Policy Conflicts, Endogenous Delay and Consumption Booms: The Unpleasant Arithmetic of Fixed Exchange Rates

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Abstract

Countries with fixed exchange rates face a dilemma whenever they need to implement a stabilization plan. Should they keep the fixed exchange rate system, or should they allow their currencies to float and inflation to rise? Whatever the final outcome, there is a significant lag between the time when stabilization is first required and when it is finally implemented.

After a negative fiscal shock new means of revenue need to be created. Delay is the result of a war of attrition between the monetary and fiscal authority. The fiscal authority keeps large deficits in the hope that the monetary authority would eventually monetize part of it, and the monetary authority, concerned with inflation, avoids monetization as long as possible in the hope that the fiscal authority will reduce the deficit. If no agreement is reached, the deficit is financed by additions to the stock of public debt, which creates larger revenue needs in the future. Delay is therefore costly, as it implies larger future distortionary taxes.

Delay results in real exchange rate appreciation and current account deficits, with consumption booms and inflation before stabilization and regardless of its nature. The behavior of the economy after stabilization will depend on the nature of the adjustment chosen.

1 Introduction

Traditional currency crises models focus their attention on events just prior to a crisis. These are inevitable and the result of a fiscal imbalance (first generation models) or the product of some change in inflation expectations that results in a self-fulfilling crises (second generation models). In general, the role the fiscal authority plays in these models and in those related to optimal monetary policy in open economies is exogenous and restricted to satisfying a budget constraint. In contrast, monetary authorities are optimizing agents with clearly defined objectives. Thus, the effect of the interaction between these two authorities with different instruments and potentially divergent objectives has been, somehow, neglected.

The central question addressed in this paper is why speedy adjustments at the time of negative fiscal shocks are not observed in countries with fixed exchange rates. Or, put another way, why is there 'costly' delay in implementing a stabilization plan in a country with a fix peg. The answer will lie in the relationship between the monetary and fiscal authorities (once the fiscal authority is introduced in a more sophisticated way) and the interaction between these two and optimizing households and firms. In particular, delay in implementing a stabilization plan may be the result of a war of attrition between the two authorities where the government keeps large deficits in the hope that sooner or later the monetary authority will monetize part of it, and the monetary authority, concerned with inflation, avoids monetization as long as possible in the hope that the fiscal authority, sooner or later, will reduce the deficit.

Fiscal problems are arguably at the heart of most, if not all, currency crises and emerge much earlier than the collapse of the peg itself, even though some literature (in particular Rebelo and Végh (2002)) suggest that this is suboptimal. In the case of the Asian crisis, Burnside et. al. (2001) point out that large prospective deficits associated with implicit bailout guarantees by the government to failing banks that *would (at least in part) be financed by seignorage revenues or an inflation tax on outstanding nominal debt led to the collapse of the fixed exchange rate regimes in Asia... raising distortionary taxes or lowering government purchases under those circumstances could well be politically unacceptable or socially undesirable relative to the alternative But these alternatives are incompatible with maintaining fixed exchange rates.* Similar examples can be found for the Mexican crisis of 1995 or the Argentinian crisis of 2002[1].

[1] In the Mexican case Sachs et.al. (1996) argue that the country *was already in need of adjustment by late 1993* and that it was *the unwillingness of monetary authorities to tighten or to permit a timely exchange rate adjustment that brought that result.* In the case of Argentina Perry and Serven (2002) argue that *"sudden stops" of capital flows acted more as an amplifier than as a primary cause of the crisis.* In fact, the overvalued currency

The model here shares some features with first and second generation models of currency crises. The nature of the crisis is a fiscal imbalance as in first generation models. In these models, Flood and Garber (1984), Krugman (1987), the monetary authority follows an exogenous rule of abandoning the fix peg if and only if a lower bound on reserves is reached. The model here abstracts from a balance of payments crisis. Implicitly it is assumed that there is an upper bound on the stock of public debt (or, equivalently, a lower bound on the level of international reserves) but it is not reached in the time horizon considered, so that the probability of a balance of payment crisis is zero. Another departure from first generation models is that both authorities' actions are given a behavioral foundation. The monetary authority doesn't follow a mechanical rule and the fiscal authority is not an exogenous agent.

The fiscal imbalance generates a need for adjustment over which the two authorities disagree. The monetary authority prefers a non-inflationary adjustment, whereas the fiscal authority the inflationary alternative. Since the two authorities are instrument independent, any stabilization that involves the instrument of the other requires his agreement. During the bargaining phase, each authority may agree to implement the other's preferred stabilization. If no agreement is reached, the deficit is financed by additions to the stock of public debt, which creates larger revenue needs in the future[2]. Delay is therefore costly as it implies larger future inflation or labor income tax, both of which are distortionary.

Eventually, one of the two adjustments will be implemented. However at the time of the crisis, rational agents will have some inflation expectation (a weighted average of the inflation rates of the different possible outcomes). This element is common to second generation models, Obstfeld (1986), where the possibility of unexpected inflation generates the crisis. However, unexpected inflation here has, ultimately, a fiscal origin. Note that inflation expectations affect the behavior of rational agents in a way that may make these expectations appear self-fulfilling as in second generation models. More importantly, since the two authorities are concerned about real variables, the behavior of agents will affect the state of the economy and feedback into the two authorities, constraining their actions.

The main results of the paper are as follows. The period of delay between

hid from the public view the serious deterioration in fiscal solvency and the increasing financial stress.

[2]To the already existing deficit, interest payments on the stock of public debt have to be added.

a negative fiscal shock and the adjustment, regardless of its nature, is characterized by a consumption boom, inflation and trade deficit. This is the case because a positive inflation differential between the domestic economy and its trading partners produces a real exchange rate appreciation, which triggers the substitution of domestically produced goods for relatively cheaper imports. That is, while there is delay and the nominal exchange rate is kept fixed, purchasing power parity does not hold. The inflationary adjustment is the most likely outcome ex ante and involves a smaller fall in consumption than the non-inflationary alternative. It also involves a nominal devaluation at the time of the crisis and a constant depreciation rate after the crisis. If the peg is to be backed, international competitiveness is regained through deflation.

These results are consistent with empirical evidence in Végh (1992), Végh and Reinhart (1995) and Kiguel and Liviatan (1992), which suggests that exchange rate stabilization programs have typically resulted in a sluggish adjustment of the inflation rate, sustained real appreciation of the domestic currency, current account deficits and an initial expansion of real activity followed by a contraction.

2 Policy Coordination, Delay and Currency Crises

It has been the tendency in many countries to make their central banks increasingly independent of day-to day political control. In many cases, this has meant the creation of an explicit and 'legally binding' inflation target (e.g. Australia, Canada, New Zealand, Sweden, United Kingdom and ECB). Central banks are in general more conservative than the politicians who run the treasury, by natural inclination or legal mandate.

The literature on commitment and discretion in monetary policy initiated by Kydland and Prescott (1977) and Barro and Gordon (1983) assumes that distortions create short-run benefits from unexpected inflation. First-best outcomes can be achieved by eliminating such distortions. Improvements over discretion can be obtained by delegation of monetary policy to a conservative central banker as suggested by Rogoff[3] (1985). Central bank independence and conservatism eliminates the inflationary bias of monetary policy that

[3] Or using simple inflation targets as suggested by Svensson (1997)

results from the incentive to exploit surprise inflation to raise output in the short run above its natural level (assumed inefficiently low).

This literature neglects the role of fiscal policy or simply takes it as exogenous. It is not realistic to assume that governments do not make discretionary adjustments above and beyond the automatic stabilizers embedded in a given fiscal policy. But, more importantly, fiscal policy also affects the price level directly, even when the central bank pursues an independent monetary policy. The reason is simple; fiscal policy affects aggregate demand through its effect on consumer budget constraints and aggregate supply through the incentive to produce more or less. Finally, fiscal policy may affect the credibility of monetary policymakers as government budget constraint links budget deficits to monetary policy.

Sargent and Wallace (1981) point out the importance of policy coordination and how low current inflation can come at the cost of high future inflation if monetary and fiscal policies are not coordinated. Some papers have concentrated on this issue by analyzing the implication of having independent monetary and fiscal policies with conflicting objectives. A stream of literature emerged in the early eighties as it was believed that a similar situation described the first years of the Reagan administration. The focus of the analysis was the evolution of public debt, Tabellini (1986), and the reputational consequences of imperfect information, Tabellini (1987) and Loewy (1988). These papers leave the private sector out of the picture in the sense that they assumed a linear law of motion of public debt and as a consequence preferences of the two authorities are functions of the instruments used.

The lack of coordination between two independent authorities or between various groups that are affected differently by a stabilization plan has been analyzed before. Alesina and Drazen (1991) show how when stabilization has significant distributional implications, affected groups may try to shift the burden of stabilization onto other groups. This process results in a war of attrition where each group attempts to wait the others out. Stabilization occurs when one group concedes and bears a disproportionate share of the burden. Thus, the model produces a 'rational' delay which depends on several political and economic variables. This paper overcomes the criticism that part of the stabilization literature has attracted, namely that in order to make stabilization necessary the departure point is an irrational exogenous combination of policies that makes a future crisis inevitable. Heterogeneity in the population is a crucial feature in their model together with uncertainty about the cost of waiting of other groups in order to generate delay. Guidotti and Végh (1997) combine the Alesina and Drazen framework in the context of a fixed exchange rate with a balance of payments crisis which provides and endogenous end to the war of attrition. They concentrate on credibility defined as the probability of a fiscal agreement or stabilization happening before a balance of payment crisis.

Corsetti and Mackowiak (2002) and Mackowiak (2002) analyzed a similar problem in the context of the fiscal theory of the price level. They stress how even without seignorage revenues the composition of debt can produce delay. In particular, a one-time devaluation reduces the real value of private agents' nominal claims on the government (monetary and non-monetary) and may eliminate the need for seignorage revenues in the post-collapse regime. Thus, crashes tend to be delayed but larger when a large fraction of public debt is foreign-currency or indexed.

These papers don't provide a behavioral foundation for policy rules and, by using an endowment economy they don't allow fluctuations in real variables. The model presented here fills some of the gaps left by the previous literature. In particular both policy makers are optimizing agents so that policy rules are optimal given their objectives. Also, by using a non-endowment economy, real variables are allowed to fluctuate providing richer and more realistic dynamics.

3 Small Open Economy

The model laid out here is a small open economy with distortionary labor taxes and flexible prices. Following Sims (1991), transactions costs generates a demand for money.

3.1 Households

Preferences are homothetic and separable in each component of the utility function. The endowment of time in each period is normalized to one so that, if the labor supplied by the representative agent is N_t, agent's leisure is $1 - N_t$. Agents can hold financial wealth in the form of money balances, M_t, or real assets, a_t. Assets held by domestic agents consist of government debt, b_t, or credit against private foreign agents, $b_{F,t}$. In order to simplify the notation it is assumed that all assets are defined in terms of the composite consumption good. Agents hold the amount of assets that maximizes their expected utility but are indifferent to the composition of assets. In addition agents supply labor in perfectly competitive labor markets and receive a share from domestic firms' profits.

The representative agent maximizes the expected utility,

$$E_t U_t = \sum_{s=t}^{\infty} \beta^{s-t} \left[\log c_s + \psi \log \left(1 - N_s\right) \right] \tag{1}$$

where the representative consumer consumes from a basket of consumption goods, c_s, defined as,

$$c_s = \left[n^{\frac{1}{\eta}} c_{H,s}^{\frac{\eta-1}{\eta}} + (1-n)^{\frac{1}{\eta}} c_{F,s}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

where η is the elasticity of substitution between domestic and foreign goods (assumed to be positive) and $c_{H,s}$ and $c_{F,s}$ are indices of consumption of domestic and foreign goods, which are given by the following CES aggregators of the quantities consumed of each type of good,

$$c_{H,t} = \left(\int_0^1 c_{H,t}\left(j\right)^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}, \; c_{F,t} = \left(\int_0^1 c_{F,t}\left(j\right)^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}$$

where θ is the elasticity of substitution among goods within each category[4].

The maximization of (1) is subject to a sequence of intertemporal budget constraints of the form,

$$\begin{aligned} & \left(1 + \alpha f\left(v_t\right)\right) \left(\int_0^1 \left[P_{H,t}\left(j\right) c_{H,t}\left(j\right) + P_{F,t}\left(j\right) c_{F,t}\left(j\right) \right] dj \right) \frac{1}{P_t} + a_{t+1} + M_t^d \\ = & \left(1 + r_t\right) a_t + \frac{M_{t-1}^d}{P_t} + \left(1 - \tau_t^N\right) \frac{W_t}{P_t} N_t + \frac{\Pi_t}{P_t} \end{aligned} \tag{2}$$

for $t = 0, 1, 2, ...$ where a_t are assets held by the consumer in the form of domestic debt, b_t or credit against foreign agents, $b_{F,t}$, $\frac{M_t}{P_t}$ are real balances, W_t is the nominal wage and τ_t^N is the tax rate on labor income. The factor $1 + \alpha f\left(v_t\right)$, where v_t is velocity defined as $\frac{P_t c_t}{M_t}$, represents the effect of transactions costs on the amount of utility-yielding consumption obtained from a given amount of expenditure. Put another way, $\alpha f\left(v_t\right)$ represents transaction costs per unit of consumption spending.

[4] All goods, domestic and foreign, are treated symmetrically. θ must be greater than 1 for a monopolist to have an interior solution since marginal revenues are negative when the elasticity is less than 1.

3.1.1 Optimal Temporal Allocation

The optimal temporal allocation problem is standard. First, the dual problem is solved to derive the price index P_t. Thus, the price index is the minimum cost (or price) of a unit of c_t. Therefore, the expression presented above solves the following problem,

$$\min E \equiv \int_0^1 P(j)\, c(j)\, dj \;\; \text{subject to } c = \left(\int_0^1 c(j)^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}} = 1$$

Then, the primal problem is solved to derive individual demand curves by,

$$\max c \text{ subject to } \int_0^1 P(j)\, c(j)\, dj = E$$

where E is an arbitrary, but fixed, level of expenditure. Thus, demand for good j becomes,

$$c_{H,t}(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\theta} c_{H,t},\; c_{F,t}(j) = \left(\frac{P_{F,t}(j)}{P_{F,t}} \right)^{-\theta} c_{F,t} \;\forall j \in [0,1]$$

where,

$$P_{H,t} \equiv \left(\int_0^1 P_{H,t}(j)^{1-\theta} dj \right)^{\frac{1}{1-\theta}},\; P_{F,t} \equiv \left(\int_0^1 P_{F,t}(j)^{1-\theta} dj \right)^{\frac{1}{1-\theta}}$$

are the price indices for domestic and imported goods, both expressed in domestic currency.

The law of one price implies,

$$P_{F,t}(j) = \varepsilon_t P_{F,t}^f(j) \quad \forall j \in [0,1]$$

where ε_t is the nominal exchange rate expressed as the price of foreign currency in terms of domestic currency and $P_{F,t}^f(j)$ is the price of foreign good j denominated in foreign currency.

Optimal allocation of expenditures between domestic and foreign goods implies,

$$c_{H,t} = n \left(\frac{P_{H,t}}{P_t} \right)^{-\eta} c_t, \; c_{F,t} = (1-n) \left(\frac{P_{F,t}}{P_t} \right)^{-\eta} c_t \tag{3}$$

where

$$P_t \equiv \left[n P_{H,t}^{1-\eta} + (1-n) P_{F,t}^{1-\eta} \right]^{\frac{1}{1-\eta}} \tag{4}$$

is the CPI.

Note that when prices of domestic and foreign goods are equal, parameter $(1-n)$ corresponds to the share of domestic consumption allocated to imported goods. It, thus, represents a natural index of openness.

Under the above optimality conditions, in the budget constraint, the term $\left(\int_0^1 \left[P_{H,t}(j) \, c_{H,t}(j) + P_{F,t}(j) \, c_{F,t}(j) \right] dj \right) \frac{1}{P_t}$ can be written as c_t.

3.1.2 Optimal Intertemporal Allocation

Thus, the representative agent's budget constraint in real terms is[5],

$$(1 + \alpha f(v_t)) \, c_t + a_{t+1} + \frac{M_t^d}{P_t} = (1 + r_t) \, a_t + \frac{M_{t-1}^d}{P_t} + \left(1 - \tau_t^N\right) \frac{W_t}{P_t} N_t + \frac{\Pi_t}{P_t} \tag{5}$$

The representative agent's problem becomes maximizing (1) subject to (5). The first order conditions with respect to consumption, money holding, labor supply and asset holdings are,

$$c_t^{-1} = \lambda_t \left(1 + \alpha f(v_t) + \alpha v_t f'(v_t)\right) \tag{6}$$

$$\frac{\lambda_t}{P_t} \left(1 - \alpha v_t^2 f'(v_t)\right) = \beta \frac{\lambda_{t+1}}{P_{t+1}} \tag{7}$$

[5] Here the timing convention in Obstfeld and Rogoff (96) is adopted by which M_t refers to money held between periods t and $t+1$ and a_t refers to assets held between periods $t-1$ and t.

$$N_t = 1 - \psi \frac{1}{\lambda_t} \left(\left(1 - \tau_t^L\right) \frac{W_t}{P_t} \right)^{-1} \tag{8}$$

$$\frac{\lambda_t}{P_t} = \beta \left(1 + r_t\right) \frac{\lambda_{t+1}}{P_{t+1}} \tag{9}$$

Combining (6) with $v_t = \frac{c_t P_t}{M_t}$,

$$\frac{\lambda_t}{P_t} = \frac{1}{v_t M_t^d \left(1 + \alpha f\left(v_t\right) + \alpha v_t f'\left(v_t\right)\right)} \tag{10}$$

Defining

$$z_t = \frac{1}{v_t \left(1 + \alpha f\left(v_t\right) + \alpha v_t f'\left(v_t\right)\right)} \tag{11}$$

and combining (10) with (7),

$$\frac{z_t}{M_t^d} \left(1 - \alpha v_t^2 f'\left(v_t\right)\right) = \beta \frac{z_{t+1}}{M_{t+1}^d} \tag{12}$$

Note that z_t is only a function of v_t. Only functions of f that makes z a monotone decreasing function will be considered, so that, when M_t is positive, (11) is really a difference equation in M and z or v alone.

Dividing (7) by (9),

$$\left(1 + r_t\right)^{-1} = 1 - \alpha v_t^2 f'\left(v_t\right) \tag{13}$$

Also, combining (6) and (8),

$$N_t = 1 - \psi c_t \frac{1}{v_t z_t} \left(\left(1 - \tau_t^N\right) \frac{W_t}{P_t} \right)^{-1} \tag{14}$$

Equations (12), (13) and (14) together with the private budget constraint (5), are the dynamic first-order conditions for the private agent's maximization problem when M is always positive.

3.2 Firms

Firms maximize their real profits,

$$\frac{\Pi_t(j)}{P_t} = \frac{P_{H,t}(j)}{P_t} y_t(j) - \frac{W_t}{P_t} N_t(j)$$

Production technology is assumed linear in labor, $y_t(j) = N_t(j)$.

In the absence of any constraint on price setting, the firm would simply maximize profits in each period in a static manner. The CES form of the utility function implies that consumer's demand for product j is given by $c_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta} c_t$. The government is assumed to consume only domestic goods.

$$y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta} \left(c_t + c_t^f\right) + g_t$$

If prices are fully flexible, firms will solve,

$$\max_{P_{H,t}(j)} \left\{ \frac{P_{H,t}(j)}{P_t} y_t(j) - \frac{W_t}{P_t} N_t(j) \right\}$$

which implies

$$P_{H,t}(j) = \frac{\theta}{\theta - 1} W_t$$

Demand for labor is $N_t = n \left(\frac{P_t(j)}{P_t}\right)^{-\theta} Y_t$

3.3 Government

Economic policy chooses the aggregate level of money balances, M_t^s, the aggregate level of debt, b_t, and the tax rate on labor income, τ_t^N, subject to,

$$g_t - \tau_t^N \frac{W_t}{P_t} N_t + r_t b_t = \frac{M_t^s - M_{t-1}^s}{P_t} + b_{t+1} - b_t \quad (15)$$

where the total liabilities of the government are made of real government bonds held by domestic consumers, b_t, and non-interest bearing money, M_t. Government spending can be financed by seignorage, $\frac{M_t^s - M_{t-1}^s}{P_t}$, borrowing, $b_{t+1} - b_t$, and taxing labor income, τ_t^N, of home consumers.

3.4 Prices

Domestic inflation is defined as the rate of change in the index of domestic goods prices, $\pi_{H,t} \equiv \log\left(\frac{P_{H,t+1}}{P_{H,t}}\right)$. On the other hand, CPI inflation is defined as the rate of change in the CPI, $\pi_t \equiv \log\left(\frac{P_{t+1}}{P_t}\right)$.

The terms of trade is the price of foreign goods in terms of domestic goods, $s_t \equiv \frac{P_{F,t}}{P_{H,t}}$. Let $p_{H,t} \equiv \frac{P_{H,t}}{P_t}$, which, combining it with (4), yields

$$p_{H,t} = \left[n + (1-n)\, s_t^{1-\eta}\right]^{1-\eta} \tag{16}$$

The small open economy assumption implies that the share of imports in the rest of the world's CPI is negligible which yields,

$$P_t^f = P_{F,t}^f \text{ or } \pi_t^f = \pi_{F,t}^f \ \ \forall t$$

Thus, the real exchange rate, e_t, is,

$$e_t \equiv \frac{\varepsilon_t P_t^f}{P_t} = \frac{\varepsilon_t P_{F,t}^f}{P_t} = \frac{P_{F,t}}{P_t}$$

Note then the simple relationship between terms of trade and the real exchange rate,

$$e_t = p_{H,t} s_t \tag{17}$$

which combined with (16) implies,

$$e_t = \left((1-n) + n s_t^{\frac{1}{1-\eta}}\right)^{1-\eta}$$

Flexible prices and the law of one price implies that when purchasing power parity holds, then the nominal exchange rate is such that $P_t = \varepsilon_t P_{F,t}^f = P_{F,t}$ and so,

$$P_t \equiv \left[n P_{H,t}^{1-\eta} + (1-n)\, P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}} = \left[n P_{H,t}^{1-\eta} + (1-n)\, P_t^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

or

$$1 = \left[\frac{n P_{H,t}^{1-\eta} + (1-n)\, P_t^{1-\eta}}{P_t^{1-\eta}}\right]^{\frac{1}{1-\eta}} = \left[n p_{H,t}^{1-\eta} + (1-n)\right] \Longrightarrow p_{H,t} = 1 \text{ and } s_t = \frac{P_{F,t}}{P_t} = 1$$

3.5 Equilibrium

3.5.1 Net Foreign Assets/Current Account

Combining the representative household's budget constraint (5) with the government budget constraint (15), the definition of profits and the profit maximizing condition the following current account equation is obtained,

$$b_{F,t+1} - b_{F,t} = p_{H,t}y_t - (1 + \alpha f(v_t))\, c_t - g_t + r_t b_{F,t} = c^f_{H,t} - c_{F,t} + r_t b_{F,t} \tag{18}$$

where $b_{F,t} = a_t - b_t$ is net foreign assets. The definition of net foreign assets follows Obstfeld and Rogoff denoting the net position towards the rest of the world. In this context $b_{F,t}$ is net of assets issued by the domestic government[6].

3.5.2 Aggregate Demand and Output Determination

The market clearing condition in the small open economy is,

$$y_t = \left(c_{H,t} + c^f_{H,t}\right)(1 + \alpha f(v_t)) + g_t - r_t b_{F,t} \tag{19}$$

Note also that from (3), $c_{H,t} = np^{-\eta}_{H,t}c_t$ and $c_{F,t} = (1-n)\, s_t^{-\eta} p^{-\eta}_{H,t} c_t$. Thus, using (19),

$$y_t = \frac{x_t - q_t}{1 - p_{H,t}q_t} q_t c_t + \frac{1 - q_t}{1 - p_{H,t}q_t} g_t - \frac{1}{1 - p_{H,t}q_t} r_t b_{F,t} \tag{20}$$

where $x_t = \left[n + (1-n)\, s_t^{-\eta}\right] p^{-\eta}_{H,t}$ and $q_t = 1 + \alpha f(v_t)$.

When PPP holds this expression simplifies to,

$$y_t = q_t c_t + g_t - r_t b_{F,t} \tag{21}$$

which, by (18), implies that the current account is balanced whenever PPP holds, $b_{F,t+1} - b_{F,t} = 0$.

[6] Note that when PPP holds the expression simplifies to, $b_{F,t+1} - b_{F,t} = y_t - (1 + \alpha f(v_t))\, c_t - g_t + r_t b_{F,t}$

3.5.3 Uncovered Interest Parity

The uncovered interest parity condition implies,

$$1 + i_t = \left(1 + i_t^f\right) \frac{\varepsilon_{t+1}}{\varepsilon_t} \tag{22}$$

Thus,

$$1 + r_t = \frac{1 + i_t}{1 + \pi_t} = \left(1 + i_t^f\right) \frac{\varepsilon_{t+1}}{\varepsilon_t} \frac{1}{1 + \pi_t}$$

3.5.4 Labor Market

Firms set prices equal to a mark up over marginal cost,

$$P_{H,t} = \frac{\theta}{\theta - 1} W_t \text{ or } \frac{W_t}{P_t} = \frac{\theta - 1}{\theta} p_{H,t} \tag{23}$$

Thus, by (14),

$$N_t = y_t = 1 - \psi \frac{\theta}{\theta - 1} c_t \frac{1}{v_t z_t} p_{H,t}^{-1} \left(1 - \tau_t^L\right)^{-1} \tag{24}$$

3.5.5 Steady State

Table 1 shows the equilibrium level of output consumption, velocity and government revenue for each potential outcome as well as for the pre-shock steady state. In particular, the steady state characterized by an inflation tax (constant growth rate of the money supply) and the one characterized by a labor income tax are described. Finally, the characterization of equilibrium while there is delay, that is after the shock and before any new policy is implemented, is also presented.

Note that in equilibrium the level of output and consumption depend on real money balances through velocity, $v_t = c_t \left(\frac{M_t}{P_t}\right)^{-1}$. Thus, money is neutral since any price level and nominal money supply that yields the same level of real money balances will lead to the same level of output and consumption (and therefore utility). On the other hand, the steady state level of velocity depends on the growth rate of money (or inflation), τ^M, and thus affects the steady state level of output and consumption. Summarizing, money is neutral but not super neutral. The higher the inflation rate, the higher velocity and the lower output and consumption.

	Pre-Shock	Inflation Tax	Lab. Inc. Tax	While Delay
c_t	$\frac{y_t}{q_t}$	$\frac{y_y - g + r_t b_{F,t+1}}{q_t}$	$\frac{y_y - g + r_t b_{F,t+1}}{q_t}$	$\frac{\left(1-p_{H,t}q_t\right)y_t-(1-q_t)g+r_t b_{F,t+1}}{(x_t-q_t)q_t}$
y_t	$1-\psi\frac{\theta}{\theta-1}c_t h_t$	$1-\psi\frac{\theta}{\theta-1}c_t h_t$	$1-\psi\frac{\theta}{\theta-1}\frac{c_t h_t}{1-\tau^N}$	$1-\psi\frac{\theta}{\theta-1}\frac{c_t h_t}{p_{H,t}}$
v_t	$d_t=\beta$	$d_t=\beta\frac{1}{\tau_t^M}$	$d_t=\beta$	$d_t=\beta\frac{z_{t+1}}{z_t}\frac{M_{t+1}}{M_t}$
$g+r_t b_t$	0	$\left(1-\frac{1}{\tau^M}\right)\frac{c_t}{v_t}$	$\tau^N\frac{\theta-1}{\theta}y_t$	$b_{t+1}-b_t$

Table 1

$$h_t = 1+\alpha f\left(v_t\right),\ q_t = 1+\alpha f\left(v_t\right),\ d_t = 1-\alpha v_t^2 f'\left(v_t\right),\ x_t = \left[n+(1-n)\,s_t^{-\eta}\right]p_{H,t}^{-\eta}$$

The initial, pre-shock, steady state is characterized by no government expenditure, no inflation and a balanced current account. Money supply is set such that the price level is one. The nominally fixed exchange rate is set to one, $\varepsilon_0 = 1$ and foreign prices are also assumed to be equal to one.

When an inflation tax is set, money supply follows a deterministic exponential growth path, $M_t \equiv M_0\left(1+\tau^M\right)^t = M_{t-1}\left(1+\tau^M\right)$.

Note that the law of one price and flexible prices ensure that purchasing power parity will hold in any steady state (before the shock and after with an inflation tax or labor income tax). However, while there is delay and the exchange rate is nominally fixed, expectations about future price and exchange rate movements as well as the increased government spending will increase domestic prices and appreciate the real exchange rate. Consumption of domestically produced goods will be substituted, to a certain extent, for foreign goods[7] which produces current account deficits while there is delay. Note that delay cannot last forever as it would violate the government's intertemporal budget constraint –the stock of debt would be increasing exponentially over time.

[7] The price of foreign goods in domestic currency is constant while the nominal exchange rate is fixed.

3.5.6 The Costs of Delay

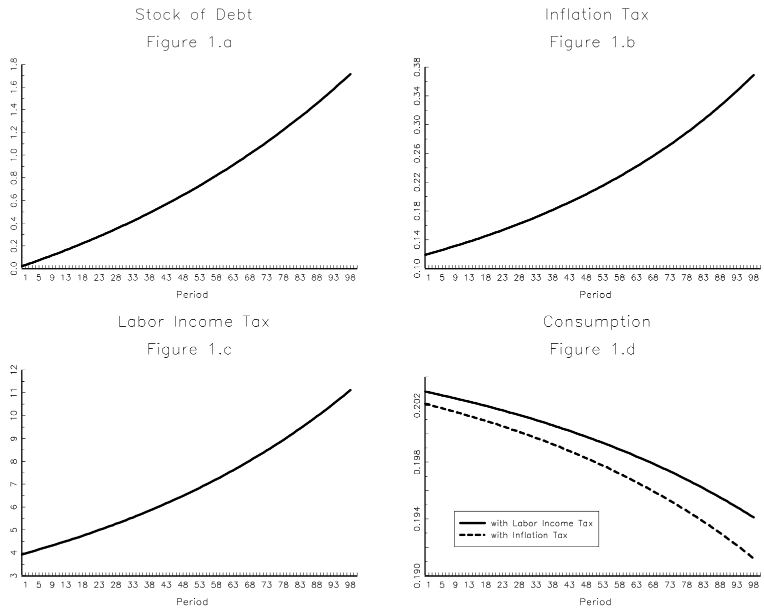

Figure 1: Costs of Delay

Figure 1 presents a simplified[8] exercise of the qualitative effect of delay on the price level and consumption when an adjustment takes place. Panel (a) shows the evolution of the stock of public debt when an economy at the initial steady state suffers a negative fiscal shock, $g = 0.005$, and no adjustment takes place. Thus, the primary deficit, equal to 0.005, is financed by additions to the stock of debt. Panel (b) graphs the inflation tax (growth rate of money) required at any given period in order to pay for the increased government expenditure and services on the stock of public debt such that the government's intertemporal budget constraint is satisfied[9]. Panel (c) shows the equivalent labor income tax needed to raise the same revenue[10]. Finally, panel (d) reflects the effect on consumption by the labor income tax or inflation tax described in panels (b) and (c).

The key element here is how the stock of debt is increasing at increasing marginal rates which implies that the increase in the inflation tax or labor

[8] Interest rates are (unrealistically) assumed constant at the pre-sock level.

[9] The required growth rate of money, τ^M, is given by the last raw, second column in Table 1.

[10] Last raw, third column in Table 1.

income tax needed for stabilization are also increasing at increasing rates over time. The effect on consumption is negative under both policies (more negative with the labor income tax) and becomes increasingly negative over time. The effect on the price level and inflation is just the opposite, increasing at increasing rates. In this sense, waiting is increasingly costly over time.

4 Economic Policy and Uncertainty

The interaction between the monetary and fiscal authorities as well as the information structure will be described here as a concession game with incomplete information, similar to Ordover and Rubinstein (1986), but with time dependent payoffs.

4.1 A Concession Game

The essence of the situation analyzed here is the following: the two authorities, monetary and fiscal, are involved in a conflict[11] that can be resolved in two ways. Each authority favors a different outcome. The two authorities are instrument independent and thus, any stabilization that involves the instrument of the other authority requires its agreement. During the bargaining phase, each authority has the option to concede allowing the implementation of the stabilization plan favored by the other authority.

For simplicity the fiscal authority will only care about the consumption of the representative agent. His preferences are given by the following quadratic loss function,

$$L_{\mathbf{F}} = \sum_{j=0}^{\infty} \beta_{\mathbf{F}}^{j} \left(c_j - c_{\mathbf{F}}\right)^2 \tag{25}$$

The monetary authority is only concerned with inflation,

$$L_{\mathbf{M}} = \sum_{j=0}^{\infty} \beta_{\mathbf{M}}^{j} \left(\pi_j - \pi_{\mathbf{M}}\right)^2 \tag{26}$$

These simplifying assumptions can be rationalized as follows. Distortions create short run benefits from unexpected inflation which the fiscal authority

[11] The nature of a stabilization plan.

is willing to exploit. On the other hand, the monetary authority may have an inflation target, $\pi_{\mathbf{M}}$, by legal mandate as is the case in most industrialized countries and has been the tendency in many developing countries. The assumption could be easily generalized making the preference of each authority a function of both inflation and unemployment,

$$L_i = \sum_{j=0}^{\infty} \beta_i^j \left[(c_j - c_i)^2 + k_i (\pi_j - \pi_i)^2 \right], \text{ with } i \in \{\mathbf{M}, \mathbf{F}\}$$

It is reasonable to assume that the weight the monetary authority places on inflation[12] is larger than that of the fiscal authority, $k_{\mathbf{M}} > k_{\mathbf{F}}$. The assumption above is just the extreme of this and has similar qualitative implications. Namely that the fiscal authority will always prefer a stabilization with the least negative effect on consumption; whereas the monetary authority will prefer the stabilization that is least inflationary.

Both authorities engage in a concession game (bargaining game with take-it-or-leave-it offers) where every period, each sequentially proposes its favored adjustment, and the other accepts it or not[13].

The fiscal authority has two types. Both types will agree on the favored adjustment but one, the 'crazy' or strong type, will never agree to any adjustment proposed by the monetary authority. The type of the fiscal authority is known only to himself but not to the monetary authority or to the representative agent[14]. This is the only uncertainty in the model which lasts for as long as the bargaining phase.

In the previous subsection it was argued how delay has an increasing effect, at increasing rates, on prices and consumption, as the required labor income tax or inflation tax needed to move the economy to a new steady state are increasing over time. This implies that, while there is delay, the losses of each authority, (25) and (26), are increasing at increasing rates. Preferences are not stationary, which implies that waiting is increasingly costly over time.

[12] Relative to unemployment

[13] Starting with the fiscal authority proposing the adjustment and the monetary auhtority accepting it or not.

[14] The fiscal authority's type is unknown but the preferences of the two types of the fiscal authority are known.

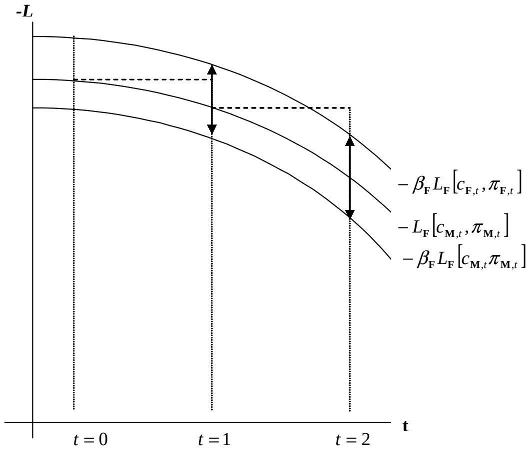

Figure 2: Fiscal's Preferences

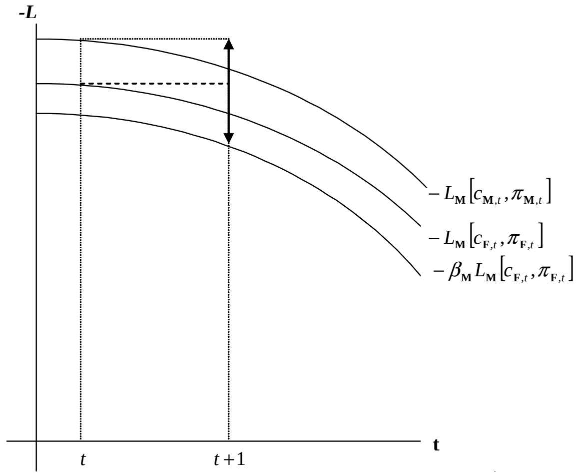

Figure 3: Monetary's Preferences

To describe the unique sequential equilibrium, the determination of the maximum length of uncertainty will first be analyzed. The fiscal authority's preferences determined the maximum length of the bargaining phase. Figure 2 presents the utility (minus the loss) of the fiscal authority over time. His preferred outcome, as argued above an inflationary adjustment, will lead to consumption and inflation of $[c_{\mathbf{F},t}, \pi_{\mathbf{F},t}]$. This outcome provides more utility than the labor-income-tax one favored by the monetary authority, $[c_{\mathbf{M},t}, \pi_{\mathbf{M},t}]$. Besides the concavity of the utility functions, over time, the following assumption, reflected in Figure 2, is also needed, $-\beta_{\mathbf{F}} L_{\mathbf{F}} [c_{\mathbf{F},t}, \pi_{\mathbf{F},t}] > -L_{\mathbf{F}} [c_{\mathbf{M},t}, \pi_{\mathbf{M},t}]$.

Hence, at $t = 1$ in Figure 2, the worst outcome the fiscal authority faces, $-L_{\mathbf{F}} [c_{\mathbf{M},1}, \pi_{\mathbf{M},1}]$, is larger than the best outcome he will get in period[15] $t = 2$, $-\beta_{\mathbf{F}} L_{\mathbf{F}} [c_{\mathbf{F},2}, \pi_{\mathbf{F},2}]$. If this is the case, independent of strategies and beliefs the fiscal authority, if weak, will give up at $t = 1$. That is to say, if the game reaches period $t = 1$ and the fiscal authority is of the weak type, he will concede with probability one, $\alpha_{\mathbf{F},1} = 1$. On the other hand, if no concession is observed by the fiscal authority in period $t = 1$, then it must be the case that he is of the strong type and will never concede. In this latter case, the monetary authority will concede in her next move in period $t = 2$,

[15] Discounted one period to make both quantities comparable.

$\alpha_{\mathbf{M},2} = 1$, and an inflationary adjustment will be implemented. Thus, the fiscal authority will reveal his type at $t = 1$ for sure if[16],

$$-L_{\mathbf{F}}\left[c_{\mathbf{M},1}, \pi_{\mathbf{M},1}\right] < -\beta_{\mathbf{F}} L_{\mathbf{F}}\left[c_{\mathbf{F},2}, \pi_{\mathbf{F},2}\right] \tag{27}$$

This result relies on the concavity of the utility function which is justified, as explained above, by the cost of delay over time – increasing at increasing rates. Also note that the fact that at $t = 1$ all uncertainty will be revealed gives the uninformed agent, the monetary authority, an incentive to enter into the bargaining phase and try to infer the type of the fiscal authority.

Next, equilibrium strategies and beliefs are studied. Figures 2 and 3 provide a graphical description of the probabilities that will make the fiscal authority and the monetary authority respectively indifferent between conceding at any given period t or waiting one more period. For example, the monetary authority is indifferent between giving up at any given period t (agreeing to an inflationary adjustment) with utility $-L_{\mathbf{M}}\left[c_{\mathbf{F},t}, \pi_{\mathbf{F},t}\right]$ or waiting one more period. In this latter case, she could get her preferred adjustment later on in the same period[17] with utility $-L_{\mathbf{M}}\left[c_{\mathbf{M},t}, \pi_{\mathbf{M},t}\right]$ or the inflationary adjustment proposed by the fiscal authority next period[18] with utility $-\beta_{\mathbf{M}} L_{\mathbf{M}}\left[c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right]$. Algebraically, the probability that makes her indifferent, ζ_t, is given by,

$$\zeta_t = \frac{L_{\mathbf{M}}\left(c_{\mathbf{F},t}, \pi_{\mathbf{F},t}\right) - \beta_{\mathbf{M}} L_{\mathbf{M}}\left(c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right)}{L_{\mathbf{M}}\left(c_{\mathbf{M},t}, \pi_{\mathbf{M},t}\right) - \beta_{\mathbf{M}} L_{\mathbf{M}}\left(c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right)}$$

Similarly, let χ_t be the probability that makes the fiscal authority indifferent,

$$\chi_t = \frac{L_{\mathbf{F}}\left(c_{\mathbf{M},t}, \pi_{\mathbf{M},t}\right) - \beta_{\mathbf{F}}\left(c_{\mathbf{M},t+1}, \pi_{\mathbf{M},t+1}\right)}{\beta_{\mathbf{F}} L_{\mathbf{F}}\left(c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right) - \beta_{\mathbf{F}}\left(c_{\mathbf{M},t+1}, \pi_{\mathbf{M},t+1}\right)}$$

Then, the fiscal authority's equilibrium strategy at period t is just to make the monetary authority indifferent given beliefs[19], or,

$$bel_t \alpha_{\mathbf{F},t} + (1 - bel_t) \cdot 0 = \zeta_t$$

[16] In general, the weak type of the fiscal authority will concede with probability one in period t_s if t_s is the first period for which, $-L_{\mathbf{F}}\left[c_{\mathbf{M},t_s}, \pi_{\mathbf{M},t_s}\right] < -\beta_{\mathbf{F}} L_{\mathbf{F}}\left[c_{\mathbf{F},t_s+1}, \pi_{\mathbf{F},t_s+1}\right]$

[17] If the fiscal authority gives up

[18] Again discounted one period

[19] Remember that the strong type of the fiscal authority has a dominant strategy not to concede.

Note that this implies that at $t = 1$ when the weak type of the fiscal authority concedes, $\alpha_{\mathbf{F},1} = 1$, it must be the case that equilibrium beliefs are given by,

$$bel_1^* = \zeta_1$$

A similar argument establishes that in order to make the fiscal authority indifferent, the monetary authority's equilibrium strategy is given by,

$$\alpha_{\mathbf{M},t+1} = \chi_t$$

Finally, beliefs are updated following Bayes rule, which implies that,

$$bel_{t+1} = \frac{(1 - \alpha_{\mathbf{F},t})\, bel_t}{1 - \alpha_{\mathbf{F},t} bel_t}$$

The following proposition describes a sequential equilibrium as outlined above,

Proposition 1 *There exists a sequential equilibrium of the game. Any sequential equilibrium $(\alpha_{\mathbf{M}}, \alpha_{\mathbf{F}}, bel)$ satisfies the following conditions*

(i) if $bel^{-1} < bel_0^*$, then $\alpha_{\mathbf{F},-1} = 0$, and $\alpha_{\mathbf{M},0} = 1$;

(ii)[20] *if $bel^{-1} > bel_0^*$, then $\alpha_{\mathbf{F},-\mathbf{1}} = \frac{bel^{-1} - bel_0^*}{bel^{-1}\left(1 - bel_0^*\right)}$, and $\forall\ t > 1$, $bel_t = bel_t^*$,*

$$\alpha_{\mathbf{M},t+1} = \frac{L_{\mathbf{F}}\left(c_{\mathbf{M},t}, \pi_{\mathbf{M},t}\right) - \beta_{\mathbf{F}}\left(c_{\mathbf{M},t+1}, \pi_{\mathbf{M},t+1}\right)}{\beta_{\mathbf{F}} L_{\mathbf{F}}\left(c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right) - \beta_{\mathbf{F}}\left(c_{\mathbf{M},t+1}, \pi_{\mathbf{M},t+1}\right)},$$

and

$$\alpha_{\mathbf{F},t} bel_t = \frac{L_{\mathbf{M}}\left(c_{\mathbf{F},t}, \pi_{\mathbf{F},t}\right) - \beta_{\mathbf{M}} L_{\mathbf{M}}\left(c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right)}{L_{\mathbf{M}}\left(c_{\mathbf{M},t}, \pi_{\mathbf{M},t}\right) - \beta_{\mathbf{M}} L_{\mathbf{M}}\left(c_{\mathbf{F},t+1}, \pi_{\mathbf{F},t+1}\right)}$$

(iii) whenever the bargaining phase reaches period t_s such that

$$-L_{\mathbf{F}}\left[c_{\mathbf{M},t_s}, \pi_{\mathbf{M},t_s}\right] < -\beta_{\mathbf{F}} L_{\mathbf{F}}\left[c_{\mathbf{F},t_s+1}, \pi_{\mathbf{F},t_s+1}\right],\ \alpha_{\mathbf{F},t_s} = 1$$

[20] Note that equilibrium beliefs, bel^*, are completely determined by equilibrium beliefs in the last period of uncertainty and Bayes rule. In Gracia (2004) a general expression of bel^* is provided.

The proof can be found in Gracia (2004) and will not be discussed here beyond the intuitive explanation already provided. Finally, notice that a preliminary round where the fiscal authority makes a move is required to make the posterior equilibrium belief bel_0^* consistent, given Bayes updating, with the exogenous prior bel^{-1}. Thus, the fiscal authority in this preliminary round is just conceding with the probability that reduces initial beliefs of the monetary authority as to who her opponent is from bel^{-1} to some value bel_0, which is precisely equal to bel_0^* [21]. That is, $\alpha_{\mathbf{F},-1} = \frac{bel^{-1} - bel_0^*}{bel^{-1}\left(1 - bel_0^*\right)}$.

Summarizing, once the fiscal authority's preferences determined the last period of uncertainty, the monetary authority's preferences will determine equilibrium beliefs that period as well as her equilibrium strategies. Then, using Bayes rule, equilibrium beliefs in previous periods can be obtained. Initial beliefs about the fiscal authority being weak should be optimistic enough, $bel^{-1} > bel_0^*$, for the monetary authority no to concede immediately and, therefore, for delay to occur with positive probability.

5 Putting the Pieces Together

In section 3 a general-equilibrium-representative-agent model was presented. Economic policy in that model depended essentially on a labor income tax and growth rate of money. In section 4 the strategic interaction between the fiscal authority and the monetary authority was introduced, as well as their objectives and information structure. Thus, in this section these two will be integrated together. The main features of the model first will be summarized, and a description of equilibrium for the case where uncertainty lasts at most two periods will be discussed later.

5.1 Main Features

The economy is initially at a steady state with a fixed exchange rate, no current account deficit and no government expenditure or debt. Just before period $t = 0$ there is a negative (unexpected) shock that permanently

[21] In the results presented below, it will be assumed that prior beliefs are just marginally larger than first period equilibrium beliefs (the monetary authority is the minimally required optimistic to obtain delay in expected value) so that $\alpha_{\mathbf{F},-1} \approx 0$, making this preliminary round trivial.

increases government spending from zero to g[22]. No other shock hits the economy ever after. If no action is taken, the economy will enter into an unsustainable path with a positive primary deficit and ever increasing stock of public debt. Assuming that adjustments on the spending side are not feasible, new, distortionary, means of revenue should be implemented. In particular two instruments are available: a labor income tax, τ^N, or seignorage (growth rate of money supply), τ^M, where $\tau^M = \frac{M_t - M_{t-1}}{M_{t-1}}$.

An adjustment or stabilization at any time t consists of a combination of both, labor income tax and growth rate of money, $\tau_{i,t} = \left(\tau^N_{i,t}, \tau^M_{i,t}\right)$, such that enough revenue is raised from both instruments to finance current government expenditure, g, and the service on the stock of debt outstanding, $r_t b_t$. Given preferences, (25) and (26), the stabilization proposed by the monetary authority is a labor income tax with no growth rate of money, $\tau_{\mathbf{M},t} = \left(\tau^N_{\mathbf{M},t}, 0\right)$, and an inflation tax is proposed by the fiscal authority with no labor income tax, $\tau_{\mathbf{F},t} = \left(0, \tau^M_{\mathbf{F},t}\right)$. If no adjustment is agreed, the deficit is financed by additions to public debt. Thus, the longer the delay, the larger the additions to the stock of public debt and, therefore, the larger the required adjustment as argued in Figure 1.

Figure 4 provides a graphical description of the timing of events. Both authorities, sequentially, engage in a concession game where one authority, starting with the fiscal authority, chooses an adjustment that would be implemented if the other authority, starting with the monetary authority, agrees to it. Households and firms optimize at the end of each period knowing whether a stabilization plan was implemented or not.

To keep the analysis as simple as possible, but without loss of generality, the results below will concentrate on the case were uncertainty cannot last more than two periods. This case is general in the sense that each authority may prevail as a result of concession by the other authority. When uncertainty only lasts one period, the monetary authority prevails, artificially, only if she has not conceded immediately and if the fiscal authority is weak. That case rules out the possibility of the monetary authority prevailing before uncertainty disappears. This is not the case when uncertainty lasts two periods.

[22] This could, alternatively, be interpreted as a negative fiscal shock that creates a deficit of size g per period

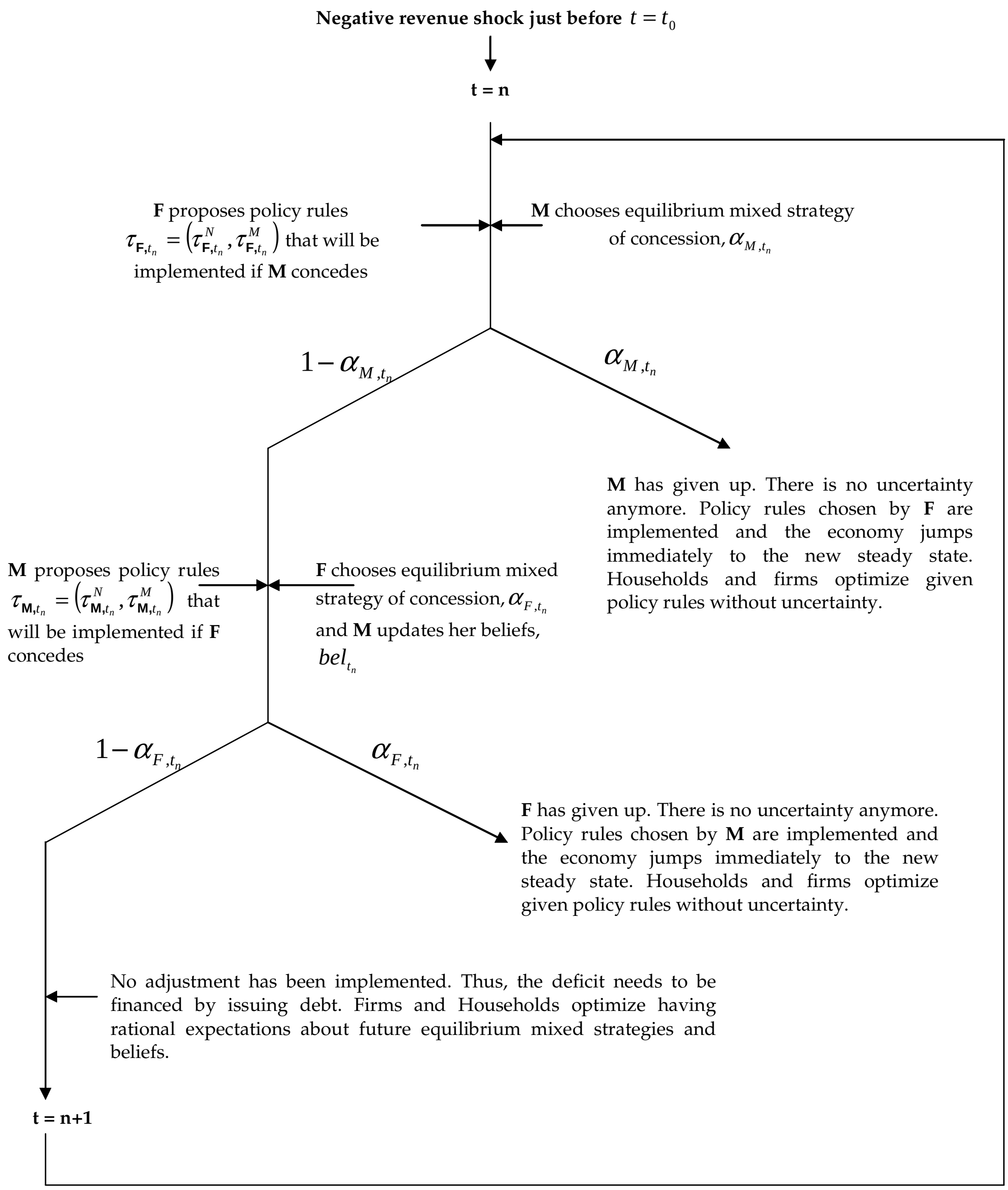

Figure 4: Timing of Events

5.2 Equilibrium with two periods uncertainty

Figure 5 presents the five possible outcomes and the description of equilibrium strategies and beliefs at each stage of the bargaining phase for this case. At the end of period $t = -1$ a negative fiscal shock hits the economy, prior exogenous beliefs about the fiscal authority being weak are bel^{-1} and the fiscal authority makes a preliminary move described in section 4.

As explained above, for uncertainty to last at most two periods condition (27) must be satisfied at $t = 1$ as it is the case in Figure 2. If the game reaches that point and the fiscal authority is weak he will concede with probability one, $\alpha_{\mathbf{F},1} = 1$. On the other hand, if no concession is observed, the fiscal authority is of the strong type and then the monetary authority concedes with probability one in her next move at period $t = 2$ allowing the implementation of an inflationary adjustment. Note that in the node $C1$ households and firms optimize knowing that an inflationary adjustment will be implemented next period for sure; there is no uncertainty anymore.

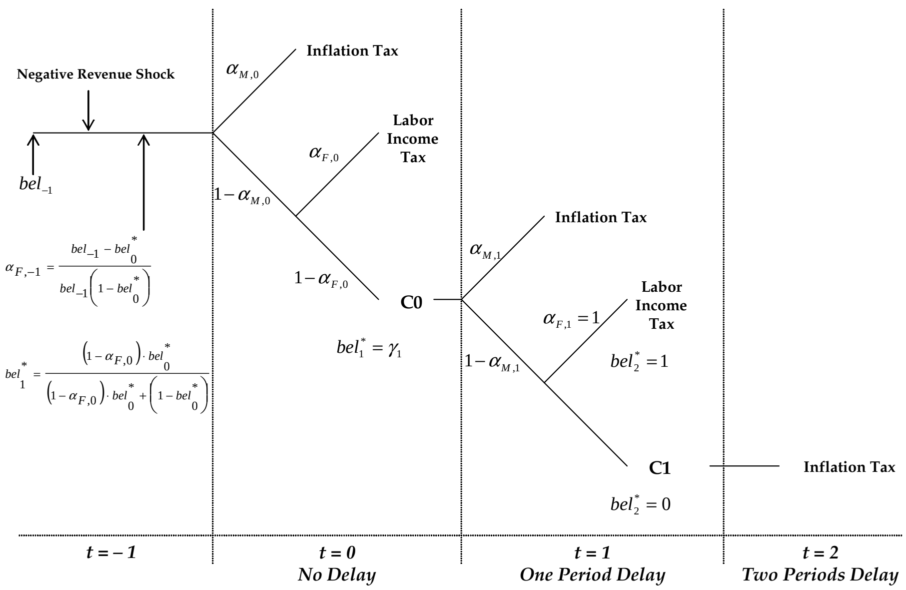

Figure 5: Equilibrium with Two Periods Uncertainty

By contrast, at $C0$, households and firms will optimize knowing that no adjustment took place that period, $t = 0$, and having rational expectations about the different possible outcomes in the future. In particular, and since they are aware of the strategic interaction between the two authorities, they know the distribution of the different possible outcomes. That is, they know that at period $t = 1$ the monetary authority may give up with certain probability given by $\alpha_{\mathbf{M},1}$ and an inflationary adjustment will be implemented. If the monetary authority does not concede, households know that if the fiscal authority is weak and given that condition (27) is satisfied, he will give up for sure and a labor income tax will be established at $t = 1$. Finally, they also know that if the fiscal authority is not weak, the monetary authority will give up for sure and an inflationary adjustment will take place in period $t = 2$.

6 Results

Table 2 presents the parameters used in the calibration. The choice of the various parameters is standard. In particular the elasticity of substitution among goods within each category is set to seven which implies a markup of prices over marginal cost of 16%. The elasticity of substitution between domestic and foreign goods is set to 1.5. The fiscal authority, the monetary authority and the representative agent have similar time preferences. The parameter that represents the index of openness, n, is set equal to 0.8, meaning that when the price of domestic and foreign goods are equal, $1-n$ or 0.20 is the share of domestic consumption allocated to imported goods. The target level of consumption and inflation for the fiscal and monetary authority respectively are the levels of these variables at the initial steady state.

β	$\beta_{\mathbf{F}}$	$\beta_{\mathbf{M}}$	θ	η	n	ψ	$c_{\mathbf{F}}$	$\pi_{\mathbf{M}}$	α
0.99	0.99	0.99	7	1.5	0.8	2.5	c_0	π_0	3

Table 2

Figure 6 presents equilibrium strategies and beliefs. If initial beliefs about the fiscal authority being weak are below 0.2699 there will be no delay and an inflationary adjustment will take place at period $t = 0$ with no delay. If initial beliefs are optimistic (above 0.2699), the monetary authority gives up with probability 0.063 at period $t = 0$ allowing an inflationary adjustment. If she does not give up, it is the turn of the fiscal authority to give up (with probability 0.2784) allowing a labor-income-tax adjustment with no delay. When the fiscal authority does not give up, the monetary authority becomes more pessimistic about the fiscal authority being weak (from 0.2699 to 0.2106). If the bargaining phase gets to period $t = 1$, the monetary authority gives up with probability 0.6195 and, if she does not give up the fiscal authority will concede with probability one[23]. On the other hand, if the fiscal authority is strong he will not concede. In either case he reveals his type.

Given equilibrium probabilities and beliefs, when faced with his optimization problem at $C0$ the representative agent faces three possible states of nature in the future. With probability 0.6195 an inflation tax will be implemented in period $t = 1$; with probability 0.1027 a labor income tax will be imposed that same period; and, with probability 0.2778 no adjustment will be agreed upon at period $t = 1$ and an inflationary adjustment will occur at period $t = 2$. Expectations in general, prices and money supply in particular, will be a weighted average given this probability distribution.

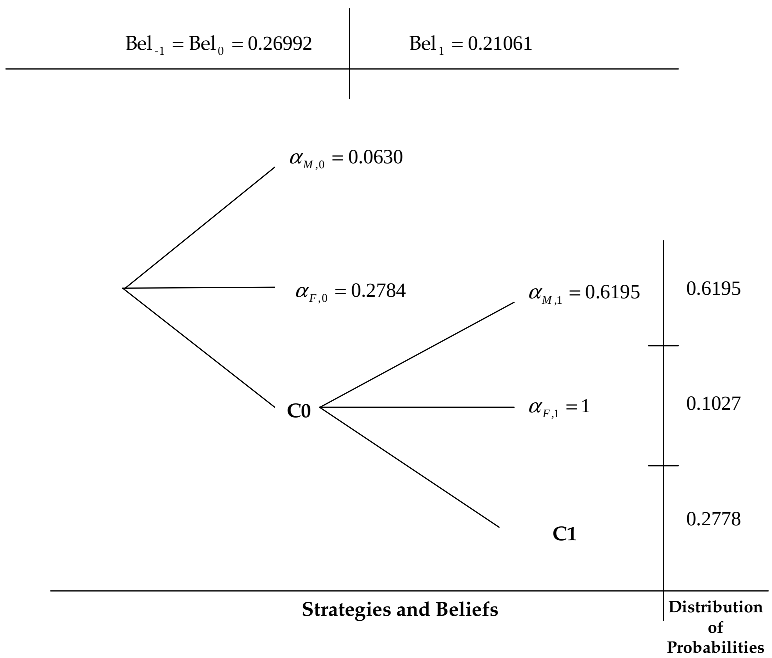

Figure 6

[23]Condition (27) is satisfied at period $t = 1$ as in Figure 2.

Figure 7 shows expected delay as a function of initial beliefs. As stated above for initial beliefs below 0.2699 there is no delay because the monetary authority gives up immediately. As priors about the fiscal authority being weak increase, the likelihood of him giving up increases as well. This is why as priors increase the expected delay decreases. In fact, when the fiscal authority is weak and the monetary authority knows this (priors of the fiscal authority being weak are exactly one) then there is no delay again, in this case because the 'weak' fiscal authority gives up immediately.

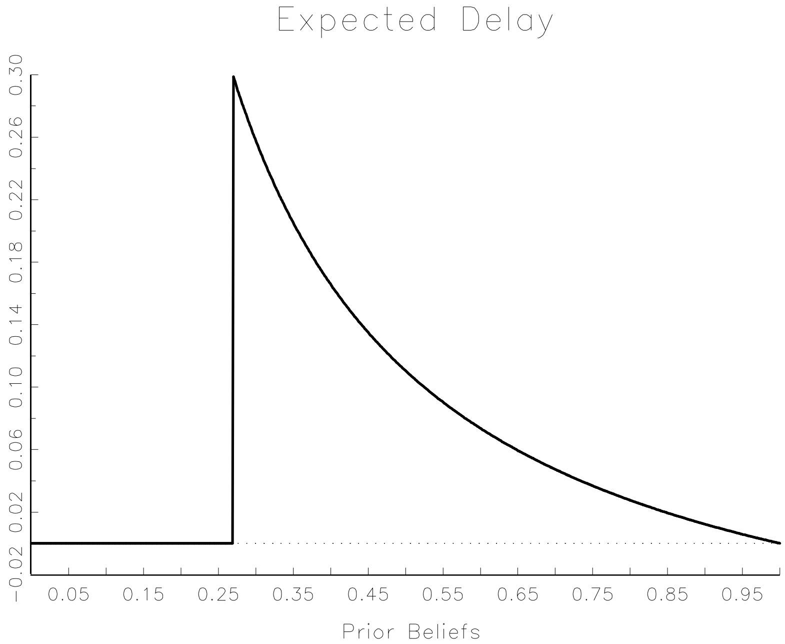

Figure 7

Figure 8 presents the impulse responses of output, consumption, the price level and velocity under the five possible outcomes described in Figure 5 for a negative fiscal shock of size $g = 0.005$ or 2.1736% of initial output. Lets first focus on the five possible outcomes compared to the initial steady state and then on the dynamics while there is delay. Relative to the initial steady state, under an inflationary adjustment, output increases and falls under a labor income tax. It is also clear from Figure 8 that the more delay the larger the effect on output and the other variables. Consumption falls in any steady state after the shock; the fall is larger the more delay and is also larger with a labor income tax relative to an inflation tax. Prices under a labor income tax will remain at the pre-shock level whereas an inflation tax will involve a jump in the price level and constant inflation rate ever after. Velocity is positively related to inflation in equilibrium (see Table 1). Since inflation imposes a negative return on money holdings, people's demand for real money balances falls with inflation. Higher velocity implies higher transaction costs. That is, more real resources are being "eaten up," (21).

Not surprisingly, a labor income tax has a negative effect on labor supply and thus on output and consumption. The effect of an inflation tax is different. As mentioned earlier, higher inflation implies higher velocity in equilibrium. As inflation increases, households want to reduce their real money holdings. They can only get rid of money by consuming but in doing so they will increase demand and induce higher output. The result is that transaction costs are large enough so that, overall, there is higher output and lower consumption. This explains also why consumption will, in general, be larger with an inflation tax than with a labor income tax.

Lets now focus on the events if there is delay. While there is delay, output falls and consumption increases. Both increase the flow utility of the representative agent and can be achieved via movements in the current account. Note that the price level increases in this case. Since prices are fully flexible and there are expectations about higher future prices, the price level, while there is delay, is a weighted average of the future price levels. In particular, at $C0$, there are three possible future outcomes. Next period, $t = 1$, a labor income tax with prices at the pre-shock level or an inflation tax with a jump in the price level and positive inflation can occur. In period $t = 2$, an inflation tax can also be implemented. Thus, at $C0$ the price level is a weighted average of these three possible outcomes.

Figure 9 presents the real interest rates as well as the nominal exchange rate, the ratio of the price of domestically produced goods to the CPI and the real exchange rate. Real interest rates increase when there is delay. The reason is that nominal interest rates depend on the future expected depreciation rate through the uncovered interest parity. And the depreciation rate will, given PPP, depend on future expected prices. Thus, the increase in nominal interest rates, due to the expected depreciation, is larger than the inflation rate while there is delay. Given flexible prices and the law of one price (which implies PPP), the nominal exchange rate will follow the price level in steady state. There is no devaluation when a labor income tax is introduced and there is a nominal devaluation followed by a constant devaluation rate under an inflation tax. Given PPP, the exchange rate will follow the price level in any steady state. However, it will depart from it while there is delay. If there is delay the price level increases while the nominal exchange rate is kept constant and this is the only nominal rigidity in the model.

The CPI, (4), has two components: the price of domestically produced goods and the price of foreign goods denominated in domestic currency. The latter is unchanged while there is delay since the nominal exchange rate is fixed as well as foreign prices denominated in foreign currency. Thus, an increase in the CPI can only come from an increase in domestically produced goods that is larger than that in the CPI itself. This is reflected in the evolution of the ratio between these two, $p_{H,t} = \frac{P_{H,t}}{P_t}$. Domestic goods become relatively more expensive the more time it takes to implement an adjustment, which results in an appreciation of the real exchange rate and a trade deficit (Figure 9).

Figure 10 shows the trade deficit, consumption of domestically produced goods, imports and exports. Consumption of domestically produced goods falls by less if there is delay at $C0$ than at any steady state if there is no delay at $t = 0$. On the other hand, if there are two periods of delay, at $C1$, the fall in domestically produced goods is the largest. While there is delay, imports increase and exports decrease. This explains the pattern of consumption and output. Output decreases mainly because exports decrease but also because consumption of domestically produced goods decreases somehow. On the other hand, consumption increases because imports increase, and the fall in the consumption of domestically produced goods is relatively small. The decrease in output comes mainly from the decrease in exports and the increase in consumption from the increase in imports. Relative to the initial trade balance, both imply a current account deficit or capital account surplus. The country, thus, becomes a net debtor to the rest of the world if there is delay.

After any adjustment, the capital account (flow) becomes balanced[24], but the net debtor position (stock) implies that interests on that debt have to be paid. Remember that the current account is the sum of net exports and interest payments. Since the capital account is balanced after any adjustment takes place, a trade surplus is needed to pay interests on the stock of foreign debt. Thus, delay produces trade deficits or capital account surpluses and trade surpluses after any adjustment regardless of its nature. This permanent trade surplus is small relative to the transitory trade deficit that created it

[24] As argued in section 3.5.2

and is explained mainly by an increase in exports. The increase in exports requires an increase in output in any new steady state relative to the output level while there is delay[25].

To summarize, delay produces u-shaped real exchange rate and current account patterns, and inverted u-shaped consumption and real interest rates. This results are consistent with empirical evidence, Végh (1992), Végh and Reinhart (1995) and Kiguel and Leviatan (1992), on exchange rate disinflation programs. Models of credibility, or the lack of it, measured as temporary actions which may be interpreted as arising from non-credible policies, induce the public to act as if the reduction in the devaluation rate were temporary. Thus, those models rely on the intertemporal substitution effects as the key channel through which stabilization policies may have real effects. This, combined with sticky prices, introduces the dynamic considerations that provide outcomes similar to empirical evidence. However, models based on credibility defined exogenously have difficulties rationalizing high real interest rates and consumption booms, followed by contractions when the program is successful. Note that consumption booms and high real interest rates depend, in the model presented above, on delay, but are independent of the final outcome. The reason is that credibility may be defined here as the probability that a non-inflationary adjustment is implemented, an outcome ruled out when the lack of credibility is assumed exogenously and the only possible outcome is the inflationary one.

Figure 11 shows how the labor income tax decreases welfare by less than the inflation tax. It shows the per period utility in consumption units of each possible outcome plus the expected utility (also per period) after the shock and when delay happens but no adjustment has been implemented[26]. The pre-shock utility has been normalized to 100. The labor income tax with delay is preferred to the inflation tax without delay, and this result is very robust to different values of all above parameters. It seems that the strikingly different effect on the steady state value of output (and of labor supply given the linear technology assumption) dominates the effect on consumption (which, as argued above, is larger with a labor income tax than with an inflation tax).

[25] Output at $C0$ at $t = 0$ relative to output with an inflation tax or labor income tax at $t = 1$. Or output at $C0$ and $C1$ relative to output with an inflation tax at $t = 2$.

[26] It shows actual utility or expected utility at every node in Figure 5 including $C0$ and $C1$

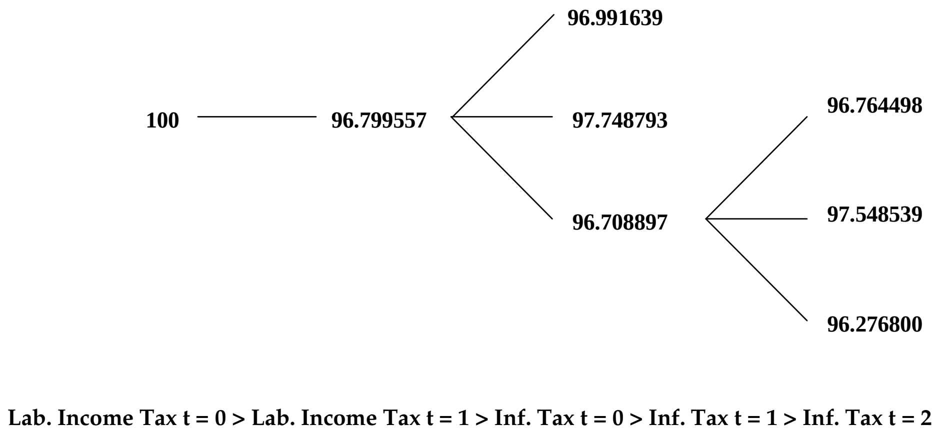

Figure 11

7 Conclusion

The interaction between different 'instrument' independent authorities has been the focus of this paper. Although the analysis here has concentrated on the interaction between monetary and fiscal policy under a fixed exchange rate, the same framework can be applied to any stabilization or adjustment that requires the agreement of different parties, whether the legislature and executive, the government and the IMF, a minority government and an opposition party and opposition, etcetera.

All dynamics in the model are the consequence of delay being increasingly costly over time. This realistic feature could not be captured in literature on stabilization since most of that literature assumes an endowment economy. The fact that failure to implement a stabilization program will result in tougher stabilization in the future creates, somehow paradoxically, the incentives to the uninformed party –monetary authority– to wait and enter into the bargaining phase. The reason being that at some point the costs for the informed agent –fiscal authority– will be so large that he will reveal his type. The larger the negative shock, the sooner the fiscal authority will reveal his type.

After a negative fiscal shock, pre-shock policies become unsustainable in the long run and an adjustment is needed. The larger the adjustment the longer it takes to implement a stabilization. Thus, the causes that ultimately produce a currency collapse or a deflationary adjustment may well have originated in the distant past. As a consequence, lessons and judgments about the design and success of fixed-exchange-rate systems cannot be based solely on the crisis itself, but also on the causes of that crisis and the period in between.

Current account deficits combined with positive inflation differential and consumption booms are a manifestation of an unsustainable situation rather than signals of future pressures on fixed pegs. In many episodes current account deficits have been interpreted as putting pressure on a fixed exchange rate system and have introduced questions about the future sustainability of the peg. In the context analyzed here, trade deficits are a manifestation of an already unsustainable situation rather than a future problem, and they, indeed, create doubts about the whole system itself since a costly deflationary stabilization is needed to back the fixed peg. This is known by agents who will have some expectations about future devaluations and act accordingly. The consequence is an increase in the price level with a real exchange rate appreciation and current account deficits.

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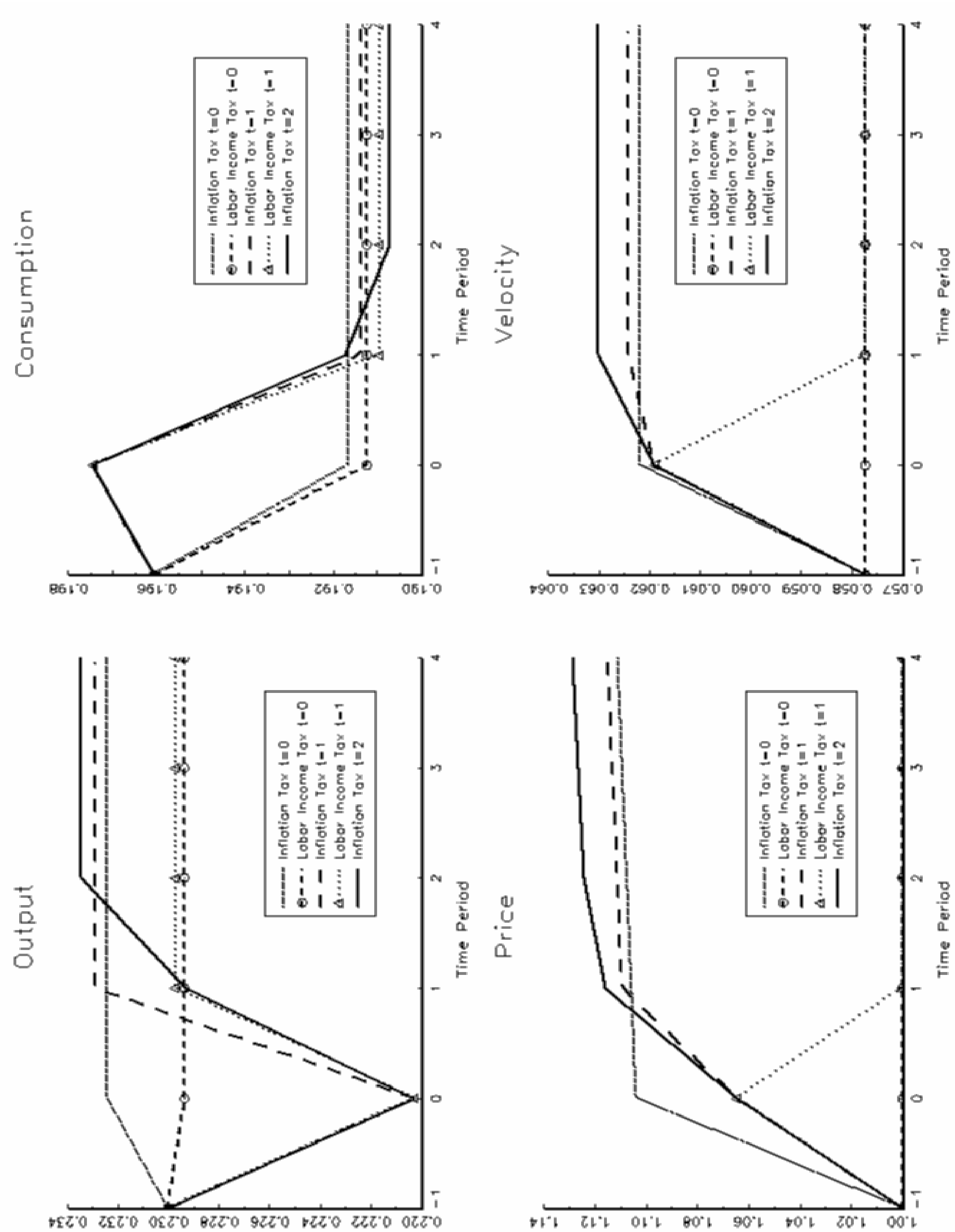
Output
Consumption
Price
Velocity
Inflation Tax t=0
Labor Income Tax t=0
Inflation Tax t=1
Labor Income Tax t=1
Inflation Tax t=2
Time Period

Figure 8

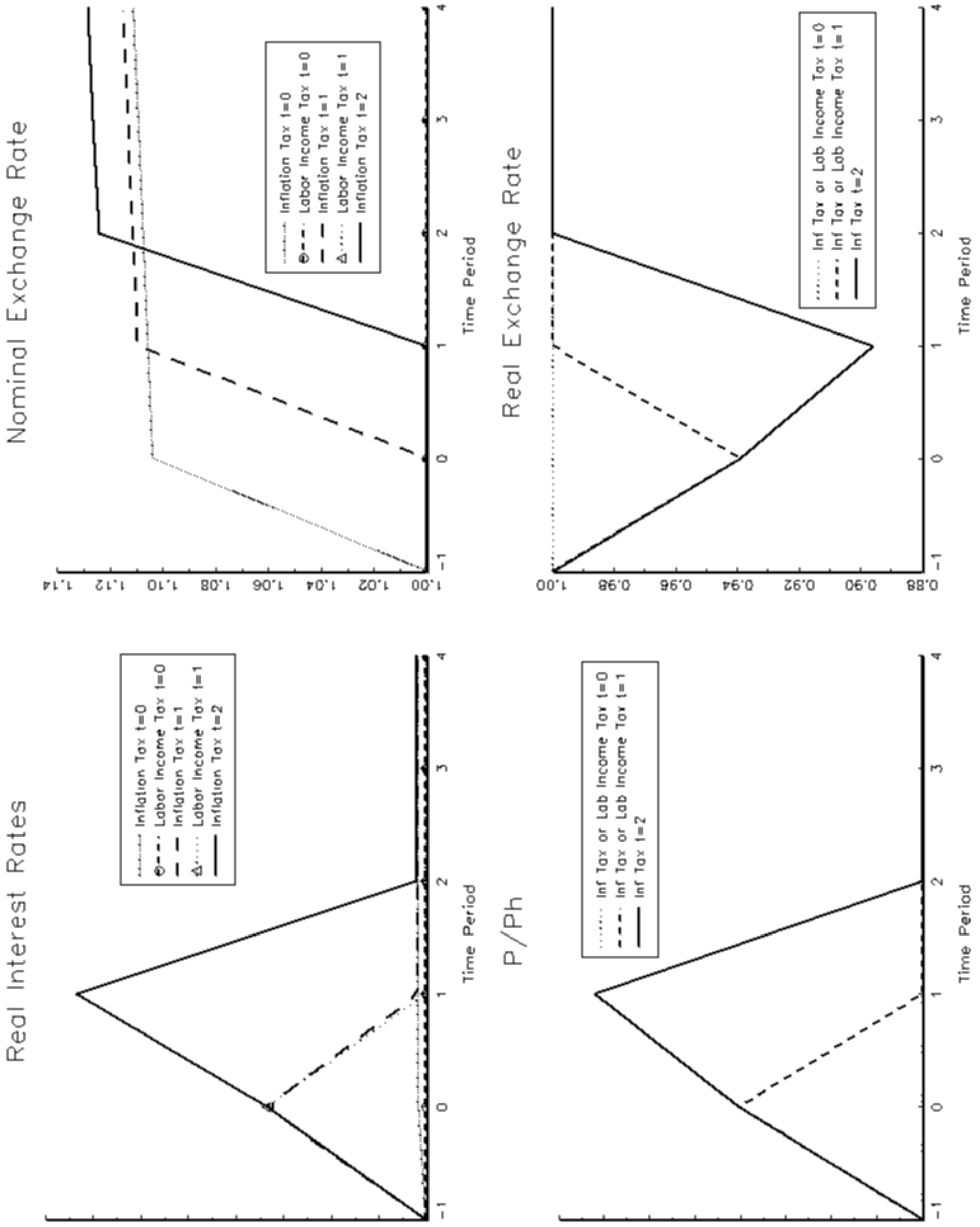
Real Interest Rates
Inflation Tax t=0
Labor Income Tax t=0
Inflation Tax t=1
Labor Income Tax t=1
Inflation Tax t=2
Time Period
Nominal Exchange Rate
Inflation Tax t=0
Labor Income Tax t=0
Inflation Tax t=1
Labor Income Tax t=1
Inflation Tax t=2
Time Period
P/Ph
Inf Tax or Lab Income Tax t=0
Inf Tax or Lab Income Tax t=1
Inf Tax t=2
Time Period
Real Exchange Rate
Inf Tax or Lab Income Tax t=0
Inf Tax or Lab Income Tax t=1
Inf Tax t=2
Time Period

Figure 9

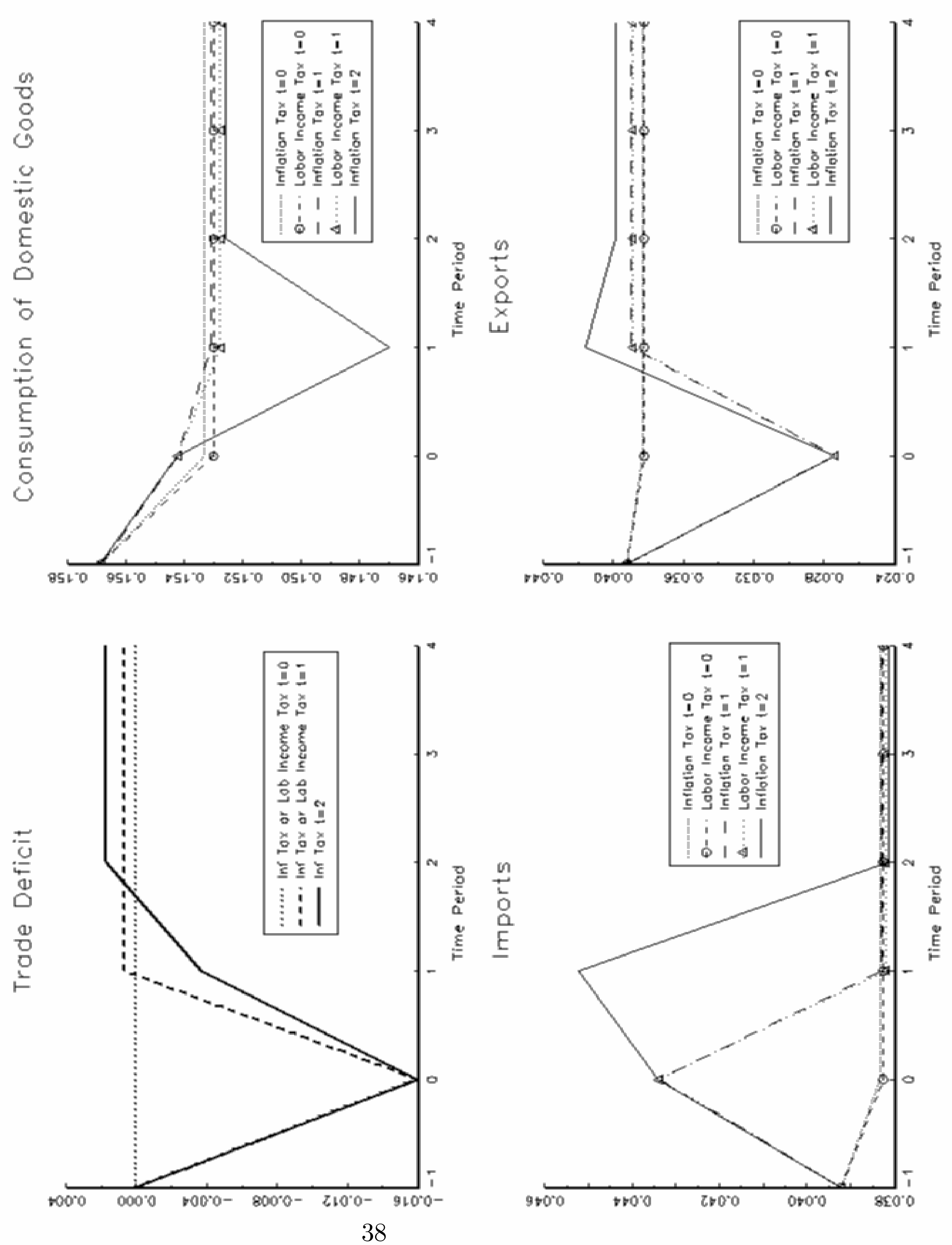
Trade Deficit
Inf Tax or Lab Income Tax t=0
Inf Tax or Lab Income Tax t=1
Inf Tax t=2
Time Period
Consumption of Domestic Goods
Inflation Tax t=0
Labor Income Tax t=0
Inflation Tax t=1
Labor Income Tax t=1
Inflation Tax t=2
Time Period
Imports
Inflation Tax t=0
Labor Income Tax t=0
Inflation Tax t=1
Labor Income Tax t=1
Inflation Tax t=2
Time Period
Exports
Inflation Tax t=0
Labor Income Tax t=0
Inflation Tax t=1
Labor Income Tax t=1
Inflation Tax t=2
Time Period

Figure 10