

Chapter 3

Intertemporal prices*

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Current draft: February 4, 2011

1 Introduction

A key feature of the basic intertemporal model presented in Chapter 1 is that the relative price of consumption was constant over time or, put differently, the relative price of consumption across different points in time was always equal to one. As a result, consumers chose a constant path of consumption. In practice, however, there are a myriad of factors that lead to a non-constant path of intertemporal prices, ranging from temporary government policies (such as changes in taxes, tariffs, and monetary policy) to temporary terms of trade shocks. In all these cases, even though they could, consumers will choose not to smooth consumption over time because they will find it in their advantage to consume more when the good is relatively cheap.

When the intertemporal price of consumption varies over time due to policy actions, we will speak of *intertemporal distortions*. They constitute a distortion because, in a first-best world, a planner would choose to keep the relative price of consumption flat over time. The bulk of this chapter is devoted to the analysis of this key feature of intertemporal models. To provide a real-world motivation for intertemporal distortions, we will follow Calvo (1987) and study a model with two goods, exportables and importables, in which temporary import tariffs introduce intertemporal distortions. In the benchmark model of Sections 2 and 3, a permanent reduction in tariffs has no impact on consumption and welfare. In contrast, a temporary reduction in tariffs leads to a temporary boom in consumption – as consumers take advantage of temporarily cheaper prices –

*Comments very welcome. This chapter is part of a graduate textbook on “Open Economy Macroeconomics in Developing Countries”, currently under preparation by the author (forthcoming in MIT Press) and should be cited accordingly. I am extremely grateful to Pablo Lopez Murphy, Agustin Roitman, Daniel Hernaiz, Fernando Im, Guillermo Tolosa, Igor Zuccardi, and Rong Qiang for their help in the preparation of this chapter. I also wish to thank Ari Aisen, Laura Alfaro, Jorge Baldrich, Ed Buffie, Marcelo Catena, Sebastian Claro, Eduardo Ganapolsky, and Rajesh Singh for helpful comments and suggestions on this chapter.

followed by a consumption bust. This non-flat path of consumption is socially sub-optimal. Hence, a temporary trade liberalization is always welfare reducing.

Taken at face value, the policy prescription of this benchmark model would be a recipe for inaction since, at best, the welfare effects of a liberalization would be nil (when the liberalization is permanent). The model, however, abstracted from possible wealth effects. In practice, trade liberalizations are likely to generate wealth effects by, say, increasing productivity in the traded goods sector. To capture such a scenario, Section 5 introduces wealth effects into the benchmark model. In this case, a permanent reduction in tariffs leads to higher consumption and welfare. More interestingly, even a temporary tariff reduction may increase welfare if the wealth effect dominates the intertemporal distortion effect. Since the wealth effect will be larger the longer is the liberalization, a long-lasting liberalization will be welfare improving even if a short-lived one is not. Hence, from a normative point of view, the model yields the policy prescription that reforms such as trade liberalization may be worth pursuing, even if they may prove temporary, as long as they generate sizable increases in productivity.

In general, policymakers will rarely embark purposely on a temporary reform. Typically, reforms turn out to be temporary because poor results coupled with waning political support force a reversal. Another intriguing source of *de facto* temporary reforms – suggested by Calvo (1989) and pursued in Section 4 – is lack of credibility. The basic idea is that when policymakers announce a reform (which they intend to be permanent), the public will not believe that the reform will be sustained over time (i.e., the announcement is not fully credible). In fact, if the public believes that the reform will be abandoned at some point in the future, the announcement will have the same short-run effects as a temporary reform. A temporary trade liberalization can thus be reinterpreted as arising from lack of credibility. Hence, lack of credibility is socially costly because it generates intertemporal distortions. Given the history of failed reforms in many developing countries, lack of credibility is bound to be an important source of social losses. This underscores the importance of efforts aimed at building mechanisms and institutions that may enhance policy credibility in developing countries.

As a second example of intertemporal distortions, Section 6 analyzes the case in which the government finances an exogenously given level of spending by resorting to a consumption tax. To fix ideas, we assume that the government must balance its budget on a period-by-period basis. In this context, permanent changes in government spending will lead to a wealth effect but no intertemporal distortions since the consumption tax rate will be constant over time. A temporary increase in government spending, however, will lead to a non-constant path of tax rates and hence introduce an intertemporal distortion. Consumers' welfare will therefore be lower because of a wealth effect (due to higher government spending) and an intertemporal distortion (non-constant tax rates). If lump-sum taxation were available, only the wealth effect would be present.

The source of fluctuations in intertemporal prices may, of course, be other than temporary policies. A prime example is given by fluctuations in interna-

tional terms of trade. Section 7 shows how the two-good model considered so far in the chapter can be used to analyze the effects of changes in the terms of trade on the current account. In particular, we show that whether a temporary deterioration in the terms of trade worsens the current account (the Harberger-Laursen-Metzler (HLM) effect) depends critically on the value of the intertemporal elasticity of substitution. If the intertemporal elasticity of substitution is less than one (the relevant case in practice), then the HLM effect holds. Whatever the effect on the current account – and since there are no distortions in this economy – the fluctuations in consumption that arise from fluctuations in the terms of trade are socially optimal. Intuitively, it is clearly optimal for this economy to take advantage of temporarily cheaper international prices for imports to consume more. We thus conclude that whether fluctuations in consumption due to non-constant intertemporal prices are optimal or not depends on the source of the fluctuations.

Section 8 closes the chapter with some concluding remarks.

2 The model

Consider a small open economy inhabited by a representative, infinitely-lived consumer. Following Calvo (1987), assume that there exist two (non-durable) tradable goods: an exportable good (not consumed) and an importable good. The international terms of trade (i.e., the world relative price of importables in terms of exportables) is assumed constant and equal to one. The economy is endowed with exportable goods (but not importables). The government may impose tariffs on the importable good and returns the proceeds to consumers in a lump-sum way.

Notice that, relative to the models of Chapters 1 and 2, we have another economic agent in the model: the government. While having two goods in the model is not critical to illustrate the effects of an intertemporal distortion, it allows us to study this key notion in the context of trade liberalization policies.¹ The assumption that consumers only derive utility from consuming the importable good enables us to isolate the effects of *intertemporal distortions*. Having exportables in the utility function would also introduce *intratemporal* (or static) distortions (a concept that will be discussed only in Chapter 4).

2.1 Consumer's problem

The lifetime utility of the representative individual is given by

$$\int_0^{\infty} u(c_t)e^{-\beta t} dt, \tag{1}$$

¹In other words, we could have introduced the concept of intertemporal distortions in the one-good model of Chapter 1 by simply adding a consumption tax that is not constant over time.

where $\beta (> 0)$ is the subjective discount rate, c denotes consumption of the importable good, and the function $u(\cdot)$ satisfies $u'(\cdot) > 0$ and $u''(\cdot) < 0$.

Let b_t denote net foreign assets (denominated in terms of the exportable good) held by the representative individual. The individual's flow constraint is given by

$$\dot{b}_t = rb_t + \bar{y} + \tau_t - p_t c_t, \quad (2)$$

where \bar{y} denotes the exogenous and constant endowment of the exportable good, τ represents lump sum transfers from the government, and p denotes the *domestic* terms of trade (i.e., the domestic relative price of importables in terms of exportables). As mentioned above, the international terms of trade are assumed to be unity. Hence, $p - 1$ captures the tariff imposed by the government.

Integrating forward equation (2) – proceeding as in Chapter 1 – yields the consumer's intertemporal budget constraint:

$$b_0 + \frac{\bar{y}}{r} + \int_0^\infty \tau_t e^{-rt} dt = \int_0^\infty p_t c_t e^{-rt} dt. \quad (3)$$

The representative individual's optimization problem consists in choosing $\{c_t\}$ for all $t \in [0, \infty)$ to maximize lifetime utility (1), subject to (3), for given paths of τ_t and p_t and given values of b_0 , r , and \bar{y} . Setting up the Lagrangian,

$$\mathcal{L} = \int_0^\infty u(c_t) e^{-\beta t} dt + \lambda \left(b_0 + \frac{\bar{y}}{r} + \int_0^\infty \tau_t e^{-rt} dt - \int_0^\infty p_t c_t e^{-rt} dt \right).$$

The first-order conditions are (3) and (assuming $\beta = r$)

$$u'(c_t) = \lambda p_t. \quad (4)$$

Equation (4) says that, at an optimum, the representative individual equates the marginal utility of consumption to the Lagrange multiplier times the relative domestic price of the good, which is a familiar condition from static consumer theory. In the current intertemporal context, however, this condition already implies a major departure from the world of Chapter 1. In Chapter 1, the relative price of the good was flat over time (and equal to unity in that particular case since there was only one good), which resulted in perfect consumption smoothing over time. In fact, the model of Chapter 1 may be viewed as a particular case of the more general model of this chapter by just setting $p_t = 1$ for all t . In this chapter, however, the relative price of the good is not necessarily constant over time. It is already apparent from equation (4) that a non-constant path of the relative price of the good will translate into a non-flat path of consumption over time. Hence, a preference for consumption smoothing (as reflected in a strictly concave utility function) coupled with perfect international mobility is not enough to obtain consumption smoothing as an implication of intertemporal optimization.

2.2 Government

Since we are not interested in studying the effects of government spending or the effects of government debt, we abstract from these considerations by simply assuming that the government sets the tariff, $p_t - 1$, and returns the proceeds to the consumer in the form of a lump-sum transfer:

$$\tau_t = (p_t - 1)c_t. \quad (5)$$

By assuming that proceeds are returned to consumers, we abstract from any possible *wealth* effects associated with tariffs. This important assumption will be relaxed in Section 5 below.

2.3 Equilibrium conditions

In Chapter 1, we only had one economic agent (the consumer). Hence, the consumer's constraints were identical to the economy's constraints. Since there are now two economic agents (the consumer and the government), we need to aggregate the constraints of each individual agent to obtain the economy's constraint.

Combining the consumer's flow constraint, given by (2), with the government's, given by (5), we obtain the economy's flow constraint (i.e., the current account):

$$\dot{b}_t (\equiv CA_t) = rb_t + \bar{y} - c_t. \quad (6)$$

By the same token, combining the consumer's intertemporal constraint, given by (3), and (5), we obtain the economy's intertemporal constraint:

$$b_0 + \frac{\bar{y}}{r} = \int_0^{\infty} c_t e^{-rt} dt. \quad (7)$$

It is worth stressing that the domestic terms of trade, p , do not enter the aggregate constraints. This was, of course, to be expected because a p higher than one represents a domestic transfer and does not imply a transfer of resources abroad.²

Finally, notice that, by definition, the trade balance will be given by:

$$TB_t \equiv \bar{y} - c_t. \quad (8)$$

2.4 Solution of the model

We now solve for the model's perfect foresight equilibrium path. In a perfect foresight equilibrium, the time path of the four endogenous variables ($c_t, b_t, \tau_t,$

²Of course, if the *international* terms of trade differed from one (as opposed to being one, as assumed in this section), then this would be captured in the aggregate constraints as it affects the purchasing power of the country's endowment of exports; see Section 7.

and λ) is completely characterized by equations (4), (5), (6), and (7).³

To study the effects of tariff reductions we will first assume that the economy is in a stationary equilibrium (i.e., tariffs are constant over time); that is, $p_t = p^H$. Since p_t is constant over time, first-order condition (4) tells us that consumption will also be constant over time (at a level denoted by \bar{c}). The resource constraint, given by (7), then determines the level of consumption:

$$\bar{c} = rb_0 + \bar{y}. \quad (9)$$

Notice that, in equilibrium, consumption does not depend on p^H . The reason is that the level of the tariff does not affect aggregate wealth (given by $b_0 + \bar{y}/r$) because of the assumption that the proceeds of the tariff are returned to the consumer in a lump-sum fashion. As analyzed below (Section 5), if the proceeds from the tariff were not returned to the consumer, there would be wealth effects and consumption would depend on the level of the tariff.

Substituting (9) into (5), we obtain the path of transfers:

$$\tau_t = (p^H - 1)(rb_0 + \bar{y}).$$

As expected, the constant level of transfers depends on the level of the tariff: the higher is the tariff, the higher are the proceeds from the tariff and therefore the higher the level of transfers to the consumer.

Substituting (9) into (8) yields the path for the trade balance:

$$TB_t = -rb_0. \quad (10)$$

Finally, substituting (10) into (6), we can see that $\dot{b}_t = rb_t - rb_0$, which implies that $b_t = b_0$ for all t . Hence,

$$CA_t = 0.$$

Finally, notice that the constant value of the Lagrange multiplier follows from substituting (9) into (4) to obtain:

$$\lambda = \frac{u'(rb_0 + \bar{y})}{p^H}.$$

3 Unanticipated shocks

3.1 Permanent fall in tariffs

Suppose now that an instant before time 0 the economy is in the stationary equilibrium just described. At $t = 0$, there is an unanticipated and permanent fall in p_t from p^H to p^L , where $p^L < p^H$ (see Figure 1). Since the shock is unanticipated, the consumer reoptimizes at $t = 0$. The new perfect foresight path will still be characterized by first-order condition (4) (with a possibly new

³Notice that we know from Chapter 1 that, as result of the assumption that $\beta = r$, the path of λ will be flat over time.

value for the Lagrange multiplier) and the resource constraint (7). Proceeding as above, we conclude that consumption is still given by (9). Hence, an unanticipated and permanent fall in tariffs leaves consumption of the importable good unchanged. The same is true, of course, of the current account.

[Figure 1 here]

Since consumption does not change, neither does welfare (i.e., lifetime utility). In other words, consumer's welfare is the same for any flat path of tariffs. This result should not be surprising since (i) there is no intertemporal distortion and (ii) there is no wealth effect. If either condition did not hold, then consumption (and thus welfare) would be affected by a permanent change in tariffs.

3.2 Temporary fall in tariffs

3.2.1 Solution of the model

Suppose again that, an instant before time 0, the economy is in the stationary equilibrium characterized above and that at time 0 there is an unanticipated and temporary fall in p_t from p^H to p^L , where $p^L < p^H$. Formally, the path of p_t is given by

$$p_t = \begin{cases} p^L, & 0 \leq t < T, \\ p^H & t \geq T. \end{cases} \quad (11)$$

for some $T > 0$. In other words, the government lowers the tariff from time 0 until time T and then raises it back to its original level (see Figure 2, Panel A).

[Figure 2 here]

Again, since the shock comes as a surprise, the consumer reoptimizes at $t = 0$. The first-order condition can be written as:

$$u'(c_t) = \tilde{\lambda} p^L, \quad 0 \leq t < T, \quad (12)$$

$$u'(c_t) = \tilde{\lambda} p^H, \quad t \geq T, \quad (13)$$

where $\tilde{\lambda}$ denotes the new value of the Lagrange multiplier. Two key implications follow immediately from (12) and (13). First, consumption will be constant in each subperiod. Formally,

$$c_t = c^1, \quad 0 \leq t < T, \quad (14)$$

$$c_t = c^2, \quad t \geq T. \quad (15)$$

Second, given that $u(c)$ is a strictly concave function and $p^L < p^H$, then $c^1 > c^2$. Consumption is thus higher between 0 and T than afterwards.

The intuition behind this result is simple enough. Since consumption is cheaper “today” than “tomorrow”, rational consumers choose to consume more today than tomorrow. Put differently, faced with a lower price for today’s consumption, consumers engage in *intertemporal consumption substitution* (i.e., they substitute away from the more expensive future consumption in favor of today’s cheaper consumption). Notice that if today’s and tomorrow’s consumption are viewed as different goods, the intuition is exactly the same as in standard consumer theory: a higher relative price of good 1 in terms of 2 induces the consumer to substitute away from good 1 and towards good 2. In fact, the analogy with standard consumer theory becomes even more transparent if, using (14) and (15), we combine first order conditions (12) and (13) to obtain:

$$\frac{u'(c^1)}{u'(c^2)} = \frac{p^L}{p^H}, \quad (16)$$

which says that the marginal rate of substitution between today’s and tomorrow’s consumption (LHS) equals the relative price of today’s consumption in terms of tomorrow’s consumption (RHS).

Having solved for the time profile of consumption, we now make use of the resource constraint to solve for the level of consumption. Given that $c^1 > c^2$, it follows from (7) that c^1 is higher than initial permanent income and c^2 is lower than initial permanent income. The logic behind this result is that wealth in the economy (given by $b_0 + \bar{y}/r$) has not been altered by the temporary fall in the tariff. Hence, the present discounted value of consumption cannot change either. It should be clear that the only path of consumption consistent with an unchanged present discounted value is the one depicted in Figure 2, Panel B, as any other path with $c^1 > c^2$ would violate the resource constraint.

The higher level of consumption during $[0, T)$ leads to the trade balance path shown in Figure 2, Panel C (which assumes, to fix ideas, that $b_0 = 0$ and hence that the initial trade balance is zero, as follows from (8)). Starting from a zero trade balance, the trade balance is thus in deficit between 0 and T and goes into a surplus thereafter.

The resulting current account path is shown in Figure 2, Panel D. Since $CA_0 = rb_0 + TB_0$, the current account falls on impact in line with the deterioration of the trade balance. During $[0, T)$, the current account falls over time because the trade balance is constant but the income balance worsens over time. At $t = T$, the economy becomes stationary again (exogenous variables are constant forever) and, as we saw in Chapter 1, this implies that the current account is necessarily zero from that point on.

3.2.2 Welfare analysis

How does a temporary liberalization affect consumer’s welfare (i.e., the consumer’s lifetime utility given by equation (1))? In this model, a temporary liberalization always reduces welfare. To show this, notice that, since the resources available to this economy (given by the LHS of (7)) are not affected by a liberalization, the present discounted value of consumption is the same

irrespective of whether there is a liberalization or not. Since resources do not change, a planner would always choose the flat path of consumption given by (9). However, faced with a temporary liberalization, the consumer chooses a non-flat path of consumption, which yields lower utility than a flat path of consumption with the same present discounted value. We thus conclude that this policy-induced intertemporal distortion is socially costly.

To some extent, this fall in welfare may seem surprising because the economy as a whole can still afford the initial flat path of consumption (i.e., the economy's resources have not changed). So why does the consumer not choose it? Simply because, from an individual point of view, choosing a flat path of consumption is clearly non-optimal as can easily be inferred from first-order condition (16). In other words, if the consumer chose the same level of consumption in both periods, he/she could always be better off by reallocating spending from period 2 (when consumption is relatively more expensive) to period 1 (when consumption is relatively cheaper).

3.2.3 Effects of T

An interesting issue is to analyze how the path of endogenous variables reacts to changes in the length of the liberalization period, T . (Exercise 1 at the end of the chapter asks you to work out the formal details.) In fact, it is quite intuitive to expect that, when the liberalization period is shortened, consumption during the liberalization period, c^1 , will increase. In other words, the shorter the liberalization period, the more consumers take advantage of cheaper relative prices per unit of time. The effects of T on welfare are less obvious because there are some trade-offs involved. Intuition suggests that a one instant liberalization (i.e., $T \rightarrow 0$) has no welfare costs because it is like having no liberalization at all. By the same token, a very long liberalization (i.e., $T \rightarrow \infty$) has no welfare costs because it is like a permanent liberalization. Since we know that, for any $T > 0$, the temporary liberalization is welfare-reducing, we would expect welfare to be a U-shaped function of T , as shown in Exercise 1 at the end of the chapter. Figure 3 provides an illustration by plotting the change in welfare (i.e., relative to welfare before the liberalization) as a function of T for the CES function specified in Exercise 1.⁴

[Figure 3 here]

3.2.4 The role of the intertemporal elasticity of substitution

A key concept when it comes to evaluating the extent of intertemporal consumption substitution is the intertemporal elasticity of substitution (see Appendix 9.1 for a formal definition). The intertemporal elasticity of substitution captures the willingness to change “today’s” consumption relative to “tomorrow’s” consumption in response to a change in intertemporal relative prices. The role

⁴The parameter values used to obtain Figure 3 are the following: $r = 0.03$, $p^H = 1$, $p^L = 0.4$, $\sigma = 0.3$, $b_0 = 0$, and $y = 10$.

of the intertemporal elasticity of substitution becomes more transparent if we focus on the class of constant-elasticity of substitution (CES) preferences, given by

$$u(c) = \begin{cases} \frac{c^{1-1/\sigma}-1}{1-1/\sigma} & \sigma \neq 1 \\ \log(c) & \sigma = 1 \end{cases} \quad (17)$$

where $\sigma > 0$ is the intertemporal elasticity of substitution.⁵ For CES preferences, using equation (16), we can show that (see Appendix 9.1):

$$\sigma = -\frac{d \log(c^1/c^2)}{d \log(p^L/p^H)}. \quad (18)$$

The parameter σ thus captures the consumer's willingness to substitute consumption across time for a given change in intertemporal relative prices. Hence, it should be intuitively clear that, for a given T and a given change in intertemporal relative prices, the higher is σ the higher will be consumption during the liberalization period (c^1) and the lower afterwards (c^2). (Exercise 1 at the end of the chapter asks you to show this formally.) In the extreme case of a consumer with Leontief preferences (which, conceptually, would correspond to the case $\sigma = 0$), consumption will not respond at all to a change in intertemporal prices and will continue to be constant over time (and given by $rb_0 + \bar{y}$).⁶

Given the critical theoretical role of the intertemporal elasticity of substitution, we should wonder how large is this parameter in practice. As discussed in Box 1, existing estimates of this parameter for developing countries fall mostly in the range of 0.2 to 0.5. Since these estimates are not very large, substantial changes in intertemporal prices will be required for this channel to be quantitatively important.

3.2.5 Intertemporal price speculation

We have just argued that with Leontief preferences over time a temporary liberalization would have no welfare effects. In fact, since estimates of the intertemporal elasticity of substitution are typically low, one might conclude that, in practice, the welfare implications of a temporary liberalization would be rather small unless changes in intertemporal prices are substantially large. This result, however, critically depends on the assumption that there are no durable goods. If we allow for durable goods (see exercise 2d at the end of the chapter), we can show that, even for Leontief preferences, a temporary liberalization would

⁵Notice that, as shown in Exercise 1 at the end of the chapter, $\log(c)$ is the limit of $(c^{1-1/\sigma}-1)/(1-1/\sigma)$ as $\sigma \rightarrow 1$. Technically, however, we need to define $u(c)$ in this piecewise form because $(c^{1-1/\sigma}-1)/(1-1/\sigma)$ does not exist at $\sigma = 1$. In the remainder of the book, however, it will be understood that $(c^{1-1/\sigma}-1)/(1-1/\sigma)$ encompasses the logarithmic case.

⁶The reader may wonder why we do not analyze how welfare changes as the intertemporal elasticity of substitution, σ , varies (as we did for the case of T). The reason is that, in addition to affecting consumption, changes in the intertemporal elasticity of substitution alter the utility function itself. This feature renders the exercise meaningless.

reduce welfare by leading to *intertemporal price speculation*. Consumers would want to purchase more durables while they are relatively cheaper. From a social point of view, however, this is not optimal because durable goods are dominated in return by foreign bonds. In other words, a planner would never choose to buy durables for storage purposes; the planner would always buy exactly the amount that will be consumed at that particular instant. Hence, once the possibility of intertemporal price speculation is taken into account, we can conclude that temporary trade liberalizations are likely to be quite costly in practice even if the intertemporal elasticity of substitution is low.⁷

4 Lack of credibility

We have just analyzed the effects of both a permanent and a temporary fall in tariffs. In fact, these two experiments can be seen as part of the same phenomenon by introducing credibility considerations. Specifically, suppose that at time $t = 0$ the government announces that import tariffs will be permanently reduced. If the announcement is fully credible, in the sense that the public believes that the reduction in tariffs will be indeed permanent, then there will be no real effects, as shown above.

In contrast, suppose that the announcement at $t = 0$ is not credible, in the sense that the public believes that tariffs will be raised again at time $T > 0$. Since consumers believe that the liberalization will be temporary, they will react in the same way as analyzed above (i.e., consuming more between 0 and T and running a current account deficit).⁸ In other words, the temporary liberalization analyzed above may be interpreted as arising from a situation in which the announcement of a permanent reduction in tariffs was not fully credible.⁹

In this simple but illuminating interpretation, lack of credibility is equivalent to having an intertemporal distortion and is therefore socially costly.¹⁰ Since lack of credibility is likely to be pervasive in environments prone to recurrent policy failures as the ones observed in most developing countries, this type of

⁷Another remarkable feature of introducing durable goods into the analysis is that even a *one-instant liberalization* (the case analyzed in Exercise 2d) will have (negative) welfare effects whereas, as argued above, without durable goods a one-instant liberalization would have no welfare effects.

⁸The reader should convince him/herself that what happens at T will be independent of whether the beliefs turn out to be true or not. If the beliefs are correct and policymakers indeed raise tariffs at T , then the experiment exactly replicates the temporary liberalization studied above. If the beliefs are not correct and policymakers stick to the lower tariff when time T arrives, this constitutes (from the consumer's point of view) an unanticipated and permanent reduction in tariffs as of time T . Consumers would then choose a flat path of consumption from T onwards that would have the same level as in the temporary case.

⁹Exercise 3 at the end of this chapter formalizes the idea of lack of credibility by modeling it as uncertainty on the part of consumers as to whether the government will impose tariffs in the second period or not. The exercise makes clear that the mere expectation of a possible tariff is enough to introduce an intertemporal distortion, regardless of whether it eventually materializes or not.

¹⁰In several papers, Calvo (1987, 1988, 1989) pioneered this interpretation.

distortion is likely to be an important feature. We will revisit this issue when we study the real effects of exchange rate-based stabilizations.

It should be noted that capital controls can be welfare improving in an environment characterized by lack of credibility. To see this, consider the extreme case of capital controls (i.e., financial autarky). In such an economy, consumers will be unable to take advantage of temporarily lower prices because they cannot borrow from abroad. This is an example of second best economics: the government faces an exogenously given distortion (i.e., lack of credibility) and by an appropriate set of taxes or regulations is able to achieve a Pareto improvement. One should be careful, however, when trying to apply this result to the real world. In practice, capital controls are known to introduce a myriad of microeconomic distortions and rent-seeking activities that our analysis has completely abstracted from. Hence, in practice, imposing capital controls would have costs of its own and the best policy would be to attack the original distortion (i.e., try to address the underlying causes of the lack of credibility).

5 Wealth effects

We concluded above that a permanent liberalization would have no effects on welfare, whereas a temporary liberalization would always reduce welfare. From a practical point of view, these results appear counterintuitive since one would argue that, in practice, there should be some static gains from trade liberalization, such as higher productivity (see Box 2). Such static gains would increase the economy's wealth and lead to higher welfare (particularly in the case of a permanent tariff reduction). This logic is, of course, right. The previous analysis ignored wealth effects to isolate the effects of intertemporal distortions. We now introduce wealth effects into the picture.

A simple way of introducing wealth effects is to relax the assumption that the government gives back to the consumer all proceeds from the tariff in a lump-sum way. In particular, we will now consider the other extreme case in which all tariffs revenues are used by the government to finance socially unproductive public spending.

In this new set-up, the flow constraint of the representative consumer is given by

$$\dot{b}_t = rb_t + \bar{y} - p_t c_t, \quad (19)$$

where the only difference with equation (2) is that the consumer is not receiving lump-sum transfers from the government. His/her corresponding intertemporal budget constraint is given by

$$b_0 + \frac{\bar{y}}{r} = \int_0^{\infty} p_t c_t e^{-rt} dt. \quad (20)$$

To fix ideas, let preferences be given by the CES utility function specified in

(17).¹¹ At the margin, the optimal choice of consumption is then characterized by

$$c_t^{-1/\sigma} = \lambda p_t. \quad (21)$$

The government sets the tariff, $p_t - 1$, and, given the individual's choice of consumption, spends all proceeds on unproductive government spending, g_t (think of the government as throwing the tariff proceeds into the ocean). The government's flow constraint is thus given by:

$$g_t = (p_t - 1)c_t. \quad (22)$$

By definition, the trade balance is given by

$$TB_t \equiv \bar{y} - c_t - g_t.$$

For further reference, note that, using (22), the trade balance can be rewritten as:

$$TB_t \equiv \bar{y} - p_t c_t. \quad (23)$$

To obtain the economy's current account and resource constraint, combine (22) with, respectively, (19) and (20) to obtain:

$$\dot{b}_t = r b_t + \bar{y} - c_t - g_t, \quad (24)$$

$$b_0 + \frac{\bar{y}}{r} = \int_0^{\infty} (c_t + g_t) e^{-rt} dt. \quad (25)$$

Notice, by comparing with (6) and (7), how government spending now constitutes an additional use of resources.

In equilibrium, the time path of the four endogenous variables of the model (c_t , b_t , g_t , and λ) is completely characterized by equations (4), (20), (22), and (24).¹²

As before, we will assume that the economy is initially in a stationary perfect foresight equilibrium path for a constant value of p_t ; that is, $p_t = p^H$ for all $t \geq 0$. From first-order condition (4), we infer that consumption is constant along a perfect foresight equilibrium path (PFEP). Hence, from (20), it follows that:

$$\bar{c} = \frac{r b_0 + \bar{y}}{p^H}. \quad (26)$$

Substituting (26) into (22), it follows that the constant level of government spending is given by:

¹¹The results hold for any utility function but the CES specification will prove useful when it comes to characterizing the behavior of the trade balance and the current account, as will become clear below.

¹²Notice that, in this particular case, it is more useful to use the consumer's intertemporal constraint to solve the model than the resource constraint because of the endogeneity of g .

$$\bar{g} = \frac{p^H - 1}{p^H} (rb_0 + \bar{y}). \quad (27)$$

To compute the trade balance, substitute (26) into (23) to obtain:

$$TB_t = -rb_0. \quad (28)$$

Finally, from (19) at time 0, we know that $CA_0 = rb_0 + TB_0$. Hence, from (28), it follows that $CA_0 = 0$. Hence, $CA_t = 0$ for all $t \geq 0$.¹³

5.1 Permanent fall in tariffs

Suppose now that an instant before time 0 the economy is in the stationary equilibrium just characterized. At time 0, there is an unanticipated and permanent reduction in the tariff from $p^H - 1$ to $p^L - 1$, where $p^L < p^H$. The consumer will reoptimize immediately. Proceeding as above, it follows that the new consumption path is given by (see Figure 4):

$$\bar{c} = \frac{rb_0 + \bar{y}}{p^L}.$$

[Figure 4 here]

We see that consumption is permanently higher as a consequence of the liberalization. The economic intuition behind the result is simply that the liberalization implies a higher wealth for the economy. Taking the argument to the extreme, a complete liberalization (i.e., $p^L = 1$ or no tariffs at all) would imply that no resources are thrown into the ocean and the private sector consumes all the resources available to this economy.

Since consumption is permanently higher, a permanent reduction in tariffs increases welfare. The contrast with the previous case in which a permanent liberalization had no effects on welfare can be easily rationalized. With full rebate, the level of tariffs was irrelevant because all the proceeds were returned to consumers. With no rebate at all, the government is just wasting whatever tariff revenues it collects. Under such circumstances, a reduction in tariffs means less wasteful spending and more resources available for private consumption.

5.2 Temporary fall in tariffs

Suppose again that an instant before time 0 the economy is in the stationary equilibrium described above. At time 0, there is an unanticipated and temporary fall in p_t from p^H to p^L , where $p^L < p^H$ (Figure 5, Panel A). Formally, the path of p_t is once again given by (11). The consumer reoptimizes at time 0 and the new optimal path of consumption is characterized by the first-order conditions

¹³To see this, notice that if $TB_t = -rb_0$ for all $t \geq 0$, then $b_t = b_0$.

$$c_t^{-1/\sigma} = \tilde{\lambda} p^L, \quad 0 \leq t < T, \quad (29)$$

$$c_t^{-1/\sigma} = \tilde{\lambda} p^H, \quad t \geq T, \quad (30)$$

which, again, implies that $c^1 > c^2$. Hence, as before, consumption is higher during the liberalization period as consumers take advantage of cheaper prices.

[Figure 5 here]

While the consumption time *profile* is the same as before, the *level* of the new path will be different. From the intertemporal constraint (20), it follows that c^1 must be higher than initial consumption (given by equation (26)). If this were not the case, the new consumption path would not exhaust the available resources since p is lower during $[0, T)$ and $c^1 > c^2$. In contrast, whether c^2 will be higher than, equal to, or lower than initial consumption depends on the value of σ . To see this, rewrite the intertemporal constraint (20) as

$$b_0 + \frac{\bar{y}}{r} = (1 - e^{-rT}) \frac{p^L c^1}{r} + e^{-rT} \frac{p^H c^2}{r}. \quad (31)$$

Then combine (29), (30), and (31) to obtain:

$$p^H c^2 = \frac{r b_0 + \bar{y}}{\left(\frac{p^L}{p^H}\right)^{1-\sigma} (1 - e^{-rT}) + e^{-rT}}.$$

It follows that:

$$p^H c^2 \begin{cases} = r b_0 + \bar{y}, & \sigma = 1, \\ > r b_0 + \bar{y}, & \sigma < 1, \\ < r b_0 + \bar{y}, & \sigma > 1. \end{cases} \quad (32)$$

Since in the initial equilibrium (i.e., before $t = 0$), $p^H \bar{c} = r b_0 + \bar{y}$, it follows that:

$$c^2 \begin{cases} = \bar{c}, & \sigma = 1, \\ > \bar{c}, & \sigma < 1, \\ < \bar{c}, & \sigma > 1. \end{cases}$$

Intuitively, the different possibilities for c^2 reflect the tension between the intertemporal substitution effect and the wealth effect. While these two effects go in the same direction for c^1 (with both effects calling for higher c^1), they go in opposite direction for c^2 : the intertemporal substitution effect calls for a lower c_2 , while the wealth effect calls for a higher c_2 . In the $\sigma < 1$ case, c_2 is higher than initially (Figure 5, Panel B) reflecting a weak intertemporal substitution effect due to the low intertemporal elasticity of substitution.

Whatever the value of c^2 , however, (31) makes clear that the present discounted value of consumption will be higher. Compared to the initial equilibrium, p is now lower between 0 and T . Hence, for a given T and, say, a given c^2 ,

c^1 will have to be higher to satisfy (31). It follows that the resources available to the private sector have increased as a result of temporarily lower tariffs.

What is the effect on the trade balance? From (23), we see that the path of the trade balance depends on the path of expenditure. Since the present discounted value of $p_t c_t$ does not change (i.e., it remains equal to $b_0 + \bar{y}/r$), (32) provides us with all the information we need. For the logarithmic case, the path of expenditure is flat over time. Hence, the trade balance is flat over time and equal to its initial value, $-rb_0$. For the more relevant case $\sigma < 1$, expenditure after T is higher than before T . The trade balance thus follows the path depicted in Figure 5, Panel C, improving at $t = 0$ and worsening at $t = T$. For $\sigma > 1$, the opposite would be true.

The behavior of the current account mirrors that of the trade balance. In the logarithmic case, there is no change in the current account. In the $\sigma < 1$ case, the current account improves at $t = 0$ and worsens at time T (Figure 5, Panel D).

How does this temporary liberalization affect welfare? Welfare unambiguously increases. To show this, notice that since the consumer's opportunity set is now larger than before, the consumer could have chosen the initial consumption path but did not. Hence, by revealed preferences, the (non-flat) consumption path that was indeed chosen must make the consumer better off. We conclude that in this case the wealth effect always dominates the intertemporal distortion effect.

Moreover, it should be clear that the consumer's welfare is a strictly increasing function of the length of the liberalization period, T . To show this, fix c^2 and p^L in equation (31). Then, a larger T must be matched by a higher c^1 for this constraint to hold. In other words, the opportunity set becomes larger as T increases. The consumer must be better off as a result.

5.3 Partial rebates

So far we have examined two extreme cases. In the full rebate case (no wealth effect), examined in Section 3, a temporary reduction in tariffs always reduces welfare. In the case examined in this section (no rebate), the same policy always leads to higher welfare. In practice, however, the wealth effects resulting from a temporary tariff reduction will likely not be captured by either extreme, but will fall somewhere in between. To capture this – and in the process provide further insights into the strength of the intertemporal distortion effect relative to the wealth effect – exercise 4 at the end of the chapter asks you to work out the case of partial rebates; that is, cases in which the government wastes some fraction ϕ of the tariff revenues and returns the rest $(1 - \phi)$ to consumers in a lump-sum fashion. Of course, as particular cases, we have the full rebate case ($\phi = 0$) and the no rebate case ($\phi = 1$).

Clearly, for large values of T , a temporary trade liberalization will be welfare improving as it becomes essentially a permanent liberalization with a wealth effect (even if smaller than in the no rebate case). The more illuminating result to come out of this exercise is that, as illustrated in Figure 6, for some parameter

configurations involving low values of ϕ (i.e., a small wealth effect), a given temporary tariff liberalization may be welfare reducing for low values of T (i.e., the intertemporal distortion effect dominates) and welfare improving for large values of T (i.e., the wealth effect dominates).^{14 15}

[Figure 6 here]

Needless to say, we have looked at partial rebates as a convenient – but admittedly mechanical – way of illustrating the tension between the intertemporal distortion and the wealth effects that are likely to be associated with temporary trade liberalizations. Box 3 discusses a much richer framework that allows for wealth effects (in the form of gains from trade) and enables us to obtain quantitative estimates of whether the resulting wealth effects are likely to dominate the intertemporal distortion effects. The punchline is that, indeed, wealth effects tend to dominate and reducing tariffs is therefore the optimal policy even under imperfect credibility.

6 Distortionary taxation

We have illustrated above how a temporary trade liberalization will impose an intertemporal distortion on the household’s consumption path. As another real-world example of this phenomenon, we will now analyze a situation in which the government needs to resort to distortionary taxation to finance an exogenously-given level of expenditures. While we will devote a later chapter (Chapter @), to study optimal fiscal policy, the purpose at hand is to illustrate how a time-varying tax rate will impose an intertemporal distortion, thus leading to a welfare loss over and above the one resulting from the presence of wasteful government spending.

Consider a small open economy perfectly integrated into the world economy in both goods and capital markets. The endowment of the only (tradable and non-storable) good is constant over time and equal to \bar{y} .

6.1 Consumers

Let preferences be given by

$$\int_0^{\infty} \log(c_t) e^{-\beta t} dt, \quad (33)$$

where c_t is consumption of the only (non-storable) good and β is the discount rate (equal to the world real interest rate).

¹⁴The parameter values used to obtain Figure 6 are the following: $\phi = 0.04$, $r = 0.03$, $p^H = 1$, $p^L = 0.4$, $\sigma = 0.3$, $b_0 = 0$, and $y = 10$.

¹⁵See Calvo and Mendoza (1994) for a quantitative analysis of the welfare effects of temporary trade liberalization under full and no rebates.

The flow constraint is given by

$$\dot{b}_t = rb_t + \bar{y} - (1 + \theta_t)c_t, \quad (34)$$

where b are net foreign assets, r is the world real interest rate, \bar{y} is the constant endowment of the good, and θ_t is a consumption tax. Integrating forward and imposing the corresponding transversality condition, we obtain

$$b_0 + \frac{\bar{y}}{r} = \int_0^\infty (1 + \theta_t)c_t e^{-rt} dt. \quad (35)$$

The representative consumer chooses $\{c_t\}_{t=0}^\infty$ to maximize (33) subject to the intertemporal constraint (35), taking as given the path of θ_t . The first-order condition is given by

$$\frac{1}{c_t} = \lambda(1 + \theta_t). \quad (36)$$

Since $1 + \theta_t$ is the price of consumption faced by the consumer, first-order condition (36) is exactly analogous to first-order condition (4) in the model with tariffs examined earlier in this chapter. Hence, we can already see that fluctuations in the tax rate will induce consumers not to choose a flat path of consumption because of the desire to engage in intertemporal consumption substitution.

6.2 Government

The government spends on tradable goods (g_t) and must balance its budget at every point in time:

$$g_t = \theta_t c_t. \quad (37)$$

The level of government spending, g_t , is exogenously-given. The tax rate, θ_t , will adjust so as to ensure that the budget constraint (37) holds.

6.3 Equilibrium conditions

Substituting (37) into the consumer's flow constraint (34), we obtain the economy's flow constraint (i.e., the current account):

$$\dot{b}_t = rb_t + \bar{y} - c_t - g_t.$$

By definition, the trade balance is

$$TB_t = \bar{y} - c_t - g_t. \quad (38)$$

Substituting (37) into the consumer's intertemporal constraint (35), we obtain the economy's intertemporal constraint (i.e., the resource constraint):

$$b_0 + \frac{\bar{y}}{r} = \int_0^\infty (c_t + g_t)e^{-rt} dt. \quad (39)$$

6.4 Initial stationary equilibrium

Let us characterize a PFEP for a constant path of g_t , given by \bar{g} . If g_t is constant over time, equation (37) tells us that $\theta_t c_t$ will be constant over time. Further, first-order condition (36) indicates that $c_t(1 + \theta_t)$ will be constant over time. Since $c_t(1 + \theta_t) = c_t + \theta_t c_t$ and we have already established that $\theta_t c_t$ is constant over time, it follows that c_t is constant over time. This, in turn, implies from (37), that θ_t will be constant over time.

Having established that all endogenous variables will be constant over time, we can derive a closed-form solution for consumption from the resource constraint (39):

$$\bar{c} = rb_0 + \bar{y} - \bar{g}. \quad (40)$$

From the government's flow constraint (37), we can derive a reduced-form for the constant value of the tax rate:

$$\bar{\theta} = \frac{\bar{g}}{rb_0 + \bar{y} - \bar{g}}. \quad (41)$$

Substituting (40) into (38),

$$TB_t = -rb_0.$$

6.5 Permanent increase in government spending

Suppose that just before $t = 0$, the economy is in the stationary equilibrium just described. At $t = 0$, there is an unanticipated and permanent increase in g_t (Figure 7, Panel A). Since the shock is permanent, the same solution derived above holds for the new PFEP. Hence, expression (40) tells us that consumption falls one-to-one with the increase in government spending and equation (41) indicates that the consumption tax rate increases (Figure 7, Panel B and C, respectively). Since the shock is permanent, there is, of course, no effect on the trade balance (Panel D, which assumes that $b_0 = 0$).

[Figure 7 here]

We conclude that the increase in government spending has imposed a wealth effect on the economy (akin to the permanent reduction in the endowment studied in 1) but no intertemporal distortion.

6.6 Temporary increase in government spending

Suppose now that, at $t = 0$, there is an unanticipated and temporary increase in g_t . Denote the initial (i.e., for $t < 0$) value of g_t by g^L . The path of g_t is then given by (Figure 8, Panel A):

$$g_t = \begin{cases} g^H, & 0 \leq t < T, \\ g^L & t \geq T. \end{cases}$$

[Figure 8 here]

The consumer reoptimizes at time $t = 0$. The first-order condition can be written as

$$\frac{1}{c_t} = \tilde{\lambda}(1 + \theta_t), \quad (42)$$

where, as usual, we have used $\tilde{\lambda}$ to call attention to the fact that the Lagrange multiplier may change at $t = 0$.

As always when studying a temporary shock, we begin by establishing the change in the endogenous variables at time T .¹⁶ Two pieces of information will be key in this instance. First, we know from the government's flow constraint (37) that $\theta_t c_t$ will be high during $[0, T)$ and low for $t \geq T$. In other words, $\theta_t c_t$ will fall at time T . Second, first-order condition (42) tells us that $c_t(1 + \theta_t)$ will be constant along the new PFEP. Combining these two pieces of information, we infer that c_t will jump up at time T . In turn, the fact that c_t jumps up at time T implies, from (42), that θ_t jumps down.

To establish the initial jump in c_t , notice that since $c_t(1 + \theta_t)$ is constant along the new PFEP and $g_t = \theta_t c_t$, it follows that $c_t + g_t$ will be constant as well. This implies that $c_t + g_t$ cannot jump at $t = 0$ for, if it did, it would violate the economy's resource constraint. Hence, c_t will fall at $t = 0$ by the same amount that g_t increases. Since g_t increases but c_t falls at $t = 0$, it follows from the government's budget constraint (37) that θ_t must increase. Finally, the fact that $c_t + g_t$ does not change at $t = 0$ implies that the trade balance does not change either (Panel D).

In sum, we have established that the temporary increase in government spending leads to a temporary rise in the consumption tax rate (Panel C). As in the case of a temporary trade liberalization studied earlier in this chapter, this non-constant path of the price of consumption introduces an intertemporal distortion. Consumers find it optimal to reduce consumption now compared to the future because of the temporarily higher price. This is clearly sub-optimal. Indeed, as can easily be checked (see exercise 5 at the end of this chapter), if lump-sum taxation were available, consumption would fall at time 0 by the amount of the reduction in permanent income but remain flat thereafter. In other words, under lump-sum taxation, only the (negative) wealth effect of the temporary increase in government spending would affect consumers. Under distortionary taxation, however, consumers suffer an additional loss of welfare due to the non-flat consumption path.

7 Terms of trade shocks

We noted at the beginning of this chapter that the effect of intertemporal distortions could be analyzed in a one-good model but that we would use a model

¹⁶Proceeding as above, it is easy to establish that within each sub-period, all endogenous variables are constant.

with importables and exportables goods to motivate the exercise as a trade liberalization. Another nice application of this same model with two tradable goods is to study the effects of terms of trade shocks on the current account.¹⁷

The existing link between terms of trade and the current account has its theoretical roots in Harberger (1950) and Laursen and Metzler (1950). They claimed that a deterioration in a country's terms of trade would result in a fall in saving and consequently in a deterioration of the current account. This proposition is known in the literature as the Harberger-Laursen-Metzler (HLM) effect: negative terms of trade shocks are associated with current account deficits and positive terms of trade shocks with current account surpluses.

The rationale behind their analysis was essentially that a worsening in the terms of trade would result in lower "real income" because of the smaller purchasing power of exports. Within a typical Keynesian model with a marginal propensity to consume less than one, a fall in real income lowers savings and results in a current account deterioration.

We will study the effect of terms of trade shocks on the current account using the model introduced in Section 2 of this chapter (using the CES preferences specified in (17)) with two modifications: (i) we abstract from the government (and hence tariffs) and (ii) the international terms of trade are now given by p_t .

In this context, the consumer's flow constraint becomes:

$$\dot{b}_t = rb_t + \bar{y}_t - p_t c_t, \quad (43)$$

with the corresponding lifetime budget constraint given by:

$$\int_0^\infty p_t c_t e^{-rt} dt = b_0 + \frac{\bar{y}}{r}. \quad (44)$$

At the margin, the optimal choice of consumption continues to be characterized by first-order condition (21). It should be apparent that this model is formally the same as the one analyzed in Section 5. We can therefore use the results derived in that section to discuss the HLM effect.

An unanticipated and permanent improvement in the terms of trade (a fall in p) results in a higher "permanent income" for the consumer because each unit of exportable is now worth more in terms of importables. Hence, consumption increases *pari passu* with permanent income and there is no change in either the trade balance or the current account. Welfare, of course, increases.

An unanticipated and temporary improvement in the terms of trade leads to higher consumption on impact. In the more relevant practical case ($\sigma < 1$), both the trade balance and the current account improve. Intuitively, expenditure falls between 0 and T because of the low intertemporal elasticity of substitution. This is consistent with the original HLM effect. However, for $\sigma = 1$, the trade balance will not change and for $\sigma > 1$ the trade balance will actually worsen on impact, as discussed in Section 5. Further, as shown in Section 5,

¹⁷We will revisit this question in Chapter 4 in the context of a model with non-tradable goods.

a temporary improvement in the terms of trade is always welfare improving because it enlarges the economy's opportunity set.

It should be noticed that while temporary terms of trade shocks do imply a non-constant path of the relative price of consumption (as in the preceding analysis) and hence lead to a non-constant path of consumption, they should not be referred to as an "intertemporal distortion" since they are not policy-induced and hence the economy is still operating in the first-best equilibrium. In other words, a planner would react in the same way as the consumer does.

The bottom line of the analysis is that the HLM effect is consistent with the intertemporal approach to the current account whenever the improvement in the terms of trade is temporary and the intertemporal elasticity of substitution is low. The HLM effect vanishes when the improvement in terms of trade is perceived as permanent.¹⁸ While the empirical evidence on the HLM is somewhat mixed (see Box 4), it is consistent with the idea that the HLM is more likely to be present in economies with small non-tradable sectors (this model with no non-tradable goods can be thought of as an extreme case) and face predominantly temporary shocks.

Finally, notice that the assumption that assets are denominated in terms of exportables is critical for our results. As Exercise 6 at the end of the chapter makes clear, if assets were denominated in terms of importables, then the impact of an improvement in the terms of trade would be different. Specifically, a temporary improvement in the terms of trade would always lead to a current account surplus. Intuitively, if you save in terms of importables, the relevant relative price for consumption decisions is one. Hence, the consumption path will always be flat. In this context, terms of trade shocks act exactly like the endowment shocks in the basic model of Chapter 1. Hence, an unanticipated and temporary fall in p_t (i.e., a temporary improvement in the terms of trade) leads to a current account surplus for consumption-smoothing purposes.¹⁹

8 Final remarks

This chapter has analyzed the implications of intertemporal fluctuations in relative prices on consumption and the current account. Fluctuations in relative prices may be due to market forces (for example, terms of trade) or policy measures (temporary tariffs or tax rates). In the latter case, we refer to them as intertemporal distortions because they induce consumers to choose a non-socially optimal path of consumption.

¹⁸See Obstfeld (1983) and Razin and Svensson (1983) for an analysis of the HLM effect in a more general context. In a model with Uzawa preferences, Obstfeld (1982) shows that a permanent improvement in the terms of trade can be associated with a worsening in the current account (contradicting the HLM effect). See Ostry and Reinhart (1992) for an analysis of the HLM effect in a model of non-tradable goods and an empirical estimation of the relevant parameters.

¹⁹If households consumed both importables and exportables, then terms of trade shocks would also affect the relevant real interest rate leading to an additional channel (see Obstfeld (1983)).

Conceptually, this chapter has introduced two key effects in intertemporal models: intertemporal substitution effects and wealth effects. In some form or another, these two effects will be present in all of the models that we will study in subsequent chapters. As a preview, Chapter 7 will study the real effects of a temporary reduction in the rate of devaluation (or inflation in a one good model). Since money will be needed to buy goods, the effective price of the good will be cheaper when inflation is low than when inflation is high. A temporary reduction in the rate of devaluation will thus introduce an intertemporal distortion by making goods temporarily cheaper. If, in addition, lower inflation leads to higher real money balances and thus to lower transaction costs, a lower rate of devaluation (even if temporary) will lead to a wealth effect. The effects on consumption of a temporary fall in the rate of devaluation will thus depend on the relative strength of the intertemporal substitution effect and the wealth effect.

9 Appendix

9.1 The intertemporal elasticity of substitution

This appendix defines and discusses the intertemporal elasticity of substitution. Specifically, we want to ask the following question: by how much (in proportional terms) will the ratio of consumption change in response to a change in intertemporal prices? In other words, we want to compute $d \log(c^1/c^2)/d \log(p^L/p^H)$. Multiplying and dividing the LHS of equation (16) by c^1/c^2 , taking logarithms, and rearranging terms, we obtain

$$\frac{d \log(c^1/c^2)}{d \log(p^L/p^H)} = -\sigma(c^1, c^2), \quad (45)$$

where $\sigma(c^1, c^2)$ is the intertemporal elasticity of substitution between c^1 and c^2 , defined as:

$$\sigma(c^1, c^2) \equiv -\frac{d \log\left(\frac{c^1}{c^2}\right)}{d \log\left(\frac{u'(c^1)}{u'(c^2)}\right)}. \quad (46)$$

This is, of course, the standard definition of an elasticity of substitution from microeconomic theory.²⁰ In this particular case, it is a property of the utility function that describes the percentage change in the consumption ratio per percentage change in the marginal rate of substitution. Since, as (16) reminds us, utility maximization implies that the marginal rate of substitution is equated to the price ratio, the elasticity of substitution can also be thought of as the percentage change in the consumption ratio per percentage change in the price ratio (as made clear by equation (45)).

Using (17) and (46), it follows immediately that, for CES utility functions,

$$\sigma(c^1, c^2) = \sigma.$$

Notice that the elasticity of substitution defined in (46) involves consumption at two *different* points in time and asks how the ratio of consumption varies in response to a change in the relative intertemporal prices. A closely related (but different) concept is to ask how consumption at a *particular* point in time would change in response to a change in prices. To answer this question, differentiate first-order condition (4) with respect to time to obtain

$$\frac{dc_t}{c_t} = -\eta(c_t) \frac{dp_t}{p_t}, \quad (47)$$

where

$$\eta(c_t) \equiv -\frac{u'(c_t)}{u''(c_t)c_t} > 0$$

²⁰See, for instance, Varian (1992).

denotes the (absolute value of the) elasticity of marginal utility with respect to consumption and captures the willingness of the consumer to change consumption at a particular point in time in response to a change in prices. For the particular case of CES functions, $\eta(c_t)$ is also constant and equal to σ . In models with uncertainty, the inverse of $\eta(c_t)$ is known as the coefficient of relative risk aversion and CES functions often referred to as constant relative risk aversion functions.

The connection between the two concepts – σ and η – is best understood by taking the limit of $\sigma(c^1, c^2)$ as c^2 becomes arbitrarily close to c^1 to obtain ²¹

$$\lim_{c^2 \rightarrow c^1} \sigma(c^1, c^2) = -\frac{\lim_{c^2 \rightarrow c^1} d \log\left(\frac{c^1}{c^2}\right)}{\lim_{c^2 \rightarrow c^1} d \log\left(\frac{u'(c^1)}{u'(c^2)}\right)} = -\frac{u'(c^1)}{c^1 u''(c^1)}.$$

As expected, as c^1 and c^2 become the same, the elasticity of substitution, σ , converges to the elasticity of the marginal utility with respect to consumption, η .

²¹To obtain the expression below, keep in mind that you need to compute the differentials before taking the limit.

Exercises²²

1. Effects of changes in the liberalization period and the intertemporal elasticity of substitution

Consider again the temporary liberalization discussed in Subsection 3.2 with $q \equiv p^L/p^H < 1$. Assume that preferences take the iso-elastic form given by equation (17) where σ is the intertemporal elasticity of substitution.

In this context:

- (a) Obtain a reduced form for c^1 and c^2 as a function of q , T , and σ .
- (b) Obtain a reduced form for the Lagrange multiplier, λ .
- (c) Show how c^1 and c^2 change as the liberalization period is shortened (i.e., as T becomes smaller).
- (d) Show how c^1 and c^2 change as the intertemporal elasticity of substitution (σ) becomes larger.
- (e) Consider the logarithmic case. Show first that logarithmic preferences are the limiting case of (17), when $\sigma \rightarrow 1$. Then derive the indirect lifetime utility as a function of q and T . Show how it varies with T .
- (f) Show how welfare changes in the case of (a) a one instant liberalization (i.e., $T \rightarrow 0$) and (b) an arbitrarily long liberalization ($T \rightarrow \infty$).
- (g) Plot welfare as a function of T (for reasonable parameter values) and verify that welfare has a U-shaped form.

2. Durable goods and intertemporal price speculation.

This exercise follows Calvo (1988). Consider the case of an individual who has Leontief preferences over time and therefore chooses a flat path of consumption (\bar{c}) independently of the path of p . Suppose also that the importable good can be stored at no cost and that there is no depreciation. Based on arbitrage considerations, it should be clear that, if p is constant over time, there are no incentives to accumulate stocks of the importable good because the good is dominated in rate of return by the foreign bond. Suppose instead that there is a “one-instant liberalization”:

$$\begin{aligned} p_0 &= 1, \\ p_t &= p > 1, \quad t > 0. \end{aligned}$$

²² An answer key is available from the author upon request.

Assume that the proceeds from the tariff are given back to consumers in a lump-sum fashion.

The consumer's intertemporal budget constraint can be written as

$$Z + p\bar{c} \int_{\phi}^{\infty} e^{-rt} dt = b_0 + \frac{\bar{y}}{r} + T, \quad (48)$$

where Z denotes the stock of importables accumulated at $t = 0$, \bar{y} is the constant endowment of the exportable good, T denotes the present discounted value of government transfers, and ϕ denotes the time at which the stock of importables, Z , is depleted. Since there is no depreciation, it follows that

$$\phi\bar{c} = Z. \quad (49)$$

In this context:

- (a) Show that the intertemporal budget constraint can be written as

$$\bar{c} \left(r\phi + pe^{-r\phi} \right) = r \left(b_0 + \frac{\bar{y}}{r} + T \right).$$

- (b) Find the optimal ϕ . Discuss the intuition behind the results.
(c) Find a reduced form for \bar{c} . (Hint: take into account that, in equilibrium, $T = (p - 1)\bar{c} \int_{\phi}^{\infty} e^{-rt} dt$.)
(d) Discuss the welfare implications of a one-instant liberalization.

3. Lack of credibility

This exercise, which follows Engel and Kletzer (1991), deals with a formalization of the idea of lack of credibility that we discussed in Section 4. Consider a two-period endowment economy. The economy is endowed with a constant endowment, \bar{y} , of an exportable good. It consumes an importable good, c . The international terms of trade are equal to one. The domestic price of importables, however, may be greater than one if a tariff is imposed. The economy can borrow/lend at a fixed rate, r . In the first period there is no tariff (i.e., the domestic relative price of importables is equal to one). In the second period a tariff $(p - 1)$ may be imposed with probability π .

The consumer's problem is to maximize expected utility

$$E\{U\} = \log c_1 + \beta(1 - \pi) \log c_2 + \beta\pi \log c_2^*,$$

where $\beta(1 + r) = 1$, c_1 is consumption in period 1, c_2 is consumption in period 2 if the tariff is not imposed and c_2^* is consumption in period 2 if a tariff is imposed.

Using the exportable good as the numeraire, the consumer's flow constraints are given by (initial net assets are assumed to be zero; that is, $b_0 = 0$):

$$\begin{aligned}c_1 &= \bar{y} - b_1, \\c_2 &= \bar{y} + (1+r)b_1, \\pc_2^* &= \bar{y} + (1+r)b_1 + \tau^*,\end{aligned}$$

where b_1 denotes end of period 1 (beginning of period 2) net foreign assets and τ^* denotes lump-sum transfers in case the tariff is imposed.²³ (In general equilibrium, $\tau^* = (p-1)c_2^*$.)

In this context:

- (a) Compute reduced forms for c_1 , c_2 , and c_2^* . Discuss the intuition behind the results.
- (b) Compute consumer's welfare as a function of π . Interpret the results.
- (c) Compare consumer's welfare when the tariff is $(p-1)$ in both periods with certainty.
- (d) What would you conclude about the desirability of trade reforms if you took the model at face value?
- (e) How could you modify the model to yield a more sensible policy prescription?

4. Effects of changes in the liberalization period with wealth effect

Let preferences be given by

$$u(c_t) = \log c_t.$$

Assume that a fraction ϕ of tariff revenues is spent on unproductive government spending, g , while a fraction $1 - \phi$ is returned to consumers as lump-sum transfers:

$$\begin{aligned}g_t &= \phi(p_t - 1)c_t, \\ \tau_t &= (1 - \phi)(p_t - 1)c_t.\end{aligned}$$

Notice that the two cases analyzed in the text are particular cases of this more general formulation: $\phi = 0$ corresponds to the full rebate case (Section 2) while $\phi = 1$ corresponds to the no rebate case (Section 5).

In this context:

²³Note that we are implicitly assuming that consumers cannot insure against uncertain trade policy in period 2 (which is, of course, the natural assumption). In other words, there are incomplete markets (as defined in Chapter 2).

- (a) Compute the reduced form for c^1 and c^2 as a function of q , T , and ϕ .
- (b) Derive the indirect utility function as a function of q , T , and ϕ .
- (c) Plot the consumer's indirect utility function as a function of T for different values of ϕ . In particular, show that for low values of ϕ there is a welfare loss for values of T below some critical value and a welfare gain for higher values (as illustrated in Figure 6), whereas for higher values of ϕ the temporary liberalization will always be welfare improving.

5. Increases in government spending with lump-sum taxation

Solve for the two experiments carried out in Section 6 – a permanent and a temporary increase in government spending – assuming that the government can resort to lump-sum taxation. Explain the intuition behind the differences that may arise.

6. The HLM effect with debt in terms of importables

As a result of using exportables as the numeraire, the model developed in the text assumes that external debt is denominated in terms of the exportable good. Perhaps a more natural assumption is that debt is denominated in terms of importables since, after all, in the real world importables and foreign debt of the typical emerging country are denominated in U.S. dollars.

To examine this alternative scenario, set-up the model of Section 7 in terms of importables (and with a general utility function) and study the current account response's to both a permanent and a temporary improvement in the terms of trade. In particular, does the HLM effect hold for temporary shocks?

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Box 1. How large is the intertemporal elasticity of substitution?

In our theoretical framework, the intertemporal elasticity of substitution plays a key role in determining the real effects of temporary policies. To judge the practical relevance of such a channel, we need to assess the quantitative importance of this parameter. What do econometric estimates of the intertemporal elasticity of substitution show?

Early empirical studies for developing countries – along the lines of Hall (1988) for United States data – suggested that the intertemporal elasticity of substitution was generally not significantly different from zero. These studies, however, were typically based on a one-good, non-monetary model. Once such restrictive assumptions were relaxed, the estimates became significantly different from zero with most estimates falling in a range of 0.2 to 0.5 (though estimates vary widely; see Table 1). Some studies kept the one-good assumption, but added money to the model. In this vein, Reinhart and Végh (1995) find elasticities to be in the 0.2-0.5 range for the Southern Cone countries. A different strand of the literature allowed for more than one type of good (typically incorporating non-tradables goods), though this line of research has been hampered by the lack of disaggregated data. Within this class of models, Ostry and Reinhart (1992) and Ogaki, Ostry, and Reinhart (1996) found elasticities in the range of 0.4-0.8 for various classifications of regions and income levels.²⁴ More recently, Duncan (2003) estimates an elasticity of 0.5 for the case of Chile.

Importantly, however, research in this area for industrial countries suggests that the available estimates for developing countries could have a downward bias. In particular, Attanasio and Weber (1995) point out that aggregation of macroeconomic data can cause such a bias, showing estimates from cohort data for the United States which are significantly higher. In addition, introducing durable goods into the picture appears to increase the estimates of the intertemporal elasticity of substitution considerably. For the case of Canada, Fauvel and Samson (1991) estimate the elasticity of substitution to be in the range 1.5-2.3 when durables goods are included. When they are excluded, the estimates become very imprecise (i.e., not significantly different from zero). For the case of the United States, Ogaki and Reinhart (1998) provide a range for the elasticity of 0.32-0.45 when durables are included and a negative point estimate when they are excluded.

²⁴Notice that, as Table 1 indicates, Ogaki, Ostry, and Reinhart (1996) find that estimates of the intertemporal elasticity tend to be higher for higher income countries. This is consistent with results obtained for developed countries (see Beaudry and van Wincoop (1995) and Cashin and McDermott (2003)), which typically imply higher elasticities than for developing countries. Higher elasticities for richer countries – which is also consistent with the work of Atkeson and Ogaki (1995) for household data – could be explained by the presence of higher levels of subsistence consumption and tighter liquidity constraints for poorer households.

Box 2. Do trade liberalizations lead to productivity gains?

Section 5 showed that, in the presence of wealth effects, a permanent trade liberalization would be welfare improving, and even a temporary trade liberalization might lead to welfare gains if the wealth effect dominates the intertemporal distortion effect (which will always be the case for a sufficiently long liberalization). We argued that, in practice, such wealth effects might be the result of increases in productivity brought about by reducing tariffs. Can we find these effects in practice?

In the real world, trade liberalization might affect plant-level productivity through several mechanisms:

- Trade liberalization could lead to easier access to imported intermediate inputs and more efficient capital goods, leading to productivity gains.
- A tariff reduction might lead to a drop in domestic prices, prompting less productive firms to exit the market (in the absence of investment irreversibility). Resources will thus be relocated to more efficient plants, increasing industry-wide efficiency.
- Trade liberalization might induce firms to use inputs more efficiently, increase international technology diffusion, increase managerial effort, improve capacity utilization or push domestic plants towards scale efficiency, generating within-plant productivity gains.
- A higher exposure to foreign competition is likely to reduce the market power of domestic producers, move down their average cost curves and expand output.

If these effects are present, trade liberalization, whether temporary or permanent, is likely to produce wealth effects through productivity gains. By and large, existing studies are consistent with this idea. Edwards (1998), for instance, analyzes empirically the relationship between openness and TFP growth in a panel of 93 countries for the period 1960-1990 and concludes that countries with higher levels of trade distortions have experienced lower TFP growth. The results of microeconomic studies – summarized in Table 2 – offer further support for the idea that trade liberalization increases productivity. In particular, plant and firm-level evidence suggests that trade liberalization is likely to encourage domestic firms to improve efficiency – through greater access to embodied technology in intermediates and capital goods and higher foreign competition – leading to important static and dynamic productivity gains.

Box 3. Is it optimal to reduce tariffs even in the presence of imperfect credibility?

In this chapter, we used Calvo's (1987) model as a benchmark model to study the welfare effects of intertemporal distortions. As shown in Sections 2 and 3, a permanent reduction in tariffs has no impact on consumption, while a temporary reduction in tariffs leads to a consumption boom-bust cycle. In the benchmark model, therefore, a temporary trade liberalization is always welfare-reducing because it imposes an intertemporal distortion. In Section 5, we introduced a wealth effect by assuming that tariffs proceeds are used to finance socially unproductive spending. In such a case, a permanent cut in tariffs is always welfare improving and even a temporary reduction may increase welfare if the wealth effect dominates the intertemporal distortion effect. Hence, trade liberalization reforms may be worth pursuing even under incomplete credibility.

In this light, the question becomes an empirical one: are the gains from trade large enough to generate a post-reform increase in welfare even under imperfect credibility? To answer this question, Buffie modifies Calvo's (1987) framework (i.e., the model of Section 2) in order to allow from gains from trade. Specifically, he departs from the assumption of complete specialization (output is exported, consumer goods are imported) and allows for substitution in consumption and production. Consumers' preferences take the form of a CES aggregator with importables, exportables, and nontradable goods. The production function is also CES with capital and labor. To provide realistic estimates, Buffie (1999) relies on parameter values from various studies and data for low and middle income countries. He highlights the importance of seven key parameters for which he takes a range of plausible values: the intertemporal elasticity of substitution, the size of the initial tariff, the intratemporal elasticity of substitution between tradable and nontradable goods, the elasticity of substitution between labor and capital in the exportables sector, the elasticity of substitution between labor and capital in the import-competing sector, the consumption share of importable goods, and the duration of the tariff reduction.

The model is solved for 240 cases defined by combinations of alternative values of the key parameters listed above. In most cases, a tariff cut is welfare improving and the results of the exercise can be summarized in four main quantitative findings:

- The optimal percentage tariff cut is always larger when the initial tariff is 100 percent than when it is 50 percent. This result supports the notion that more protectionist economies should liberalize more.
- When the intertemporal and intratemporal elasticities of substitution are the same, the optimal tariff cut is very large, ranging from 60 to 86 percent.
- In a small open economy, the optimal tariff cut exceeds 50 percent even when the intertemporal elasticity of substitution is much larger than the intratemporal one.

- Free trade is welfare improving if either (i) the consumption share of the importable good is not abnormally large or (ii) the intertemporal elasticity of substitution is less than one.

Buffie (1999) concludes proposing the rule of thumb that an optimal tariff cut of at least 50 percent is robust when the costs of imperfect credibility are limited to those captured by the theoretical model.

Box 4. What are the effects of terms of trade shocks on the current account?

Terms of trade shocks are widely regarded as a major force driving business cycle fluctuations in small open economies. The effects of terms of trade movements on the current account were initially studied by Harberger (1950) and Laursen and Metzler (1950). Using a Keynesian model, they show that an exogenous rise in the terms of trade leads to an improvement in the trade balance. Intuitively, an improvement in a country's terms of trade raises its current income and, given a marginal propensity to consume less than unity, increases current consumption by less than income (i.e., private saving increases). This is the so-called Harberger-Laursen-Metzler effect.

What does the evidence show? Overall, the empirical evidence is mixed (see Table 3 for a summary of the main studies). Evidence in favor of the HLM can be found in Otto (2003) and Kent and Cashin (2003). Using a structural vector-autoregression model, Otto (2003) finds strong evidence of the HLM effect in a sample of 55 countries. Kent and Cashin (2003) find that the HLM effect is present when countries face predominantly temporary terms of trade shocks.²⁵ On the other hand, Cashin and McDermott (2002) find that terms of trade shocks do not affect the current account in countries with large non-tradable sectors. Using a different empirical approach, Bouakez and Kano (2008) conclude that terms of trade shocks do not have a significant effect on the current account.

We thus conclude that the jury is still out regarding the empirical validity of the HLM. The evidence, however, is consistent with the idea that we are more likely to observe the HLM effect in economies that more open to trade and face predominantly temporary terms of trade shocks.

²⁵It is worth noting that Kent and Cashin's (2003) findings are fully consistent with our analysis of Chapter 1 in which we show that, in a model with investment, the response of the current account is related to the duration of the shocks (i.e., the less persistent the shock, the more likely that the savings effect will dominate).

Figure 1. Permanent fall in tariffs

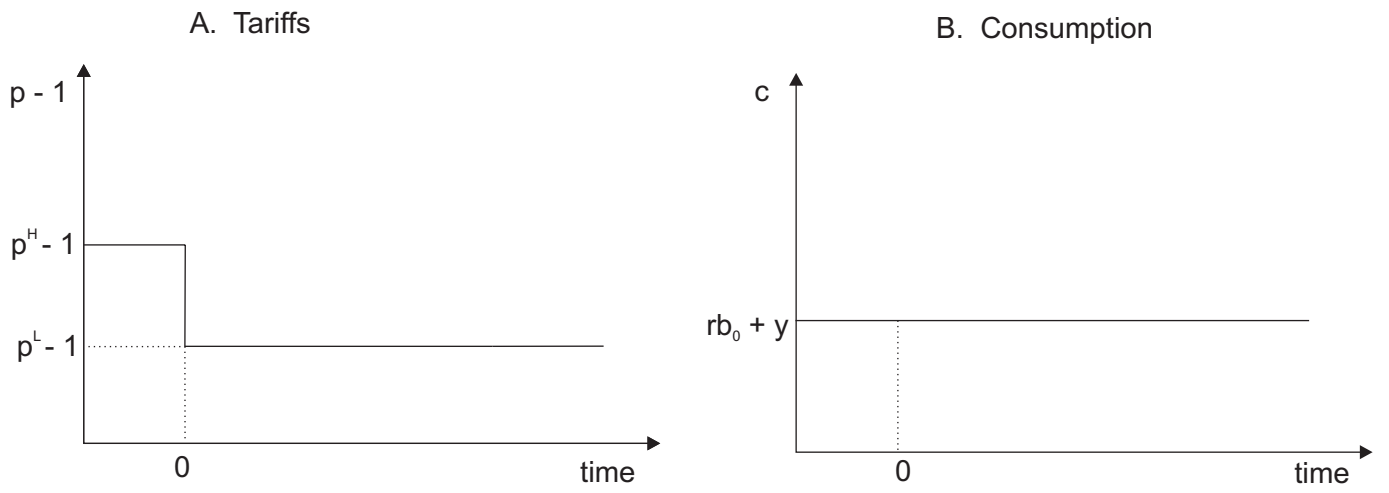
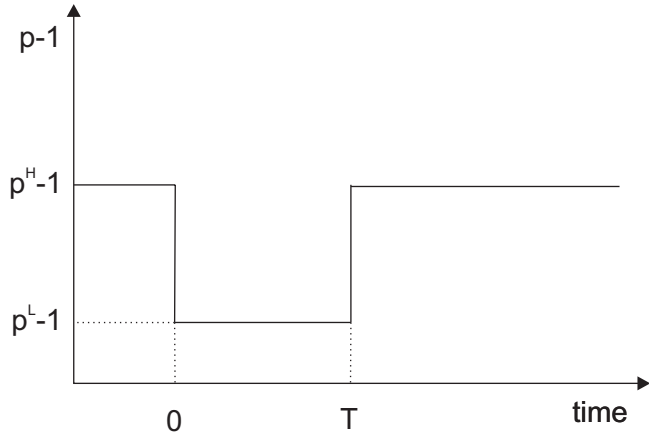
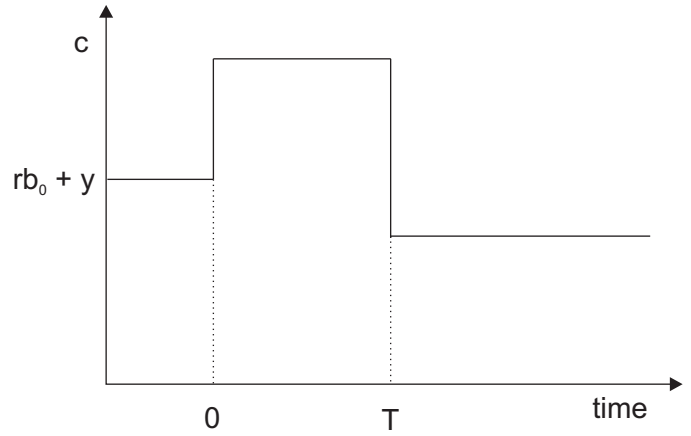


Figure 2. Temporary fall in tariffs

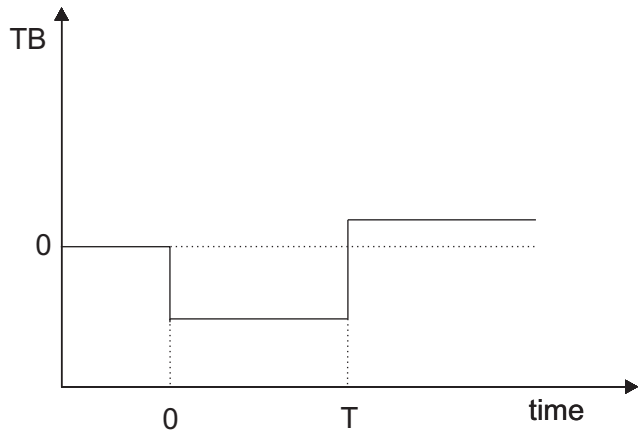
A. Tariffs



B. Consumption



C. Trade Balance



D. Current account

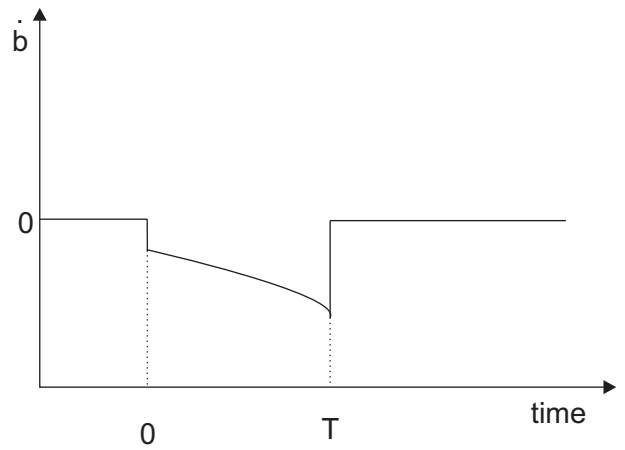


Figure 3. Welfare as a function of T

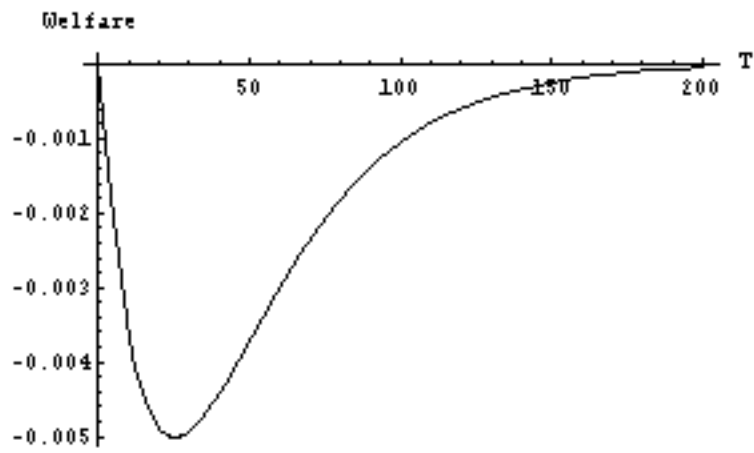


Figure 4. Permanent fall in tariffs (with wealth effect)

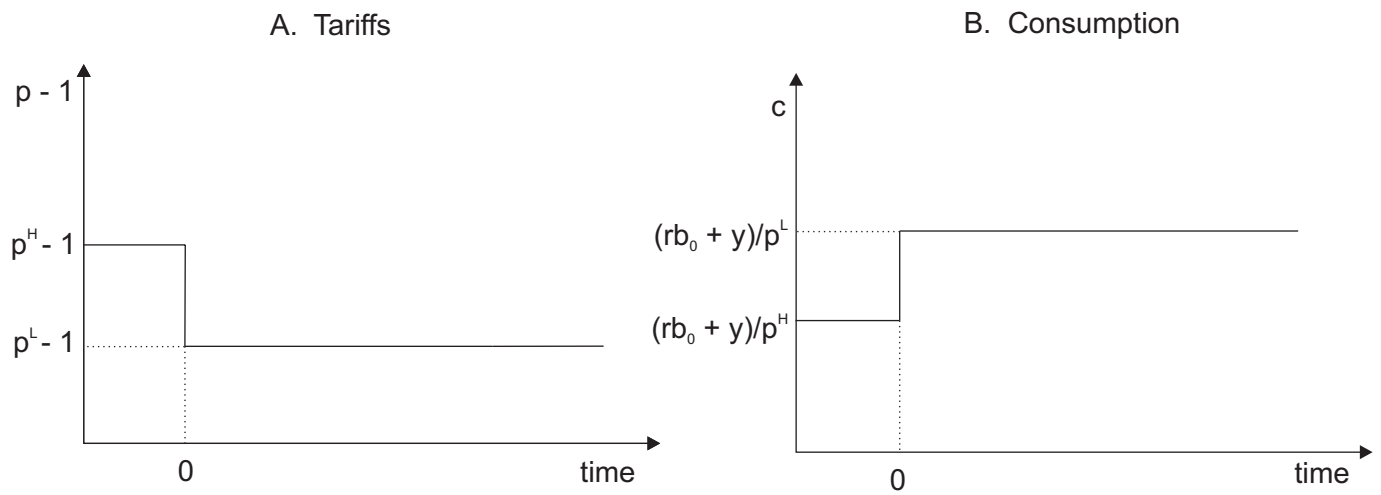
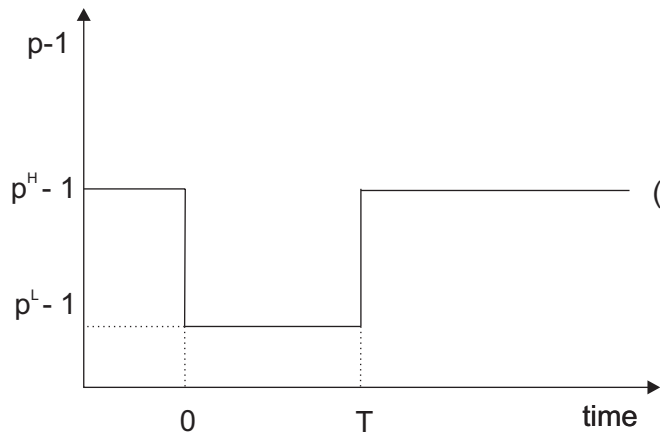
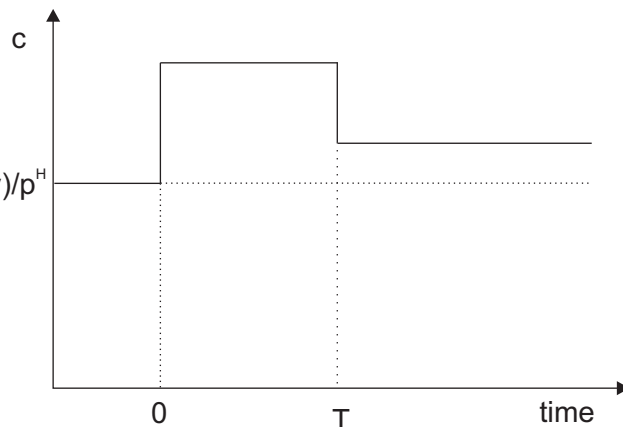


Figure 5. Temporary fall in tariffs (with wealth effect)

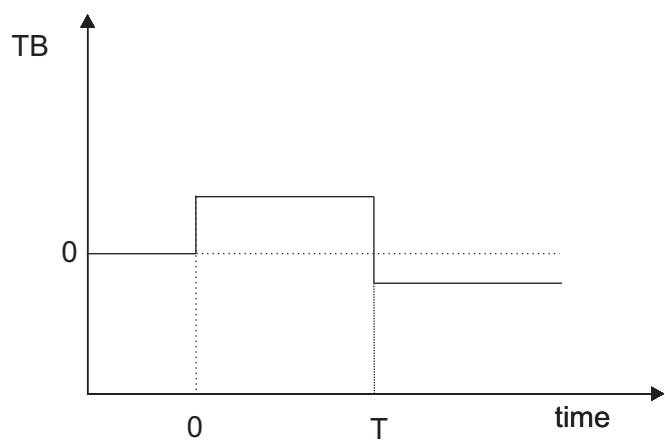
A. Tariffs



B. Consumption



C. Trade Balance



D. Current account

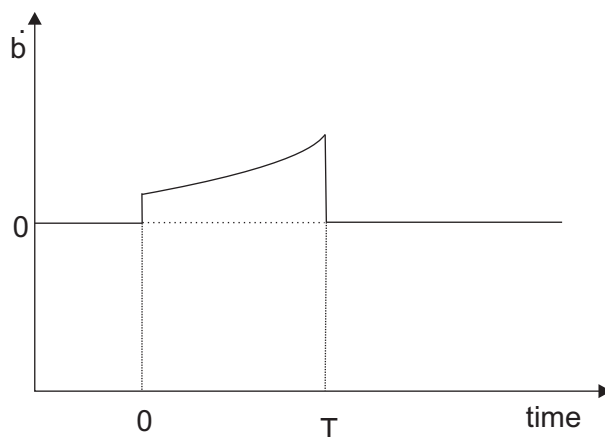


Figure 6. Welfare as a function of T (with wealth effect and partial rebate)

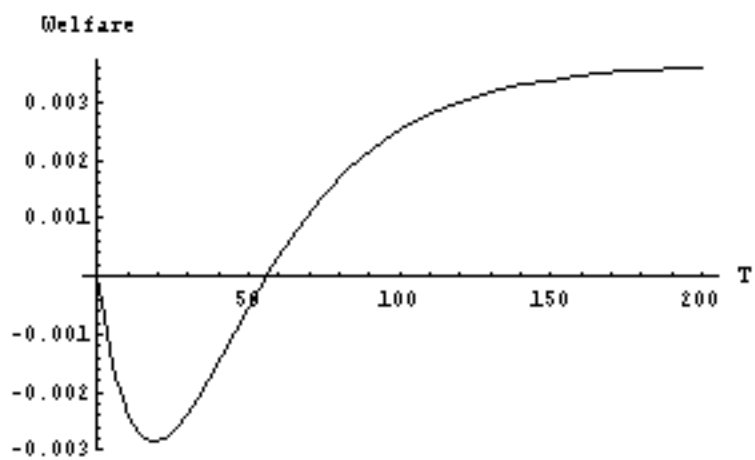
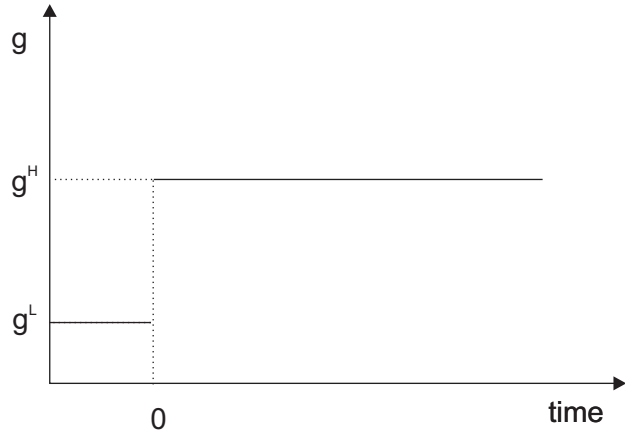
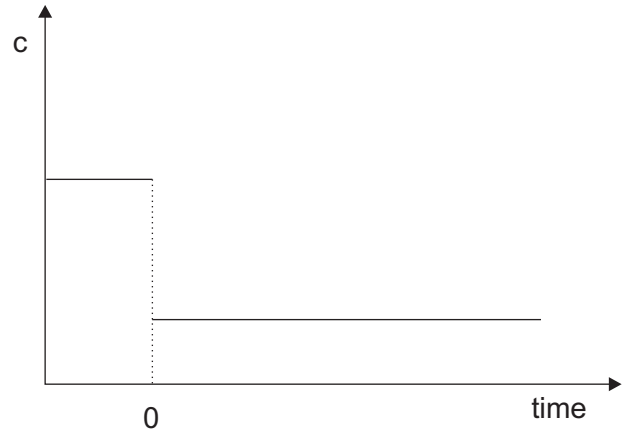


Figure 7. Permanent increase in government spending

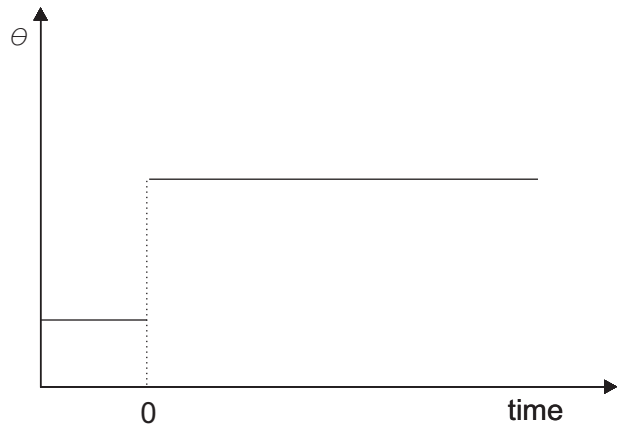
A. Government spending



B. Consumption



C. Tax rate



D. Trade balance

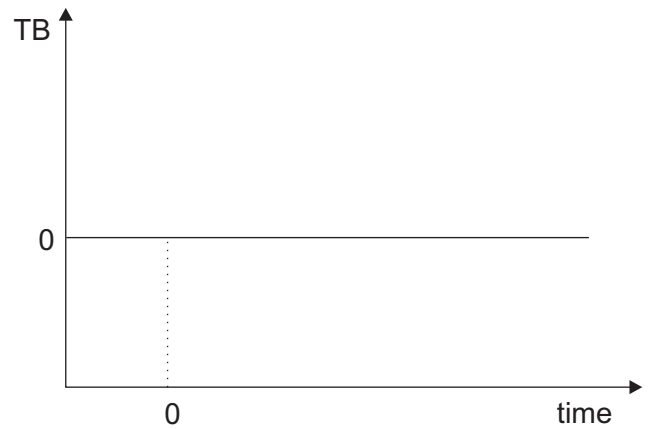
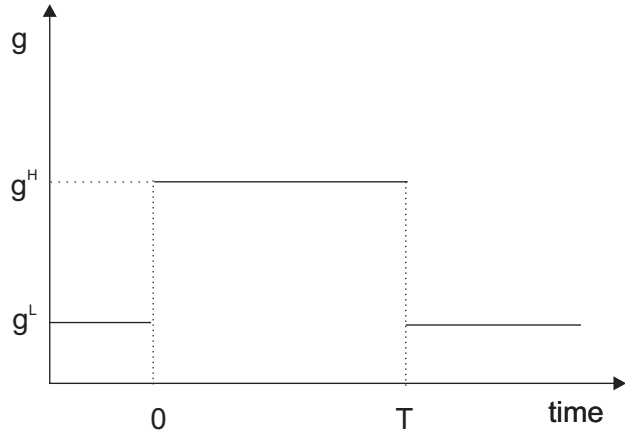
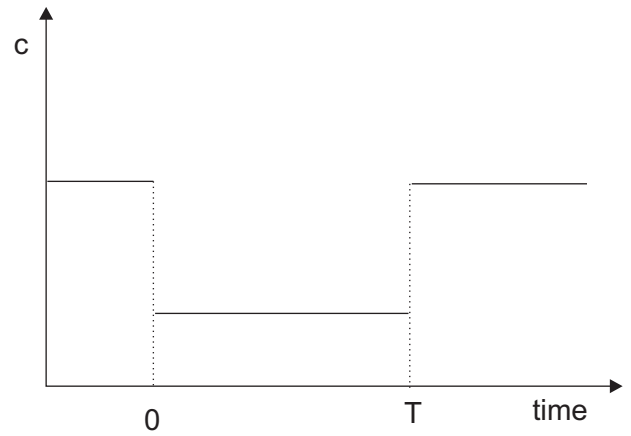


Figure 8. Temporary increase in government spending

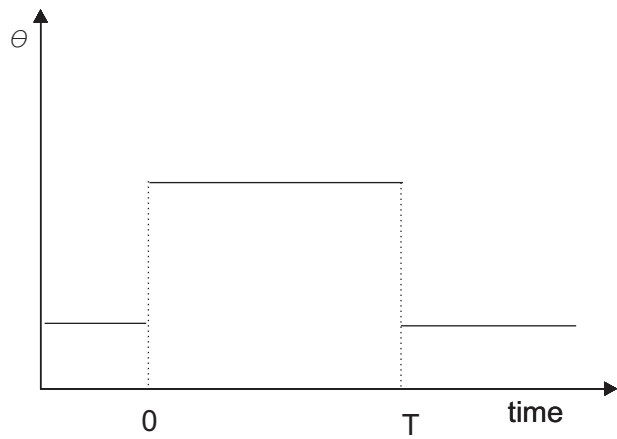
A. Government spending



B. Consumption



C. Tax rate



D. Trade balance

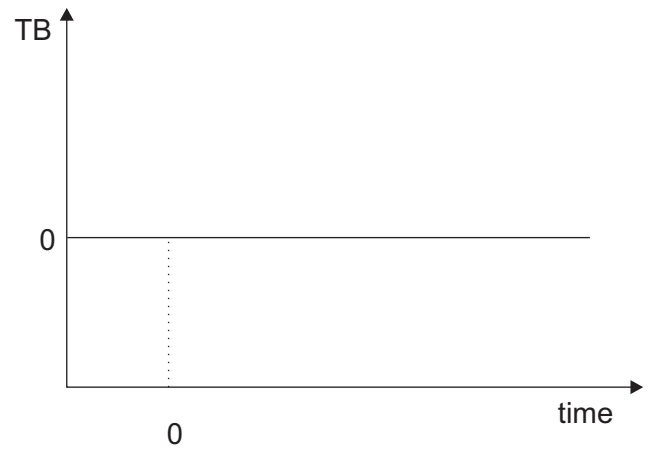


TABLE 1. Empirical estimates of the intertemporal elasticity of substitution

Countries	Point estimates	Sample and frequency	Type of model	Source
Argentina	0.21 (0.03)	Quarterly 1978:1-1989:2	Transaction costs model	Reinhart and Végh (1995)
	0.15 to 0.19 (0.16) (0.11)	Annual 1960-77	Hall's one good, pure consumption model	Giovannini (1985)
Brazil	-0.17 to 0.01 (0.13) (0.14)	Annual 1967-79	Hall's one good, pure consumption model	Giovannini (1985)
Chile	0.19 (0.10)	Quarterly 1976:2-1989:2	Transaction costs model	Reinhart and Végh (1995)
	1.59 (n.a)	Quarterly 1971:3-1981:4	Money in the utility function model	Arrau (1990)
	0.46 to 0.56 (0.15) (0.26)	Quarterly 1986:1-2002:4	Pure consumption two-good model	Duncan (2003)
Israel	0.15 to 1.32 (n.a) (n.a)	Quarterly 1970:1-1988:3	Money in the utility function model	Eckstein and Leiderman (1991)
Mexico	2.87 (n.a.)	Quarterly 1980:1-1987:4	Money in the utility function model	Arrau (1990)
	0.07 to 0.12 (0.10) (0.12)	Annual 1965-79	Hall's one good, pure consumption model	Giovannini (1985)
Uruguay	0.53 (0.22)	Quarterly 1977:2-1989:3	Transaction costs model	Reinhart and Végh (1995)
Panel of countries*		Annual	Pure consumption two-good model	Ostry and Reinhart (1992)
Latin America (4)	0.37 to 0.43 (0.11) (0.14)	1968-87		
Asia (5)	0.80 to 0.80 (0.20) (0.24)			
Africa (4)	0.44 to 0.45 (0.18) (0.16)			
Panel of countries*		Annual	Pure consumption two-good model. Stone-Geary utility function.	Ostry, Ogaki, and Reinhart (1996)
Low Income (31)	0.34 (n.a.)	1968-1992		
Lower-Middle Income (21)	0.58 (n.a.)			
Upper-Middle Income(15)	0.61 (n.a.)			
Panel of 9 South American Countries	0.09 (0.07)	Annual 1973-83	Hall's one good, pure consumption model	Rossi (1988)
	0.09 (0.04)	Annual 1973-81	With liquidity constraints	Rossi (1988)

Note: The highest and lowest point estimates are reported. Standard errors are in parenthesis. An "n.a." denotes the standard error was not reported.

*Number of countries in parentheses

Table 2. Impact of trade liberalization on productivity

Author	Country/Data	Methodology	Main results
Tybout et al. (1991)	Chile 1974-1979 Industrial census establishment-level data	Maximum likelihood estimation	-Overall, no evidence found of improvements in productive efficiency for the manufacturing sector. -Some evidence of improvements in average efficiency levels and cross-plant efficiency dispersion in industries undergoing relative large reductions in protection. -Adverse macroeconomic shocks might have masked the effects of the trade liberalization.
MacDonald (1994)	United States 1972-1987 3- and 4-digit manufacturing industry data	Instrumental variable approach, fixed effects	-Statistically weak, small and positive association between import shocks and productivity growth. -Import shocks have a large and statistically significant effect on next period productivity in highly concentrated industries.
Tybout and Westbrook (1995)	Mexico 1984-1990 Plant-level panel data	Panel data analysis	-Fall in average costs in most industries and gains in productivity (especially in tradables). Largest fall in average costs in more open sectors. -Minor gains in scale efficiency after liberalization, uncorrelated with increases in import competition. -Productivity gains through movements of individuals plants toward the production frontier, innovation and externalities.
Krishna and Mitra (1998)	India 1986-1993 Firm-level data	Panel data analysis, numerical simulations	-Evidence of increased foreign competition reflected in the drop of price-marginal cost markups in the post liberalization period. -Statistically weak evidence of increases in productivity growth.
Hay (2001)	Brazil 1986-1994 Data of large manufacturing firms	Panel data analysis	-Trade liberalization had a negative effect on market shares of domestic producers, as well as it led to a fall in profits. -Growth in productivity, due to recovery from recession, trade liberalization and deregulation of the economy (hard to distinguish among these).
Pavcnik (2002)	Chile 1979-1986 Industrial census Establishment-level data	Panel data analysis	-Evidence of productivity improvements due to trade liberalization. -Exit of less productive plants helps reallocating market shares and resources within the economy, contributing to productivity gains. -Continuing plants in import competing sectors improve their productivity, adjusting to a more trade-open environment (within-plant productivity improvements). -Export-oriented sectors do not experience productivity gains due to trade liberalization.
Fernandes (2007)	Colombia 1977-1991 Annual Colombian manufacturing census plant-level data	Panel data analysis	-Protection had a statistically significant negative effect on TFP, after controlling for plant and industry heterogeneity, RER and cyclical effects. -Impact of tariffs is greater for larger plants and for plants in less competitive industries. -Productivity gains through increases in within-plant imports of intermediate inputs, skill intensity, machinery investments and output reallocations from less to more efficient plants

Table 3. Empirical studies on the HLM effect

Author	Dataset	Testing strategy	Results
Bouakez and Kano (2008)	Quarterly data Australia 1972-2001, Canada 1962-2001, and United Kingdom (1971-2001)	Derives an approximate closed-form solution for the present-value representation of the current account that takes into account, in addition to the HLM effect, consumption-smoothing effects of future changes in the interest rate and exchange rate.	Terms of trade shocks do not significantly affect the current account. Extended model is rejected by the data, indicating that terms-of trade shocks are not important in explaining current account movements in Australia and Canada. For United Kingdom, model is not rejected but improvement is marginal.
Kent and Cashin (2003)	128 countries 1960-1999	Consumption-smoothing effect on savings and the investment effect work in opposite directions – the greater the persistence of a terms of trade shock, the more the investment effect will dominate the saving effect.	Persistence of terms of trade shocks varies across countries. The current account response is positively (negatively) related to unanticipated changes in the terms of trade for countries with predominantly temporary (permanent) terms of trade shocks.
Otto (2003)	15 small OECD and 40 developing countries 1960-1999	Uses a structural vector autoregression (SVAR) model to summarize the first and second moments of the data. Empirical evidence of a HLM effect is obtained from the SVAR model by examining the estimated response function for the trade balance following a terms of trade shock.	Strong evidence in favor of the HLM effect. The immediate effect of a positive shock to the terms of trade is an improvement in the balance of trade. On average, terms of trade shocks are marginally more important in explaining fluctuations in the trade balance for developing countries than for developed countries.
Cashin and McDermott (2002)	5 OECD countries 1970-1997	By comparing two commodity-exporting countries with relative small nontradables sectors with three major industrial countries, study examines how important terms of trade shocks are in affecting current account balance.	Terms of trade shocks found to be highly persistent. However, they do not have any impact on the current account balance of countries with large nontradable sector. Only for those countries with relatively small nontradable sectors (Australia and New Zealand), is there evidence in support of the HLM effect.