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Trade liberalisation with costly adjustment

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Abstract

This paper discusses the welfare effects of trade in a Heckscher-Ohlin model of trade with costs of adjustment. The paper analyses the efficiency and the distributional effects of eliminating a tariff in a formerly protected sector. The tariff can be eliminated at the onset or after a while. In case of postponing the elimination of the tariff, the government may pre-announce the policy change or may not do it and surprise the private sector. It is shown that while large adjustment costs reduce the efficiency gains from trade liberalisation, small to moderate adjustment costs may *raise* the efficiency gains from a pre-announced liberalisation. The (net) adjustment costs reduce the welfare gains and losses of owners of production factors from a sudden unanticipated liberalisation. The policy risk is partially shifted towards owners of firms. The distributional effects of trade liberalisations are more complex when the policy is pre-announced. The adjustment costs may increase the gains and losses of owners of the production factors, for small and moderate levels. Also, the announcement that the tariff will be eliminated affects the value of the firms, and when the adjustment cost are not high it may raise rather than reduce the value of the firms in the formerly protected sector.

Resumen

El trabajo discute los efectos del comercio internacional sobre el bienestar utilizando un modelo Heckscher-Ohlin donde se incorporan costos de ajuste. En particular se analizan los efectos sobre la eficiencia y el bienestar de eliminar un arancel en un sector protegido. El arancel se puede eliminar inicialmente o después de un período. En caso de posponer la eliminación de la tarifa, el gobierno puede anunciar o no el cambio de política. Si no anuncia el cambio sorprende al sector privado. Se muestra que mientras altos costos de ajuste reducen las ganancias de eficiencia de la liberalización comercial, para costos de ajuste de nivel bajo o moderado aumentan las ganancias de eficiencia de la liberalización pre-anunciada. Los costos de ajuste (netos) reducen las ganancias y pérdidas de bienestar de los propietarios de los factores de producción en una liberalización no anticipada. El riesgo de la política es parcialmente trasladado a los propietarios de las firmas. Los efectos distributivos de la liberalización comercial son más complejos cuando la política es pre-anunciada. Los costos de ajuste pueden incrementar las ganancias y las pérdidas de los propietarios de los factores de producción, cuando los costos de ajuste son bajos o moderados. Asimismo, el anuncio de la futura eliminación del arancel afecta el valor de las firmas y, si el costo de ajuste no es alto, puede aumentar en lugar de reducir el valor de las firmas en el sector previamente protegido.

JEL: F110, F130

1. Introduction

This paper analyses the welfare gains and losses from the elimination of tariffs in the presence of costs of adjustment, using a dynamic extension of an otherwise standard Heckscher-Ohlin (HO) model of trade. The paper compares different alternatives of trade liberalisation, including a sudden unanticipated elimination of the tariffs, a pre-announced elimination of the tariffs, and a postponed, but still not announced, elimination of the tariffs. We analyse both the efficiency and the distributional effects of the trade policy. The efficiency effects are measured as the response in the welfare of the representative agent in an homogeneous-society version of the model, and the distributional effects are measured by the welfare gains and losses of different individuals in an heterogeneous-society version of the model.

Costs of adjustment arise from many sources, including hiring, firing, and training labour, installing and adapting machines and buildings, and doing marketing and adapting the products distribution nets. With these so many sources of costs of adjustment, it is not obvious how the adjustment costs function should be specified. Furthermore, there is now an extensive literature showing that the economic dynamics associated to costly adjustment does depend on some details of the specification of the adjustment costs function. In one vein, some authors have emphasised the relevance of distinguishing *net* from *gross* adjustment costs (Hamermesh, 1993; Hamermesh, Hassink and van Ours, 1994). The former arise when the level of employment is changed, and the latter occur whenever workers are hired or fired, even if the level of employment remains unchanged. A similar distinction has been made for capital (Neary, 1978; Grossman, 1983; Clarete, Trela and Whalley, 1994). Gross adjustment costs give rise to sector specificity and to different returns of the same production factor across sectors.

In a related but different vein, the literature has explored the effects of adding fixed adjustment costs, non convex adjustment costs, and marginal adjustment costs that do not tend to zero as the input change tends to zero (Oi, 1962; Rothschild, 1971; Kemp and Wan, 1974; Hamermesh, 1989; among others). This literature has shown that these adjustment-cost functions may give place to very different responses to price shocks, ranging from no response at all to minor shocks, to immediate one-period adjustment

We adopt a quadratic adjustment cost function, in the fashion of Sargent (1978). In so doing, we make several choices. First, we focus on net adjustment costs, leaving aside the costs stemming from turnover. Factors can be costlessly moved from one sector to the other, and hence the return to production factors is equalised across sectors. In this respect, we keep close to the standard HO model. But because of the cost of changing the level of production, competitive firms make non-zero profits. Hence, unlike previous models of trade liberalisation, the model in this paper exhibits changes in the value of the firms associated to trade reforms. Besides, these changes are different across sectors. In the real world, structural changes in which some sectors expand and some other sectors contract seem to be associated to significant changes in the values of the involved firms. Our model may be useful to analyse this aspect of the liberalisation process that has received little attention in the literature. Second, quadratic adjustment costs leave out of our analysis issues of hysteresis and lumpy responses to shocks. Admittedly, these issues are likely to be important in the real world. We leave them aside because we want to preserve the HO characteristics of the model in the steady state, while having a gradual adjustment process during the transition.

Being our goal analytic, we decided to focus on a narrow set of issues, keeping the model as close as possible to the HO tradition, hence leaving aside many important considerations that should not

be dismissed in a balanced assessment of trade reform. Concerns about *unemployment* are usually prominent in the policy debate about trade liberalisation, despite of some recent empirical literature indicating that the short run effects of trade liberalisation on unemployment may be small (Papageorgiou et al., 1991; Edwards, 1994). Early analytical treatments of this issue can be found in Neary (1982) and Mussa (1986). Several episodes of trade liberalisation were associated to large *current account deficits* and *consumption booms*. These distortions have been explained in terms of the lack of credibility of the liberalisation process, or the hypothesis that agents think that the tariff reduction may be temporary (Calvo, 1988; Calvo and Mendoza, 1994). Karp and Paul (1994) analyse the optimal timing of trade reform in the presence of *congestion costs*. They argue that because of congestion externalities, private and social marginal adjustment costs may differ, and reallocation tends to occur too rapidly. Nevertheless, they show that trade reforms should begin with trade liberalisation, and only if the government has commitment capacity there should be an intermediate phase with positive tariffs, followed by full liberalisation. Investment decisions are usually *costly to reverse*. Coupled with uncertainty, irreversibility may give rise to substantial inertia and hysteresis (for a survey, see Dixit, 1992). Albuquerque and Rebelo (1998) explore the implications of irreversible investment and uncertain duration of the trade reform for the performance of the economy in the aftermath of the trade liberalisation reform.

The paper proceeds as follows. In section 2, we present and solve the formal model. In section 3, we report the main results from simulations. Section 4 concludes with some final remarks.

2. The model

2.1. Production and income

There are two productive sectors that use two factors of production, capital and labour. The technology is assumed Cobb Douglas:

$$F_i\left(L_{i,t}, K_{i,t}\right) = H_i \left(K_{i,t}\right)^{\alpha_i} \left(L_{i,t}\right)^{1-\alpha_i} \quad i = A, B \qquad \textbf{(1)}$$

Competitive firms rent capital paying return r_t per unit of capital to owners of capital. Firms also hire labour, paying a wage w_t to workers, and incurring in quadratic adjustment costs when the total amount of labour occupied in the firm is changed. With only net adjustment costs, there is no significant difference between labour and capital adjustment costs. Indeed, we are assuming that there is a cost associated to changing the level of production. For ease of computation, we write it as a cost of changing the employment of a production factor, but it can be shown that there is an equivalent formulation in terms of the other production factor and still another equivalent formulation in terms of output.

Individual firms do not control prices of production factor services nor prices of goods ($P_{i,t}$). Entrepreneurs in sector *i* choose the path of labour and capital to maximise the value of the firm[1]:

[1] In order to simplify notation the same symbols represent both the employment of the firm and that of the whole sector.

$$\text{Maximise} \quad \sum_{t=0}^{\infty}\left[\left(P_{i,t}Y_{i,t} - w_t L_{i,t} - r_t K_{i,t}\right) \Big/ \prod_{s=0}^{t}\left(1+R_s\right)\right]$$

$$\{L_{i,t}, K_{i,t}\}_{t\,=\,0,\ldots,\infty}$$

$$\text{s.t.} \quad Y_{i,t} = F_i(L_{i,t}, K_{i,t}) - \frac{a_i}{2}\left(L_{i,t} - L_{i,t-1}\right)^2$$

$$0 \le L_{i,t} \le \overline{L} \;;\; 0 \le K_{i,t} \le \overline{K}$$

$$L_{i,-1} \text{ given}$$

(2)

where a_i is the adjustment cost parameter in sector i, $\overline{L}$ and $\overline{K}$ are the factor endowments, $L_{i,-1}$ is the initial allocation of labour, and R_s is the interest rate.

The first order conditions are:

$$P_{,t} H_i (1-\alpha_i)\left(\frac{K_{i,t}}{L_{i,t}}\right)^{\alpha_i} = w_t + a_i P_{i,t}\left(L_{i,t} - L_{i,t-1}\right) - \frac{a_i P_{i,t+1}}{1+R_{t+1}}\left(L_{i,t+1} - L_{i,t}\right) \qquad ; \quad t = 0,\ldots\infty$$

(3)

$$P_{i,t} H_i \alpha_i \left(\frac{K_{i,t}}{L_{i,t}}\right)^{\alpha_i - 1} = r_t \qquad ; \quad t = 0,\ldots\infty$$

(4)

In the tradition of the Heckscher-Ohlin model, we assume that factor endowments in the economy are fixed. There is no capital accumulation, and no demographic growth. Markets are competitive and prices are fully flexible, so the markets for production factors clear in every moment:

$$L_{A,t} + L_{B,t} = \overline{L} \qquad ; \quad t = 0,\ldots\infty$$

(5)

$$K_{A,t} + K_{B,t} = \overline{K} \qquad ; \quad t = 0,\ldots\infty$$

(6)

The economy is small. Domestic events do not modify international prices ($P^*_{i,t}$), but the government sets taxes and subsidies on foreign trade ($\tau_{i,t}$) that alter domestic prices (the foreign exchange rate is normalised to 1):

$$P_{i,t} = P^*_{i,t}\left(1+\tau_{i,t}\right)$$

(7)

There is no international borrowing and lending. The interest rates are determined to clear domestic credit markets (see next section).

Equations (3) to (7) define a system of non-linear second-order difference equations, that can be solved for eight endogenous variables: $L_{A,t}$, $L_{B,t}$, $K_{A,t}$, $K_{B,t}$, r_t, w_t, $P_{A,t}$ and $P_{B,t}$. Two points in the path of each of the two dynamic variables ($L_{A,t}$ and $L_{B,t}$) must be given to pin down a particular solution.

It is natural to set the initial level of employment, $L_{A,-1}$ and $L_{B,-1}$, as one of those points. Infinite paths are still consistent with both the system (3) to (7) and initial employment, but the saddle path dynamics of this system imply that firms can rule out all save one path, the one converging to the steady state. Other paths are diverging and eventually violate the employment constraints in the firms' programs $\left(0 \le L_{i,t} \le \overline{L}\right)$. Rationality hence implies that the economy eventually converges to the steady state. Output in both sectors can be computed using the paths of capital and labour and equation (1).

Profits are zero in the long run, but not during the transition. In the steady state, when employment stabilises, production factors are paid their marginal product (see equations (3) and (4)). This result and the assumption of constant returns to scale imply zero profits in the long run. During the transition, adjustment costs operate as barriers to entry and exit and firms make profits or loses. Accordingly, there is a value attached to the firm. Interestingly, the simulation results presented below show that there is no simple relationship between the performance of the sector, as measured by output or employment, and the value of the firms. Depending on the timing of the announcements and the implementation of trade liberalisation, firms in the contracting sectors may make loses or profits.

2.2. Consumption, interest rates and foreign trade

We develop two versions of the model, one with homogeneous and the other with heterogeneous population. The representative agent version of the model allows us to focus on the efficiency effects of trade liberalisation, postponing the analysis of the distributional effects of this policy. The heterogeneous population version of the model assumes that the property rights over the production factors and the firms are non-uniformly distributed in the population. The productive sector is the same in both versions. Like in the static HO model, the productive decisions do not depend on the distribution of the property rights over production factors. We present the representative agent version first and the heterogeneous population model later in this same section.

i) The representative agent model

The economy is populated by a constant number of identical and infinitely lived individuals. In order to simplify notation, the size of the population is normalised to 1. The same symbol represents both the aggregate and the individual variables. Individuals own the production factors and the firms. Hence, both the returns of the production factors and the benefits of the firms add to individuals' income, and this sum equals gross revenues of the firms $\left(r_t \overline{K} + w_t \overline{L} + \text{Benefits} = P_{A,t} Y_{A,t} + P_{B,t} Y_{B,t}\right)$. Individuals also receive a uniform lump-sum transfer from the government (b_t). [2] To keep as close as possible to the conventional H-O model, we get rid off accumulation of goods by assuming that both goods are perishable. Individuals can accumulate net financial assets (A_t), borrowing and lending at the interest rate R_t.

The utility function is additively separable in time, with discount factor β. Per period utility is Cobb-Douglas in consumption of both goods.

[2] This assumption is discussed in the following section.

$$\underset{\{C_{A,t},C_{B,t}\}_{t=0,\ldots,\infty}}{\text{Maximise}} \sum_{t=0}^{\infty} \beta^t C_{A,t}^{\ \theta} C_{B,t}^{\ 1-\theta}$$

$$\text{s.t. } P_{A,t}C_{A,t} + P_{B,t}C_{A,t} + A_{t+1} \le P_{A,t}Y_{A,t} + P_{B,t}Y_{B,t} + b_t + A_t(1+R_t) \quad ; \quad t = 0,\ldots,\infty$$

(8)

This program yields corner solutions, in terms of the choice of present versus future consumption, for most combinations of values of parameters and of exogenous variables. These solutions imply that the consumer chooses either to consume all his wealth in the first period and nothing therein or, in the other extreme, to indefinitely postpone consumption. In the first case, all families would want to borrow in the first period and the credit market would be in excess demand. The interest rate would necessarily rise. In the second extreme case, all families would want to lend so there would be an excess supply of loans. The interest rate would fall. There is an intermediate value of the interest rate such that individuals' plans can be consistent in the aggregate. We derive the expression for this equilibrium interest rate in the appendix, and reproduce it here as equation (9):

$$1 + R_t = \left(\frac{P_{A,t}^{\ \theta} P_{B,t}^{\ 1-\theta}}{P_{A,t-1}^{\ \theta} P_{B,t-1}^{\ 1-\theta}} \right) \frac{1}{\beta} = \left(1 + \frac{P_t - P_{t-1}}{P_{t-1}} \right) (1 + \text{subjective discount rate})$$

(9)

Therefore, the equilibrium real interest rate equalises the subjective discount rate, with the real interest rate computed with the relevant price index for this economy $\left(P_t = P_{A,t}^{\ \theta} P_{B,t}^{\ 1-\theta}\right)$. [3]

Two different consumption decisions are embedded in program (8). One is an intratemporal decision: how much to consume of each good within each period. The first order conditions indicate that the composition of the consumption basket in each period must be determined according to the following rule:

$$\frac{C_{B,t}}{C_{A,t}} = \left(\frac{1-\theta}{\theta} \right) \frac{P_{A,t}}{P_{B,t}} \quad ; \quad t = 0,\ldots,\infty$$

(10)

The other decision consumers must make is intertemporal in nature: how much to consume today and how much tomorrow. Consumers are indifferent between consuming today or tomorrow, when the interest rate satisfies equation (9) (see the appendix for the details). Hence, individual consumption is not fully determined by program (8).

Goods markets are in equilibrium when output plus net imports $(M_{i,t})$ equal domestic consumption. There is no accumulation of goods, for goods are assumed perishable.

$$Y_{i,t} + M_{i,t} = C_{i,t} \quad ; \quad t = 0,\ldots,\infty$$

(11)

The assumption that there is no international credit imply trade balance:

[3] This solution depends on the particular assumptions about the utility function (see, for instance, Sargent 1988).

$$P^{*}_{A,t}M_{A,t} + P^{*}_{B,t}M_{B,t} = 0 \quad ; \quad t = 0,...,\infty$$

(12)

The system of equations (10) to (12) determine consumption and net imports in both sectors, given prices and output.

ii) The heterogeneous population model

Individuals in this economy may receive income from five different sources: wages, returns to capital, profits of firms in sector A, profits of firms in sector B, and transfers from the government. Individual 'h' solves the following program:

$$\underset{\{C^{h}_{A,t}, C^{h}_{B,t}\}_{t=0,...,\infty}}{\text{Maximise}} \sum_{t=0}^{\infty} \beta^{t} C^{h}_{A,t}{}^{\theta} C^{h}_{B,t}{}^{1-\theta}$$

$$\text{s.t. } P_{A,t}C^{h}_{A,t} + P_{B,t}C^{h}_{B,t} + A^{h}_{t+1} \le r_t K^{h}_{t} + w_t L^{h}_{t} + B^{h}_{A,t} + B^{h}_{B,t} + b^{h}_{t} + A^{h}_{t+1}(1 + R_t) \quad ; \quad t = 0,...,\infty$$

where $B^{h}_{i,t}$ are the profits that agent 'h' makes from the property of firms in sector i. Adding the individual budget constraints over 'h' gives the representative agent resource constraint in equation (8).

Equations (9) and (10) continue to hold, and hence the consumption basket has the same composition for all consumers. The difference is in the level: consumers with more resources will enjoy larger consumption. We use these properties in the simulations below to compute the welfare gains from different groups of individuals.

2.3. The government

The government sets taxes and subsidies on foreign trade, driving a wedge between domestic and foreign price ratios. The proceeds of net taxes on foreign trade are distributed uniformly among individuals in a lump-sum fashion. Hence, the government budget is balanced in each period. This assumption allows us to focus on the straight effects from trade policy.

$$\tau_{A,t}P^{*}_{A,t}M_{A,t} + \tau_{B,t}P^{*}_{B,t}M_{B,t} = b_t$$

(13)

Note that $\tau_{i,t}$ represent several trade policy instruments. It is an *import tariff* if $M_{i,t}>0$ and $\tau_{i,t}>0$; it is an *import subsidy* if $M_{i,t}>0$ and $\tau_{i,t}<0$; it is an *export tax* if $M_{i,t}<0$ and $\tau_{i,t}<0$; and it is an *export subsidy* if $M_{i,t}<0$ and $\tau_{i,t}>0$. Taxes and subsidies on foreign trade are policy instruments, while the lump-sum transfers are endogenously determined by the government budget (13).

2.4. The phase diagram

The qualitative properties of the model can be analysed with the help of a phase diagram. The model exhibits saddle path dynamics, and the steady state is the standard static H-O equilibrium.

Equations (4) to (6) imply that:

$$P_{A,t} H_A \alpha_A \left(\frac{K_{A,t}}{L_{A,t}} \right)^{\alpha_A - 1} = P_{A,t} H_A \alpha_A \left(\frac{\overline{K} - K_{B,t}}{\overline{L} - L_{B,t}} \right)^{\alpha_A - 1} = P_{B,t} H_B \alpha_B \left(\frac{K_{B,t}}{L_{B,t}} \right)^{\alpha_B - 1} = P_{B,t} H_B \alpha_B \left(\frac{\overline{K} - K_{A,t}}{\overline{L} - L_{A,t}} \right)^{\alpha_B - 1}$$

(14)

These equations define two implicit functions mapping employment into capital in each sector:

$$K_{i,t} = K_i \left(L_{i,t} \right); \; i = A, B$$

(15)

with first derivatives:

$$\frac{dK_{A,t}}{dL_{A,t}} = \frac{dK_{B,t}}{dL_{B,t}} = \left[\frac{(1-\alpha_A) L_{B,t} + (1-\alpha_B) L_{A,t}}{(1-\alpha_A) K_{B,t} + (1-\alpha_B) K_{A,t}} \right] \frac{K_{A,t} K_{B,t}}{L_{A,t} L_{B,t}} > 0$$

(16)

The fundamental dynamic equation of the model follows from equations (3) (5) and (15):

$$P_{A,t} H_A (1-\alpha_A) \left(\frac{K_A(L_{A,t})}{L_{A,t}} \right)^{\alpha_A} - P_{B,t} H_B (1-\alpha_B) \left(\frac{\overline{K} - K_A(L_{A,t})}{\overline{L} - L_{A,t}} \right)^{\alpha_B} =$$
$$= (a_A P_{A,t} + a_B P_{B,t})(L_{A,t} - L_{A,t-1}) - \frac{(a_A P_{A,t+1} + a_B P_{B,t+1})}{1 + R_{t+1}} (L_{A,t+1} - L_{A,t})$$

(17)

This non-linear-second-order difference equation in employment determines a family of integral curves. Two additional conditions are needed to pin down a particular solution to equation (17). One is the initial level of employment. The other is a transversality condition, implicit in the feasibility constraint that employment in any sector is non negative and smaller than or equal to total labour supply. It is shown below that all save one path eventually violate this feasibility constraint.

It proves useful to write equation (17) as a first-order system in the level and the first difference of employment:

$$P_{A,t} H_A (1-\alpha_A) \left(\frac{K_A(L_{A,t})}{L_{A,t}} \right)^{\alpha_A} - P_{B,t} H_B (1-\alpha_B) \left(\frac{\overline{K} - K_A(L_{A,t})}{\overline{L} - L_{A,t}} \right)^{\alpha_B} =$$
$$= (a_A P_{A,t} + a_B P_{B,t})(L_{A,t} - L_{A,t-1}) - \frac{a_A P_{A,t+1} + a_B P_{B,t+1}}{1 + R_{t+1}} X_t$$

(18)

$$X_{t-1} = L_{A,t} - L_{A,t-1}$$

(19)

The phase diagram of this system will be represented in $(L_{A,t-1}, X_{t-1})$.

(i) The locus of constant employment, $L_{A,t} = L_{A,t-1}$

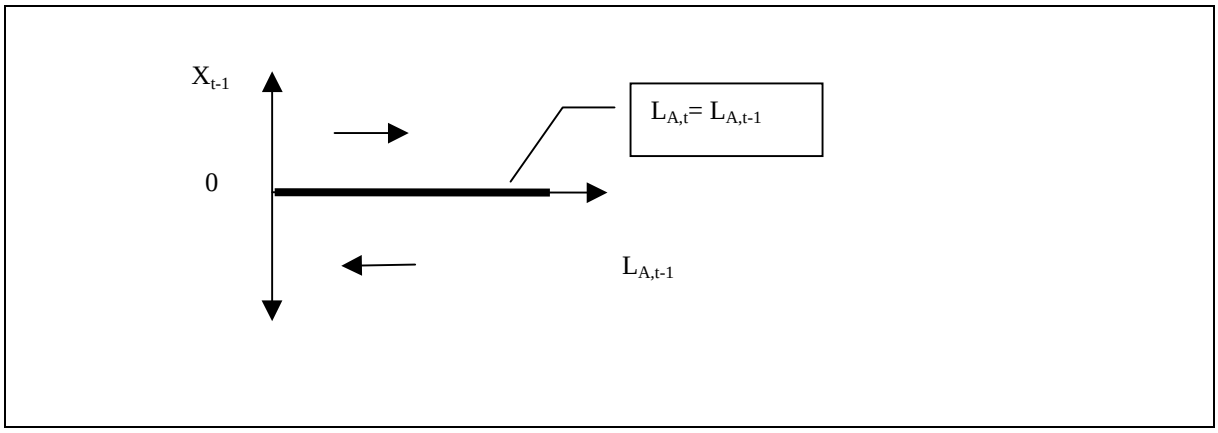
Equation(19) imply that this locus is $X_{t-1} = 0$.

(ii) Dynamics of employment

$$\Delta L_A = L_{A,t} - L_{A,t-1} > (=, <) 0 \qquad \text{if} \qquad X_{t-1} > (=, <) 0$$

The locus of constant employment and the dynamics of employment are represented in figure 1.

Figure 1: The locus of constant employment



(iii) The locus of constant variation of employment, $X_t = X_{t-1}$

The condition that defines this locus is:

$$X_t = X_{t-1} = L_{A,t} - L_{A,t-1}$$

Using this condition in (18):

$$P_{A,t} H_A (1-\alpha_A) \left(\frac{K_A (L_{A,t-1} + X_{t-1})}{L_{A,t-1} + X_{t-1}} \right)^{\alpha_A} - P_{B,t} H_B (1-\alpha_B) \left(\frac{\overline{K} - K_A (L_{A,t-1} + X_{t-1})}{\overline{L} - L_{A,t-1} - X_{t-1}} \right)^{\alpha_B} =$$

$$= \left(a_A P_{A,t} + a_B P_{B,t} - \frac{a_A P_{A,t+1} + a_B P_{B,t+1}}{1 + R_{t+1}} \right) X_{t-1}$$

The locus of constant variation of employment crosses the locus of constant employment in the steady state. Its slope can be positive or negative, depending on parameter values.

(iv) The dynamics of the variation of employment

Equations (18) and (19) imply that:

$$\frac{a_A P_{A,t+1} + a_B P_{B,t+1}}{1 + R_{t+1}} \Delta X_t = \left(a_A P_{A,t} + a_B P_{B,t} - \frac{a_A P_{A,t+1} + a_B P_{B,t+1}}{1 + R_{t+1}} \right) X_{t-1}$$

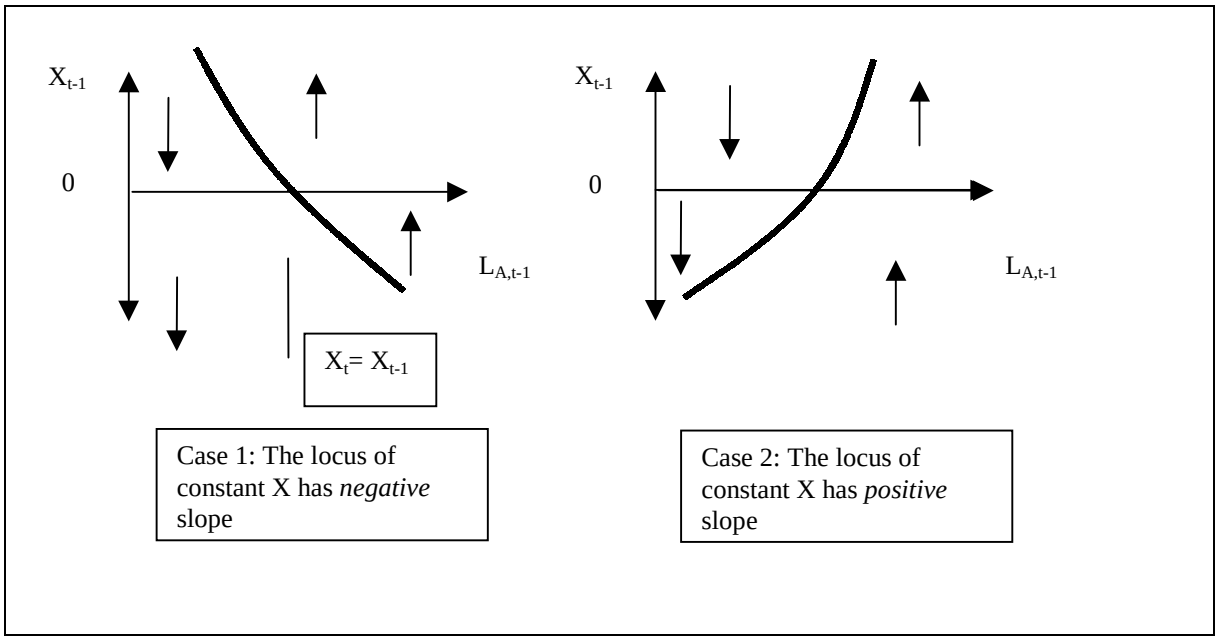
$$- P_{A,t} H_A (1-\alpha_A) \left(\frac{K_A (L_{A,t})}{L_{A,t}} \right)^{\alpha_A} + P_{B,t} H_B (1-\alpha_B) \left(\frac{\overline{K} - K_A (L_{A,t})}{\overline{L} - L_{A,t}} \right)^{\alpha_B}$$

(20)

X_t is increasing to the right and decreasing to the left of the locus of constant X_t. Indeed, from (4) and (20):

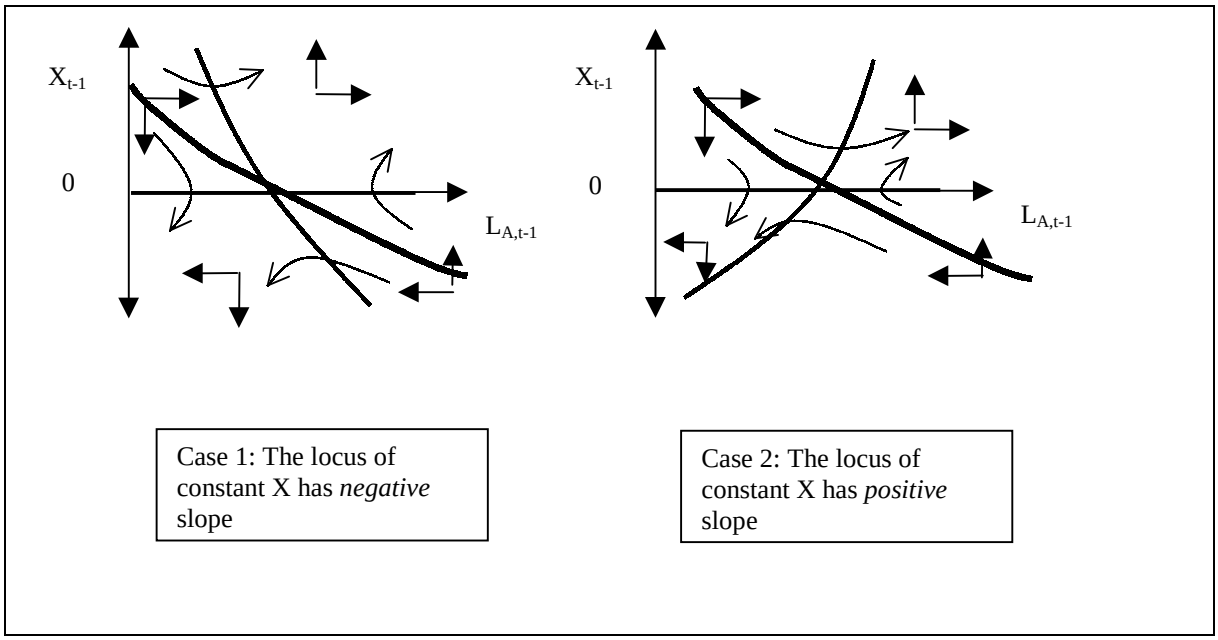
$$\frac{\partial \Delta X_t}{\partial L_{A,t-1}} = \frac{r_t(1+R_{t+1})}{(a_A P_{A,t+1} + a_B P_{B,t+1})} \frac{(1-\alpha_A)(1-\alpha_B)(k_{A,t} - k_{B,t})^2}{[(1-\alpha_A)K_{B,t} + (1-\alpha_B)K_{A,t}]} > 0$$

Figure 2: The locus of constant variation in employment



The results in (i) to (iv) determine the phase diagram presented in figure 3.

Figure 3: The phase diagram.

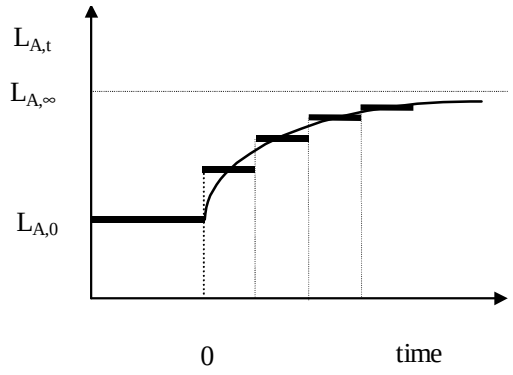


The economy exhibits saddle path dynamics. Firms choose how much to increase or decrease employment from the current to the next period $\left(X_{t-1} = L_{A,t} - L_{A,t-1}\right)$, given previous period employment ($L_{A,t-1}$). Rational entrepreneurs pick the value of X_{t-1} on the saddle path, for any other choice would put the economy on an unsustainable path that eventually violates the feasibility conditions of employment $\left(0 \le L_{A,t} \le \bar{L}\right)$.

2.5. Comparative dynamics

Consider an increase in the price of sector A that moves the economy away from an initial steady state. The steady state level of employment in sector A rises, and hence both the locus of constant variation of employment $\left(X_t = X_{t-1}\right)$ and the saddle path shift to the right. Sector A starts hiring new labour. Unlike in the static models, employment does not jump immediately to the new steady state (the new equilibrium in the static model), because of costs of adjustment. Doing all the adjustment instantly would involve incurring in huge adjustment costs. Rather, entrepreneurs in sector A expand employment gradually, at a pace dictated by the saddle path. Firms in sector B reduce employment at the same velocity firms in sector A expand it, so that total employment remains equal to the exogenous labour supply (see equation (5)).

Figure 4 The dynamics of employment in sector A after an increase in the price of good A



Moving capital is costless in this model. Nevertheless, capital moves gradually from sector B to sector A, at the pace dictated by the movement of labour (equation (16)). Firms in the expanding sector do not want to hire more capital they can efficiently use with the workers they have in each period. Firms in the contracting sector remain using for a while some of the capital they will eventually free. The adjustment costs in one factor determine a slow adjustment not only in that factor but also in other production factors.

The speed of adjustment depends on the adjustment costs in both sectors (equation (18)). The adjustment in sector A is slower the higher is the adjustment cost parameter in sector A, but also in sector B. Firms facing these costs adjust slowly; this is the direct and more obvious effect. But there are also indirect general equilibrium effects going through the returns of production factors that determine a slow adjustment also in the other sector (equations (3)).

The increase in the price of sector A induces a change in the consumption basket. Families reduce consumption of good A relative to good B.

Net imports of sector A shrink as production in the sector rises and domestic consumption of this good decreases. Net imports of sector B rise as production reduce and domestic consumption of B increases.

3. Trade liberalisation, some simulation results

3.1. Liberalise now or later?

Should the government liberalise foreign trade once and for all or should it make the announcement first and give the private sector some time to adjust? There is no point in waiting if, as it is assumed in the standard static HO model of trade, adjusting is costless. But, does this conclusion extend to the more realistic case in which firms do incur in adjustment costs? According to the static HO model, trade liberalisation is good because it induces a more efficient allocation of resources. But, what would be the benefits from trade liberalisation if, because of adjustment costs, resources do not reallocate or do it very slowly? Do adjustment costs provide a rationale for delay or even no liberalisation?

To answer these questions, we compare the general equilibrium welfare effects of eliminating tariffs now or, alternatively, announcing now that tariffs will be eliminated in the future (first two rows in table 1). Table 1 presents the welfare gains defined as the difference between the sum of discounted utilities with and without trade liberalisation. There is a 15 per cent tariff on the capital

intensive import sector in the initial steady state. We consider five values of the adjustment cost parameter, including the limiting case in which the cost of adjustment is zero.

Table 1: Welfare gains from trade liberalisation, representative agent model

	Adjustment costs levels				
Timing	Null	Low	Moderate Low	Moderate High	High
Unanticipated liberalisation in period 0	516	510	486	411	251
Liberalisation in period 20, announced in period 0	194	197	204	219	170
Liberalisation in period 20, announced in period 20	194	192	183	155	95

The first conclusion we can draw from table 1 is that trade liberalisation increases welfare - welfare gains are positive in all these cases. Hence, adjustment costs do not seem to justify keeping positive tariffs, at least not in the scenarios presented in this table.

A second conclusion from the results in table 1 is that liberalising now is better than waiting. Welfare increases more with a sudden immediate tariff elimination than with a postponement and this is so for all the parameter levels considered in these simulations.

Welfare gains from a sudden unanticipated trade liberalisation are decreasing in the adjustment parameter (first row in table 1). Adjustment costs slow down the reallocation of resources and hence reduce the efficiency gains from free trade. In the extreme case of infinite adjustment costs, liberalisation does not induce any reallocation at all.

Nevertheless, small to moderate adjustment costs raise the welfare gains from a pre-announced cut in tariffs (second row in table 1). Because of adjustment costs, firms start reallocating resources when the government announces that the tariff will be eliminated. Without these costs, firms would not begin the adjustment until the tariff is eliminated. Therefore, the adjustment costs may have a positive effect on economic efficiency after the announcement and before the implementation of the tariff reduction. Adjustment costs still slow down the reallocation of resources after the tariff reduction. These countervailing effects determine that welfare gains from a postponed announced liberalisation are non monotone in the adjustment parameter.

The effects of the adjustment costs on the welfare gains from trade liberalisation can be interpreted in the light of taxation theory. The larger the tax elasticity of a tax base the larger the welfare losses caused by a distortionary tax, and the smaller the welfare gains from eliminating the tax. Adjustment costs reduce the contemporaneous tax elasticity of output, and postpone the efficiency gains from a reduction of a tariff. Hence, the discounted sum of efficiency gains from a sudden and permanent tariff reduction is a decreasing function of these costs. Infinitely large adjustment costs would turn the tariff into a non-distortionary tax. Eliminating the tariff would not contribute to raise efficiency in such a case. But moderate adjustment costs increase the elasticity of current output to a tariff reduction that is known to take place in the future. Therefore, the discounted sum of efficiency gains from a pre-announced liberalisation is an increasing function of the adjustment cost parameter for a range of values.

3.2. The value of pre-announcing trade liberalisation

According to the results discussed above, postponing trade liberalisation reduces the welfare gains from this policy. Therefore, there seems to be no room for pre-announcing it. However, real-world changes in trade policy usually take time. Governments seldom eliminate barriers to trade unilaterally. They rather do it after extensive negotiations with other governments. In this more realistic scenario, which are the effects of announcing that barriers to trade will be eliminated in the future? Does the anticipation of tariff reductions increase welfare?

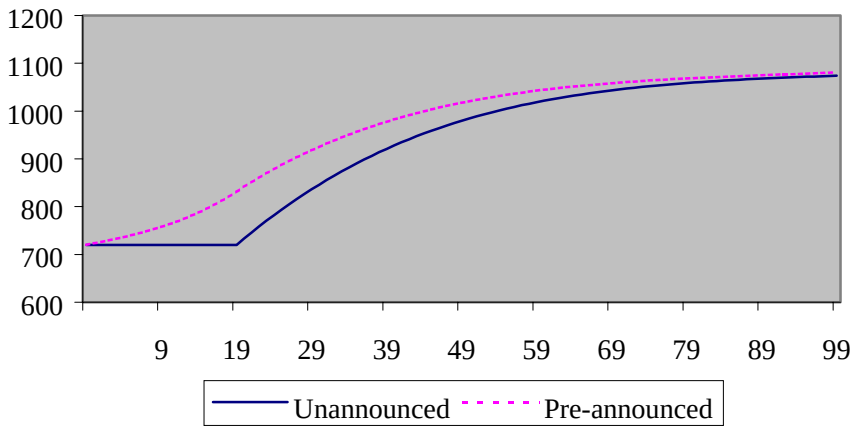
Anticipation of tariff reductions make future consumption relatively less expensive than current consumption, inducing higher domestic savings and a surplus in the current account of the balance of payments. This phenomenon is the reverse of the well known consumption boom and current account deficit that have been associated to trade liberalisations that are thought to be temporary (Calvo, 1988). The policy implications of this phenomenon in terms of the timing of trade and financial liberalisations have been extensively analysed in the literature (Falvey and Kim, 1992). The productive effects of expected variations in tariffs have been far less analysed.[4] In order to focus on the productive dynamic effects of a pre-announced liberalisation, we get rid off the consumption and savings effects, assuming that the goods are perishable and that the economy has no access to international credit markets. The standard HO model highlights the static productive distortions caused by tariffs. The dynamic version presented in this paper allows for the simultaneous analysis of the static and the dynamic distortions in the allocation of resources.

In principle, good information about economic policy helps private agents to make the right choices. But announcing a tariff reduction adds an inter-temporal distortion to the existing intra-temporal distortion caused by the tariff. The goods affected by the tariff become relatively more expensive not only with respect to other goods in the same period, but also with respect to the same goods in the future. Yet, because of the second-best principle, it is not a-priori obvious whether adding this inter-temporal distortion increases or decreases welfare. To address this issue, we simulated an elimination of the tariff in period twenty, assuming first that agents are informed about this policy in period zero, and assuming later that agents learn about this policy only when the tariff reduction takes place – i.e. agents are surprised -.

The results summarised in table 1 (rows 2 and 3) indicate that a pre-announced trade liberalisation is more beneficial than a surprise one, i.e. there is a positive value associated with the announcement when there are adjustment costs. Because of them, the reallocation of resources that enhances efficiency begins when the tariff elimination is announced (figure 5). Therefore, the announcement should not be delayed.

[4] Leamer (1980) analyses these effects in a very simplified two-periods economy.

Figure 5: Employment in the expanding sector
(Liberalization in period 20)



The welfare gains caused by announcing the trade liberalisation – the "value of the announcement" – depend on the adjustment cost parameter. With zero adjustment costs, the information that the tariff will be reduced does not raise welfare. If reallocating resources is costless, firms do not start reallocating productive factors until the tariff is actually reduced, no matter whether they learn about the reduction before or in the very moment in which it takes place. In the simulations reported in table 1, the "value of the announcement" increases with the adjustment cost parameter. After the announcement and before the tariff is actually eliminated, firms reallocate resources faster the more costly is to do it.

3.3. Winners and losers from trade liberalisation

Trade would not affect individuals differently if the property rights over productive factors were uniformly distributed in the population or if the government implemented compensating transfers. The representative agent model presented in previous sections assumes that resources are uniformly distributed in the population. This assumption allowed us to focus on the efficiency effects of trade liberalisation, leaving aside the distributional effects of this policy. But the adjustment costs also have some interesting non trivial consequences on the distributional effects of trade liberalisation. In order to address this issue, we consider now a version of the dynamic-HO model with heterogeneous population.

Owners of production factors receive the same return in both sectors, if production factors are not specialised. With non-specialised labour, all workers are equally affected by trade; the same is true for capitalists. Adjustment costs do not modify this basic property of the HO model. But things are different regarding to the property of firms. Because of adjustment costs, competitive firms make non-zero profits and profits may differ across sectors. While owners of firms in one sector may be making benefits, owners of firms in the other sector may be suffering loses. These considerations led us to identify four distinctive groups in the society: workers, capitalists, owners of firms in

sector A and owners of firms in sector B. [5] Of course, societies are usually not so neatly stratified, but this stark assumption about the distribution of property rights is useful to highlight the distributional effects of trade liberalisation. Table 2 summarises the effects of eliminating the tariff in the capital-intensive sector on the welfare of these four different groups.

Table 2: Welfare gains from trade liberalisation, heterogeneous population

	Adjustment costs levels				
	Null	Low	Moderate Low	Moderate High	High
a) Workers					
Unanticipated liberalisation in period 0	2303	2271	2133	1716	851
Liberalisation in period 20, announced in period 0	869	872	879	886	606
b) Capitalists					
Unanticipated liberalisation in period 0	-1792	-1775	-1693	-1438	-879
Liberalisation in period 20, announced in period 0	-677	-679	-682	-683	-513
c) Owners of firms in sector A					
Unanticipated liberalisation in period 0	0	13	66	219	515
Liberalisation in period 20, announced in period 0	0	1	2	11	115
d) Owners of firms in sector B					
Unanticipated liberalisation in period 0	0	-4	-24	-88	-235
Liberalisation in period 20, announced in period 0	0	1	2	5	-39

Table 2 helps to analyse winners and losers from trade liberalisation. Workers are among the winners and capitalists are among the losers in this example, because sector B –the one whose tariff is being eliminated- is capital intensive. These are standard results from the static HO model. The news is that owners of firms in the expanding sector receive a positive discounted sum of profits, while owners of firms in the contracting sector may or may not experience loses. At first glance, the first result looks easier to understand than the second, but more careful analysis shows that both results respond to quite complex general equilibrium dynamic effects. The fact that the elimination of the tariff in sector B "favours" sector A does not imply that firms in this sector must make profits. Depending on the timing of the process, firms in the expanding sector may even experience initial loses (figure 7 presents an example).

Adjustment costs reduce the impact of a sudden unanticipated trade liberalisation on workers and capitalists (table 2). The larger the adjustment parameter, the smaller the welfare gains of the former and the welfare loses of the latter. In turn, owners of firms are more affected when reallocating resources is costly: owners of firms in the expanding sector are benefited the more and owners of firms in the contracting sector are damaged the more, the larger the adjustment

[5] The government is assumed to channel the proceeds of tariffs to consumers of import goods in a lump-sum fashion. This neutral assumption is made to isolate the effects of distortions caused by tariffs from the income extraction effect which is common to any tax.

parameter. Adjustment costs thus shift the burden of the risk of unanticipated trade policy shifts from owners of production factors to owners of firms. [6]

Things are more complex in the case of a pre-announced liberalisation. According to the results summarised in table 2, workers get larger welfare gains and capitalists experience larger loses the larger the adjustment parameter for small and moderate levels. But sufficiently large adjustment costs reduce gains and loses, just as they do in the unanticipated case. The ambiguity stems from the crossing of the return curves for different levels of the parameter (figure 6). The wage and the return to capital start to change as soon as the announcement is made. After the policy is announced and before it is implemented, the return to production factors change faster the larger the adjustment parameter. But after the tariff is actually eliminated, the return to production factors change slower the larger are the costs involved. Therefore, in this case adjustment costs do not always reduce the trade policy risk for owners of production factors.

Figure 6a: The dynamics of the returns to capital in a pre-announced liberalization

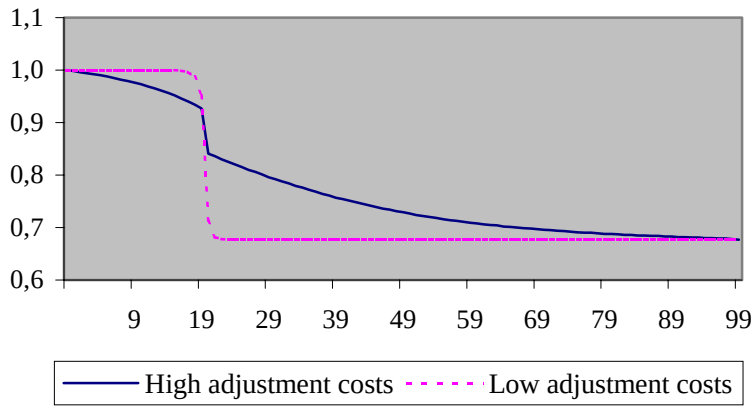
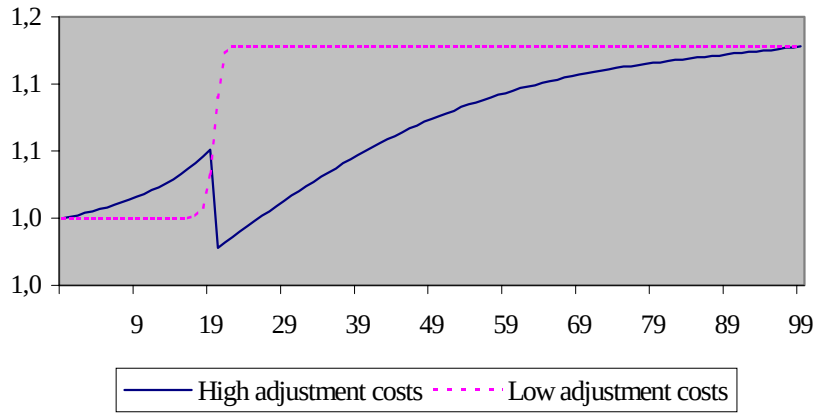


Figure 6b: The dynamics of wages in a pre-announced liberalization

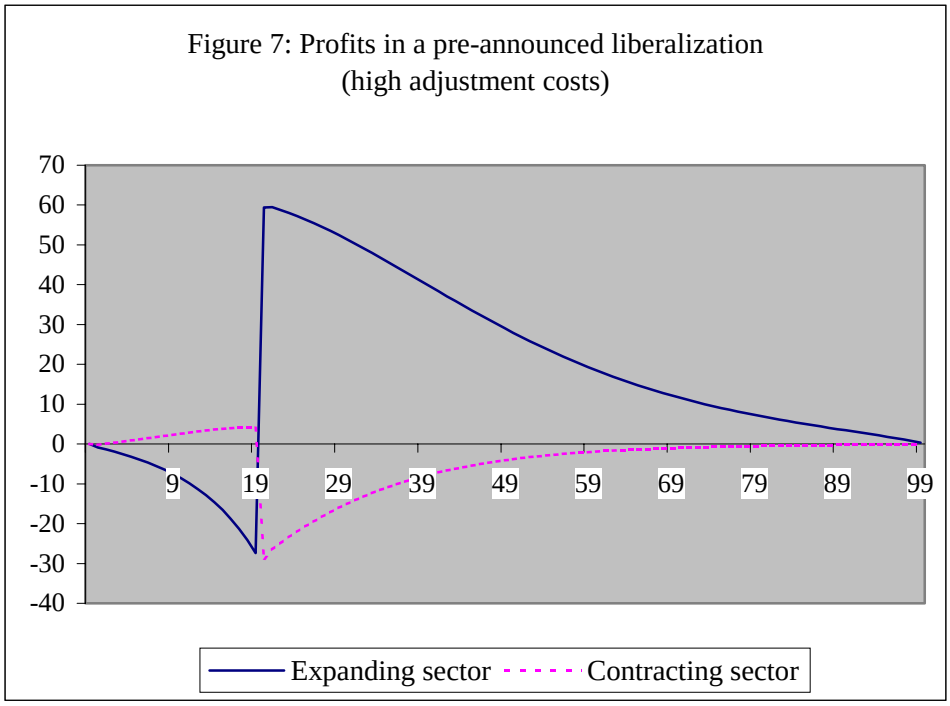


6 It is quite immediate that the same holds true for the risk of variation of international prices.

Pre-announcing trade liberalisation has non trivial effects on the value of the firms and the welfare of their owners. The value of the firms in the expanding sector rises in a pre-announced liberalisation, as it does in a surprise unanticipated one. Also, it rises the more, the larger the adjustment cost parameter. But unlike in the unanticipated liberalisation, the value of the firms in the contracting sector may also rise when it is pre-announced, if the parameter is not too large.

The possibility that firms in the contracting sector increase their value stems from the depressing effect of the announcement of the tariff elimination on the return to capital, the factor in which the contracting sector is intensive. The news that the protected sector will have to face an output price decline due to the programmed elimination of the tariff, coupled with the existence of costs of adjustment, induces firms in this sector to immediately start firing resources and firms in the other sector to start hiring resources. Being the contracting sector more intensive in the use of capital than the expanding sector, capital becomes relatively abundant while labour becomes relatively scarce. The return to capital decreases and the return to labour increases. The decline in the return to capital relative to the return to labour favours the capital-intensive protected sector and damages the labour-intensive export-oriented sector. Therefore, immediately after the announcement, the expanding sector experiences loses while the other makes profits. When the tariff is eliminated, firms in the formerly protected sector face a sharp one-step decline in the output price and start making loses. Firms in the expanding sector start making profits, as the return to capital drops following the sharp decline in the price of the good in the capital-intensive sector (figure 7). Because of these complex time profiles of the profits, a pre-announced reduction of a tariff in presence of costs of adjustment may raise the value of the firms even in the sector that is being unprotected.

Figure 7: Profits in a pre-announced liberalization
(high adjustment costs)



Postponing the measure obviously reduces the present value of the welfare gains and loses caused by the elimination of the tariff. As it comes clear from table 2, the unanticipated liberalisation in period zero yields larger gains and loses than the liberalisation in period twenty announced in

period zero.[7] But this observation is not particularly illuminating: indefinitely postponing the liberalisation would cause no gains and no loses. Not surprisingly, similar conclusions have been reported in quite different frameworks (Mussa, 1986; Albuquerque and Rebelo, 1998).

4. Concluding remarks

This paper revisits some of the issues analysed in Mussa (1986), assuming net rather than gross adjustment costs in a dynamic version of a HO model of trade. Some new issues arise. Firstly, as expected, trade liberalisation enhances efficiency and there is no efficiency reason for postponing it in this HO model with adjustment costs. But, if for other reasons, such as distributional concerns and political support, the elimination of tariffs must be postponed, the announcement of the policy has a positive effect on efficiency, speeding up the reallocation of resources. Of course, announcing a future tax reduction may have other distortionary effects on the intertemporal allocation of consumption and savings, making the balance ambiguous. But we make the point that the positive effect of the announcement fostering the reallocation of resources should not be dismissed when reallocating resources is costly. Previous literature on trade liberalisation that has not explicitly considered the costs of adjustment did not take the efficiency value of the announcement into account.

Adjustment costs reduce the efficiency gains from a sudden unanticipated trade liberalisation. This is not surprising since the expected efficiency gains stem from the reallocation of resources that is hindered by costly adjustment. However, small to moderate adjustment costs may *raise* the efficiency gains from a pre-announced liberalisation. Adjustment costs are needed for the announcement of a future elimination of the tariff to induce the reallocation of resources now. With zero adjustment costs, firms would expect until the tariffs are actually eliminated to reallocate resources, and the announcement would be valueless.

These results have implications for the design of reform packages that involve both liberalising foreign trade and removing regulations that slow down the reallocation of resources. If the country is engaged in a gradual process of trade liberalisation, it may not be optimal to *fully* remove these regulations until the process of trade liberalisation is complete. Furthermore, it would not be advisable to announce that the regulations that slow down the adjustment process will be removed immediately after the elimination of barriers to trade, for this announcement would eliminate the incentives to reallocate resources before. This result is an application of the second-best principle: removing a distortion may not be beneficial when other distortions remain (for other examples of the same principle, see Edwards, 1988, and Rama, 1997). Unfortunately, this principle is not easily applicable in practice. Imperfect knowledge of the appropriate model and parameter values make it difficult to determine to what extent regulations that slow down adjustment should be maintained. In any case, this second-best type of argument should be taken into account in any careful assessment of a reform package.

The distributional effects of trade reform in the presence of adjustment costs depend on whether the policy is pre-announced or not. By and large, adjustment costs reduce the welfare gains and loses of owners of production factors from a tariff elimination that is not anticipated. The burden of the risk is mostly shifted to the owners of firms. When adjustment costs are present, pre-announced trade liberalisations have more complex distributional effects than unanticipated liberalisations. Owners of the production factor that is negatively affected by the tariff elimination may experience larger loses with moderate than with low adjustment costs. Owners of firms in the contracting

[7] The difference is even larger if the liberalisation in period twenty is not pre-announced.

sector may experience welfare gains with a pre-announced liberalisation when adjustment costs are moderate.

The results in this paper suggest that the costs of adjustment matter for the political support for trade liberalisation, but they also suggest that this relationship is complex. On one hand, large adjustment costs dampen the efficiency gains from trade liberalisation and may thus reinforce protectionism. Because of adjustment costs, the efficiency gains from freer trade take time to materialise, reducing the appeal of liberalisation for the government, particularly so if the government has to incur in some short run costs to implement the reform. Moreover, protectionism has often contributed to raise adjustment costs, since non-competitive environments favour lobbying for regulations that create rents and reduce flexibility. Therefore, protectionism and regulations that increase rigidity may reinforce each other in a vicious circle. On the other hand, adjustment costs impact on the distributive effects of trade liberalisation potentially modifying the political support of the reform. Nevertheless, no simple conclusion can be drawn from our analysis in this respect. While some losers from liberalisation experience smaller loses, some other losers suffer larger loses due to the adjustment costs. The opposition to trade reform of the former may be ameliorated, but the opposition of the latter will likely be exacerbated by the costs of adjustment.

APPENDIX

Consumers program

Adding the consumers per period budget constraints, we can rewrite program (8) with the intertemporal budget constraint:

$$\underset{\{C_{A,t},C_{B,t}\}_{t=0,\ldots,\infty}}{\text{Maximise}} \quad \sum_{t=0}^{\infty}\beta^{t}C_{A,t}{}^{\theta}C_{B,t}{}^{1-\theta}$$

$$\text{s.t.} \qquad \sum_{t=0}^{\infty}\frac{P_{A,t}\left(C_{A,t}-Y_{A,t}\right)+P_{B,t}\left(C_{B,t}-Y_{B,t}\right)}{\prod_{i=0}^{t}\left(1+R_{i}\right)}=A_{0} \qquad \textbf{(21)}$$

We have imposed a transversality condition in the intertemporal budget constraint, namely that the present value of net assets that consumers hold in the infinitely far future is zero:

$$\lim_{t\to\infty}\frac{A_{t}}{\prod_{i=0}^{t}\left(1+R_{i}\right)}=0$$

The first order conditions of this program imply equation(10). Using this result back into (21), we rewrite the consumers program as:

$$\underset{\{C_{A,t},C_{B,t}\}_{t=0,\ldots,\infty}}{\text{Maximise}} \quad \sum_{t=0}^{\infty}\beta^{t}\left(\frac{1-\theta}{\theta}\right)^{1-\theta}\left(\frac{P_{A,t}}{P_{B,t}}\right)^{1-\theta}C_{A,t}$$

$$\text{s.t.} \qquad \sum_{t=0}^{\infty}\frac{(1/\theta)P_{A,t}C_{A,t}-\left(P_{A,t}Y_{A,t}+P_{B,t}Y_{B,t}\right)}{\prod_{i=0}^{t}\left(1+R_{i}\right)}=A_{0}$$

$$C_{B,t}=\left(\frac{1-\theta}{\theta}\right)\left(\frac{P_{A,t}}{P_{B,t}}\right)C_{A,t}$$

This is a linear programming problem. Indifference curves and budget lines in the $(C_{A,t},C_{A,t+1})$ space are both straight lines. The program yields corner solutions unless the slope of the budget lines and the indifference curves coincide, in which case consumers are indifferent between consuming in t or in t+1. Corner solutions are not consistent with credit market equilibrium, so these slopes must coincide:

$$\left.\frac{dC_{A,t+1}}{dC_{A,t}}\right|_{\text{budget}}=-\frac{P_{A,t}}{P_{A,t+1}}\left(1+R_{t+1}\right)=\left.\frac{dC_{A,t+1}}{dC_{A,t}}\right|_{\text{indifference}}=-\frac{1}{\beta}\left(\frac{P_{A,t}}{P_{A,t+1}}\frac{P_{B,t+1}}{P_{B,t}}\right)^{\theta}$$

Equation (9) follows.

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