UNCERTAIN DURATION OF REFORM:
Dynamic Implications [*]

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ABSTRACT: We develop a framework to study the effects of policies of uncertain duration on consumption dynamics under both complete and incomplete markets. We focus on the dynamic implications of market incompleteness, specifically on the lack of state-contingent bonds. Two policies are considered: pure output-increasing and tariff-reducing (trade liberalization). With complete markets, the output-increasing policy leads to flat consumption, while with no contingent assets, consumption jumps upward on the announcement of the policy, continues rising as long as the policy is in effect, and collapses when it is abandoned. A similar consumption path obtains in a trade liberalization in the realistic case of low elasticity of substitution and no rebate of tariffs. Market incompleteness rationalizes the existence of gradual changes in consumption.

I. <u>Introduction</u>

Although policymakers usually present major economic reforms as permanent structural changes, citizens, on the basis of their past experience, are skeptical about the permanence of such reforms. Doubts about the permanence of reforms not only reflect the nature of the programs--often, drastic breaks with previous policy--but also strongly influence the economic effects reforms will have.

Price stabilization programs, for example, provide ample evidence that outcomes may very much reflect the degree of credibility enjoyed by the program.   Consider the consumption/output boom often observed at the beginning of an exchange-rate-based stabilization program (see Kiguel and Liviatan (1992)). <u>1</u>/ Calvo and Végh (1993) show that initial lack of credibility in the sustainability of the exchange rate anchor can account for the initial boom, as well as several other stylized facts associated with these programs, like eventual consumption/output contraction. With the exception of Drazen and Helpman (1988, 1990), however, this type of credibility or limited-policy-durability work has mostly focused on perfect-foresight models in which the timing of the policy switch is fully known at the beginning of the program. <u>2</u>/

The objective of this paper is to analyze the effects of uncertain duration of reform, that is, uncertainty about the date a program may be abandoned, on the dynamics of consumption and the current account. The emphasis on consumption and real variables distinguishes our

<u>1</u>/ Eastern Europe, provides a counterexample -- reform programs were accompanied by a steep fall in output (see Calvo and Coricelli (1993)).
<u>2</u>/ Other papers which have used the framework of Drazen and Helpman to analyze uncertain duration include van Wijnbergen (1988).

paper from the work of Drazen and Helpman, who concentrated on the dynamics of nominal variables, such as inflation and the nominal exchange rate. Moreover, in contrast to other papers in the literature, we demonstrate how the effects of uncertain duration will depend crucially on the structure of asset markets.

Our primary result is that policies characterized by uncertain duration can generate consumption booms which mirror what has been observed in many economies, even though the same policies would not generate empirically realistic consumption dynamics if their duration were known. For example, a policy which yields an increase in economy wide income whose duration is uncertain can generate high and continually rising consumption while the policy is in effect; if the duration of the policy were known, however, it would yield a flat consumption path. A trade liberalization of uncertain duration can generate a number of different consumption paths, depending on both how the government disposes of its tariff revenues and on the elasticity of intertemporal substitution. In the realistic case of the government not rebating tariff revenues to consumers and low elasticity of substitution, high and continually rising consumption results, a pattern observed in many countries in which consumers doubted the permanence of trade liberalization. Here too, if the date on which the liberalization would be abandoned were known, the model would not yield this pattern.

The plan of the paper is as follows. In the next section we set up a basic model of a non-monetary economy that produces a single exportable good, and consumes a different importable good. We outline two basic types of policies: an "endowment or productivity-increasing" policy--by which output of exportables is higher while the program lasts--and a "trade liberalization" policy--by which tariffs are set to zero while the program lasts, but are expected to be positive afterwards. In section III we study the consumption dynamics that would be observed in a model with only one real asset, deriving the paths described above, and compare

them with the paths that would obtain if there were a full set of state-contingent markets (or equivalently if the duration of the policies were certain). Section IV closes the paper, and an appendix examines the case of complete markets, which helps more fully to understand the role of capital-market incompleteness.

II. The Basic Model

We assume that the timing of the policy switch is the only source of uncertainty. The government announces a policy at time $t = 0$, to which the public assigns an uncertain duration (that is, believes there is a chance of a future "policy switch"). Let T denote the time of the policy switch. We assume the public has a subjective probability distribution on T, where its c.d.f. is denoted by $H(T)$. Thus, $H(T)$ is the probability that the policy switch occurs at time T or earlier. 3/ Function H is assumed to be common knowledge.

The country is endowed with a path of exportables which depends on current economic policy. Residents are assumed to have no taste for exportables and, instead, consume only importables, where the terms of trade in the absence of taxes on imports or exports are assumed to be constant over time and, without loss of generality, are set equal to unity. Import tariffs are represented by $\theta(t)$, equal to one plus the tariff rate.

The economy has a representative individual whose utility is a function of consumption. We assume that the von Neumann-Morgenstern utility function is time-separable. The period utility function $u(\cdot)$ is strictly concave, twice-continuously differentiable, and monotonically increasing. Domestic residents take the international rate of interest r as given, and the

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3/ This formulation is consistent with two different interpretations: either that the policymaker intends the policy to be temporary; or, more interestingly, that the policy is intended to be permanent, but imperfect policy credibility leads the public to expect a future policy reversal.

international bond is the only available financial asset. The representative individual holdings at time t are indicated by $a(t)$. Maximum utility (at T) associated with $a(T)$ is denoted by the value function $V(a(T))$. 4/ Therefore, utility at time zero can now be expressed as follows, where r is the rate of discount:

$$(1) \quad \int_0^\infty \left[\int_0^T u(c(t))e^{-rt}dt \ + \ e^{-rT}V(a(T)) \right] dH(T).$$

To abstract from dynamic considerations that are extraneous to the present discussion, we will assume that the international interest rate is constant and equal to the subjective discount rate. Thus, bond holdings evolve according to

$$(2) \quad \dot{a}(t) \ = \ y(t) \ + \ ra(t) \ - \ e(t)c(t) \ + \ \hat{o}(t).$$

where $\tau(t)$ denotes time-t lump-sum government transfers (in terms of exportables). Therefore,

$$(3) \quad a(T) \ = \ a(0)e^{rT} \ + \ \int_0^T [y(t) \ - \ e(t)c(t) \ + \ \hat{o}(t)]e^{r(T \ - \ t)}dt.$$

Condition (3) now stands for the individual's budget constraint.

Maximization of utility yields the following central first-order condition, conditional on the policy switch not having occurred at time t, which can be obtained by pointwise maximization after substituting (3) into (1):

4/ To simplify the notation, we will assume that tariffs, outputs and subsidies are constant after the policy shift, and are independent of the point in time at which the policy switch occurs. This allows us to write the value function as in the text. Without those simplifying assumptions one should include T as another argument in V--thus, writing $V(a(T),T)$.

(4) $\dfrac{u'(c(t))}{\grave{e}(t)} = \displaystyle\int_t^\infty V'(a(T))\,\dfrac{dH(T)}{1 - H(t)} \equiv \grave{u}(t).$

Equation (4) has a clear interpretation. Consider the experiment of increasing consumption at time t by one unit <u>if the policy switch has not yet occurred at time t.</u> <u>5/</u> This increases utility (1) by $u'(c(t))[1 - H(t)]e^{-rt}$, where $[1 - H(t)]$ is the probability that the policy switch will not have taken place by time t. To stay within his budget constraint, the individual is assumed to cut his consumption <u>after</u> the policy switch. This implies that the brunt of the adjustment will fall upon $a(T), T \geq t$. By budget constraint (3), an additional unit of $c(t)$ lowers $a(T)$ by $\theta(t)\,e^{r(T-t)}$. The latter lowers utility (1) by $\theta(t)e^{-rt}V'(a(T))h(T), T \geq t$, (where $h(t)$ is the p.d.f. associated with H) which, adding over $T \geq t$, yields a marginal cost equal to

(5) $\grave{e}(t)e^{-rt}\displaystyle\int_t^\infty V'(a(T))\,dH(T).$

Equating marginal benefit $u'(c(t))[1 - H(t)]e^{-rt}$ to marginal cost, as given by equation (5), results in first-order condition (4).

Differentiating the right-hand side of (4) with respect to time yields

(6) $\breve{u}(t) = \ddot{o}(t)[\grave{u}(t) - V'(a(t))]$

where $\phi(t) = h(t)/[1 - H(t)]$ is the "hazard rate" at time t. Equation (6) represents a basic differential equation associated with the utility maximization problem under no contingent markets, and it applies for every $t < T$. It is in fact the standard Euler equation in continuous

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 5/ More precisely, the experiment consists of increasing $c(s)$ for s in some small interval around t. Otherwise, t being just a point under the integral, increasing $c(t)$ only would have no perceptible effect on welfare or the budget constraint.

time. To see this, note that the return to a unit of assets is the flow return r plus the probability of a policy switch at t, $\phi(t)$, multiplied by the percentage "capital gain" in utility that an individual will enjoy if a switch takes place, namely $(V'(a(t)) - \omega)/\omega$. According to the Euler equation the percentage change in the marginal utility of consumption ω is simply the discount rate minus the return to the asset, which is (6) as the discount rate is r.

We assume that the economy is stationary after the policy switch, with $y(t) = \underline{y}$, $\theta(t) = \kappa$, and $\tau(t) = $ constant, for all $t \geq T$.6/ Therefore, given the equality between the international interest rate and the subjective rate of discount, consumption after the switch is constant and equals $[\underline{y} + ra(T) + \tau]/\kappa$. Hence,

$$(7) \quad V(a(T)) \; = \; \frac{1}{r} \; u\left(\frac{\underline{y} \; + \; ra(T) \; + \; \hat{o}}{\hat{e}} \right);$$

implying,

$$(8) \quad V'(a(T)) \; = \; \frac{u'\left(\dfrac{\underline{y} \; + \; ra(T) \; + \; \hat{o}}{\hat{e}} \right)}{\hat{e}}.$$

Thus, by equations (3), (6) and (8), we get:

6/ Constancy of lump-sum taxes after the policy switch is
consistent with the assumptions made in the next section.

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(9) \quad \breve{u}(t) \; = \; \ddot{o}(t) \left[\grave{u}(t) \; - \; \frac{u'\left(\dfrac{\underline{y} \; + \; ra(t) \; + \; \hat{o}}{\hat{e}} \right)}{\hat{e}} \right].
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For each of the policies considered in the next section, individual maximization and the budget

constraint will allow us to represent the economy's dynamics by a system of two differential

equations, based on equations (2) and (9).

III. Uncertain Reform and Consumption Dynamics

We now consider the dynamics of consumption (as well as the current account) under

different policies of uncertain duration. We first consider the endowment-increasing policy

which increases output while the policy is in effect. Specifically, we study the case in which $y(t)$

$= \bar{y} > \underline{y}$ if the policy is in effect, $y(t) = \underline{y}$ otherwise, where we assume no tariffs, so that $\kappa = 1$,

and zero lump-sum transfers, i.e., $\tau = 0$.

If a full set of state-contingent markets existed, the constant relative price of consumption

will imply that after the policy announcement, consumption is constant across time and states of

nature (see the appendix for details). Consumption will be independent of whether the program

is terminated after a week or after a year, even though the longer the program stays in place, the

larger will be the accumulated output of exportables generated by the endowment-increasing

policy. Intuitively, it is like fully insuring against a contingency (such as one's house burning

down): with perfect insurance, consumption is independent of when or if the event occurs. The

same flat pattern of consumption would be observed if T, the date of policy collapse, were

known with certainty.

In the absence of state-contingent securities, the story is quite different. By equations (2)

and (9), the budget constraint and necessary conditions imply, for $t < T$:

(10) $\dot{a}(t) = \bar{y} + ra(t) - C(\grave{u}(t))$,

and

(11) $\grave{u}(t) = \ddot{o}(t)[\grave{u}(t) - u'(\underline{y} + ra(t)]$

where, recalling (4), function C is defined by the condition

(12) $u'(C(\grave{u})) = \grave{u}$.

By dynamic equations (10) and (11), we have

(13) $\dot{a} = 0$ $\Leftrightarrow$ $\grave{u} = u'(\bar{y} + ra)$,

(14) $\check{u} = 0$ $\Leftrightarrow$ $\grave{u} = u'(\underline{y} + ra)$.

Therefore, for $\phi > 0$, dynamic behavior is described by the phase diagram in the (a,ω)-plane is as depicted in Figure 1, in which the locus where $\dot{\omega} = 0$ lies above the one where $\dot{a} = 0$.   The direction of movement remains invariant to changes in hazard function ϕ, as long as $\phi > 0$.

(Insert Fig. 1)

The initial condition $a(0)$ is given by history. However, $\omega(0)$ is, in principle, free to take any positive value. To pin it down, one works backwards. Let T^c be the first point in time at

which the policy switch will have occurred with probability 1, that is, let it satisfy the condition (as seen from time 0):

(15) $H(T^c) = 1$, and $H(T) < 1$ for all $T < T^c$. $\underline{7}$/

At T^c, therefore, the consumer faces a perfect-foresight problem and, hence, if the consumption plan is optimal, the marginal utility of wealth, ω, cannot jump at T^c. This imposes a boundary condition on ω at $t = T^c$ which, in terms of Figure 1, implies that the equilibrium path should reach the $\dot{\omega} = 0$ locus at time T^c. Clearly, the only trajectories compatible with such a condition would be those like the path from A to B in Figure 1. Consequently, ω falls over time which, by (12), implies that <u>consumption rises monotonically before the policy switch</u>. Moreover, if the switch occurs before T^c, say at $T < T^c$, then, right after the switch, $\omega = u'(\underline{y} + ra(T))$. In terms of Figure 1, this means that at the time of the switch, ω jumps from E to F. Thus, <u>if the policy switch is not fully expected, then the switch is associated with a sudden and permanent fall in consumption</u>. These results are in sharp contrast with those under complete markets. Finally, bond holdings a accumulate before the policy switch, and stay constant afterwards. Thus, <u>the current account is positive as long as the endowment-increasing policy is kept in place</u>. $\underline{8}$/

The main reason for the difference in results from the complete-markets case is that if the consumer has no access to insurance markets, random shocks produce "income" effects, i.e., they change the opportunity set faced by the consumer. Suppose the endowment-increasing

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$\underline{7}$/ Unless otherwise stated, the ensuing discussion will assume
ö$(t) > 0$, $t \le T^c$.
  $\underline{8}$/ If $T^t = \infty$, then we define the equilibrium solution to be the limit of solutions corresponding to a sequence of finite-T^t distributions converging to the one displaying $T^t = \infty$. Technical convergence issues will not discussed here.

policy is still in force at *t*. Just before *t*, the consumer assigned a probability less than 1 that the program will be in force at *t*. Hence, since $\bar{y} > \underline{y}$, the choice of *c(t)* thus reflects a windfall relative to what was expected before: finding out that the program has not expired at time t is "good news," it (marginally) increases the individual's permanent income <u>after</u> time *t*. Hence consumption will be slowly rising over time to reflect a continued "windfall" as long as the program is in force. Since the consumer assigns a probability less than 1 that the program will be in force after *t*, some of the excess of $\bar{y}$ over $\underline{y}$ is treated as "transitory" income and saved, which explains the co-existence of surpluses in the current account. In contrast, the realization of the policy switch at time *T (for T < Tᶜ)* is "bad news," because before time *T* the event "policy switch at *T*" had probability less than 1. Furthermore, by assumption, after the policy switch, the economy's endowment goes permanently back to its low level $\underline{y}$. Therefore, it is again plausible that consumption takes a precipitous fall when there is a policy switch. After the switch, the current account is in balance because, by assumption, the economy is fully stationary.

Consider now a <u>temporary trade liberalization</u> involving a temporary setting of import tariffs to zero, so that $\theta(t) = 1$ for $T > t \geq 0$, and $\theta(t) = \kappa$ for some constant $\kappa > 1$, otherwise. We assume that output of exportables is constant at $\underline{y}$, independent of whether or not the liberalization policy is discontinued. We begin by assuming that tariffs are fully rebated in the form of lump-sum subsidies. Thus, $\tau(t) = 0$, for $t < T$, and $\tau(t) = (\kappa - 1)c(t)$, otherwise.

In the case in which markets are perfect, consumption will be high, but constant, while the trade liberalization is in effect (reflecting the constant price of imports) and will jump down to a lower constant level when the liberal trade policies are abandoned (see the appendix). In the absence of state-contingent assets, results are quite different. Therefore, by equations (2) and (9), we have

(16) $\quad \dot{a}(t) \;=\; \underline{y} \;+\; ra(t) \;-\; C(\grave{u}(t)),$

(17) $\quad \breve{u}(t) \;=\; \ddot{o}(t)\left[\,\grave{u}(t) \;-\; \dfrac{u^{\prime}(\underline{y} + ra(t))}{\hat{e}}\,\right].$

Hence, we now have

(18) $\quad \dot{a} \;=\; 0 \quad \Leftrightarrow \quad \grave{u} \;=\; u^{\prime}(\underline{y} + ra)$

(19) $\quad \breve{u} \;=\; 0 \quad \Leftrightarrow \quad \grave{u} \;=\; \dfrac{u^{\prime}(\underline{y} + ra)}{\hat{e}}.$

The economy's dynamics can be represented as in Figure 2, where the $\dot{a} = 0$ locus lies above the $\dot{\omega} = 0$ line. Therefore, applying earlier reasoning, we conclude that the equilibrium path will look like the curve joining points A and B in Figure 2. This implies that, <u>before the policy switch, consumption and bond holdings decrease monotonically over time</u>. Moreover, if the switch occurs at $T < T^c$, then, at time T, ω falls from E to F in Figure 2. However, since an instant before the switch $\dot{a} < 0$, it follows from (16) that consumption takes a sudden <u>fall</u> at time T (and remains constant forever after). 9/

(Insert Fig. 2)

The basic intuition behind these results follows from the complete-markets case, in which it can be shown (see the appendix) that equilibrium consumption is higher during the period of

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9/ Notice that, as compared with the endowment-increasing policy, c is now monotonically declining (instead of monotonically increasing as in the export-oriented policy) over time. However, in both cases consumption collapses at T if $T < T^c$.

trade liberalization than afterwards, independently of tariff rebate policy, for the simple reason that consumption is cheaper while trade liberalization lasts. Moreover, the decline in consumption over time before the switch reflects the fact that (as in the previous example) the individual assigns a probability between 0 and 1 to a policy switch. Suppose, having reached time t, the individual knew for sure that no switch would occur for the next h periods. It would then be optimal to set consumption constant over the interval from t to $t+h$. 10/ In contrast, a positive probability of a policy switch in the interval $(t,t+h)$ means that consumption prices may go up in that interval, increasing the individual's incentives to consume more than he would under perfect foresight. If, however, no policy switch occurs in the interval $(t,t+h)$, the individual realizes that he has overconsumed and, thus, depleted his bond holdings by more than he would if he knew that there would be no policy switch in the interval. This leads him to revise his consumption downwards. (Note also the presence of a current account deficit before the policy switch, corresponding to the fall in bond holdings over time.)

The trade-liberalization experiment discussed so far concentrates on pure substitution effects, since tariffs are rebated. In general, however, higher tariffs may be accompanied by higher government expenditure on, say, "white elephants" and, thus, the policy switch will be accompanied by substitution and income effects--which, as shown above, have opposite effects on the pattern of consumption before the policy switch. 11/ To examine this type of trade

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10/ A formal proof is obtained noticing that perfect certainty over the interval $(t,t+h)$ is equivalent to saying that the hazard rate ö $= 0$ over that interval. Thus, by (25) ù--and, hence, c--is constant over the interval $(t,t+h)$.

11/ However, as shown in the appendix, the pattern of consumption before the policy switch under complete markets is independent of whether or not tariffs are rebated to the public.

liberalization, let us assume that, contrary to the previous case, the tariff is not rebated back to the public and, thus, that lump-sum subsidies are identically equal to zero.

Therefore,

$$(20) \quad \check{u}(t) = \ddot{o}(t) \left[\dot{u}(t) - \frac{u'\left(\dfrac{\underline{y} + ra(t)}{\hat{e}}\right)}{\hat{e}} \right],$$

while bond holdings, a, still satisfy equation (16). Hence,

$$(21) \quad \dot{a} = 0 \quad \Leftrightarrow \quad \dot{u} = u'(\underline{y} + ra)$$

$$(22) \quad \check{u} = 0 \quad \Leftrightarrow \quad \dot{u} = \frac{u'\left(\dfrac{\underline{y} + ra}{\hat{e}}\right)}{\hat{e}}.$$

The position of the $\dot{a} = 0$ and $\dot{\omega} = 0$ loci is now ambiguous and depends on the intertemporal elasticity of substitution σ ($\sigma = -u'/u''c$). One can show the following Proposition:

Proposition 1. *Consider the case of trade liberalization without tariff rebate: (a) if $\sigma = 1$ then consumption is constant over time, and the private sector's current account is always in balance, (b) if $\sigma < 1$ then the paths of consumption and the private sector's current account follow the patterns associated with the endowment-increasing policy (see Fig. 1), and (c) if $\sigma > 1$ then the paths of consumption and the private sector's current account follow the patterns associated with trade liberalization when tariffs are fully rebated to the public (see Fig. 2).*

Proof of Proposition 1. Case (a) is trivial, because the two stationary curves in the phase diagram coincide. By (21) and (22), the phase diagram for case (b) follows the pattern indicated in Figure 1. Thus, a and c increase over time. Right before the switch $u'(c(T)) = \omega(T)$; right after the switch ω satisfies the rightmost equation in expression (22). Let us indicate

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such value by $\omega^+(T)$. Then, by Figure 1, $\omega^+(T) > \omega(T)$, which implies that $u'(c^+) = \omega^+(T)\kappa >$ $\omega(T) = u'(c(T))$. Hence $c^+ < c(T)$, as asserted. Finally, by (21) and (22), case (c) is associated with the phase diagram shown in Figure 2. Therefore, before the policy switch, a and c fall over time. Right before the switch $\dot{a}(T) < 0$, and after the switch $\dot{a} = 0$, and the consumption price rises from 1 to κ: thus, it is required for consumption to take a discontinuous fall at T, as asserted. **#**

The empirically relevant case appears to be $\sigma < 1$. Thus, under no rebate all the policies studied in this section yield the same pattern: before the switch, consumption rises over time while the private current account is in surplus; at switch time, consumption collapses, and remains constant forever after.

IV. <u>Final Words</u>

This paper has presented an analytical framework in which <u>lack of credibility</u> significantly affects the outcome of economic reform programs. We showed that uncertain program duration coupled with incomplete markets provides an explanation for the consumption dynamics which often accompany sharp changes in policies. The model could be enriched in several ways. For example, non-traded goods could be introduced into the model, and under some simple assumptions the real exchange rate (defined as the real price of tradables in terms of home goods) will appreciate (depreciate) as c grows (decreases) over time. The model could thus rationalize periods of <u>gradual</u> appreciation of the real exchange rate--often observed in temporary price stabilization programs (Végh (1992))--<u>even though the "fundamental" variables show a "flat" pattern</u>. These dynamics would characterize an endowment-increasing policy, as well as a temporary trade liberalization with no tariff rebate (if the intertemporal elasticity of substitution is less than unity).

Theory can only suggest. Recent empirical work, however, indicates that similar models can help to explain consumption booms in a significant number of stabilization episodes (see Reinhart and Végh (1992), Buffman and Leiderman (1992)). Nonetheless, we feel that we are just beginning to tap on the large well of empirical evidence connected with recent worldwide reform programs. A thorough and systematic analysis of this evidence should improve the chances of distinguishing between the hypotheses explored in this paper, and competing ones like, for example, credit market segmentation (see Calvo and Coricelli (1993)).

APPENDIX -- Complete Markets

With complete markets, we describe the representative individual's consumption plan by two functions: $c(t)$ and $c^+(t,v)$; where $c(t)$ is consumption at time t if the policy switch has still not occurred at time t, and where $c^+(t,v)$ denotes consumption at time t if the policy switch has occurred at time v, $v \le t$ (i.e., if the policy switch is of "<u>v</u>intage" v). Expected utility at time zero can be represented as the sum of discounted utility of consumption in each of the two possible states of nature at each point in time t multiplied by the probability of that state, where, as indicated above, in the case of there having been a policy switch at $v \le t$, consumption depends on both v and t. We therefore have

$$(A-1) \quad \int_0^\infty u(c(t))[1-H(t)]e^{-rt}dt \; + \; \int_0^\infty \left[\int_0^t u(c^+(t,v))\,dH(v) \right] e^{-rt}dt,$$

where r is the constant subjective rate of discount. (To help in understanding (A-1), note that if c^+ were independent of v, the second term in (A-1) would simplify to $\int_0^\infty u(c^+(t))\,H(t)\,e^{-rt}dt$.)

Prices of importable goods (in terms of exportables discounted to time 0, which we term "present prices") are defined by two functions: $q(t)$ and $q^+(t,v)$; where $q(t)$ is the present after-tariff price of importables consumed at time t if the policy switch has not yet occurred at time t, and $q^+(t,v)$ is the present after-tariff price of importables consumed at time t if the policy switch occurred at time v, $v \le t$. $p(t)$ and $p^+(t,v)$ are the analogous price concepts for exportables. Thus, if initial financial wealth is zero, the representative individual's budget constraint takes the following form:

$$\int_0^\infty q(t)c(t)\,dt \ + \ \int_0^\infty \left[\int_0^t q^+(t,v)c^+(t,v)\,dv \right] dt \ =$$

(A-2) $\qquad\qquad \int_0^\infty p(t)[\ y(t)\ +\ \hat{o}(t)\ ]\ dt\ +$

$$\int_0^\infty \left\{ \int_0^t p^+(t,v)[y^+(t,v)\ +\ \hat{o}^+(t,v)]\ dv \right\} dt,$$

where the non-superscripted and superscripted variables have the same meaning as in the text.

Assuming the country faces risk-neutral investors, Arrow-Debreu prices satisfy (where θ is 1 <u>plus</u> tariff, $t < v$, and θ^+ is the same concept at $t \geq v$):

(A-3a) $\quad q(t) = [1 - H(t)]\theta(t)e^{-rt},$

(A-3b) $\quad q^+(t,v) = h(v)\theta^+(t,v)e^{-rt},$

(A-3c) $\quad p(t) = [1 - H(t)]e^{-rt},$

(A-3d) $\quad p^+(t,v) = h(v)e^{-rt},$

In words, <u>for each state of nature at time</u> t Arrow-Debreu import prices are, by risk-neutrality, equal to the present discounted value (after tariffs and in terms of present exportables) at time t of a unit of importables (in the corresponding state of nature) multiplied by the probability of the corresponding state of nature at time, with a similar interpretation for export prices.

The representative individual is assumed to maximize utility (A-1) by choosing contingent paths of consumption, $c(t)$ and $c^+(t,v)$ (for all $t \geq v \geq 0$), such that budget constraint (A-2) is satisfied, given the contingent paths of y, q and τ, and c.d.f. H. Therefore, in the presence of a risk-neutral (foreign) investor, the first-order conditions for an (interior) optimum are:

(A-4a) $\ u'(c(t)) = \lambda\theta(t),$

(A-4b) $\ \ u'(c^+(t,v)) = \lambda\theta^+(t,v),$

where λ is the (constant) Lagrange multiplier corresponding to budget constraint (A-2).

The results in the text on the endowment increasing policy leading to flat consumption follow form (A-4), since we assumed that the tariff rate was held equal to zero (i.e., $\theta \equiv \theta^+ \equiv 1$). For the case of a trade liberalization, we assumed that tariffs satisfy: $\theta(t) \equiv 1$ and $\theta^+(t,v) \equiv \kappa > 1$, for $t \geq v$. Hence, by (A-4), consumption equals a constant $\bar{c}$ while the trade liberalization is still in effect, and a constant $\underline{c} < \bar{c}$ after it collapses. This pattern holds independently of whether tariffs are rebated to the public.

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