage. This wage is equal to the real value marginal (and average) labor productivity, a combination of volume productivity c and relative price p.

The second productivity that matters is b_2 in its role as the highest labor productivity in the state sector ($a_{2\ max} = b_2$) which determines the sector's average productivity. A higher b_2 leaves the NN schedule unchanged while the LL schedule shifts to the right. If the state sector is more productive, the non-traded good sector must offer a higher real wage to displace workers

[7] Technically, labor productivity c and the real exchange rate p only appear as cp.

and this requires a higher relative price.[8]

Quite intuitively, an increase in foreign capital inflows (Z) results in a more appreciated real exchange rate. Foreign financing does not affect the labor market so the schedule LL in Figure 3 remains unaffected. As Z rises the NN schedule shifts down in both panels. The state sector shrinks because the additional flow of foreign currency increases disposable income and raises demand for both goods. The additional demand for traded goods is satisfied through additional imports as the current account deteriorates. On the other side, the demand for non-traded goods has to be met by domestic production. The relative price of non-traded goods and the real wage in that sector increases as a response. The state sector responds to higher wages abandoning more production lines and freeing labor. The laid-off workers join the non-traded good sector and increase the supply of non-traded goods.

A higher wage gap F is also accompanied by a more appreciated real exchange rate. Graphically, in Figure 3 the LL schedule shifts to the right because labor exit out of the state sector is reduced, forcing the non-traded sector into a higher relative price to offer a higher real wage. The NN schedule shifts to the left because the wage gap inefficiency rises, reducing disposable income and demand for both traded and non-traded goods. The figure, confirmed by Appendix 1, shows that the real exchange rate always rises, i.e. that the first effect dominates the second. The reason is that a larger wage gap reduces the demand for both goods, while it reduces the supply of non-traded goods (L^N goes down) and increases the supply of traded goods (L^S goes up). Inevitably, therefore, the relative price of non-traded goods has to rise.

The effects of the two exogenous factors F and Z are linked, revealing an interesting complementarity. Starting from a situation where no foreign financing is available (Z = 0), and holding F constant, imagine that Z increases. Eventually, when Z/F passes the threshold $\alpha\underline{L}$, we switch from the right-hand side to the left-hand side panel in Figure 3. At that stage L^S falls below $\alpha\underline{L}$: the share of labor employed in the non-traded good sector becomes less than the share of spending on output from that sector. This illustrates the fact that foreign financing allows to overcome the inefficiency cost associated with the wage gap: by providing them with means to purchase foreign goods; international financing reduces the dependence of consumers on the distorted trade sector. This raises an incentive issue not captured in our model: foreign grants which make domestic distortions less crippling may result in less energetic efforts to introduce hard budget constraints in the state sector. This has profound effects on the transition process that follows.[9]

4. Transition Dynamics

Once it starts operating, the modern traded good sector invests its entire profit margin into productive capital.[10] As indicated by (15), this happens when the real producer wage is lower

[8] The effect on employment depends on the configuration. In the left hand-side panel of Figure 3, L^S increases with b_2 while it decreases on the right hand-side panel. This is again a manifestation of the inefficiency associated with the wage gap.

[9] This observation leads to an alternative interpretation of the beginning of transition, presented so far as an exogenous event which leads to the discrete emergence of demand for non-traded goods. One can see transition starting when the wage gap exogenously declines from a very high level which so far prevented exit from the state sector. One might even consider that an inefficient state service sector used to exist and disappears at day zero and is replaced by the new sector that does not have to accumulate capital.

[10] To start operating the traded good sector needs capital, and to accumulate capital it needs to first generate profit. To break the logjam, it is assumed that at t = 0 it receives for free an infinitesimal fraction of transfers Z. This should be regarded as a parable, of course.

than labor productivity ($w^T = w^N = cp < b_2$). This requires that the relative price of non-traded to traded goods, the real exchange rate p, be sufficiently low. From (17), we see that at time t=0 this condition is not necessarily satisfied. If the wage gap F is large relative to foreign financing Z and labor productivity b_2 the modern industrial sector does not take off, a sort of transition trap. Equally well it is possible that foreign capital inflows increase the demand for goods to the point where the whole labor force is employed in the non-traded good sector. This effect can be interpreted as a form of Dutch disease. Only when the capital inflows are reduced or labor mobility is increased can the economy transform itself successfully. We further discuss the possibility of such traps in more detail in the appendix.

The evolution of the economy after big bang is described in Figure 4. The path of the economy is found by combining (7), (12) and (10b) to obtain:

$$L^T = \alpha\underline{L} - (2\underline{L} / b_2) [- cp + A + B/cp] \qquad (18)$$

with

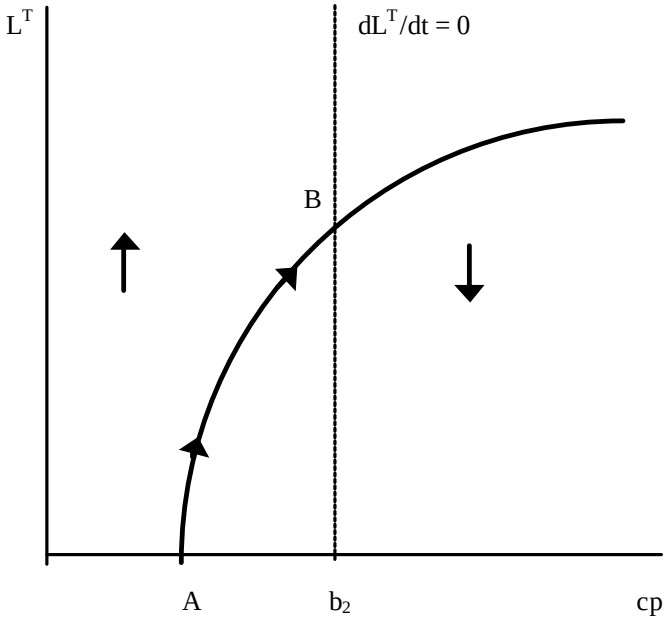
$$A = b_2 + F + (1 - \alpha)F$$

$$B = (1 - \alpha) [Zb_2 / (2\underline{L}) - F(b_2 + F)]$$

which is unambiguously upward-sloping for the possible values of the real exchange rate $b_2/2+F<pc<b_2$ (see Appendix 1). The real exchange rate will always exceed $b_2/2+F$, because $b_2/2$ is the wage level paid to state workers if all production lines in the state sector are still operated. Because the demand for non-tradable goods is non zero by assumption, a non-traded good sector has to emerge. It can only attract workers by paying more than $b_2/2 +F$. If the real exchange rate exceeds b_2 transition cannot start either because the modern traded sector does not even begin to accumulate capital as pointed out above. The schedule $dL^T/dt = 0$ corresponds to (15) and only considers the case of a successful transition, i.e. $cp(0) < b_2$.[11]

[11] For the parameter values F and L that induce an initial exchange rate higher that b_2 the economy is stuck on the $L^T=0$ axis.

Figure 4
Transition Dynamics

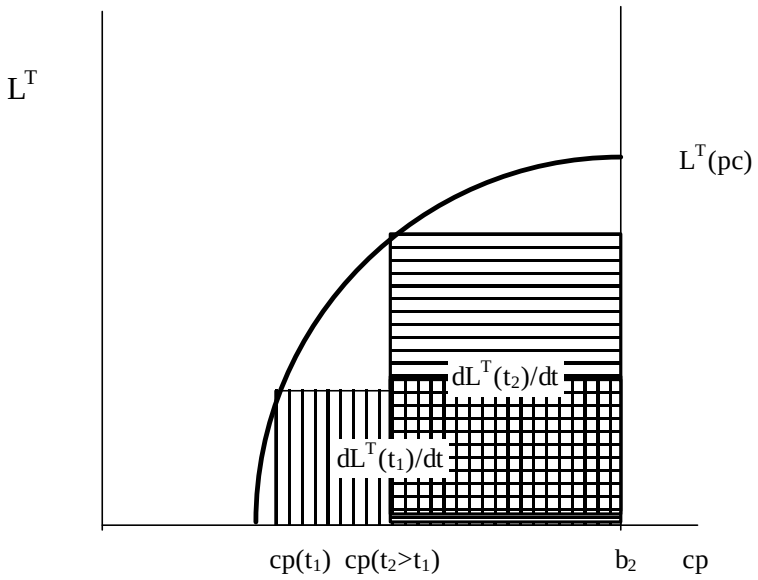


Point A in Figure 4 represents the initial situation where the modern traded good sector has not yet started to operate. It is enough that some arbitrarily small amount of financing be made available to that sector for capital accumulation to start and for employment L^T to grow. The figure reveals that, along the way, the real exchange rate appreciates. The reason is not productivity gains or other familiar interpretations from the growth literature. In the zero steady-state growth economy depicted by the model, the absolute amount of capital that needs to be accumulated gradually declines. Consequently, retained earnings progressively decline and this allows the real wage to rise. It is the real exchange appreciation which allows the real wage to increase (see (5) and (6)).

Hiring in the traded good sector (measured by changes in employment L^T) initially rises, then it peaks and eventually levels off as productivity in the state sector converges to productivity in the modern sector. By assumption the production lines that are closed down as the state sector shrinks are the currently least productive ones. The process continues until the last remaining line has the same productivity as the modern state sector less the wage gap ($a_2 = b_2 - F$). Hiring is proportional to the size of the rectangles shown in Figure 5.[12] High foreign financing and relative low obstacles to labor mobility help the new traded sector initially to emerge without a strong appreciation.

[12] Hiring is given by $dL^T/dt = b_1/b_2\ (b_2 - pc)\ L^T$. The $L^T(pc)$ curve in figure 5 can be either convex as depicted ($Z/\underline{L} > 2F(1+F/b_2)$ or concave ($(Z/+F/b_2\underline{L} < 2F(1+F/b_2)$.

Figure 5
Hiring in the New Sector



The evolution of the size of the non-traded good sector is ambiguous. It depends on the relative size of the wage gap and the amount of foreign financing. The non-traded good sector tends to decline the more abundant is foreign financing and the lower are the barriers to labor mobility.[13] To understand why, suppose that the wage gap F is zero. The non-traded good sector is not financially restricted at t=0 and jumps to a point such that a share α of disposable income $Z+\underline{L}pc$ is spent on a supply cL^n of non-traded goods at a relative price p. Goods market equilibrium then implies:

$$\alpha(Z+\underline{L}pc)=pcL^n \qquad (19)$$

This equilibrium condition implies that employment in the non-traded sector must decline as the real exchange rate p appreciates. Why? Given the technology of the non-traded good sector as described by (4) and the no-profit assumption, the real wage *measured in terms of the non-traded good* remains constant and equal to c. In the absence of a wage gap, by (6), the same holds for all real wages. The real exchange rate appreciation implies that disposable income *measured in terms of the non-traded good* $Z/p+\underline{L}c$ declines because the amount of foreign financing is not adjusted to compensate for the decline of the relative price of traded goods. Thus both substitution and income effects of the change in the relative price p act towards reducing the demand for non-traded goods. This effect can be overcome if labor income in terms of the non-traded goods is increasing during the transition period. The wage gap does just that. Labor income in terms of non-traded goods $c\underline{L} - F\,\underline{L}^S/p$ is rising during the transition. The aggregate efficiency loss associated with the wage gap decreases in line with the declining employment in the state sector and the appreciating real exchange rate. This effect raises employment in the non-traded sector because it is proportional to disposable income measured in terms of the price of non-traded goods. In the end the evolution of the number of

[13] Employment in the non-traded good sector is declining for $Z>2F\underline{L}(1-F/b_2)$, otherwise it is increasing.

workers in the non-traded sector depends on the relative size of these two effects.

5. The Steady State

The steady state is characterized as follows:

$$cp = b_2 \tag{20a}$$

$$L^S = (2F/ b_2)\underline{L} \tag{20b}$$

$$L^T = \alpha\underline{L} - (1 - \alpha)(Z/b_2) - [1 - (1-\alpha)(F/b_2)]\, L^S \tag{20c}$$

$$L^N = (1 -\alpha)\underline{L} + (1 - \alpha)(Z/b_2) - (1-\alpha)(F/b_2)\, L^S \tag{20d}$$

Eventually opportunities to earn non zero profits in the new traded good sector disappear and the economy converges towards it steady state. At that stage the relative price of traded goods is not held up by the finance constraint anymore and the real exchange rate equals b_2/c, the relative productivities in the traded and non-traded good sectors, as in any normal Leontief economy. It is neither affected by foreign financing nor by the wage gap. Yet, the presence of the wage gap preserves the state sector from complete extinction and therefore reduces the size of the modern sectors. Finally, external finance Z increases disposable income and the size of the non-traded good sector, while it reduces the size of the traded good sector as it provides (free) financing for the purchase of foreign goods. This last feature is unrealistic for the long run, because it ignores the nation's budget constraint. It may have some relevance in the medium run, as well as for fast growing transition economies that outgrow their external indebtedness.

6. Conclusion

This paper presents a model of the real exchange rate during the transition process. The model emphasizes the link between productivity, capital accumulation, real wages and relative prices as the old state sector gradually makes room for the modern sectors to expand.

A key issue is how to model transition in order to study the behavior of the real exchange rate. We have argued that two features are specific to the transition process: the absence of any correlation between the nominal and the real exchange rate and trend real appreciation. The first characteristic justifies ignoring nominal aspects. The second characteristic points towards the Balassa-Samuelson effect, but closer scrutiny suggests that this effect is unlikely to be more than a small part of the story. Accordingly we have deliberately shut off the Balassa-Samuelson channel to better analyze alternative sources of real appreciation.

Instead, the model proposes to represent transition with the following five features. First, a weak banking system, together with a fuzzy transformation of property rights, result in the almost complete absence of lending to the new private sector. The model is crude in assuming that investment is solely financed by retained profits, but it is well known that information problems can lead to the breakdown of bank lending (Akerlof, 1970; Stiglitz and Weiss, 1971). Second, parts of the old manufacturing sector continue to operate under soft budget constraints. This has the effect of freezing resources in low productivity production

lines, many of which are actually effectively insolvent. The resulting inefficiency affects both the demand and the supply sides. Third, labor mobility away from the old state sector is limited by a variety of factors inherited from the command economy, including access to housing, health, education. This effect is captured through an admittedly *ad hoc* gap between wages in the modern sectors and wages in the old state sector. Fourth, transition is described as the instantaneous release of pent-up demand for services and for internationally traded goods, along with access to foreign financing which permits a discrete jump in the supply of internationally traded goods. The result is the emergence of a market-determined real exchange rate, the ratio of the price of non-traded goods to the price of traded goods. Finally, the dismantling of "Berlin walls" is accompanied by the availability of foreign financing. The model, again, is crude in treating this financing as exogenous and constant, but the main conclusions are unlikely to be overturned by a better account of intertemporal budget constraints.

A number of results emerge. First, the real exchange rate is just the other side of the coin of the real wage.[14] Labor costs and the real exchange rate need to be initially low to allow the new traded sector to generate high enough profit margins to be able to expand. At the same time a continuous real appreciation is needed to attract labor away from the state sector which is then forced to close down inefficient production lines. The link between real appreciation and rising productivity in the traded good sector can be seen as a Balassa Samuelson effect in reverse. Productivity increases are a reaction to the real appreciation, not the exogenous driving force behind it.

Second, the proper level of the real exchange rate is a knife-edge. Too low real wages do not provide incentives for labor to leave the state sector. Too high real wages reduce retained earnings and accumulation in the modern manufacturing sector. In the latter case another outcome occurs: there exist only the old manufacturing sector and the low capital intensive service sector. This knife-edge property gives rise to *transition traps* described below.

Third, frictions in the labor market and subsidies to the state sector (here cross subsidies inside the state sector) enhance this effect by requiring higher real wages and a more appreciated real exchange rate. The frictions can be so high that a modern manufacturing sector cannot emerge at all. This is a first case of transition trap.

Fourth, foreign finance tends to offset the effects of subsidies and labor market frictions. Under certain conditions it sustains demand and tends to appreciate the real exchange rate which, in turn, imposes tougher foreign competition on the old sector. Put differently, limits to foreign borrowing causes the real exchange rate to be undervalued (given the productivity levels) and keeps real wages too low.

Fifth, if too large, foreign finance can lead to another transition trap akin to the Dutch disease. A large supply of foreign funds props up demand which leads to real appreciation and high real wages. This can wipe up profits in the modern traded sector and, given the financial market distortion, block investment and the development of state-of-the-art manufacturing.

These results suggest a number of policy implications. These implications are specific to the model of course and must be considered with great circumspection until more research determines their robustness. The first implication is that it is futile and possibly counter-productive to resist real appreciation. The real appreciation is the market channel through which labor is attracted out of the inefficient state sector. Yet, much as undervaluation blocks

[14] This matches the facts: across transition countries we find a correlation coefficient of 95% between dollar wages and the non-traded/traded good price ratio.

transition by preventing labor from migrating in the modern sectors (traded and non-traded goods), overvaluation may wipe out profitability in the new manufacturing sector.

The model also illustrates the crucial role IMF or World Bank money plays in the early days of reform. In the absence of outside sources, such financing allows to overcome the debilitating effects of distortions in the labor and financial markets. This is true even though we assume that foreign loans finance pure consumption. The popular argument that a current account financed consumption boom is harmful, does not hold in this model. Since we do not impose the long-term budget constraint on the country, this implication may have to be qualified. Nevertheless it is important to keep in mind that the inflows, although entirely consumed, raise the productivity of the economy and help the country to outgrow its external debt. Still the model should not be taken at face value. To the very least, direct investment is preferable because it accelerates capital accumulation over and above addition to retained earnings and because grants may act as a disincentive to the elimination of soft budget constraints in the state sector.

Other modeling strategies are possible. We have explored a version of the model where the good produced by the state sector an inferior imperfect substitute to foreign manufactured goods, so that demand declines as income increases. In that setup the role of the real exchange rate is not to crowd out the state sector (which declines because of capital depreciation and obsolescence) and real appreciation is not linked to productivity gains. Instead, because it determines real wages in the traded good sector, the real exchange rate affects the distribution of revenues between labor and firms. In the absence of financial markets, this is what determines the level of investment. Real appreciation sets in as the need for capital accumulation financed by saving declines.

Quite clearly, the model presented here should be seen as a first exploration of complex phenomena. While we believe that the results shed some light on the role of the real exchange rate during the transition process, further research must explore some of its limitations.

First, we have explicitly eliminated sector-level productivity changes which give rise to the Balassa-Samuelson effect. The interplay of this effect with those outlined here may lead to interesting dynamics.

Second, we have assumed that financial markets are missing. Even though financial markets have played a limited role so far, their influence is growing and needs to be acknowledged. This concerns domestic markets which allow both for private savings and intertemporal consumption smoothing as well as outside borrowing. This also concerns foreign borrowing and the link between domestic and foreign interest rates. Our assumption of a constant and permanent flow of income from abroad is quite unrealistic. Our conjecture is that that what is important is that the country has only limited access to international capital markets.

Third, labor market frictions are captured by the existence of an exogenous and constant wage gap. A more explicit modeling of the labor market is obviously needed. An alternative natural extension would be to introduce explicit subsidies to the state sector. In the absence of a proper treatment of government subsidies including the state's budget constraint, Appendix 2 shows that there exists an equivalence between subsidies and the wage gap.

Fourth, the adoption of Leontief technologies greatly simplifies the analysis. It is unlikely that allowing for substitutability between production factors will change the main results.

Fifth, the assumption of price and wage flexibility leads to full employment. This is obviously unrealistic. What is needed is a model which explains transition unemployment. To be relevant such a model would also need to explore other sources of unemployment factors

than western-style wage rigidities, including mismatch, search costs and rent seeking.

Finally, to keep the model tractable, we have left out all nominal variable in the model. This rules out the study of non-neutralities which may interfere with the transition process.

Appendix 1

This appendix establishes:

1. the statement in section 4 that the real exchange rate is increasing during the transition process,
2. the conditions on the parameter values that have to hold to allow the new traded sector to emerge,
3. that the exchange rate at big bang depends positively on the size of the wage gap F.

1. We know from equation (15), that hiring in the new sector is positive as long as the relative price p doesn't exceed the ratio of the productivities in the two new sectors b_2/c. We can use this fact to show that the real exchange rate p monotonically appreciates.
The slope of the $L^T(cp)$ curve (18) is given by:

$$dL^T/dt = 2\underline{L}/b_2\,(1+B/pc^2)\,d(pc)/dt \qquad \text{(A1.1)}$$

where $B= (1-\alpha)\,(Z/2\underline{L}\ b_2 - F(\ b_2\ +F))$.

The left hand side of equation (A1.1) is positive as long as $cp < b_2$. Hence the real exchange rate is monotonically increasing for $cp < b_2$ as long as

$$1+B/c^2p\ > 0. \qquad \text{(A1.2)}$$

If condition (A1.2) holds at t = 0 it also holds for the subsequent higher exchange rates. To show that it holds at t = 0 we first solve explicitly for the initial exchange rate. The real exchange rate at t = 0 follows from equations (16) and (17):

$$cp(0) = - Q/2 \pm (Q^2\ /4 + B)^{1/2} \qquad \text{(A1.3)}$$

where $Q= (\alpha -2)\,(F+ b_2/2)< 0$.

To make sure that the real exchange rate is well defined for any parameter value, we check that the term under the square root is unambiguously positive.

$$B > -Q^2/4 \quad \Leftrightarrow \quad (1-\alpha)\,(Z\ b_2/(2\underline{L}) + b_2^2/4)> - \alpha^2/4\,(F+ b_2/2)^2 \qquad \text{(A1.4)}$$

which is clearly true for all parameter values.

The initial exchange rate cp(0) has to exceed $F+b_2/2$ to allow the new non-traded sector to draw workers out of the state sector (i.e. we exclude a negative employment level in the non-traded good sector). This condition rules out the lowest of the two solutions in (A1.3) (corresponding to the case where the square root is subtracted):

$$cp(0) \geq F + b_2/2 \quad \Leftrightarrow \quad -(Q^2/4 + B)^{1/2} \geq \alpha/2(F+b_2/2) \qquad \text{(A1.5)}$$

Now we can prove that the real exchange rate monotonically appreciates. Given that the initial exchange rate is low enough to permit a successful transition, it appreciates if (see (A1.1) and

(A1.2) :

$$1+B/c^2 p> 0 \quad \Leftrightarrow \quad Q(Q^2/4 + B)^{1/2} < 2\,(Q^2/4 + B) \qquad (A1.6)$$

This inequality holds for all values of F and Z, because the left hand side is negative (Q<0) while the right hand side is positive (see (A1.4)) for all parameter values.
QED

2. We now derive the conditions that ensure that the new traded sector can develop. For that to happen firms in that sector must make positive profits at t = 0:

$$b_2 > cp(0) \Leftrightarrow b_2 + Q/2 > (Q^2/4 + B)^{1/2} \qquad (A1.7)$$

A necessary condition is that the left hand-side of (A1.7) be positive, i.e.:

$$b_2 > -Q/2, \qquad \text{which is equivalent to: } b_2 > 2(2-\alpha)/(\alpha+2)\,F \qquad (A1.8)$$

From (A1.6) one concludes that for the transition to be successful it must be that:

$$((1-\alpha)F/b_2 - 1)F + \alpha b_2/2 > (1-\alpha)\,Z/(2\underline{L}). \qquad (A1.9)$$

As long as (A1.8) and (A1.9) hold, the initial exchange rate is in the interval:

$$b_2 + F/2 < cp(0) < b_2.$$

When either (A1.8) or (A1.9) does not hold, the transition cannot start. The initial exchange rate is too high to earn positive profits in the traded good sector. The steady state is instantaneously reached at big bang with the share of labor employed in the state and the non-traded sector being determined by demand, the size of the capital inflows and the wage gap. This outcome occurs if:

- either the limitations to labor mobility F are so high that the new traded sector cannot compete profitably with the old state sector (A1.8)
- or capital inflows are so large that the real exchange rate appreciates to levels where the domestic new sector cannot compete with imports from abroad. (A1.9)

3. In section 3, we saw the wage gap F has two opposite effects on the initial exchange rate. It reduces both the supply of (by increasing the costs) and the demand for(by reducing aggregate income) for the non-traded goods. We now show that the first effect dominates the second so that the initial exchange rate unambiguously rises with the wage gap F. The admissible solution in (A1.3) implies that:

$$dcp/dF = \tfrac{1}{2}\,(-dQ/dF + (Q^2/4 + B)^{-1/2}\,(\tfrac{1}{2}\,Q\,dQ/dF + dB/dF).$$

$dB/dF = -(1-\alpha)\,(b_2 + 2F) < 0$

$dQ/dF = (\alpha-2) < 0$

Some algebra shows that:

$dcp/dF > 0 \Leftrightarrow \frac{1}{2} Q + (dB/dF) / (dQ/dF) = -\alpha^2/(4-2\alpha)\ (F+ b_2/2) < 0 < (Q^2/4 + B)^{1/2}$

which proves that the initial exchange rate depends positively on the wage gap F.

Appendix 2: The Case of Subsidies to the State Sector

So far we have assumed that the state sector as a whole has to break even. This is unrealistic since in most transition countries the state sector as a whole is a net recipient of subsidies through direct transfers, cheap credit or other means. In this appendix we allow for explicit subsidies. We assume that the state sector firms receive a fixed amount of subsidies S per worker. These transfers are financed by a flat consumption tax, that could also be interpreted as an inflation tax. As before the state sector pays all its revenues out to workers. Average productivity must again be equal to the cost per worker. The productivity of the least efficient firm still operating at time t is now given by:

$$(b_2 + x(t))/2 = c\,p(t) - (F+S) \qquad \text{(A2.1)}$$

which implies

$$x(t) = 2[pc-(F+S)] - b_2 \qquad \text{(A2.2)}$$

Given the exchange rate the productivity of the least efficient state firm still operating is now lower than in the no-subsidy case. The same is necessarily true for the average productivity in the sector and the number of people employed in the state sector is correspondingly higher as shown by the modified equation (12):

$$L^S = 2\,\underline{L}\,(b_2 - cp + (F+S))/b_2 \qquad \text{(12')}$$

Assuming that, like companies and households, the government has no access to financial markets the tax rate s on consumption is determined by the size of the subsidies:

$$s\,(cp\underline{L} - FL^S + Z) = S\,L^S. \qquad \text{(A2.3)}$$

The consumers budget constraint can then be written as:

$$pC^N + C^T \leq (1-s)(\,cp\underline{L} - FL^S + Z) = cp\underline{L} - (F+S) + Z \qquad \text{(A2.4)}$$

and demand is given by (9) changed to:

$$C^T = \alpha\,(cp\underline{L} - (F+S)L^S + Z) \qquad \text{(9a')}$$

$$pC^N = (1-\alpha)\,(cp\underline{L} - (F+S)L^S + Z). \qquad \text{(9b')}$$

A comparison of equations (9a'), (9b') and (12') with equations (9a), (9b) and (12) readily shows that subsidies S affect the economy in the same way as the wage gap F does. Subsidies that are financed by raising a flat consumption tax, do not add to the analysis.

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