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ABSTRACT

In the presence of lumpy investment cost of adjustment, globalization may have non-conventional effects on the level of investment and its cyclical behavior. Trade openness may lead to a discrete "jump" in the level of investment, as it may trigger a discrete change in the terms of trade. Such a shift creates a sizeable boost in aggregate investment. But trade openness may also lead to boom-bust cycles of investment (namely, multiple equilibrium) supported by self-validating expectations. In this sense globalization destabilizes the economy. There can be substantial gains from globalization in the investment-boom equilibrium. However, gains could be small, or negative, in the investment-bust equilibrium.

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TRADE OPENNESS AND INVESTMENT INSTABILITY[1]

by

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1 Introduction

The idea that "globalization may lead to instability" attracted the attention of the profession in recent years. A number of papers have shown that increased capital mobility can be destabilizing in the sense that it increases the possibility of multiple self-fulfilling expectations equilibria; see, for example, Lahiri (1999), Meng and Velasco (1999), and Weder (2000). In this body of the growth literature, some external economies (as may be associated, for instance with human capital), may lead to multiplicity of equilibria. Capital account liberalization which facilitates intertemporal consumption smoothing, increases the range of parameter values for which multiple equilibria occur.

In the present paper we focus on the destabilizing effect of trade openness, which usually precedes capital account liberalization in the globalization process during economic development. We employ a "lumpy" adjustment cost for new investment, in the form of a fixed setup cost of investment. This specification, which has been recently supported empirically by Caballero and Engel (1999, 2000), creates economies of scale in investment. As a result, it tends to lump investment over time, in contrast to the more standard convex cost-of-adjustment specification, that leads to the spreading of investment spending over

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time. Trade-openness may affect the result in the appreciation or depreciation of the setup cost of investment, through the terms-of-trade, and thereby generates instability in the form of boom-bust investment cycles. It is demonstrated that this multiplicity of self-validating expectations equilibria (as it is triggered by terms-of-trade effects) is an intrinsic feature of trade-openness.

Economies of scale either in the production or investment technologies are a key contributor to the gains from trade and economic integration. For example, based on estimates taken from a partial equilibrium analysis, the Cecchini (1988) Report assesses that the gains from taking advantage of economies of scale will constitute about 30 percent of the total gains from the European market integration in 1992. Similarly, in a static general-equilibrium setting, Smith and Venables (1988) provide some industry simulations of the effects of the European integration, and find again a substantial role for economies of scale.

This paper, in essence, sheds a different light on the gains-from-trade implications of economies of scale. There could be indeed substantial gains from trade in an investment-boom equilibrium, but the gains could be meager or even negative in an investment-bust equilibrium.

The organization of the paper is as follows. Section 2 develops a model of a setup investment cost. Section 3 describes the consumption side of the model economy. The free-trade equilibrium is analyzed in section 4. The destabilization effect of trade-openness is demonstrated in section 5, for an exogenously given export demand function, and in section 6 for a two-country model with endogenous export and import demand functions. Section 7 concludes.

2 Lumpy Adjustment Costs of Investment

Consider a two-good economy, and assume for simplicity that under free international trade the economy completely specializes in the production of one good, according to the standard comparative advantage paradigm. To get first the intuition about the basic mechanism underlying the equilibrium level of investment, we initially assume that the demand for the country's export is exogenously given. In a subsequent section we will analyze a two-country extension in which export demands are endogenously determined.

Specifically, one good (x) is produced domestically and can be exported abroad, but not produced elsewhere, whereas the other good (y) is not produced domestically, and can be only imported from abroad. The price of the domestic (and export) good is chosen as a numeraire: $p_x = 1$. The price of the foreign (and import) good is denoted by p.

Initially, there exists a continuum of N firms in the $x-$industry which differ from each other by a productivity index ε. We denote a firm which has a productivity index of ε by an $\varepsilon-$firm. The cumulative distribution function of ε is denoted by $G(\cdot)$. With no loss of generality, we assume that the average value of the productivity index is zero, that is $E(\varepsilon) = 0$. For the sake of simplicity, we further normalize the initial number of firms to one; $N = 1$. The number of each type of firms grows at the rate of population growth, n, in order to fit the overlapping-generations framework in the next section.

The production process of good x lasts one period, so that if an $\varepsilon-$firm employs a stock of capital K, it will generate a certain gross output flow (of the domestic good x) of $F(K)(1+\varepsilon)$, where F exhibits diminishing marginal productivity of capital, that is, $F' > 0$, $F'' < 0$. Naturally, output cannot be negative, so that $\varepsilon = -1$, that is $G(-1) = 0$. It is also assumed that output is bounded from above, so that there exists $\overline{\varepsilon}$ such that $G(\overline{\varepsilon}) = 1$; for simplicity, assume that $\overline{\varepsilon} = 1$. We further assume for the sake of simplicity that capital fully depreciates at the end of the production process. Thus, at the start of each period the initial stock of capital is zero.

The domestic good x serves for both consumption, domestic investment, and exports. However, there is a fixed setup cost of investment which has to be imported;[5] in the subsequent two-country extension, we let this setup cost consist of the domestic good as well. The fixed cost is C units of the foreign good (y).

If an $\varepsilon-$firm invests an amount K in some period, it will have a capital stock of K and will generate in the next period a gross output of $F(K)(1+\varepsilon)$ of good x. The objective of an $\varepsilon-$firm is to maximize its value. That is, it chooses K so as to:

[5] See Rothschild (1971) for one of the earliest analyses of such non-convex adjustment cost of investment.

$$Max_{\{K\}}\left\{\frac{F(K)(1+\varepsilon)}{1+r}-K-pC\right\}, \tag{1}$$

where r is the domestic rate of interest.

The first-order condition for the maximization of (1) yields the optimal K for an $\varepsilon-$firm as a function of r, denoted by $\hat{K}(\varepsilon,r)$. This $\hat{K}(\varepsilon,r)$ is thus given implicitly by:

$$F'[\hat{K}(\varepsilon,r)](1+\varepsilon)=1+r, \tag{2}$$

where $F'(\cdot)$ denotes the derivative of $F(\cdot)$.

Note, however, that the firm always has the option not to invest at all and avoid the setup cost (C) of a new investment. Therefore, whether an $\varepsilon-$firm will indeed carry the new investment prescribed by equation (2) depends on whether its productivity is high enough so as to more than offset the fixed setup cost required for new investments. That is, the $\varepsilon-$firm will indeed carry on the investment prescribed by the first-order condition (2), if and only if:

$$\frac{F\left[\hat{K}(\varepsilon,r)\right](1+\varepsilon)}{1+r}-\left[\hat{K}(\varepsilon,r)+pC\right]=0.$$

Therefore, there exists a cutoff level of ε, denoted by ε_0, so that an $\varepsilon-$firm will invest, if and only if $\varepsilon=\varepsilon_0$. The cutoff level of ε is defined by:

$$F\left[\hat{K}(\varepsilon_0,r)\right](1+\varepsilon_0)=(1+r)\left[\hat{K}(\varepsilon_0,r)+pC\right]. \tag{3}$$

The left-hand side of equation (3) is the output generated by the new investment. The right-hand-side is the (future value of the) capital cost of this investment, which consists of a variable cost, $\hat{K}(\varepsilon,r)$, and a setup cost, pC.

While the marginal productivity condition (2) determines the level of investment that each firm will undertake (if it chooses to do so), condition (3) can be viewed as determining whether or not to invest at all. Firms with a productivity index larger than ε_0 would indeed attract new investment. But firms with a productivity index below ε_0 will attract no new investment.

Another way of describing how the decision whether or not to invest is determined is obtained by substituting equation (2) into equation (3) to get:

$$(1+\varepsilon_0)\{F\left[\hat{K}(\varepsilon_0,r)\right]-F'\left[\hat{K}(\varepsilon_0,r)\right]\hat{K}(\varepsilon_0,r)\}=(1+r)pC. \tag{3'}$$

Equation (3′) thus states that the infra-marginal incremental output generated by the new investment [namely, the left-hand-side of equation (3′)] must equal (the future value of) the setup cost; see Figure 1. Thus, an $\varepsilon-$firm will choose $\hat{K}(\varepsilon,r)$ as its optimal stock of capital if its productivity index is above ε_0; otherwise, it will not invest or produce at all. Therefore, the optimal stock of capital for an $\varepsilon-$firm, denoted by $K(\varepsilon,r)$, is generally given by:

$$K(\varepsilon,r)=\begin{cases}\hat{K}(\varepsilon,r) & \text{if } \varepsilon \geq \varepsilon_0 \\ 0 & \text{if } \varepsilon \leq \varepsilon_0\end{cases}. \tag{4}$$

3 Consumption

Consider now an overlapping-generations model with a standard representative consumer who lives for two periods and a population growth rate of n. The individual consumes two goods in each of the two periods, so that altogether she consumes four goods: c_{x1}, c_{y1}, c_{x2}, and c_{y2}, where c_{ji} is consumption of good $j=x,y$ in the ith period of her life, $i=1,2$. She is endowed in the first period of her life with x_0 units of the domestic good. For the sake of simplicity, we consider a time-separable Cobb-Douglas utility function with a subjective discount factor θ :

$$\begin{aligned} u(c_{x1},c_{y1},c_{x2},c_{y2}) &= [\alpha \ln c_{x1}+(1-\alpha)\ln c_{y1}] \\ &+\theta\left[\alpha \ln c_{x2}+(1-\alpha)\ln c_{y2}\right], \end{aligned} \tag{5}$$

where α is the share of the domestic good in each period in the total consumption of that same period.

As usual, this utility function gives rise to the following demand functions:

$$c_{x1} = \alpha W/(1+\theta). \tag{6a}$$

$$c_{y1} = (1-\alpha)W/(1+\theta)p. \tag{6b}$$

$$c_{x2} = \alpha\theta W(1+r)/(1+\theta). \tag{6c}$$

$$c_{y2} = (1-\alpha)\theta W(1+r)/(1+\theta)p, \tag{6d}$$

where W is the present value of life-time income (wealth) at birth. Note that, as we shall consider a steady state, the price (p) of the foreign good remains constant over time and the same W which is applicable to both old and young is the same.

In each period there is a new generation of firms whose ε is distributed according to G. These firms are owned by the newly-born generation. Therefore, the wealth of a representative consumer is the present value of the profits of these firms. Thus, the wealth of a representative young individual is:

$$W = x_0 + \frac{1}{1+r}\int_{\varepsilon_0}^{1} F\left[K(\varepsilon, r)\right](1+\varepsilon)dG(\varepsilon) - \int_{\varepsilon_0}^{1}\left[K(\varepsilon, r) + pC\right]dG(\varepsilon),$$

which can be rewritten as:

$$W = x_0 + \frac{1}{1+r}\int_{\varepsilon_0}^{1} F\left[K(\varepsilon, r)\right](1+\varepsilon)dG(\varepsilon) - \int_{\varepsilon_0}^{1} K(\varepsilon, r)dG(\varepsilon) - pC[1-G(\varepsilon_0)]. \tag{7}$$

[Recall that only the firms with a productivity index above ε_0 carry out new investment, and the number of such firms per young individual is $1 - G(\varepsilon_0)$.]

4 Free-Trade Equilibrium

The economy is open to free trade in goods as was already mentioned, but we assume that it does not have an access to the world capital markets. However, there are domestic financial intermediaries that lend or take deposits at a fixed rate.[6] As we assume that there is an exogenously given downward-sloping demand curve for the country's export, reflecting some market power in the world markets. Denote the foreign demand function for good x per young individual by $D(p)$. As p is the relative price of y, it follows that as p rises, the demand for x rises too, so that $D'(p) > 0$.

In order to complete the description of the steady-state of this economy, it remains to state the equilibrium conditions in the markets for the two goods (x and y). Market clearing in the domestic good (x) requires that domestic consumption of both the young (namely, c_{x1}) and the old [namely, $c_{x2}(1+n)^{-1}$, per young individual], plus the domestic component of investment [namely, $\int_{\varepsilon_0}^1 K(\varepsilon, r)dG(\varepsilon)$], plus exports [namely, $D(p)$] must equal domestic output [namely, $(1+n)^{-1}\int_{\varepsilon_0}^1 F[K(\varepsilon, r)]dG(\varepsilon)$, per young individual], plus the initial endowment (namely, x_0). That is:

$$\begin{aligned} &\frac{\alpha W}{1+\theta} + \frac{\alpha\theta W(1+r)}{(1+\theta)(1+n)} + \int_{\varepsilon_0}^1 K(\varepsilon, r)dG(\varepsilon) + D(p) \\ = &\frac{1}{1+n}\int_{\varepsilon_0}^1 F[K(\varepsilon, r)]dG(\varepsilon) + x_0. \end{aligned} \tag{8}$$

With no access to foreign capital markets, the import of the foreign good is determined by the value of exports of the domestic good, as trade in goods must be balanced period-by-period. The imports of the foreign good in each period are equal to domestic consumption of the young (namely, c_{y1}), and the old [namely, $c_{y2}(1+n)^{-1}$, per young individual], plus the

[6]These intermediaries play the role of "the social contrivance of money" in Samuelson's (1958) formulation.

setup cost which is exclusively imported (namely, $[1-G(\varepsilon_0)]C$). Note that only firms with productivity index ε above ε_0 make new investment and incur the setup cost C; the number of such firms per young individual is $1-G(\varepsilon_0)$. Exports of $D(p)$ units of the domestic good can finance imports of $D(p)/p$ units of the foreign good. Therefore:

$$\frac{(1-\alpha)W}{(1+\theta)p}+\frac{(1-\alpha)\theta W(1+r)}{(1+\theta)p(1+n)}+[1-G(\varepsilon_0)]C=\frac{D(p)}{p}. \tag{9}$$

This completes the description of the market equilibrium in the trade-open economy. There are four endogenous variables - W, p, r, and ε_0 - and four equations - (3), (7), (8) and (9). Note that $K(\varepsilon,r)$ is defined implicitly by the first-order condition, equation (2) and equation (4).

Naturally, for an economy with financial intermediaries, we shall focus our attention on the golden-rule (efficient) steady-state equilibrium in which the rate of interest (namely, r) will be equal to the rate of population growth (namely, n), this rate is known as the "biological" rate of interest. To see that this is indeed an equilibrium note that by employing equation (7) we can rewrite equation (8) as:

$$\begin{aligned}&\frac{\alpha W}{1+\theta}+\frac{\alpha\theta W(1+r)}{(1+\theta)(1+n)}-W-\frac{r-n}{(1+r)(1+n)}\int_{\varepsilon_0}^{1}F[K(\varepsilon,r)]dG(\varepsilon)-\\&[1-G(\varepsilon_0)]pC+D(p)=0.\end{aligned} \tag{8'}$$

Now, by adding up equations (8′) and (9) we get:

$$\frac{\theta W(r-n)(1+r)}{1+\theta}=(r-n)\int_{\varepsilon_0}^{1}F[K(\varepsilon,r)]dG(\varepsilon). \tag{10}$$

Thus, the golden rule (namely, $r=n$) is indeed an equilibrium steady state.[7]

Because of the setup cost of a new investment, low-productivity firms may not find

[7] But as Gale (1973) pointed out, there is another steady state equilibrium in which $r\neq n$. In this case the term $r-n$ cancels out on both sides of equation (10), and it follows that the value of second-period consumption of each individual [namely, $\theta W(1+r)/(1+\theta)$] is equal to the output that accrues to that individual in the second period [namely, $\int_{\varepsilon_0}^{1}F[K(\varepsilon,r)]dG(\varepsilon)$]. This situation is termed by Gale as autarky vis-a-vis the young and the old.

it worthwhile to carry out a new investment. On the other hand, very high-productivity firms are likely to invest. That is: as long as $G(\varepsilon_0) < 1$, there will be a positive mass of firms (namely, the firms with $\varepsilon \geq \varepsilon_0$) that will carry out new investment. The endogenously determined cutoff ε (namely, ε_0) depends crucially on the setup cost C. If C is high enough, then no firm will carry out a new investment, that is the endogenously-determined ε_0 is equal to (or exceeds) 1.[8]

5 Globalization and Boom-Bust Investment Cycles: Exogenous Export Demand

Does globalization introduce instability? Put differently: Does the trade-open-economy have more than one self-fulfilling expectations equilibrium, some with "pessimistic" expectations and "low" investment ("bust equilibria) and others with "optimistic" expectations and "high" investments ("boom" equilibria). Furthermore, is this multiplicity of equilibria a distinct feature of globalization?

First, note that the phenomenon of multiple equilibria does not occur under autarky. We can envisage a closed economy (autarkic) counterpart which can produce both x and y, according to linear technologies, yielding a Ricardian linear production possibility frontier; see Figure 2. In autarky, the price of y (denoted by $\overline{p}$) is **uniquely** determined by the inverse of the slope of the production possibility frontier. Then, the marginal productivity condition (2) and the cutoff equation (3) **uniquely** determine the autarkic level of investment and the cutoff ε (recall that $r = n$). Thus, the autarkic equilibrium is **unique**.[9]

However, the domestic technology of producing y is old relative to the modern world technology; that is $\overline{p}$ is "very much" higher than p. Put differently, the domestic economy

[8] More realistically there may be other sectors of the economy with different investment technologies that carry out new investment and generate capital accumulation and growth; our one-industry economy is obviously a theoretical simplification.

[9] Note that the uniqueness result carries over to the more general cast of a convex production possibility set (as in the Hecksher-Ohlin framework). Suppose that $\overline{p}$ is an equilibrium. Now, a lower price of y will increase the number of investing firms (namely, will lower ε_0) and therefore the investment demand for y; it will also boost the consumption demand for y. At the same time, because of the convexity of the production possibility set, the supply of y will shrink, thus creating an excess demand for y. Similarly, a higher-price of y will generate an excess supply of y. Thus, the equilibrium must be unique.

has a comparative advantage in producing x (or, equivalently, a comparative disadvantage in producing y). Hence, opening up the economy to trade in goods induces it to specialize à-la-Ricardo in producing x and benefit from the modern world technology of producing y, by importing y.

Second, multiple equilibria may well exist under free international trade. In order to gain some insight into the possibility of such a multiplicity of equilibria, consider the cutoff equation (3) and the trade-balance equation (9). Suppose that the 4-tuple, $\varepsilon_0 = \varepsilon_0^0$, $p = p^0$, $W = W^0$ and $r = n$, constitutes an equilibrium.. Consider now a lower foreign good price (p). This reduces the domestic value (pC) of the setup cost (C), and, as can be seen from equation (3), it will induce more firms to make new investments. That is, a lower p may reduce the cutoff level ε_0 below ε_0^0, so that the proportion $1 - G(\varepsilon_0)$ of investing firms rises. For such a change to occur, the economy must also have higher export revenues [namely, $D(p)/p$)] in order to finance the new imports of the foreign good (namely, $[1 - G(\varepsilon_0)]C$) required for the setup cost and the increased domestic consumption demand for the foreign good (because of its lower price).

To see that this demand indeed increases, substitute for W [from equation (7)] in the trade-balance equation (9), to get:

$$\frac{(1-\alpha)[1+\theta(1+r)(1+n)^{-1}]Z(\varepsilon_0, r)}{(1+\theta)p} + \left\{1 - \frac{(1-\alpha)[1+\theta(1+r)(1+n)^{-1}]}{1+\theta}\right\}[1-G(\varepsilon_0)]C = \frac{D(p)}{p}, \tag{11}$$

where:

$$Z(\varepsilon_0, r) = x_0 + \frac{1}{1+r}\int_{\varepsilon_0}^{1} F[K(\varepsilon, r)](1+\varepsilon)dG(\varepsilon) - \int_{\varepsilon_0}^{1} K(\varepsilon, r)dG(\varepsilon).$$

Indeed, one can see from (11) that a lower p boosts domestic consumption demand for the foreign good.[10]

[10] Recall that $r = n$, so that the term multiplying $[1 - G(\varepsilon_0)]C$ on the left-hand-side of (11) reduces to $\alpha > 0$.

Now, if the export revenues $D(p)/p$ indeed increase when p falls, then there may exist another equilibrium with a lower p (below p^0) and a lower ε_0 (below ε_0^0) with a higher proportion of firms making new investments. Thus, the possibility of a multiple equilibria seems to rest on the price elasticity of the foreign demand for the country's exports. If this demand is inelastic, then indeed a decline in p will generate higher export revenues.[11] (Note that the price of the domestic good is $1/p$, so that a decline in p means an increase in the price of the domestic good; and if the foreign demand for the domestic good is inelastic, then indeed an increase in its price raises export revenues.)

We establish the possibility of multiple equilibria by numerical simulations. We specify a uniform distribution of ε over the interval $[-1, 1]$, so that $G(\varepsilon) = (1 + \varepsilon)/2$ for $\varepsilon \in [-1, 1]$. The production function is of the Cobb-Douglas form $F(K) = K^\beta$, where β is the capital share in GNP. The foreign demand for the domestic good is specified as $D(p) = (a + p)^\sigma$, with both a and σ being positive. The simulations are depicted in Figure 3. For a range of values of C, there are (at least) two equilibria: One with a high ε_0, a high p and low investment (the "bust" equilibrium), and another with a low ε_0, a low p, and high investment (the "boom" equilibrium).

Our simple model suggests that the trade-open economy is plagued by an endogenously determined "boom" and "bust" investment cycles. Optimistic expectations regarding the terms-of-trade (namely, p) are self-validated by low setup costs (namely pC), high investment, high exports, high export revenues, and low p. On the other hand, pessimistic expectations regarding the terms of trade are also self-validated by high setup costs, low investment, low exports, low export revenues, and high p. It should be emphasized again that, as we have already pointed out, this multiplicity of equilibria is an intrinsic feature of opening up the economy, because in the closed (autarkic) economy the equilibrium is unique.

[11] Note that even though the aggregate foreign demand for the country's export may be inelastic, still each domestic firm is atomistically small and faces a perfectly elastic demand.

6 Globalization and Boom-Bust Investment Cycles: Endogenous Export Demand

A key mechanism behind the instability (multiplicity) of equilibria brought about by globalization is the small (less than one) elasticity of the **exogenously** given demand for the country's export. In this case only a price effect plays a role in generating the instability. Indeed, inelastic demands are not unusual in certain industries.[12] In general, however, demand facing exports of small developed countries, though fairly inelastic, its elasticity though is still above one. Nevertheless, the instability associated with globalization is not confined to the "partial-equilibrium" specification of an exogeously given demand for the country's exports. In such a partial equilibrium setting only a price effect plays a role in generating instability. In this section we extend our analysis to a general-equilibrium, two-country "home" and "foreign country" model in which both **income** and **price** effects play a role in shaping the demand for a country's exports.

We continue to assume complete specialization under free-trade. Specifically, suppose that $\overline{p}$ and $\overline{p}^*$ are the autarkic relative prices of y (namely, the inverses of the absolute values of the slopes of the linear production possibility frontiers) in the home and foreign country, respectively. Hence, any free-trade equilibrium relative price of y will be between $\overline{p}$ and $\overline{p}^*$. The initial endowments are (x_0, y_0) and (x_0^*, y_0^*) in the home and foreign country, respectively. These are in addition to the ownership of the firms in each country by the residents of that country.

We now specify a more general technology for the setup cost of investment as follows.

[12] In general, the demand facing exports of small developed countries is fairly low (unlike the textbook paradigm of a small country), but still above one. For example, a widely cited survey by Goldstein and Khan (1985) put this elasticity in the range of 1.0-1.6 for Austria, Belgium and Denmark. However, this elasticity refers to aggregate measures of exports, but for a specific export good things may be different. An inelastic demand for a country's certain export good can arise when the country is a major supplier of this good in the world market. One can think of at least three categories of such goods: energy, commodities, and high-tech products. Indeed, Robert Pindyck (1979) estimated the demand elasticity of various energy products to be significantly below one in the short run, but about one or even a bit higher in the long-run. (For instance, 0.15-0.30 for residential and industrial demand for oil). Similarly, Pindyck (1978) estimated the demand elasticity for a commodity such as bauxite (used to produce aluminium) to be extremely small, about 0.05-0.10. However, estimates of elasticity of demand for high-tech products, such as semiconductors [Irwin and Klenow (1994)] and computers [Gordon (2000)] are higher than one, between 1.5 and 2.0.

(We refer to the home country; the specification for the foreign country is similar with asterisks in the notation.) There is a minimal setup input (C_0), where this input is produced by inputs v_x and v_y of x and y, respectively, according to a constant-returns-to-scale technology: $H(v_x, v_y)$.

Each investing firm chooses v_x and v_y so as to minimize the setup cost, $v_x + pv_y$ subject to $H(v_x, v_y) = C_0$. The minimizing inputs of x and y are denoted by $V_x(p, C_0)$ and $V_y(p, C_0)$, respectively, and the minimal setup cost is denoted by:

$$C(p, C_0) = V_x(p, C_0) + pV_y(p, C_0), \tag{12}$$

in units of good x. For the foreign country, the minimal setup cost is denoted by:

$$C^*(p, C_0^*) = \frac{1}{p} V_x^*(p, C_0^*) + V_y^*(p, C_0^*), \tag{12*}$$

in units of good y. (Note that it is the same p, namely the free-trade equilibrium price of y, that appears in the minimal setup cost equation in both countries.) The cutoff levels of ε in the home and foreign country, that is ε_0 and ε_0^*, respectively, are now defined implicitly by:[13]

$$F[\hat{K}(\varepsilon_0, r)](1 + \varepsilon_0) = (1 + r)[\hat{K}(\varepsilon_0, r) + C(p, C_0)] \tag{13}$$

and

$$F^*[\hat{K}^*(\varepsilon_0^*, r^*)](1 + \varepsilon_0^*) = (1 + r^*)[\hat{K}^*(\varepsilon_0^*, r) + C^*(p, C_0^*)]. \tag{13*}$$

The representative utility function in the home country is given by equation (5), whereas the representative utility function in the foreign country is given by:

[13] Note that the investment technology in the home country invests in units of good x and produces good x, whereas in the foreign country it invests in units of good y and produces good y.

$$u^*(c^*_{x1}, c^*_{y1}, c^*_{x2}, c^*_{y2}) = [\alpha^* \ln c^*_{x1} + (1-\alpha^*) \ln c^*_{y1}] + \theta^*[\alpha^* \ln c^*_{x2} + (1-\alpha^*) \ln c^*_{y2}]. \quad (5^*)$$

Similarly, the home country demand functions are given by equations (6a)-(6d), whereas the demand functions in the foreign country are given by the same equations with θ^*, α^*, r* and W^* replacing θ, α, r and W, respectively. The specifications of W and W^* are now given by:

$$W = x_0 + py_0 + \frac{1}{1+r}\int_{\varepsilon_0}^{1} F[K(\varepsilon, r)](1+\varepsilon)dG(\varepsilon) - \int_{\varepsilon_0}^{1} K(\varepsilon, r)dG(\varepsilon) - C(p, C_0)[1 - G(\varepsilon_0)] \quad (14)$$

and

$$W^* = x^*_0 + py^*_0 + \frac{p}{1+r^*}\int_{\varepsilon^*_0}^{1} F^*[K^*(\varepsilon, r^*)](1+\varepsilon)dG^*(\varepsilon) - p\int_{\varepsilon^*_0}^{1} K^*(\varepsilon, r^*)dG^*(\varepsilon) - pC^*(p, C^*_0)[1 - G^*(\varepsilon^*_0)], \quad (14^*)$$

respectively.

The free-trade market clearing equations for good x and good y are given, respectively, by:[14]

[14] Strictly speaking, we are essentially assuming that there are two production technologies for producing each good. One is a Ricardian linear technology associated with some primary input, say labor. The other technology is associated with capital [according to $F(K)(1+\varepsilon)$] and exhibits diminishing marginal products of capital; it can be employed only if the labor input used in the first technology exceeds some threshold level. The home country meets the threshold in good x and the foreign country meets the threshold in good y. Also, the initial endowments in each country are inclusive of what is produced under specialization via the first technology.

$$\begin{aligned}
& \frac{\alpha W}{1+\theta}+\frac{\alpha\theta W(1+r)}{(1+\theta)(1+n)}+\int_{\varepsilon_0}^{1} K(\varepsilon,r)dG(\varepsilon)+V_x(p,C_0)\left[1-G(\varepsilon_0)\right]+ \\
& \frac{\alpha^* W^*}{1+\theta^*}+\frac{\alpha^*\theta^* W^*(1+r^*)}{(1+\theta^*)(1+n^*)}+V_x^*(p,C_o^*)[1-G^*(\varepsilon_0^*)] \\
= \; & x_0+\frac{1}{1+n}\int_{\varepsilon_0}^{1} F[K(\varepsilon,r)]dG(\varepsilon)+x_0^*,
\end{aligned} \tag{15}$$

and

$$\begin{aligned}
& \frac{(1-\alpha)W}{(1+\theta)p}+\frac{(1-\alpha)\theta W(1+r)}{(1+\theta)p(1+n)}+V_y(p,C_0)[1-G(\varepsilon_0)] \\
& +\frac{(1-\alpha^*)W^*}{(1+\theta^*)p}+\frac{(1-\alpha^*)\theta^* W^*(1+r^*)}{(1+\theta^*)p(1+n^*)}+\int_{\varepsilon_0^*}^{1} K^*(\varepsilon,r^*)dG^*(\varepsilon)+ \\
& V_y^*(p,C_0^*)[1-G^*(\varepsilon_0^*)] \\
= \; & y_0+y_0^*+\frac{1}{1+n^*}\int_{\varepsilon_0^*}^{1} F^*[K^*(\varepsilon,r^*)]dG^*(\varepsilon).
\end{aligned} \tag{16}$$

In this case too we focus on the golden-rule (efficient) steady-state equilibrium in which $r = n$ and $r^* = n^*$.

We establish the existence of multiple equilibria via numerical simulations. The setup technologies are taken to be of the Constant-Elasticity-of-Substitution (CES) form:

$$H(v_x, v_y) = [bv_x^\rho + (1-b)v_y^\rho]^{1/\rho} \tag{17}$$

for the home country, and

$$H^*(v_x^*, v_y^*) = [b^* v_x^{*\rho} + (1-b^*)v_y^{*\rho}]^{1/\rho^*} \tag{17*}$$

for the foreign country. Upon proper substitutions, an equilibrium with a positive number of investing firms in both countries (that is, both ε_0 and ε_0^* below one) is defined by a single (reduced-form) excess demand equation of good x, denoted by $E(p) = 0$, in the terms-of-trade variable p. The derivation of this equation is delegated to the appendix. Figure 4 describes the graph of $E(\cdot)$ and we can see that there are three free-trade equilibria with $p = 0.8$, 1.6 and 4.1. (In addition, there may exist still other equilibria with no firms making new investments in either country.) We have thus established the instability introduced by globalization under endogenously-determined demand functions for imports and exports, derived from fairly common utility and production functions.[15]

7 Concluding Remarks

In the presence of economies-of-scale in the investment technology, globalization may have non-conventional effects on the level of investment and its cyclical behavior. Trade openness may lead to a discrete "jump" in the level of investment as it may trigger a discrete price change and specialization. In the presence of economies-of-scale, such a shift creates a sizable boost in aggregate investment. But trade openness may also lead to boom-bust cycles of investment (namely, multiple equilibria) supported by self-fulfilling expectations.[16] In this sense, globalization destablizes the economy. The economy may alternate between "optimistic" expectations, "good" terms-of-trade and investment boom to "pessimistic" expectations, "bad" terms-of-trade and investment bust.[17]

The analysis sheds new light on the implications of economies-of-scale for the gains-from-trade argument. There could be substantial gains in the investment-boom equilibrium. However, gains could be small and even negative in the investment-bust equilibrium.

[15] Note also that for certain parameter values there may exist no equilibrium.

[16] Investment cycles may be driven also by other mechanisms, such as balance-sheet effects; see Krugman (2000).

[17] An interesting issue yet to be investigated, is whether it is desirable to try to use trade policy to prevent the boom-bust cycles.

8 Appendix: Derivation of the Equilibrium in a Two-Country Model

With a Cobb-Douglas production function, $F(K) = K^{\beta}$, the capital stock function of the investing firms in the home country, as derived from equation (2), is given by:

$$\hat{K}(\varepsilon, r) = \left[\frac{\beta(1+\varepsilon)}{1+r}\right]^{\frac{1}{1-\beta}} \tag{A1}$$

With the CES form [equation(17)] for the setup technologies, we can derive the minimizing input requirement functions and the minimal setup cost function as follows:

$$V_x(p, C_0) = \frac{C_0\varphi(p)}{[b\varphi(p)^{\rho} + (1-b)]^{1/\rho}}, \tag{A2}$$

$$V_y(p, C_0) = \frac{C_0}{[b\varphi(p)^{\rho} + (1-b)]^{1/\rho}}, \tag{A3}$$

and

$$C(p, C_0) = \frac{C_0[\varphi(p) + p]}{[b\varphi(p)^{\rho} + (1-b)]^{1/\rho}}, \tag{A4}$$

where

$$\varphi(p) = \left(\frac{pb}{1-b}\right)^{\frac{1}{1-\rho}}. \tag{A5}$$

With a uniform distribution of ε [namely, $G(\varepsilon) = (1+\varepsilon)/2$], the cutoff level of ε, as derived from (3), is as follows [employing equation (A1)]:

$$\varepsilon_0 = \left[\frac{C_0[\varphi(p) + p]}{\gamma[b\varphi(p)^{\rho} + (1-b)]^{1/\rho}}\right]^{1-\beta} - 1, \tag{A6}$$

where

$$\gamma = \left(\frac{\beta^{\beta}}{1+r}\right)^{\frac{1}{1-\beta}} - \left(\frac{\beta}{1+r}\right)^{\frac{1}{1-\beta}}. \tag{A7}$$

The wealth of a representative individual, as defined in equation (14), is given by:

$$W = x_0 + py_0 + \left(\frac{1-\beta}{2-\beta}\right)\left[\frac{1}{1+r}\left(\frac{\beta}{1+r}\right)^{\frac{\beta}{1-\beta}} + \left(\frac{\beta}{1+r}\right)^{\frac{1}{1-\beta}}\right]\left[2^{\frac{2-\beta}{1-\beta}} - (1+\varepsilon_0)^{\frac{2-\beta}{1-\beta}}\right] - \frac{(1-\varepsilon_0)C_0[\varphi(p)+p]}{2[b\varphi(p)^\rho + (1-b)]^{1/\rho}} \tag{A8}$$

The analogous equations for the foreign country are given by equations (A1)-(A8) with C_0^*, b*, ρ^*, ε_0^*, γ^*, β^*, r*, x$_0^*$ and y_0^* replacing C_0, b, ρ, ε_0, γ, β, r, x$_0$ and y_0, respectively.

Substituting equations (A1)-(A8) and their foreign country counterparts in either one of the two market clearing equations (15) and (16) yield a single (reduced-form) excess demand equation for good x, $E(p) = 0$, in the terms-of-trade variable p.

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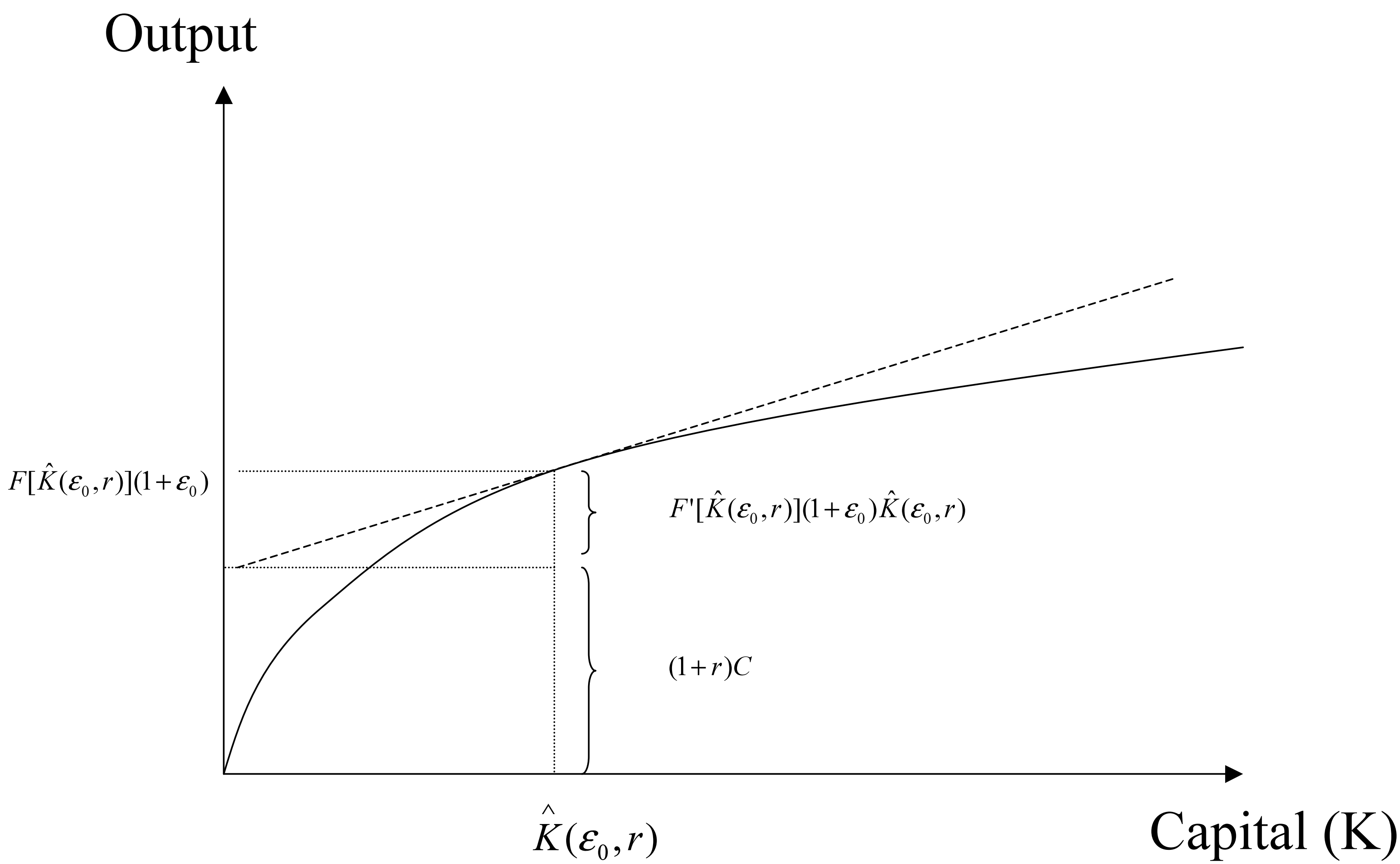

Figure 1: The Determination of the Cutoff Productivity Level

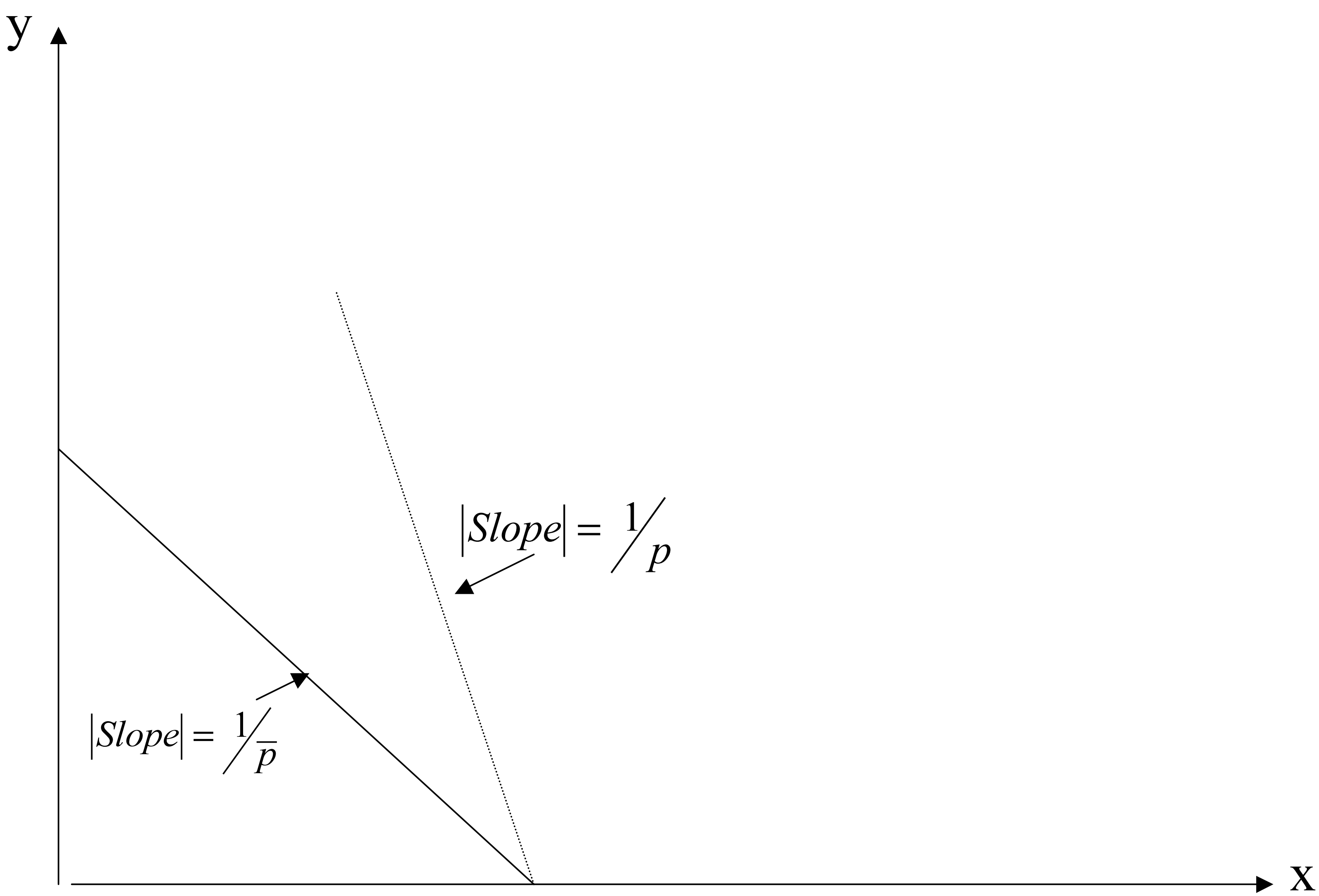

Figure 2: A Ricardian Production Possibility Frontier

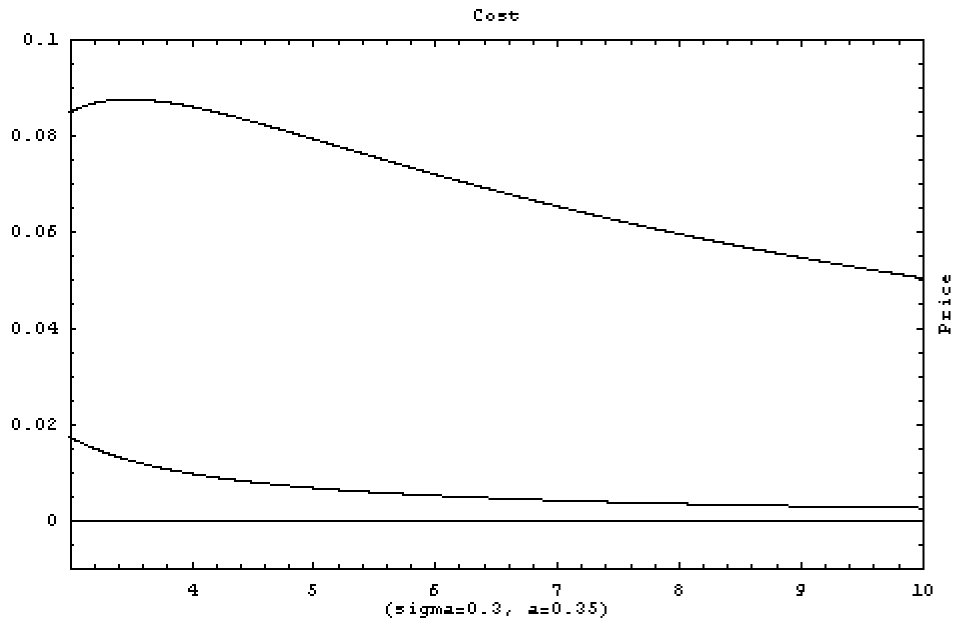

Figure 3: Multiple Equilibria for various values of the setup cost.
Notes: ε is distributed uniformly over [-1,1].
$\sigma = 0.3, a = 0.35, \beta = 0.33, x_0 = 1, \theta = 0.5, n = 0$.

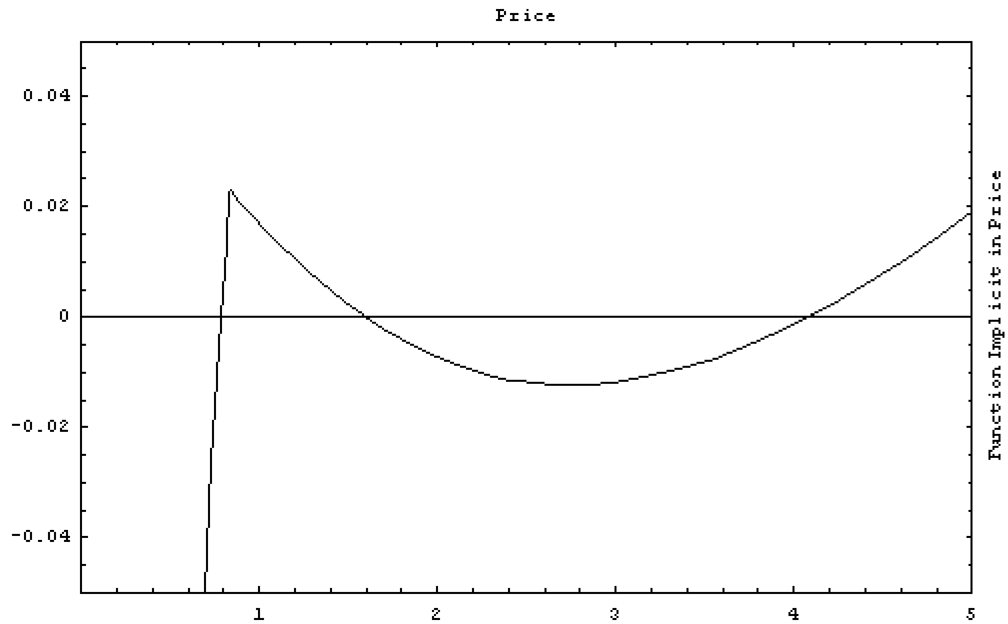

Figure 4: Multiple Equilibria Under Free Trade

Notes: $\beta = \beta^* = 0.33, n = n^* = 0, a = a^* = 0.5, \theta = \theta^* = 0.5$
$\alpha = \alpha^* = 0.5, x_0 + x_0^* = 0.62, y_0 + y_0^* = 0.1$

(Notice that because the two countries have the same homothetic preferences, the distribution of the initial endowments between them is irrelevant for the equilibrium prices.)