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Abstract

The empirical evidence on trade reforms suggests that these have a surprisingly small impact on the country's industrial configuration. This industrial structure inertia is difficult to rationalize in standard trade models. This paper develops a two-sector industry dynamics model in which industrial composition inertia arises naturally. The model is then used to study the consequences of different types of trade reforms (e.g. permanent, temporary, gradual, pre-announced) on investment, employment composition and income distribution.

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1. Introduction

Over the last two decades numerous countries have implemented reform packages that sought to improve the efficiency of their economies. Trade reform, liberalization of capital flows, changes in tax legislation, improvements in the protection of property rights, and de-regulation of the financial intermediation sector, have been widely used to try to improve economic performance.

Every time these reforms are implemented agents debate the extent to which they are likely to be temporary or permanent. Why is this important? Calvo and Mendoza (1994) stress two reasons. The duration of the reform is relevant: (i) in determining the size of the wealth effect experienced by the private sector; and (ii) in setting in motion intertemporal substitution effects in reforms perceived as temporary. Both of these mechanisms affect consumption and labor supply decisions as well as the economy's trade balance.

In this paper we analyze a third mechanism through which the temporariness of the reform may have important consequences. Reforms tend to induce important sectoral reallocations of investment. If investment decisions are costly to reverse, the duration of the reform becomes a critical determinant of capital and labor reallocation, firm entry, and firm exit.

A model where investment is reversible and capital can be freely re-allocated across sectors predicts that trade reforms—even temporary ones—should have very large effects on investment and on the industrial configuration. These predictions stand in sharp contrast with the evidence collected in numerous case studies by Papageorgiou et al. (1990) and Helleiner (1994) which suggests that there is substantial inertia in the process of firm creation and firm destruction. To give two examples, Rayner and Lattimore (1991, page 119) summarize the effects of trade reform in New Zealand as follows: "The 40 years covered by this study of trade liberalization in New Zealand saw many changes, some gradual and some extraordinarily swift and even drastic. But beneath these surface movements the structure of the economy has been remarkably resistant to change". Ros (1994) provides the following summary of the Mexican experience with trade reforms in the 1980's: "For those expecting a large, painful, but greatly beneficial reallocation of resources in favour of traditional exportable goods, and labour—and natural resource—intensive goods, the experience with trade liberalization to date will have been greatly disappointing. [...] the 1980's have witnessed an extrapolation of past trends in trade and industrial patterns."

Introducing adjustment costs into an otherwise frictionless model of capital

allocation preserves the prediction that trade reforms have an impact on capital allocation, however these effects take place gradually over time. In contrast, the industry dynamics model with irreversible investment that lies at the core of our analysis implies naturally that there is substantial inertia in the response of an economy to trade reforms. Firms that have previously been protected may not exit, even when trade reforms are permanent. And certain reforms—both temporary and permanent—may fail to elicit changes in industrial configuration. Ours is an economy in which the industrial structure is difficult to change and, in which the changes that do occur tend to be persistent.

Our emphasis on the role of fixed costs and investment irreversibilities in determining the outcome of trade reforms accords with the recent investment literature which stresses the importance of these features for understanding the episodic nature of investment dynamics (see, for example, Doms and Dunne (1993), Caballero, Engel and Haltiwanger (1995), and Eberly (1997)).

We use our model to address a set of questions that always emerges every time a reform plan is implemented: (i) should the reform be sudden or pre-announced?; (ii) are there advantages to gradual reforms?; (iii) if several policy measures are being considered is the sequence of implementation relevant?; (iv) do failed reforms condition the success of future reforms?; (v) what is the role of initial conditions in determining the reform outcome?; and (vi) is there a relation between the size of the reform and its outcome?

We discuss at length the effects of different reforms on the distribution of income across factors of production and across the sectors of the economy. Both theoretical work (Fernandez and Rodrick (1991), Hillman (1989)) and empirical studies (Little et al. (1970), Krueger (1978), and Papageorgiou et al. (1990)) have pointed clearly to the impact on the distribution of income as a key consideration in the design and implementation of reforms.

Section 2 lays out the basic model that forms the backdrop for our investigation. Section 3 studies the effects of different deterministic reforms in an economy with free access to international capital markets. Section 4 studies the implications of similar reforms in an economy without access to international capital markets. A final section summarizes the main results.

2. The Model

The economy is populated by a large number of agents with identical preferences. These agents own domestic firms and supply inelastically one unit of labor in

every period. They can borrow and lend in the international capital market at a real interest rate r^* . For this reason consumption and savings decisions can be separated from production and investment decisions. The latter seek to maximize the economy's wealth. Given the level of wealth thus obtained households choose optimally their consumption bundle and their savings rate. Since we are interested in analyzing production and investment decisions we can do so by focusing on the wealth maximization problem and abstract from the household's consumption and savings decisions.

Domestic firms take prices as given in the world goods market and produce either good a or b . Domestic prices do not coincide with prices in the world market due to the presence of import tariffs. Our economy has a comparative advantage in the production of good a , so it will tend to export good a and import good b .

Firms choose to enter or exit in response to changes in their industry's profitability. We normalize the time that it takes to enter or exit the industry to one period. It is thus appropriate to interpret each time period in the model as being longer than one year.

In both sectors production is organized in firms as in Hopenhayn (1992). To set up a firm it is necessary to make a one-time investment of ϕ units of good a . If this cost is paid at time t the firm will be able to operate at time $t + 1$. Plants produce according to the following technology:

$$Y_{it} = Z_i N_{it}^\alpha, \quad 0 < \alpha < 1, \quad i = a, b,$$

where Y_{it} denotes the output of sector i and N_{it} the number of units of labor that this sector employs. To simplify we assume that the production functions in the two sectors differ only with respect to the level parameter Z_i . The elasticity of production with respect to labor (α) is assumed to be identical in both sectors.

In every period each firm must pay a overhead cost of ψ units of good a . This cost plays two roles. First, it keeps the number of firms bounded. Given the presence of decreasing returns to scale the equilibrium number of firms would be infinite with $\psi = 0$. Second, the overhead cost will induce firms to exit in response to a sufficiently large deterioration in the relative price of their product. With $\psi = 0$ firms would never exit since they would always earn positive profits.

At the end of every period, a firm can choose to produce or to discontinue its operation. To simplify we assume that a firm which discontinues its operations for one period cannot resume its operations in future periods and has a liquidation value of zero. The problem facing an incumbent firm in sector i can be described

in terms of the following dynamic programming problem, where π_{it} represents time- t maximal profits in the i sector:

$$V_{it} = \pi_{it} + \frac{1}{1 + r^*} \max(V_{it+1}, 0).$$

The problem facing a potential entrant in sector i is:

$$\tilde{V}_{it} = \max\left(\frac{1}{1 + r^*} V_{it+1} - \phi, 0\right), \quad i = a, b.$$

Optimal profits in the two sectors (in units of a) are given by:

$$\pi_{at} = \max_{N_{at}}(Z_a N_{at}^\alpha - \psi - w_{at} N_{at}),$$

$$\pi_{bt} = \max_{N_{bt}}(p_t Z_b N_{bt}^\alpha - \psi - w_{at} N_{bt}).$$

In these expressions w_{at} represents the real wage rate measured in units of good a , and p_t is the domestic relative price of good b in units of good a . To simplify we assume that the international relative price of good b (p^*) is constant. The domestic relative price is given by:

$$p_t = p^*(1 + \tau_t), \quad (2.1)$$

where τ_t is a tariff rate imposed by the government and whose revenue is rebated to the households in a lump sum fashion.¹ We assume for now that τ_t is constant over time.

The real wage in this economy is a weighted average of the two product wages, w_a and w_b , which is the real wage measured in units of good b :

$$w_b = w_a/p = \alpha Z_b N_b^{\alpha-1}. \quad (2.2)$$

If momentary utility from consumption of goods a and b (C_a , and C_b) had the Cobb-Douglas form $u = [(C_a^\gamma C_b^{1-\gamma})^{1-\sigma} - 1]/(1 - \sigma)$, the real wage (deflated by the consumer price index) would be a geometric average of the two product wages: $w_a^\gamma w_b^{1-\gamma}$. Since we want to be agnostic about the weights used in the construction of the consumer price index, we analyze separately the evolution of both w_a and w_b .

¹The results we will discuss continue to hold if we assume, as in Section 4 below, that these tariffs are used to finance public expenditures that do not affect the productivity of the private sector or the marginal utility of private consumption.

Optimal labor hiring decisions in the two sectors are characterized by:

$$\begin{aligned}\alpha Z_a N_a^{\alpha-1} &= w_a, \\ p\alpha Z_b N_b^{\alpha-1} &= w_a.\end{aligned}\tag{2.3}$$

It is useful to define θ as the ratio of labor allocation in the two sectors,

$$\theta \equiv \frac{N_{at}}{N_{bt}} = \left(\frac{Z_a}{Z_b p} \right)^{1/(1-\alpha)}.\tag{2.4}$$

Assumption 1: $\theta > 1$.

This assumption is just a normalization that means that the economy has a comparative advantage at producing good a .

Denote the number of incumbents in sector i by M_{it} . Using the adding up condition for labor,

$$M_{at}N_{at} + M_{bt}N_{bt} = 1,\tag{2.5}$$

we can write the values of N_a and N_b as:

$$N_{at} = \frac{\theta}{M_{at}\theta + M_{bt}},\tag{2.6}$$

$$N_{bt} = \frac{1}{M_{at}\theta + M_{bt}}.\tag{2.7}$$

Note that when the economy specializes in good a , so that $M_b = 0$, the variable θ is still well defined since it gives us the ratio of labor employed by a type a firm relative to the labor employed by a potential entrant into the b sector. When $M_b = 0$ equation (2.6) implies that the available labor is evenly divided among sector a firms.

The values of π_a and π_b are:

$$\pi_{at} = (1 - \alpha)Z_a \left(\frac{\theta}{M_{at}\theta + M_{bt}} \right)^\alpha - \psi,\tag{2.8}$$

$$\pi_{bt} = p(1 - \alpha)Z_b \left(\frac{1}{M_{at}\theta + M_{bt}} \right)^\alpha - \psi.\tag{2.9}$$

Combining these two equations and using (2.4) we obtain a simple relation between the optimal profits of the two sectors:

$$\pi_{at} = \theta(\pi_{bt} + \psi) - \psi. \quad (2.10)$$

The problem of finding the investment and exit decisions in the two sectors that maximize the wealth of the economy can be expressed in a recursive fashion:

$$\begin{aligned} W(M_a, M_b) = \max_{M'_a, M'_b \geq 0} \{ & M_a \pi_a + M_b \pi_b + w_a \\ & - \phi[\max(M'_a - M_a, 0) + \max(M'_b - M_b, 0)] \\ & + \frac{1}{1 + r^*} W(M'_a, M'_b) \}. \end{aligned} \quad (2.11)$$

Here we used primes to denote the value of a given variable in the next period.

Proposition 2.1. *For each θ there exists a unique, bounded and continuous function W . The value function W is strictly concave and differentiable almost everywhere, and the decision rules are continuous, single-valued functions.²*

Proof. See appendix. ■

There is an explicit analytical solution to the value function W which is described in the appendix.

Lemma 2.2 (Specialization). *The economy has a comparative advantage in good a : if we start the economy with $M_a > 0$ and $M_b = 0$ we will not observe entry in sector b ; the economy will remain specialized in the production of good a .*

Proof. See Lemmas 6.1 and 6.2 in the appendix. ■

2.1. The Steady State Set

In the steady state of this economy the number of firms in both sectors remains constant. There are multiple (M_a, M_b) combinations consistent with the steady state. These combinations can be characterized by studying the firm entry and exit decisions for both sectors of the economy.

²When $\theta = 1$ the value function can be written as $W(M_a + M_b)$, that is, plants in sector a are in this case perfect substitutes for plants in sector b .

A pair (M_a, M_b) belongs to the steady state set if it satisfies two properties: (i) the value of firms in both sectors is non-negative ($V_{it} \geq 0, i = a, b$), which implies that there is no incentive to exit; and (ii) the value of existent firms is lower than the cost of entry ($V_{it} \leq \phi(1+r^*), i = a, b$), which implies that there is no incentive to enter.

For latter reference it is useful to define \overline{M}_a as the highest number of a firms compatible with the steady state requirements. The number \overline{M}_a is such that $\pi_a = 0$ in an economy with no b firms:

$$(1 - \alpha)Z_a(1/\overline{M}_a)^\alpha - \psi = 0.$$

\underline{M}_a is defined as the number of a firms such that profits compensate the annuitized entry cost ($\pi_a = \phi r^*$) in an economy with no b firms:

$$(1 - \alpha)Z_a(1/\underline{M}_a)^\alpha - \psi = \phi r^*.$$

Consider first the case in which we start the economy with $M_a > 0$ and $M_b = 0$. Lemma 2.2 implies that there will be no entry of b firms; the labor force will be divided equally among firms in sector a and profits will be given by:

$$\pi_a = (1 - \alpha)Z_a(1/M_a)^\alpha - \psi.$$

Thus, M_a is a steady state if:

$$\begin{aligned} \pi_a &\geq 0, \\ \pi_a &\leq \phi r^*. \end{aligned}$$

that is,

$$\underline{M}_a \leq M_a \leq \overline{M}_a.$$

Suppose now that we start the economy with $M_a > 0$ and $M_b > 0$, so the fixed costs of setting up M_b firms in sector b have already been incurred. Will the firms in sector b remain in operation? There are two possibilities. Figure 2.1 depicts the case in which firms of type b survive in the steady state. In this case the steady state set is determined by the intersection of the areas defined by the following four conditions: $\pi_a \geq 0, \pi_b \geq 0, \pi_a \leq \phi r^*$ and $\pi_b \leq \phi r^*$. This set includes elements in which both M_a and M_b are positive. We call these “non-specialized steady states”.

Figure 2.2 depicts the “specialized steady state” case. In this case there are no elements of the steady state set such that $M_a > 0$ and $M_b > 0$. Points in which b

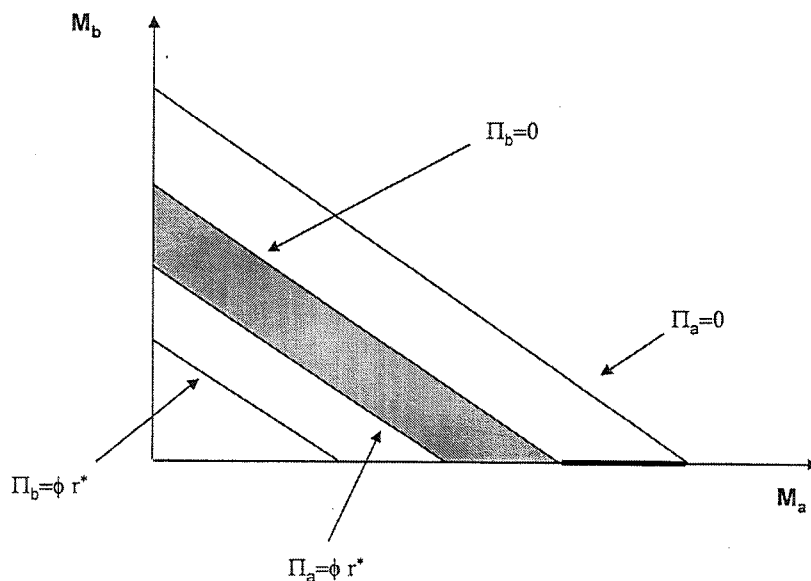


Figure 2.1: Non-Specialized Steady State

firms would be willing to continue producing because $\pi_b \geq 0$ will trigger entry of firms in the a sector to the point where b firms will become unprofitable and be driven to exit.

To determine whether we will have a specialized steady state we ask whether a marginal incumbent in the b sector would survive when the number of a firms is the lowest number consistent with sector a 's no-entry condition. This value of M_a is determined by the condition $\pi_a = \phi r^*$. A value of M_a lower than the one implied by this condition would mean lower wages and hence higher profits in the a sector. The present value of profits in the a sector would then rise above the entry cost ϕ , thus triggering entry of a firms. The profits of a marginal firm in sector b in this scenario can be determined using equation (2.10):

$$\pi_{bt} = \frac{r^* \phi + \psi}{\theta} - \psi.$$

If we define $\bar{\theta}$ as the value of θ consistent with $\pi_{bt} = 0$,

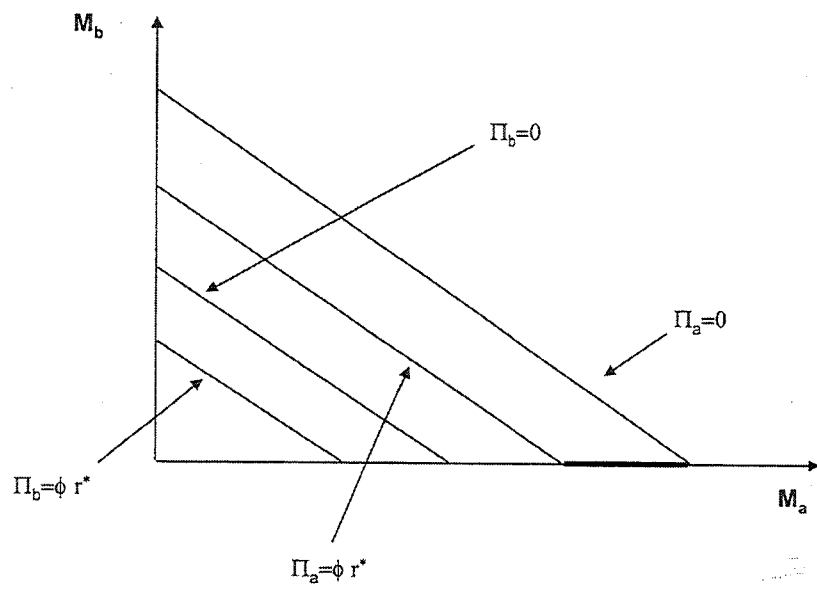


Figure 2.2: Specialized Steady State

$$\bar{\theta} = 1 + \frac{r^*\phi}{\psi},$$

we obtain the following lemma.

Lemma 2.3. *The steady state is specialized when $\theta > \bar{\theta}$ and non-specialized otherwise.*

Before we study the transition dynamics of the model it is useful to summarize the properties of the set of industry configurations that satisfy $\pi_a = r^*\phi$.

Lemma 2.4. *Denote by $\Omega(\theta)$ the set of pairs (M_a, M_b) that satisfy the condition $\pi_a = r^*\phi$. $\Omega(\theta)$ is given by:*

$$\Omega(\theta) = \left\{ (M_a, M_b) : M_b = \theta \left(\frac{(1-\alpha)Z_a}{\psi + r^*\phi} \right)^{1/\alpha} - \theta M_a \right\}. \quad (2.12)$$

For a given value of θ the real wage rate measured in units of good a , w_a is the same for all $(M_a, M_b) \in \Omega(\theta)$; denote this value as $w_a(\theta)$. The value of w_a is also the same across loci with different θ , that is $w_a(\theta_1) = w_a(\theta_2)$, $\forall \theta_1, \theta_2$.

Proof. Expression (2.12) can be obtained by using equations (2.8), and $\pi_a = r^*\phi$. To show the constancy of w_a note that (2.8) implies that w_a is constant if N_a is constant. To complete the proof note that (2.12) and (2.6) imply that along a locus $\Omega(\theta)$ the value of N_a is constant and independent of θ . ■

Figure 2.3 illustrates this result. Suppose that there is a decrease in p . Equation (2.4) implies that θ increases from θ_1 to θ_2 . This leads to a rotation of the $\Omega(\theta)$ locus from $\Omega(\theta_1)$ to $\Omega(\theta_2)$. The product wage w_a is the same for all points in $\Omega(\theta_1)$. It is also identical in all points along $\Omega(\theta_2)$. Finally w_a is the same in both of these loci.³

³A symmetric result holds for sector b . In all the points (M_a, M_b) such that $\pi_b = r^*\phi$ the value of w_b is constant and independent of θ .

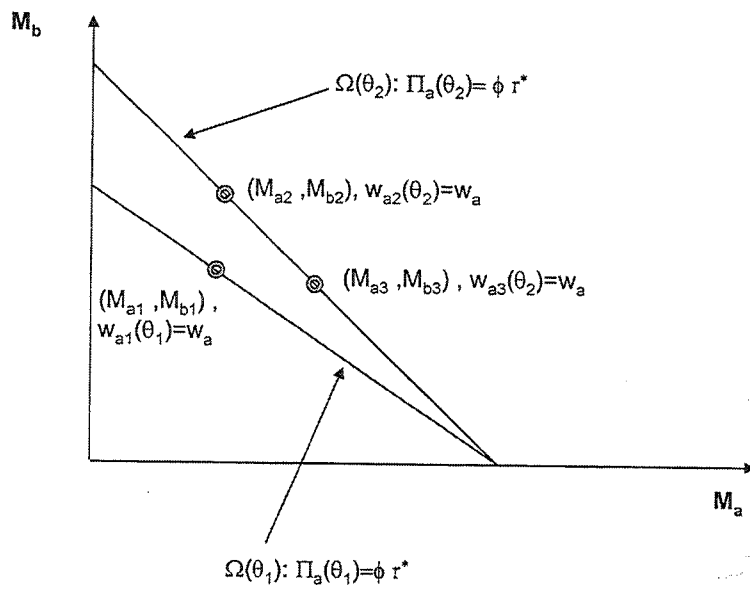


Figure 2.3: The $\Omega(\theta)$ Locus

2.2. Transition Dynamics

Since the economy can borrow and lend freely in the international capital market and there are no adjustment costs to investment, the transition to the steady state occurs in a single period. The transition dynamics summarized in the following proposition can be read straight out of the value function W described in the appendix.

Proposition 2.5. *When $\theta < \bar{\theta}$ the economy converges to a non-specialized steady state. Entry of b firms never occurs. For industry configurations where $\pi_a > r^*\phi$ there is entry of firms in sector a with M_b remaining constant. For all other non-steady state configurations in which $M_a < \bar{M}_a$, b firms make losses and hence exit while M_a remains constant. For industry configurations in which $M_a > \bar{M}_a$ the economy converges to $M_a = \bar{M}_a$, $M_b = 0$.*

When $\theta > \bar{\theta}$ the economy converges to a specialized steady state. Transition dynamics always involve the immediate exit of all b firms. M_a remains constant when $\underline{M}_a < M_a < \bar{M}_a$, converges to \underline{M}_a when $M_a < \underline{M}_a$, and to \bar{M}_a when $M_a > \bar{M}_a$.

These transition dynamics are depicted in Figure 2.4 for the “non-specialized steady state” and in Figure 2.5 for the “specialized steady state” case.

3. Trade Reforms with Free Capital Mobility

We now discuss the effects of different types of trade liberalization reforms to provide answers to some of the questions posed in the introduction. Trade reforms are a potential Pareto improvement in our economy—if the government could make appropriate transfers among agents everybody could be made better off. Since in practice lump sum transfers are not available and factor ownership is unevenly distributed, trade reforms can result in dramatic changes in income distribution. To study these distribution effects we focus on the impact of reforms on π_a , π_b and on the real wage.

We start by studying two permanent reforms, one that is unanticipated by private agents and one that is pre-announced. The dynamics of entry and exit associated with these reforms are characterized using the results in Proposition 2.5. We then turn to reforms that are gradual and to temporary reforms.

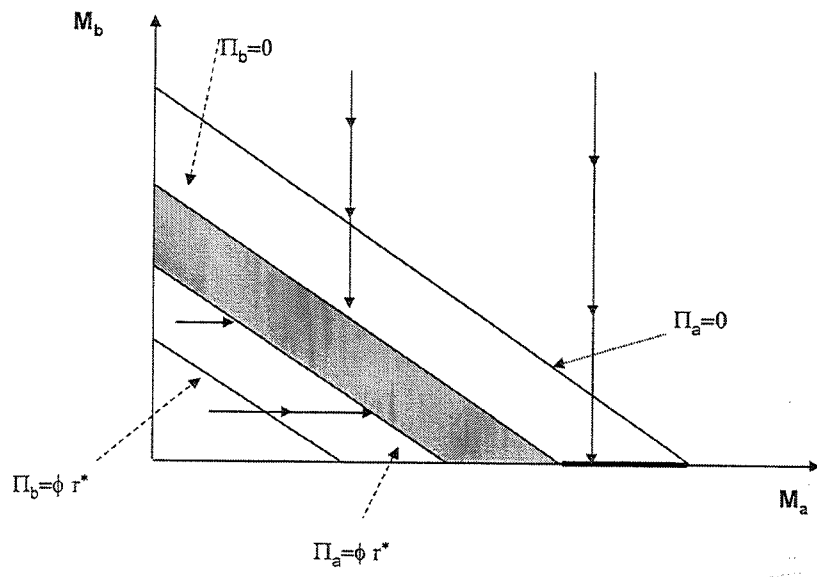


Figure 2.4: Transition Dynamics, Non-Specialized Steady State

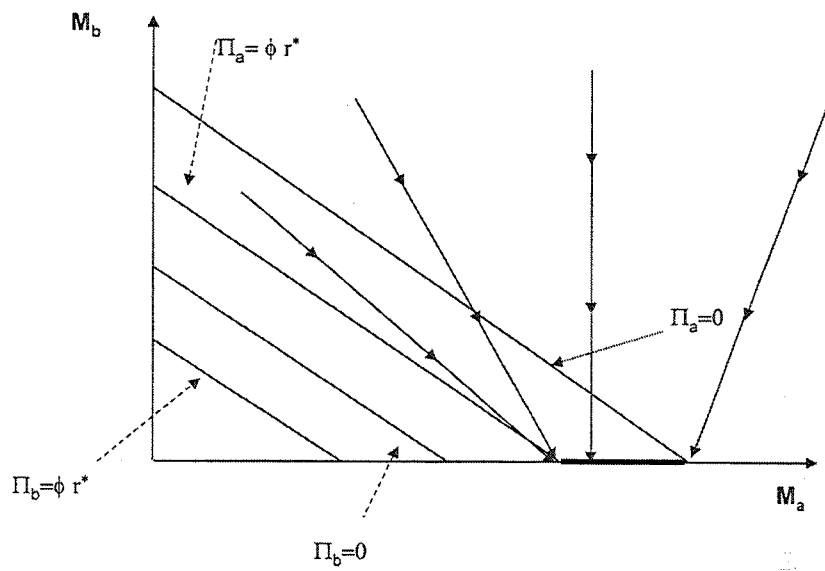


Figure 2.5: Transition Dynamics, Specialized Steady State

3.1. A Permanent Unanticipated Reform

We will now discuss the effects of a permanent unanticipated reform that lowers tariffs thus reducing p , the domestic price of good b . We study two distinct cases: (i) the economy departs from a situation where $\pi_a = \phi r^*$ before the reform; and (ii) the economy departs from an interior point in the steady state set. Since the differences between these two scenarios are similar in all the other reforms we will study we will later focus only on the first case.

3.1.1. Case 1 ($\pi_a = \phi r^*$ in the initial steady state)

The five panels of Figure 3.1 show the effects of a permanent unanticipated reform in the first case. The top panel shows the locus $\Omega(\theta)$ which gives the (M_a, M_b) combinations such that $\pi_a = r^* \phi$. This will be used to analyze the incentive for a firms to enter. Given that the reform favors the a sector we already know from our analysis of transition dynamics that there will be no entry of b firms.

Suppose that p declines from p_1 to p_2 . This raises θ from its initial value θ_1 to a new value θ_2 (see equation (2.4)) producing a clockwise rotation in the $\pi_a = r^* \phi$ line. Suppose that the pre-reform industry configuration was a point in $\Omega(\theta_1)$, such as point 1 in Figure 3.1. The decline in p increases the profits of sector a to the point where it justifies entry into this sector. What happens in sector b ? If the new steady state involves complete specialization all b firms will exit. Otherwise they will continue to make positive profits and hence they will all remain in operation.

The reform exerts two distinct effects on the real wage. The first is a static effect associated with the change in p . The second reflects the consequences of firm entry. The static effect takes place because when p decreases there is a reallocation of labor toward the sector a (see (2.6)). Thus N_a increases leading to a reduction in w_a (see (2.3)). The reform made good a more expensive and hence wages measured in units of a fall while wages measured in units of b rise.

If M_a and M_b were fixed this would be the end of the story. However, there will be entry in sector a and the economy will move from point 1 to point 2 in Figure 3.1. Recall from Lemma 2.4 that w_a is identical along $\Omega(\theta_1)$ and $\Omega(\theta_2)$. This means that entry will exactly offset the initial decline in w_a , restoring w_a to its pre-reform level. Entry of a firms leads to a reduction in N_b (see (2.7)) and to a second increase in w_b (see (2.2)).

The last two panels of Figure 3.1 depict the effects of the reform on the profits of the two sectors. In the first period of the reform a firms receive a profit windfall

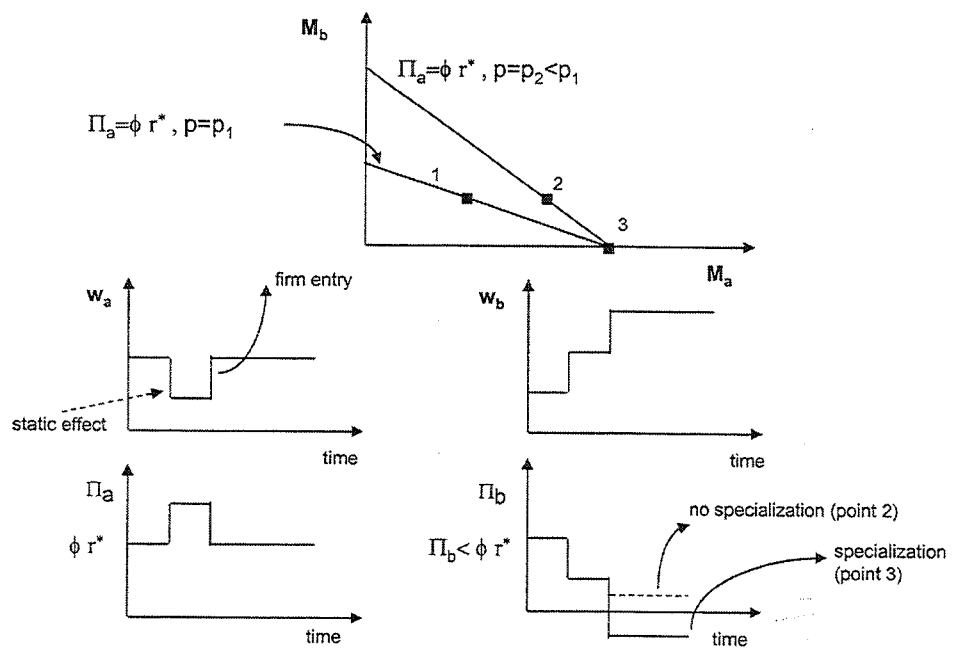


Figure 3.1: A Permanent Unanticipated Reform

associated with the decline in w_a at the same time that profits decline in sector b (see (2.9)). Entry of a firms in the second period restores profitability in sector a to pre-reform levels and leads to a further reduction in the profits of sector b . When this reduction is severe enough profits in the b sector may become negative. This happens when the new value of θ is higher than $\bar{\theta}$ (Lemma 2.2). In this case the new steady state will entail complete specialization in the production of good a , that is, the economy moves from point 1 to point 3 in Figure 3.1.⁴

Note that the effects of reform are non-linear with respect to the level of tariffs. Small changes in τ tend to produce correspondingly small effects in terms of entry into sector a and no effects on exit from sector b . However, once tariffs move enough that the new steady state entails specialization ($\theta > \bar{\theta}$) there is a watershed effect involving potentially large entry of a firms with exit of all b firms. Figure 3.2 shows how the industry configuration changes in response to changes in the level of tariffs. Suppose the economy starts with a value of θ equal to θ_0 , which corresponds to a level of tariffs τ_0 . Suppose also that the initial conditions M_{a0} and M_{b0} lie on the schedule $\Omega(\theta_0)$. The Figure shows the number of a firms that will enter if tariffs are reduced from τ_0 to a new lower value τ . For tariffs lower than $\bar{\tau}$ (the value of τ consistent with $\theta = \bar{\theta}$) the economy specializes completely—all b firms exit while the number of a firms increases to \underline{M}_a .

To summarize the main results: an unanticipated reform that lowers tariffs, thus lowering the price of good b , leads to entry in the a sector, motivated by the initial increase in the profitability of this sector. Profitability falls in sector b . The product wage measured in units of good a falls initially but is then restored to its pre-reform level. The values of w_a and π_a are the same in period 2 as before the reform. In contrast, sector b , which was more protected in the pre-reform era features higher product wages (w_b) and correspondingly lower profits. The effects of reforms are non linear in τ ; if the new level of tariffs is low enough to be compatible with a specialized steady state this has large effects on firm entry and firm exit.

3.1.2. Case 2 (initial steady state is an interior point)

Consider now the case in which the economy starts off at an interior point in the steady state set, such as point 1 in Figure 3.3. In this case if the change in the

⁴The implication that all firms b exit at the same time creating a large watershed effect would be mitigated in a version of the model where firms have heterogenous productivities, as in Bacchetta and Dellas (1997). In such an environment the least productive, smaller firms would tend to exit but more efficient units could remain in operation.

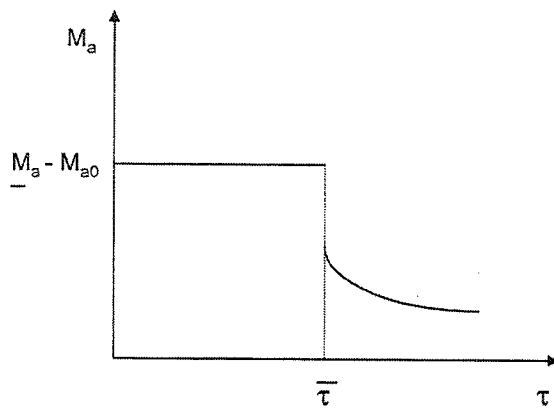


Figure 3.2: The Effect of Tariffs on Firm Entry, Initial Industrial Configuration: $\underline{M}_a > M_{a0}$.

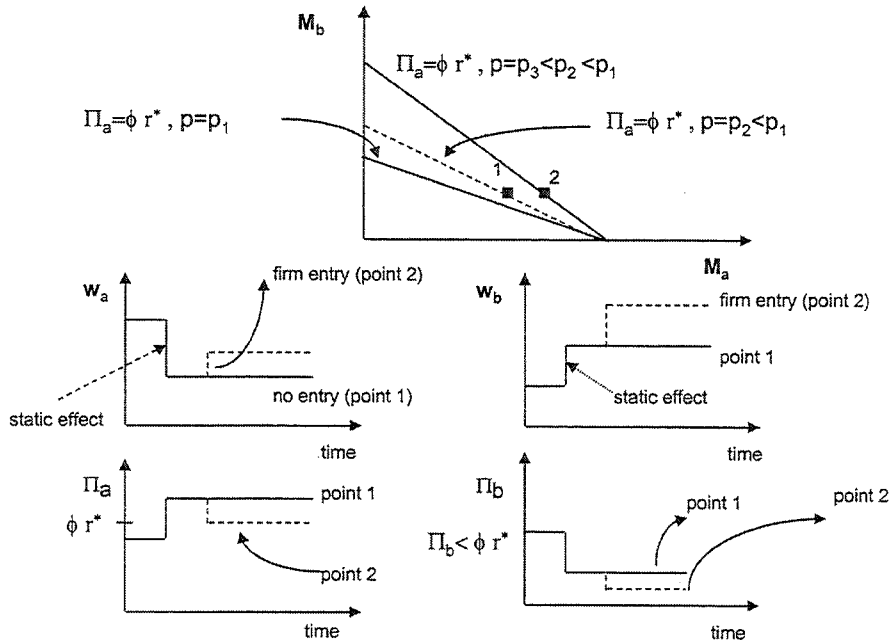


Figure 3.3: A Permanent Unanticipated Reform

domestic price is small enough to cause no entry in sector a , all we observe are static effects: a permanent decline in w_a and in π_b and a permanent rise in w_b and π_a . The economy remains at point 1 despite the reform. The same dynamic effects discussed before will be added if the decline in p from p_1 to p_3 leads to entry in sector a , moving the economy from point 1 to point 2. (For simplicity we ignore the case where the change in price is large enough to induce specialization.) Figure 3.3 also depicts what happens in this case. Notice that, because we started the economy off at a point where $\pi_a < r^*\phi$, entry in sector a does not restore w_a to its pre-reform level. Relative to the situation before the reform we now observe a permanent decline in w_a and an increase in profits to the level $r^*\phi$.

In the non-specialized steady state case, the higher the pre-reform steady state value of M_b for a given value of M_a the lower the impact of the trade reform. In other words, if the initial industry configuration is significantly biased away from the economy's comparative advantage, the effects of trade reform will be small in

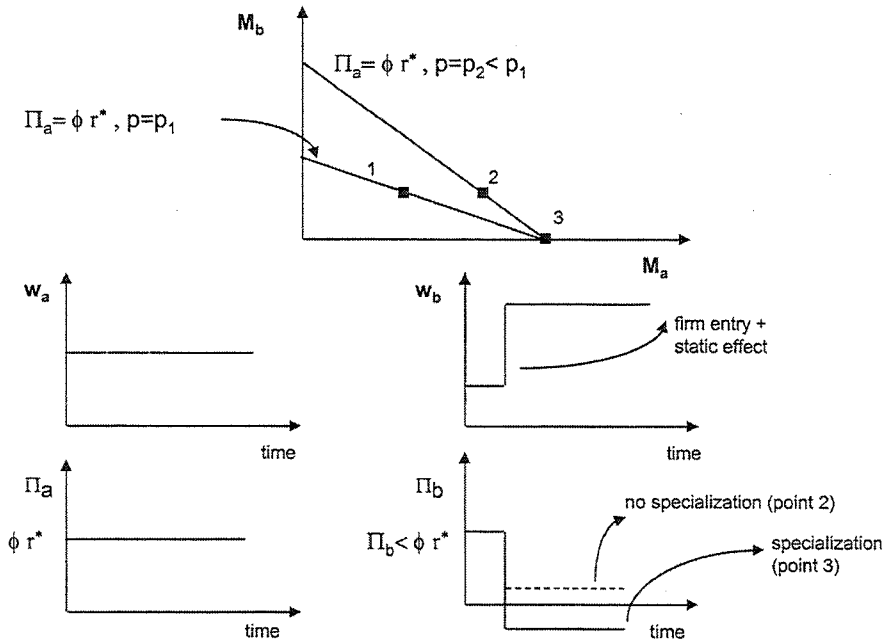


Figure 3.4: A Permanent Pre-Announced Reform

the sense that few firms of type *a* will enter. Policies that try to tilt the economy away from its comparative advantage lead to smaller effects of trade reform.

3.2. A Permanent Pre-Announced Reform

A common alternative to a surprise reform involves announcing in advance the policy changes associated with the reform. Figure 3.4 depicts the effect of a reform that takes place in period 1 and is pre-announced in period 0. In this case entry of *a* firms eliminates the static effects in period 1. The only effects of the reform on sector *a* are an expansion in the number of firms and in the number of workers employed by each firm. Sector *b* experiences a decline in profits (which become negative if the new steady state is specialized) and an increase in its product wage, w_b .

This reform is clearly worse in welfare terms than the previous one because the

economy waits one period to implement a reform that is welfare improving. To see this note that the total value of firms at time 0, $W(M_{a0}, M_{b0})$, is strictly higher when the reform is unanticipated than with a pre-announced reform since keeping M_a , and M_b constant for next period is feasible, but not optimal. However, pre-announcing the reform may have some advantages for a policy maker concerned with short term effects on the income distribution. While the real wage can fall in an unanticipated reform if good a has a high enough weight in the consumption basket, the real wage is guaranteed to rise in a pre-announced reform.

Pre-announcing also has an important effect on profits. The fact that sector a receives a profit windfall at the same time that sector b is made less profitable may make the unanticipated reform more difficult to sustain. Pre-announcing eliminates the profit windfall to sector a .

In the experiment just described we assumed that the reform has perfect credibility. While it is possible that pre-announcing the reform hurts its credibility (e.g. Stockman (1982)), in the case studies compiled by Papageorgiou et al. (1991) the majority of the pre-announced reforms survived either fully or partially.

3.3. A Permanent Gradual Reform

Policy makers often entertain the possibility of pre-announcing a schedule of reforms that are implemented gradually over time. The liberalization of trade within Europe brought forth by the European Union took this gradualist approach. What does gradualism buy us? Suppose that at time zero we announce a gradual reduction in tariffs starting immediately in period zero. The result, depicted in Figure 3.5, is a combination of the two reforms that we just studied. At time zero we have the impact of the unanticipated change in p_0 . This produces our familiar static effect: a decline in w_a , a rise in π_a , an increase in w_b , and a reduction in π_b . From period 1 on the profitability of sector a remains constant at $\pi_a = r^*\phi$ since firm entry offsets exactly the increase in profits produced by a drop in p . Since at time t the industry configuration is on the locus $\Omega(\theta_t)$, w_a remains constant from period 1 on (see Lemma 2.4).

In the b sector the decline in π_b and the rise in w_b which in the previous reform occurs in period 1 now takes place gradually over time in tandem with changes in p .

In terms of welfare this reform is worse than the unanticipated reform because the implementation of welfare improving changes in tariffs is further delayed in time. As far as its short term impact on income distribution this reform seems

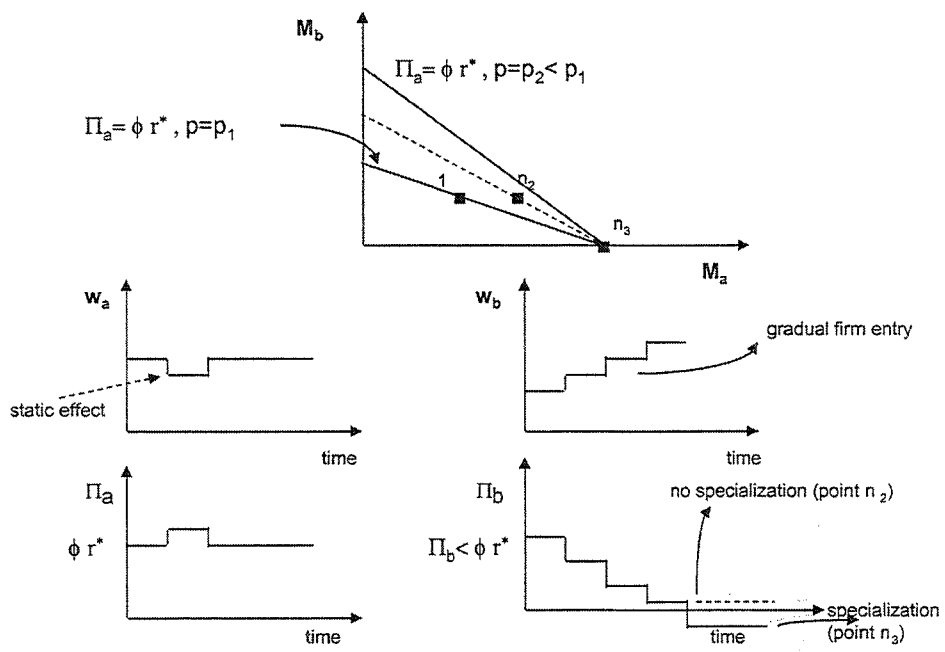


Figure 3.5: A Gradual Permanent Reform

also dominated by the pre-announced reform. In a gradual unanticipated reform the real wage can potentially fall, and there is a profit windfall to sector a .

Gradual reforms have often been recommended as a way of achieving a smoother reallocation of factors across sectors (Little et. al (1970) and Michaely (1985)). Since these benefits can just as well be achieved through pre-announcement, the case for gradualism must depend on potential credibility effects associated with a gradual implementation of the reform.

3.4. A Temporary Unanticipated Reform

Consider now a temporary unanticipated decline in tariffs announced at time zero that lasts for two periods (the results of longer lasting temporary reforms are similar). After two periods tariff levels return to their pre-reform level. Experiments of this type are common in the temporariness literature (see e.g. Calvo (1988)). Suppose that the pre-reform industry configuration was a point in $\Omega(\theta_0)$, such as point 1 in Figure 3.6.

In this case we will observe entry in the a sector. Without entry in the first period the temporary price decline would raise the present value of profits above the entry threshold $\phi(1 + r^*)$. In period 0 we observe the familiar static effects associated with the unanticipated nature of the reform: w_a and π_b decline at the same time that w_b and π_a increase. In the permanent reform firm entry into sector a offsets completely the static effects on w_a and π_a . In the temporary reform entry is restricted by the fact that once the reform ends the present discounted value of profits from period 2 on, V_{a2} , is lower than the entry threshold $\phi(1 + r^*)$ therefore the marginal entrant into sector a will have excess profits in period 1 since:

$$\frac{\pi_{a1}}{1 + r^*} + \frac{V_{a2}}{(1 + r^*)^2} = \phi.$$

Given that there will be fewer firms a entering some of the static effect will remain. When the reform is reversed in period 2 the economy will look “uncompetitive”. Because the number of firms in the a sector is larger than before the reform, the wage rate is higher measured both in units of a and in units of b . Also, profits are lower in both sectors as compared to the pre-reform era.

Is it possible to observe entry of firms a that is later reversed by exit when the reform ends? The following Lemma states that the answer to this question is negative.

Lemma 3.1. *Consider a temporary reform that lasts for $T > 1$ periods. During the reform period p declines from p_1 to p_2 . At time $T + 1$, p reverts back to p_1 .*

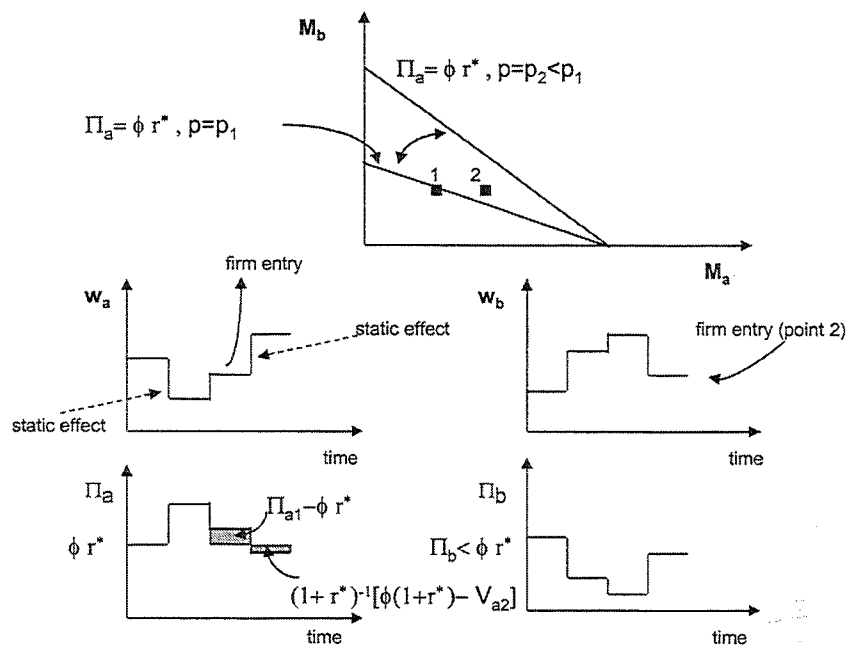


Figure 3.6: A Temporary Unanticipated Reform

We will not observe exit of a firms at any point in time as a response to this temporary reform.

Proof. See Appendix. ■

Failed reforms may make future reforms easier from a political standpoint. If opposition to reform stems from the profits being captured by the protected sector, temporary reforms that lead to entry of a firms will permanently lower these profits, thus paving the way for future reforms.

The implication of the model—that temporary reforms generate no exit from the protected sector and modest entry into the sector favored by the reform—accords well with informal descriptions of the outcome of failed reforms. For example, Shepherd and Albuero (1991, page 292) discuss trade reform in the Philippines as follows (italics are ours): “The 1960-62 import decontrol was undoubtedly a significant achievement [...]. Yet decontrol changed the economy *curiously* little. Certainly it immediately encouraged traditional exports, as well as small amounts of nontraditional manufactured exports. However, while the import substituting manufacturing sector was visibly hit by imports in the early to middle 1960’s, it neither contracted [...], nor did its structure change in any obvious ways”.

4. Trade Reforms Without Access to International Capital Markets

We now study a version of the model presented in Section 2 in which the economy can trade internationally but has no access to world capital markets. Since the real interest rate is determined endogenously in this economy we can no longer separate investment from savings decisions. Hence we need to be explicit about the objectives and constraints facing households.

Households choose the path of consumption of goods a and b (C_a , and C_b) so as to maximize their life-time utility, which is given by:

$$U = \sum_{t=0}^{\infty} \beta^t \frac{(C_{at}^\gamma C_{bt}^{1-\gamma})^{1-\sigma} - 1}{1-\sigma}, \quad (4.1)$$

$$\sigma > 0, \quad 0 < \gamma < 1.$$

Since later on we will discuss the implications of capital flows liberalization it is useful to assume:

Assumption 2: $\beta = \frac{1}{1+r^*}$.

Assumption 2 eliminates trends in the current account in a version of this economy with free international capital mobility. It also ensures that the steady state of this economy coincides with the one described in Section 2, where the steady state real interest rate is also r^* .

To discuss the impact of various reforms on the distribution of income we want to consider the case in which firm ownership is heterogenous. Some agents may receive mostly labor income, while others may have investments concentrated in one of the sectors of the economy. Since the utility function (4.1) satisfies Gorman aggregation we can build a stand-in representative agent to study aggregate consumption decisions despite the presence of heterogeneity in factor ownership. In addition to the labor resource constraint (2.5) familiar from before, the stand-in representative agent faces the following resource constraint:

$$\begin{aligned} M_{at}Y_{at} + p_tM_{bt}Y_{bt} - (M_{at} + M_{bt})\psi &= C_{at} + p_tC_{bt} + \\ \phi \max(M_{at+1} - M_{at}, 0) + \phi \max(M_{bt+1} - M_{bt}, 0) \end{aligned} \quad (4.2)$$

In the left-hand side of this expression, $M_{at}Y_{at} + p_tM_{bt}Y_{bt} - (M_{at} + M_{bt})\psi$ represents total output in the economy net of the overhead cost ψ and expressed in units of good a using domestic prices. The right hand side of the budget constraint has two components. The first is the total value of consumption ($C_{at} + p_tC_{bt}$). the second is total investment, with $\phi \max(M_{it+1} - M_{it}, 0)$ representing investment in sector i . Recall that it is necessary to invest ϕ units of good a to obtain a new plant. Also, when a firm exits it cannot operate again and its capital cannot be used by other firms. Thus, no resources are recovered by reducing the number of firms.

The government collects tariffs on imports at rate τ_t . To simplify, we assume that these tariffs are used by the government to finance public purchases of the two goods in the economy. These government expenditures (G_t) are not productive and do not influence the marginal utility of private consumption. When $\theta > 1$ the economy exports good a and imports good b and the government budget constraint can be written as:

$$G_t = \tau_t p^*(C_{bt} - M_{bt}Y_{bt}),$$

where, as before, p^* represents the relative price of b in world markets which is related to its domestic price by equation (2.1).

When $\theta < 1$ the economy imports a and exports b and the government budget constraint is:

$$G_t = \tau_t [C_a + \psi(M_{at} + M_{bt}) + \phi \max(M_{at+1} - M_{at}, 0) + \phi \max(M_{bt+1} - M_{bt}, 0) - M_{at} Y_{at}],$$

The problem of the stand-in representative household of maximizing (4.1) subject to the sequence of constraints (4.2) and (2.5) involves two intratemporal decisions: the choice of the consumption mix and the allocation of labor across the two industries. There are also two intertemporal choices involving how much to save and how to allocate these savings to investment in the two sectors of the economy.

The efficiency condition that characterizes the optimal allocation of consumption across the two goods is:

$$\frac{1 - \gamma}{\gamma} \frac{C_{at}}{C_{bt}} = p^*(1 + \tau_t). \quad (4.3)$$

The optimal sectoral allocation of labor is described, as in the model of Section 2, by equations (2.6) and (2.7). Using these conditions together with (4.3) we can write the dynamic problem of the stand-in representative household recursively as:

$$\begin{aligned} U(M_a, M_b) &= \max_{C_a, M'_a, M'_b \geq 0} \left\{ \frac{\eta(p) C_a^{1-\sigma} - 1}{1 - \sigma} + \beta U(M'_a, M'_b) \right\} \\ \text{s.t. } \frac{C_a}{\gamma} &= p Z_b (\theta M_a + M_b)^{1-\alpha} - \psi(M_a + M_b) \\ &\quad - \phi \max(M'_a - M_a, 0) - \phi \max(M'_b - M_b, 0), \end{aligned} \quad (4.4)$$

where $\eta(p) = [(1 - \gamma)/p\gamma]^{(1-\gamma)(1-\sigma)}$. Again, we use primes to denote next period's value of a given variable. The properties of this problem are summarized in the following proposition.

Proposition 4.1. *For each θ there exists a unique, bounded and continuous function U . When $\theta \neq 1$ the value function U is strictly concave and differentiable almost everywhere. The decision rules are continuous, single-valued functions. When $\theta = 1$, U can be written as $U(M_a + M_b)$ and these same properties hold with respect to $M_a + M_b$.*

Proof. The proof of the proposition follows the same steps of the proof of Proposition 2.5 and is omitted. ■

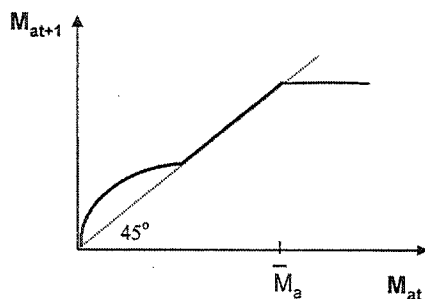


Figure 4.1: Transition Dynamics for any M_{a0} , Economy Without Access to International Capital Markets

The transition dynamics in this economy are characterized by a slower adjustment towards the steady state since no international borrowing is allowed. However, as before, there is no entry of firms b , while a firms increase whenever $\pi_a > \phi r^*$. Figure 4.1 describes the transitional dynamics of this economy. The pattern of adjustment toward the steady state is exactly the same as that described in Proposition 2.5 for the open economy. The only difference is that entry of firms into sector a takes place gradually over time because it is too costly, in terms of foregone consumption, to have an instantaneous adjustment toward the steady state. Whenever entry of a firms occur the value of each firm a is $V_{at} = \phi(1 + r^*)$. In this case the real interest rate must be above its steady state level r^* . In fact, the real interest rate is given by $r_t = \pi_{at+1}/\phi$, which implies that the real interest rate declines toward r^* as the economy converges to the steady state. These results are formally stated in Proposition 6.3 in the Appendix.

4.1. Trade Reforms

The effects of a permanent unanticipated trade reform in this economy are depicted in Figure 4.2.⁵ These effects are similar to the ones studied for the case in which there is free access to international capital markets. The main difference is that, whenever the reform elicits entry of a firms, this entry takes place gradually over time, as suggested by our discussion of the transition dynamics of the model. This gradual adjustment in M_a has important implications for wage rate behavior. In an economy that can freely borrow and lend internationally w_a does not fall in permanent pre-announced reforms and falls for only one period in a permanent unanticipated reform. In contrast, without access to international capital markets both of these types of reforms produce prolonged declines in w_a .

4.2. Sequencing

Should the liberalization of international capital flows precede trade reform? From a welfare standpoint both of these reforms should be implemented immediately. The effects of different reform sequences are similar to those obtained by Edwards and van Wijnbergen (1986) in a two-period model: liberalizing capital flows before liberalizing trade can channel investment to the sector that is currently protected.

Consider an economy with no access to international capital markets, where tariffs are high enough to induce entry into the b sector. The economy is in the process of transition toward the steady state. Suppose that capital flows are liberalized at the same time that the government announces a tariff reduction to take place in a few periods. While the pre-announced trade reform will lower the incentive to enter the b sector, the decline in the real interest rate associated with capital flow liberalization reduces the cost of investing, thus fostering entry of b firms. When the second effect dominates new firms enter into the b sector, moving the economy away from its comparative advantage. A larger number of b firms will, as discussed before, mitigate the results of the trade reform, leading to a weaker entry response on the part of firms a . The larger b sector produced by the capital markets liberalization may also result in powerful lobbying against trade reform.

Suppose now that trade reform takes place first, at the same time that the government pre-announces a future capital market liberalization. This sequencing will ensure that entry will take place only in sector a .

⁵The effects of other types of reform can easily be inferred from our previous discussion and the results in Proposition 6.3 in the Appendix.

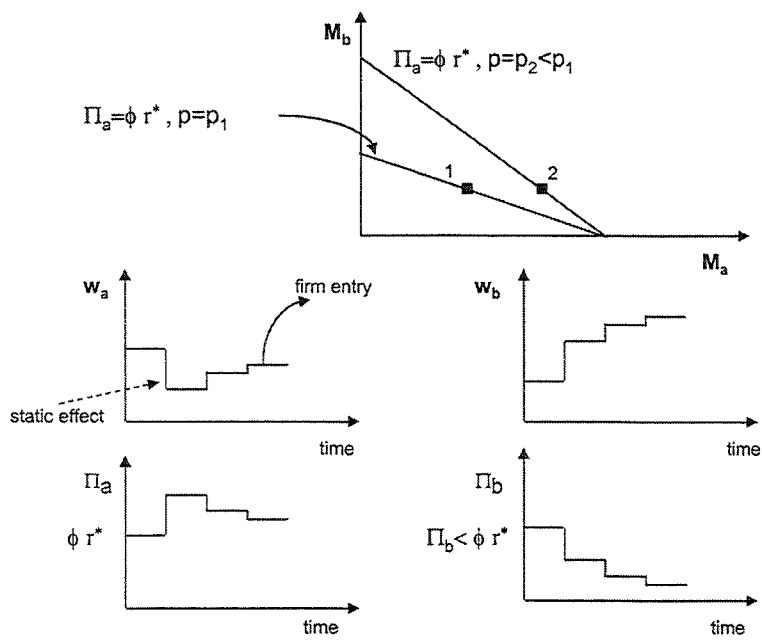


Figure 4.2: A Permanent Unanticipated Reform, Economy Without Access to International Capital Markets

5. Conclusions

We have studied the effects of capital flow liberalization and of trade reforms with different degrees of permanence and timing in a model of industry dynamics with irreversible investment. In our economy it is optimal to liberalize immediately international trade and capital flows. Yet, these reforms may not take place because of concern over their impact on the distribution of income. A policy maker who does not have the ability to compensate losers may be reluctant to implement reforms that lower the real wage or dramatically alter sectoral profitability.

Our main findings can be summarized by providing answers to the questions posed in the introduction:

(i) Surprise permanent trade reforms in economies with free access to world capital markets can generate important effects on the distribution of income across factors of production and across the sectors of the economy; in particular these reforms can lower the real wage and reduce profitability in the traditionally protected sector at the same time that they provide a profit windfall to the sector that is favored by the reform. These effects are not present in a pre-announced trade reform.

(ii) A gradual trade reform is a combination of a smaller unanticipated reform with a sequence of pre-announced reforms. This reform exerts smaller impact effects on the distribution of income than an unanticipated reform.

(iii) The sequencing of trade and capital market liberalizations has important consequences for the distribution of the gains of reforms. In an economy with no access to international capital markets trade reforms can potentially produce a more prolonged decline in the real wage. Liberalizing capital flows and pre-announcing the trade reform so as to allow firms to enter into the sector favored by the reform as changes in tariffs take place is the best way of eliminating potentially undesirable effects on the distribution of income. Also liberalizing international borrowing and lending before trade reform can potentially lead to entry of firms into the protected sector.

(iv) Temporary reforms either produce no effects on the industrial configuration or make the economy seem “uncompetitive” once the reform ends: in the post-reform period the real wage is higher than before while profits in both sectors are lower than before. This may help pave the way for future trade reforms. If opposition to trade reform emanates from the protected sector of the economy failed attempts to liberalize trade can be helpful in attracting some entry of new firms and permanently lowering the profitability of the protected sector. Finally,

an unanticipated reform that is perceived as temporary has a stronger short-run effect on distribution of income than one that is permanent.

(v) Consider two economies with the same number of firms in their comparative advantage sector. If in one of the economies trade protection were pervasive in the past and has created a large protected sector, this dulls the effects of a given tariff reduction in terms of entry of new firms and reallocation of resources toward the comparative advantage sector.

(vi) The entry and exit dynamics imbedded in our model, together with the presence of a potential for complete specialization, generate a pronounced non-linearity in the effect of a trade reform. When tariffs fall below a certain threshold we observe a large discrete change in the industrial structure of the economy. Also the fact that the economy has a zone of inaction implies that small reforms are likely to have no effects on firm entry and exit.

There are several extensions of our simple model that would make it a better guide to understanding the origins and consequences of real world reforms. One of the most important extensions is the study of the impact of uncertainty on reform outcome. The inertia effects present in the deterministic reforms that we considered are likely to continue to play an important role in environments with uncertainty—the size of the steady state set will in general be affected by the degree of reform uncertainty.

We assumed that there are no costs to the reallocation of labor across sectors. This seemed to us a natural first step, in light of the findings reviewed in Papageorgiou et al. (1991), and Edwards (1994) which suggest that the short run effect on unemployment of many trade reforms has been negligible. Including labor reallocation costs, namely the presence of unemployment spells associated with the search for new jobs and the loss of sector specific human capital may make the model a better guide to how the economy responds to terms of trade shocks such as those emphasized in Reinhart and Wickham (1994).

Finally, it would be desirable to integrate our model of the outcome of trade reforms with a political economy model that determines why and when these reforms take place.

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6. Appendix

We start by defining the total output function which will be used in different proofs:

$$y(M_a, M_b) = M_a Z_a \left(\frac{\theta}{\theta M_a + M_b} \right)^\alpha + M_b p Z_b \left(\frac{1}{\theta M_a + M_b} \right)^\alpha - \psi(M_a + M_b).$$

Proof of Proposition 2.1. The proof of these results is standard in dynamic programming problems with bounded returns (see Stokey and Lucas with Prescott (1989)). We need to show that the period return function is bounded and is strictly concave for $\theta \neq 1$. Let $R(M_a, M_b, M'_a, M'_b) = y(M_a, M_b) - i(M_a, M_b, M'_a, M'_b)$ be the period return function, with

$$i(M_a, M_b, M'_a, M'_b) = \phi[\max(M'_a - M_a, 0) + \max(M'_b - M_b, 0)].$$

Boundedness of r can be achieved by compactifying the feasible set. Natural upper bounds on the number of firms are \bar{M}_a , and \bar{M}_b , with \bar{M}_b defined by: $(1 - \alpha) p Z_b (1/\bar{M}_b)^\alpha - \psi = 0$ (remember that p is fixed).

We now show that R is strictly concave. The Hessian of the function y can be shown to be

$$D^2 y = -\alpha(1 - \alpha) \begin{bmatrix} Z_a N_a^{1+\alpha} & Z_a N_a^\alpha N_b \\ Z_a N_a^\alpha N_b & p Z_b N_b^{1+\alpha} \end{bmatrix}$$

using (2.3), and (2.5)-(2.7). When $\theta \neq 1$, $D^2 y$ is clearly negative definite for all pairs, except for $(0, 0)$, where it is not defined. (Remember that when $\theta = 1$, $N_a = N_b$, and $Z_a = p Z_b$.) Therefore, y is strictly concave for $(M_a, M_b) > 0$ (note that the feasible set is obviously convex). It remains to show that i is weakly convex. But,

$$i(M_a, M_b, M'_a, M'_b) = \begin{cases} \phi(M'_a - M_a + M'_b - M_b) & , M'_a > M_a, M'_b > M_b \\ \phi(M'_a - M_a) & , M'_a > M_a, M'_b \leq M_b \\ \phi(M'_b - M_b) & , M'_a \leq M_a, M'_b > M_b \\ 0 & , M'_a \leq M_a, M'_b \leq M_b \end{cases}$$

Let I - IV be the regions that define i . Then,

$$I = \{(M_a, M_b, M'_a, M'_b) : M'_a > M_a, M'_b > M_b\}$$

and so on.

Clearly, if we take convex combinations of points that belong to the same region, the linearity of i will be enough (for weak convexity). Suppose now that we take two points in different regions. Let $P_1 = (M_{a1}, M_{b1}, M'_{a1}, M'_{b1}) \in \text{I}$, and $P_2 = (M_{a2}, M_{b2}, M'_{a2}, M'_{b2}) \in \text{II}$. (For simplicity we just prove that g is convex for this combination of points. All other cases are similar.) Take $\lambda \in [0, 1]$, and assume for now $\lambda M'_{b1} + (1 - \lambda) M'_{b2} > \lambda M_{b1} + (1 - \lambda) M_{b2}$. Then:

$$\begin{aligned}
i(\lambda P_1 + (1 - \lambda) P_2) &= \phi(\lambda M'_{a1} + (1 - \lambda) M'_{a2} - \lambda M_{a1} - (1 - \lambda) M_{a2}) \\
&\quad + \phi(\lambda M'_{b1} + (1 - \lambda) M'_{b2} - \lambda M_{b1} - (1 - \lambda) M_{b2}) \\
&= \phi(\lambda (M'_{a1} - M_{a1}) + (1 - \lambda) (M'_{a2} - M_{a2})) \\
&\quad + \phi(\lambda (M'_{b1} - M_{b1}) + (1 - \lambda) (M'_{b2} - M_{b2})) \\
&\leq \phi(\lambda (M'_{a1} - M_{a1}) + (1 - \lambda) (M'_{a2} - M_{a2})) + \phi\lambda (M'_{b1} - M_{b1}) \\
&= \lambda i(P_1) + (1 - \lambda) i(P_2)
\end{aligned}$$

since $M'_{b2} \leq M_{b2}$, by assumption that $P_2 \in \text{II}$. If, instead $\lambda M'_{b1} + (1 - \lambda) M'_{b2} \leq \lambda M_{b1} + (1 - \lambda) M_{b2}$, then:

$$\begin{aligned}
i(\lambda P_1 + (1 - \lambda) P_2) &= \phi(\lambda M'_{a1} + (1 - \lambda) M'_{a2} - \lambda M_{a1} - (1 - \lambda) M_{a2}) \\
&= \phi(\lambda (M'_{a1} - M_{a1}) + (1 - \lambda) (M'_{a2} - M_{a2})) \\
&< \phi(\lambda (M'_{a1} - M_{a1}) + (1 - \lambda) (M'_{a2} - M_{a2})) + \phi\lambda (M'_{b1} - M_{b1}) \\
&= \lambda i(P_1) + (1 - \lambda) i(P_2)
\end{aligned}$$

since $M'_{b1} > M_{b1}$, by assumption that $P_1 \in \text{I}$. This concludes the proof that R is strictly concave.

When $\theta = 1$, $y = Z_a M^{1-\alpha} - \psi M$, with $M = M_a + M_b$. The industrial configuration is irrelevant except for the investment decisions, so we can trace out the relevant dynamics of the aggregate number of firms M by analyzing the function $\bar{W}(M) = W(M_a, M_b)$. The function \bar{W} has the same properties of function W , but with respect to M . ■

The following lemma gives an explicit analytical solution for the function W for various values of θ in the case where the economy reaches a specialized steady state. Lemma 6.2 discusses the case in which a non-specialized steady state is reached. The knife-hedge case of $\theta = 1$ is a simplified version of the former case and is omitted.

Lemma 6.1. Assume $\theta > \bar{\theta} > 1$, so that the economy specializes in the steady state. Then, for any M_b ,

$$W(M_a, M_b) = \begin{cases} y(M_a, M_b) - \phi(\underline{M}_a - M_a) + \frac{1}{r^*}y(\underline{M}_a, 0) & , M_a < \underline{M}_a \\ y(M_a, M_b) + \frac{1}{r^*}y(M_a, 0) & , \underline{M}_a \leq M_a \leq \bar{M}_a \\ y(M_a, M_b) + \frac{1}{r^*}y(\bar{M}_a, 0) & , M_a > \bar{M}_a. \end{cases}$$

Proof. The proof uses the above guess with the implied decision rules to show that this function solves problem (2.11). One can show that our guess is strictly concave so that for any (M_a, M_b) , problem (2.11) solved with the above W function admits only one solution. Instead of analyzing all feasible paths, we investigate only whether the suggested decision rules solve the first order conditions.

Pick any M_b , and $M_a < \underline{M}_a$. We guess that $M'_b = 0$, and $M'_a = \underline{M}_a$ is optimal. The first-order conditions that need to be verified are:

$$\frac{1}{1+r^*} \left((1-\alpha)Z_a \underline{M}_a^{1-\alpha} - \psi + \frac{(1-\alpha)Z_a \underline{M}_a^{1-\alpha} - \psi}{r^*} \right) = \phi$$

and

$$\mu_b = -\frac{1}{1+r^*} \left((1-\alpha)pZ_b \left(\frac{1}{\theta \underline{M}_a} \right)^\alpha - \psi \right) > 0.$$

The first condition is obviously verified by definition of \underline{M}_a . The second condition states that the Lagrange multiplier associated with the constraint $M'_b \geq 0$, is strictly positive. Substituting for \underline{M}_a , we have

$$\mu_b = -\frac{1}{1+r^*} \left(\theta^{-1}\phi r^* + (\theta^{-1} - 1)\psi \right) > 0$$

since $\theta > \bar{\theta}$.

Now, pick $\underline{M}_a \leq M_a \leq \bar{M}_a$, and any M_b . We guess that $M'_a = M_a$, and $M'_b = 0$. The first-order conditions that need to be verified are:

$$0 \leq \frac{1}{1+r^*} W_{M_a}(M'_a, M'_b) \leq \phi$$

$$\mu_b = -\frac{1}{1+r^*} \left((1-\alpha)pZ_b \left(\frac{1}{\theta M_a} \right)^\alpha - \psi \right) > 0.$$

The second condition is equivalent to the one we had before, and is simply a virtue of the fact that there is specialization in sector a in the steady state. The first

condition, however, states that the marginal benefit of increasing the number of firms in sector a , $\frac{1}{1+r^*}W_{M_a}(M'_a, M'_b)$, is not high enough for entry to occur, but is also not small enough to induce exit. To see that the first set of inequalities hold, we replace $W_{M_a}(M'_a, M'_b)$ by its value at the guessed solution:

$$0 \leq \frac{(1-\alpha)Z_a M_a^{-\alpha} - \psi}{r^*} \leq \phi,$$

which is true since $\underline{M}_a \leq M_a \leq \overline{M}_a$.

Finally, let $M_a > \overline{M}_a$, with any M_b . The guess is $M'_a = \overline{M}_a$, and $M'_b = 0$. The associated first-order conditions are:

$$0 = \frac{1}{1+r^*}W_{M_a}(M'_a, M'_b)$$

and

$$\mu_b = -\frac{1}{1+r^*} \left((1-\alpha)pZ_b \left(\frac{1}{\theta \overline{M}_a} \right)^\alpha - \psi \right) > 0.$$

The first condition requires that $(1-\alpha)Z_a M_a^{-\alpha} - \psi = 0$, which is achieved by setting $M'_a = \overline{M}_a$. The second condition holds because $\theta > 1$.

To complete the proof we have to show that the value function W is recovered once we substitute the optimal solution into problem (2.11). This, however, is trivial. ■

The next lemma characterizes the value function W when $\bar{\theta} \geq \theta > 1$. To facilitate the description of W we provide Figure 6.1, which defines the areas A through E which represent a partition of the feasible set.

In Lemma 6.2 and Proposition 6.3 we use the following notation: $m_i(M_j, \pi)$ is next period's value of M_i that solves $\pi'_i = \pi$, when $M'_j = M_j$, $i \neq j$.

Lemma 6.2. Assume $\bar{\theta} \geq \theta > 1$. Then

$$W(M_a, M_b) = \begin{cases} y(M_a, M_b) - \phi(m_a(M_b, \phi r^*) - M_a) + \frac{1}{r^*}y(M_a(m_b, \phi r^*), M_b) & , (M_a, M_b) \in A \\ y(M_a, M_b) + \frac{1}{r^*}y(M_a, M_b) & , (M_a, M_b) \in B \\ y(M_a, M_b) + \frac{1}{r^*}y(M_a, m_b(M_a, 0)) & , (M_a, M_b) \in C \\ y(M_a, M_b) + \frac{1}{r^*}y(M_a, 0) & , (M_a, M_b) \in D \\ y(M_a, M_b) + \frac{1}{r^*}y(\overline{M}_a, 0) & , (M_a, M_b) \in E \end{cases}$$

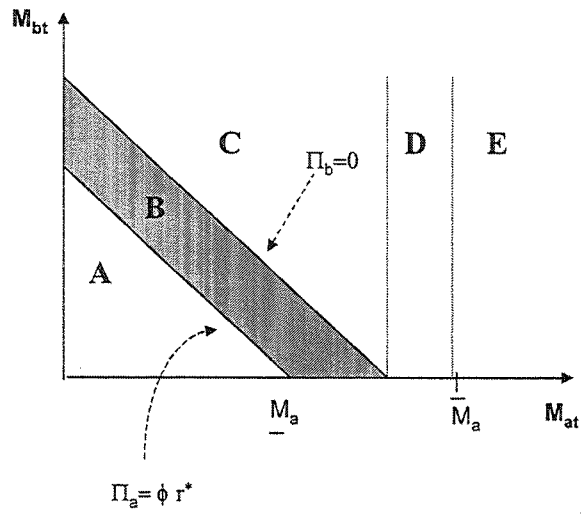


Figure 6.1: The Domain of the W Function: The Non-Specialized Steady State

Proof. The strategy of the proof is the same as in the proof of Lemma 6.1. The proof uses the above guess for the value function W with the implied decision rules to show that this function solves problem (2.11). One can show that our guess is strictly concave so that for any (M_a, M_b) , problem (2.11) solved with the above W function admits only one solution. Hence, we restrict attention to the suggested decision rules. This proof is very tedious and repetitive, and since no insight is lost, we shall limit it to the description of one case.

Suppose that $(M_a, M_b) \in A$. Then, we guess that $M'_a = m_a(M_b, \phi r^*) > M_a$, and $M'_b = M_b$, which implies $(M'_a, M'_b) \in B$. The first-order conditions that need to be verified are:

$$\frac{1}{1+r^*} W_{M_a}(M'_a, M'_b) = \phi$$

and

$$0 \leq \frac{1}{1+r^*} W_{M_b}(M'_a, M'_b) \leq \phi.$$

The first condition, when evaluated at the guessed optimum (recall the definition of $m_i(M_j, \pi)$), is equivalent to:

$$\frac{1}{1+r^*} (\phi r^* + \phi) = \phi,$$

whereas the second condition is equivalent to:

$$0 \leq \frac{1}{r^*} \left((1-\alpha) p Z_b \left(\frac{1}{\theta M'_a + M_b} \right)^\alpha - \psi \right) \leq \phi.$$

The left inequality is true since $\bar{\theta} \geq \theta$, whereas the right inequality is true given $\theta > 1$. It remains to show that $M'_a > M_a$. However, this is just an implication of $(M_a, M_b) \in A$, and profits of firms in sector a being decreasing with M_a . Finally, note that with $(M'_a, M'_b) \in B$ we have,

$$W(M_a, M_b) = y(M_a, M_b) - \theta (m_a(M_b, \phi r^*) - M_a) + \frac{y(m_a(M_b, \phi r^*), M_b)}{r^*},$$

when $(M_a, M_b) \in A$. ■

Proof of Lemma 3.1: (Heuristic proof.)

Consider the following alternative reform path. Permanently reduce tariffs shifting the relative price of good b from p_1 to p_2 , and at time T , announce an unanticipated reversal of the reform bringing the relative price back to p_1 . It is

obvious from our previous discussion that no firm in sector a would exit when the reform is reversed, since exit of firms in sector a from T on would only occur if at time T , $M_a > \overline{M}_a$. (Recall that \overline{M}_a is independent of p .) Now, consider again the trade reform path in the text of the Lemma. Since agents have more information compared to our alternative reform path above they can only do better in terms of achieving a higher value of W . That means that no exit of firms in sector a will occur anyway. ■

The remainder of the appendix explores the dynamics of the model with no access to the international capital market. We show that the only difference regarding the dynamics implied by Lemma 6.2 is that the convergence towards the steady state when there is firm growth (which is still restricted to sector a because $\theta > 1$) is only asymptotic. We prove this result for the case $\bar{\theta} > \theta$, but it is easy to see that the same result holds for the case where the steady state is specialized.

Proposition 6.3. *Assume $\bar{\theta} > \theta > 1$. The decision rules associated with problem (4.4) are the same as those implicit in Lemma 6.2 except that when the initial industry configuration is in area A , $M_{at} \rightarrow m_a(M_b, \phi r^*)$ as $t \rightarrow \infty$.*

Proof. We start by noting that because of Assumption 2, the steady state sets in the models of section 2 and 4 are equivalent. Suppose then that the initial industry configuration $(M_a, M_b) \in A$. The first order conditions of problem (4.4) are the following:

$$0 \leq \beta U_1(M'_a, M'_b), \beta U_2(M'_a, M'_b) \quad (6.1)$$

$$\beta U_1(M'_a, M'_b) \leq \phi \gamma \eta C_a^{-\sigma}, \text{ with equality if } M'_a > M_a \quad (6.2)$$

$$\beta U_2(M'_a, M'_b) \leq \phi \gamma \eta C_a^{-\sigma}, \text{ with equality if } M'_b > M_b. \quad (6.3)$$

We first show that if $M'_a > M_a$, and $(M'_a, M_b) \in A$, then $M'_b = M_b$. Next we show that if $M'_b = M_b$, then $M'_a > M_a$ is optimal, with $(M'_a, M_b) \in A$. Assume then that in region A , M_a is increasing over time. Then the envelope conditions are:

$$U_1(M'_a, M_b) = \gamma \eta (C'_a)^{-\sigma} (\pi'_a + \phi)$$

$$U_2(M'_a, M_b) = \gamma \eta (C'_a)^{-\sigma} \pi'_b.$$

Clearly, (6.1) is satisfied since $(M_a, M_b) \in A$, or $\pi'_a, \pi'_b \geq 0$. Equation (6.3) can be written, with the help of (6.2) (expressed as an equality), as:

$$\beta \gamma \eta (C'_a)^{-\sigma} \pi'_b < \gamma \eta (C'_a)^{-\sigma} (\pi'_a + \phi).$$

Using (2.10) this inequality this inequality is equivalent to

$$0 < (\theta - 1) (\psi + \pi_b) + \phi$$

which is always true given $\theta > 1$. Therefore $M'_b = M_b$ is optimal.

Assume now that the optimal solution prescribes $M'_b = M_b$. If $M'_a = M_a$, then we must be at a steady state, but we know that since $(M_a, M_b) \in A$, $\pi'_a > \phi r^*$. Therefore, $M'_a = G(M_a, M_b) > M_a$ (where G denotes the optimal decision rule). Finally, besides showing that $M'_a > M_a$, we're also required to show that M_a is increasing over time, that is, that G is strictly increasing in its first argument. To see this take $M_{a2} > M_{a1}$ and assume the contrary, that $G(M_{a2}, M_b) \leq G(M_{a1}, M_b)$. Taking the ratio of the first order condition evaluated at these points we have

$$\begin{aligned} & \frac{\beta U'(G(M_{a1}, M_b), M_b)}{\beta U'(G(M_{a2}, M_b), M_b)} \\ = & \frac{\phi \gamma \eta (p Z_b (\theta M_{a1} + M_b)^{1-\alpha} - \psi (M_{a1} + M_b) - \phi (G(M_{a1}, M_b) - M_{a1}))^{-\sigma}}{\phi \gamma \eta (p Z_b (\theta M_{a2} + M_b)^{1-\alpha} - \psi (M_{a2} + M_b) - \phi (G(M_{a2}, M_b) - M_{a2}))^{-\sigma}}. \end{aligned}$$

The left-hand-side is less than or equal than unity because U is strictly concave. However, the right-hand-side is strictly bigger than one since $G(M_{a2}, M_b) - M_{a2} < G(M_{a1}, M_b) - M_{a1}$, and $(M_a, M_b) \in A$. This contradiction yields the first result.

Suppose now that the initial industry configuration $(M_a, M_b) \in C$. It is clear that the solution encompasses $0 \leq \beta U_1(M_a, m_b(M_a, 0)) \leq \phi \gamma \eta C_a^{-\sigma}$, and $\beta U_2(M_a, m_b(M_a, 0)) = 0$, which requires that

$$\pi'_b = 0.$$

This is immediately verified as suggested by our construction of the function $m_b(M_a, 0)$.

The other cases are similar and are left without proof. ■