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THEORETICAL NOTES ON ENDING BIG INFLATIONS ABRUPTLY, WITHOUT LOSS OF OUTPUT

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THEORETICAL NOTES ON ENDING BIG INFLATIONS ABRUPTLY, WITHOUT LOSS OF OUTPUT*

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Abstract

Historical hyperinflations were terminated abruptly, sometimes by new governments with no anti-inflation reputation. The theoretical mechanisms which achieved the outcome are not well understood. Recently, Latin American governments have used the intuition to launch many instantaneous stabilization attempts ("pacotes", "planos") with variable success. A simple model is presented which achieves the result by way of a one-shot, Cournot-Nash equilibrium in a macroeconomic game of conflict among private agents. The supply curve for money plays the same role here as the demand curve of consumers in the original Cournot model. There is no need for social pacts, a cooperative game solution concept. Generalized judicial price freezes are an example of the latter. These fail because each agent has an incentive to defect, a problem which is avoided by Cournot-Nash. Suggestions for new work are given.

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Theoretical notes on ending big inflations abruptly, without loss of output.

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Among both sets of survivors of the recent macroeconomic debates, new classicals and new Keynesians, there are many who accept that it is possible for a government to bring down rapidly even high rates of inflation without loss of output. The surprise deflation generates no reverse-direction Phillips curve. However, exactly how this can be achieved has not been well specified in the literature. Various concepts have been used - credibility, strategic behavior by governments and their central banks to build reputation, strategic behavior by private citizens as players, with government as a more or less passive agent reacting mechanically in a macroeconomic game. At the practical level, we have suggestions such as - (i) an independent central bank; (ii) a fixed rule for the money supply; (iii) a zero fiscal deficit; and (iv) tieing the currency to another at fixed parity and letting the balance of payments determine the money supply, a version of the colonial currency board.

One fruitful line of work using game theory, started by Fraga and Werlang [1983] and Simonsen [1988,1989], was extended by De Castro [1991]. The point of departure is the result by De Castro, reported here in Section 2, that inflation can be removed from the non-cooperative equilibrium of the macroeconomic game first formulated by Fraga and Werlang, without resort to a social pact, a cooperative solution concept. He showed how the government's behavior, even when it is not a strategic agent (not a "player"), can change the Cournot-Nash non-cooperative outcome. The inflation disappears with no loss of output, in the first period after the government announces its supply curve for money, provided the latter has the correct value for a crucial parameter.

Although this result may appear to be unduly optimistic, it fits one of the basic stylized facts about how hyperinflations terminate. Dornbusch [1991] has used the fact recently to criticize the theoretical work with multi-stage and repeated games which use reputation, on the grounds that historically, even new governments with no time to build reputation, were able to bring hyperinflations to a halt. He cited in particular the Poincaré episode in France in 1926. However, he proceeded to build a model with a completely passive set of private agents, passive that is, with respect to whatever policy is chosen by the government - the Lucas critique is ignored once again.

Our point of departure will be the model by Fraga and Werlang[1983] which linked a one-shot, Cournot-Nash inflationary equilibrium to the neo-structuralist theory, common in Latin America, that inflation is the result of a conflict among private agents, over the income distribution (see Canavese [1982]). The cooperative, non-inflationary solution can only be reached by means of a social pact since each party has an incentive to defect. Unlike the game in Barro and Gordon [1983a,b], the government is not a player and acts only to supply passively, any quantity of money the public may require.

We show in section 2 that in the original Fraga-Werlang game, each agent's reaction curve in the strategy space of the money demands is independent of the strategies chosen by others. The non-cooperative response, in the form of money demand, is a constant and in the example given, double the value of the cooperative solution which has no inflation and no loss of output.

We then introduce a slightly more active government but without making it a player. That is, while it does not act strategically, it can vary the money supply with the price level using a fixed rule. Its new role is analagous to the consumers in the Cournot duopoly. There, the two firms can decide quantities strategically while the consumers react mechanically, in a manner represented by the demand curve, to determine the price. They are not players but they are not entirely passive. The government's fixed rule, a supply curve for money, plays the same role here as the demand curve in Cournot.

The result is a one-shot game in which the reaction curves become dependent on the money demands of other agents, through a parameter(b) which appears in the fixed rule. By varying this parameter, we show how the government can choose its value such that the non-cooperative, Cournot-Nash, inflationary equilibrium can be made coincident with the cooperative solution which has no inflation and maximum output.

We do not consider here whether the fixed rule can be dynamically inconsistent in the sense of Kydland and Prescott [1977]. However unlike theirs, our government does not act strategically, in keeping with Fraga and Werlang. The rule is certainly credible in one sense - that it allows maximum output when the government is doing the right thing.

Gustavo Franco [1989] has modelled a context where, despite the implicit existence of a social pact in the form of a government actively attempting to remove inflation by generalized price freezes, the result is "inertial" inflation caused by free riders who gain by getting around the controls. However, this is precisely the situation which the Cournot-Nash theory was invented to avoid. That is, the theory finds an equilibrium where no agent acting alone, can do better for himself.

Here the problem is reduced to one of mechanism design. The government is not a player in this line of research. Yet we are able to show a case where the inflation can be removed without the need for cooperative behaviour by the strategic agents. We do not want to claim that an independent central bank, which can implement the fixed rule, would be definitely the institutional setting required, since we have studied neither the dynamics nor other alternatives to the rule. However, if there were such a bank, our argument would lead obviously, to one with no discretionary powers, at least in the static case.

In the final section (3), some suggestions are given for new work.

1. The original Fraga-Werlang(F-W) game

There are 2 private agents(n later) who demand money(MD_i) in such a way that each would maximize his part(c_i) of real output(y) which in turn is affected by the level of inflation(p/p_o). When there is no inflation, the level of output is a maximum. The government is entirely passive, supplying any amounts of money which agents may require. Although agents demand money based on their expectations of the price level(pe_i) their expectations are assumed always to be correct.

The equations of the model are:

$$pe_i \, . \, c_i = MD_i \, , \, i = 1,2; \; MD_i = Ms_i \equiv M_i \qquad ...(1)$$

$$c_1 + c_2 = y \; ; \text{ equilibrium in the good market} \qquad ...(2)$$

$$pe_i = p \; ; \text{ perfect foresight by all agents} \qquad ...(3)$$

$$y = f(p/p_o) \; ; \; f' < 0 \text{ if } p > p_o \qquad ...(4)$$

$$f' > 0 \text{ if } p < p_o$$

Equation (4) links real output with the level of inflation in a way that is very different to that of an old fashioned Phillips curve. When the price level is stable ($p/p_o = 1$), real output is at a maximium. Any deviation from stability is penalized by a loss of output. The economic interpretation is that inflation causes inefficiencies by inducing wrong production decisions. In the original Phillips curve, the inflation would explode as output approaches capacity levels(y^c) whereas here it goes to zero($p/p_o = 1$). Figure 1 illustrates the two different assumptions.

---Figure 1 here---

The cooperative solution to the F-W game would be obtained by the maximization of total joint (real)product:

$$\text{Max } \; Z = c_1 + c_2 = M_1/p + M_2/p$$

$$\text{subject to } \; M_1 + M_2 = p.y \equiv p.f(p/p_o)$$

Here the maximization of joint product would require no inflation in order that output(y) should be a maximum($f'=0$). This would yield $p/p_o = 1$.

In the example give by Fraga and Werlang, f(.) had the log form:

$$y = (1 + \ln p/p_o)/(p/p_o)$$

which has the maximum value of y, y^c, as 1 when $p/p_o = 1$. The cooperative solution has total money demand, $M_1 + M_2 = p_o$ and thus maximum output, $y = y^c = 1$.

In the non-cooperative, Cournot-Nash solution, each agent would demand money (M_i) in such a way as to maximize his part(c_i) of real output, treating the other agent's demand (M_2) parametrically:

For agent 1, for given M_2 :

$$\text{Max } Z_1 = c_1 \equiv M_1/p$$

$$\text{subject to } M_1 + M_2 = p.y = p.f(p/p_o)$$

In the example for f(.), the result is $M_1 = p_o$ which by symmetry, is also the result for agent 2, so that the total money demand is $2p_o$, twice that of the cooperative solution, generating a level of inflation, $p/p_o = e > 1$, and output $y = 2/e < y^c = 1$.

The two solutions are compared in the strategy space of money demands (M_1 ,M_2) in Figure 2.

—Figure 2 here—

2. A more active government

Now let us introduce a slightly more active government. In order to do so, we need to specify a rule which it will use to decide the quantity of money it will supply to the economy, given the price level decided by the private agents. As a preliminary example, we use:

$$p = (1/p_o - b.(M_1 + M_2 - p_o))^{-1} \text{ ; } b > 0 \text{ ..... (5)}$$

We draw attention to two properties of this rule. One is that the government is offerring always to increase the money supply when the price level increases in the economy. That is, although there is an upper limit to the money supply(M^u) it is only reached assymtotically:

$$M^u = p_o + 1/bp_o$$

The second is that when the money supply is equal to p_o , the price level is also p_o, which yields maximum output because there is no inflation. This is the cooperative solution in the F-W game.

These properties are illustrated in Figure 3

---Figure 3 here---

The non-cooperative, Cournot-Nash solution can now be obtained by solving for each agent's reaction curve in this new situation:

For agent 1, for given M_2 :

$$\text{Max } Z = c_1/p \equiv M_1/p$$

subject to : equation(5), the government's rule.

The resulting reaction curve for agent 1 is:

$$M_2 = (p_o + 1/bp_o) - 2M_1$$

Using symmetry, one can easily obtain the other curve and solve for the Cournot-Nash equilibrium:

$$M_1 = 1/3 .(p_o + 1/bp_o) = M_2$$

and the resulting price level:

$$p = 3. (bp_o + 1/p_o)^{-1}$$

which is seen to vary with the choice of parameter b.

Let us see what value of b would make the total money supply induced by the *non-cooperative* solution, equal to the cooperative level, p_o. That is:

$$p_o = 2/3 .(p_o + 1/p_o b)$$

which gives:

$$b = 2/ (p_o)^2 \text{ and } M_1 = M_2 = p_o/2$$

This result is illustrated in Figures 2 and 3 which show our Cournot-Nash solution coincident with that given by the social pact in the F-W game, when b has the correct value.

In the more general case of n agents, the effect of n on the resulting inflation rate is the same as in the F-W game. For given b, the inflation rate increases with the number of agents. However, for given n, we can find a value for b such that the inflation rate is zero. This is obtained from the simple relation:

$$b = n/(p_o)^2$$

3. Suggestions for further work

The main argument of the model is that there is at least one middle road between those economists who do not accept the notion that the government's behavior should be modelled as a strategic player in a game against its citizens, and those who leave it completely passive. There are many reasons, both philosophical and behavioral, why the first is an unacceptable procedure. One can see this clearly in the more recent literature of the Barro-Gordon research programme where, in a context of incomplete information, the optimal behavior required of the government is for it to choose whether to inflate the economy by a completely random process. Some models have been able to remove this requirement (Vickers [1986]; Driffill [1989] but the research draws our attention to the fundamental issue.

Another line of work using games has been to try to link the behaviour of the government to its political base. This literature was not mentioned in Simonsen's survey. Alesina's model [1987] is probably the best known. However, the search for what we may call ideal social mechanisms, would still be valid, if only as measures of the relative inefficiency of representative democracy as a political system.

Using these insights, we are now able to outline a research agenda. The fundamental idea is to maintain the basic result, but in a richer and thus more realistic macroeconomic environment. The major extension in this direction must be to seek ways of incorporating fiscal behavior, since the basic model treats with only monetary policy. Two clarifications are necessary. The first is that we talk here of behavior and not policy even though the two concepts may be difficult to separate in economics since it contains no theory of government. The phrase is used nevertheless to indicate that the research should make no a priori commitment to the effectiveness of fiscal policy. The latter should be a result not a premise. The second is that one tractable way to deal with fiscal behavior may be to try to develop decomposability theorems which can show the conditions under which it can be dealt with separately from the monetary behavior.

One start on this fiscal dimension could be to examine how the basic model now links nominal behavior in the economy to real output. As De Castro [1991, p.43] has pointed out, it assumes a rather unorthodox type of Phillips curve which has a maximum at the zero inflation point. This assumption was needed to ensure the existence of Cournot-Nash equilibria in the Fraga-Werlang game, because a standard Phillips curve would always yield more output with more inflation. In other words, each (private) strategic agent's optimisation would have unbounded solutions. This criticism, of course, is not an argument for the return to an orthodox Phillips curve as this relation is precisely the one being questioned by research in this field.

Contrary to our basic model, most of the mainstream work using games have modelled the government as a strategic player in a situation, effectively, of confrontation with its citizens (see eg Andersen [1989]). That is to say, no account is taken of the fact that, in a real sense, the government represents the interests of a coalition of at least some of its electors who are the other strategic players. It may be possibile to mount a general model for which both types of games, government as player, and government as rule maker or arbiter, can be seen to be special cases. This may very well be a difficult enterprise but it should be considered.

Finally, the research should try to remove from the basic model, its rather trivial incorporation of the rational-expectations hypothesis (See Guesnerie [1992, 1993]). This may be a rather tall order as the literature in this area has exploded in recent yeers. It may appear to be irrelevant to our particular problem, in the sense that expectations are formed by agents using information accumulated from past behavior of both government and themselves. Since our basic premise is the possibility that a new government, perhaps with some new set of institutions , can induce a zero inflation outcome almost immediately, this accumulation process would seem to be taken as exogenous.

However, one can think of the ending of big inflations as a kind of optimal stopping rule problem in which by some change of regime, most agents, despite their accumulated stocks of information about the past, can be induced *simultaneously to find it* optimal, each in his own private interest, to cease to increase his nominal prices. Some form of expectation formation at that point may need to be specified perhaps something like what Dornbusch calls "credibility".

By thinking of the problem like this, government behavior may be conceived as a mechanism which can influence the weights in the objective functions of each (private) agent, such that the optimal time to stop nominal price increases for each agent, is the same for all agents. In fact, this is also a way of thinking about how hyperinflations are caused, rather than ended, since a hyperinflation occurs when each agent's decision to quit the currency coincides with all other agents or at least a significant number of them.

It is hoped that this research will enable us to establish results which can lead to a specification of the social mechanism required for this highly desireable macroeconomic outcome - the almost instantaneous reduction of massive inflation without significant falls in aggregate output. It appears to be pie in the sky, but this is what every stabilization scheme in Brazil and in Latin America in recent years has promised and sought. This research may help to deliver. And even if the correct one is found before, by intuitive means, it may indicate how big inflations can be avoided in the future.

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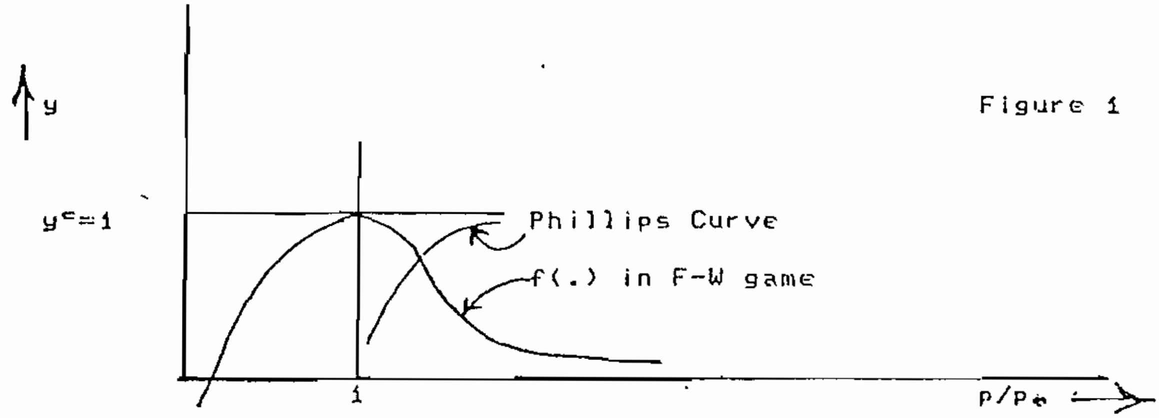

Figure 1

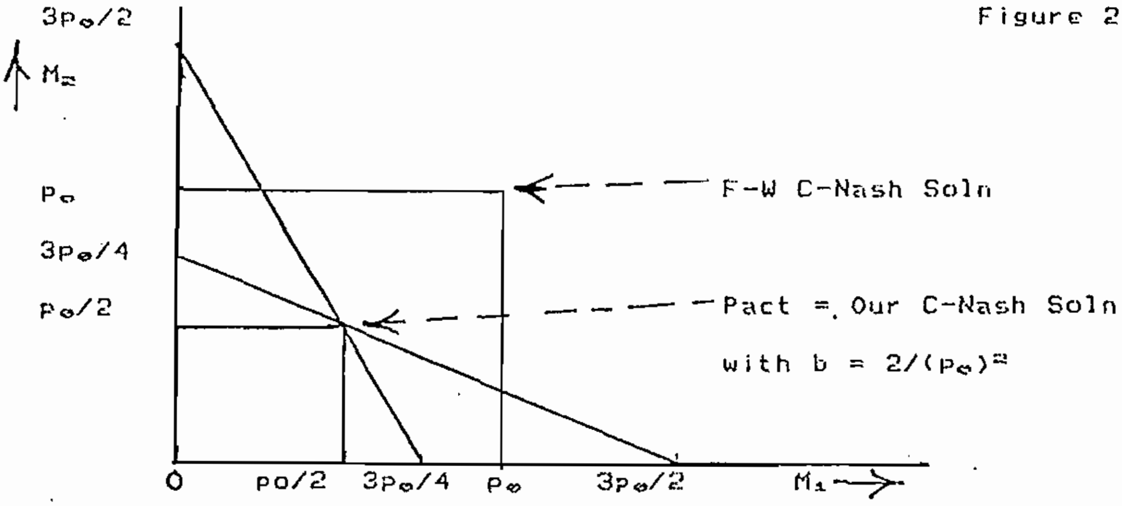

Figure 2

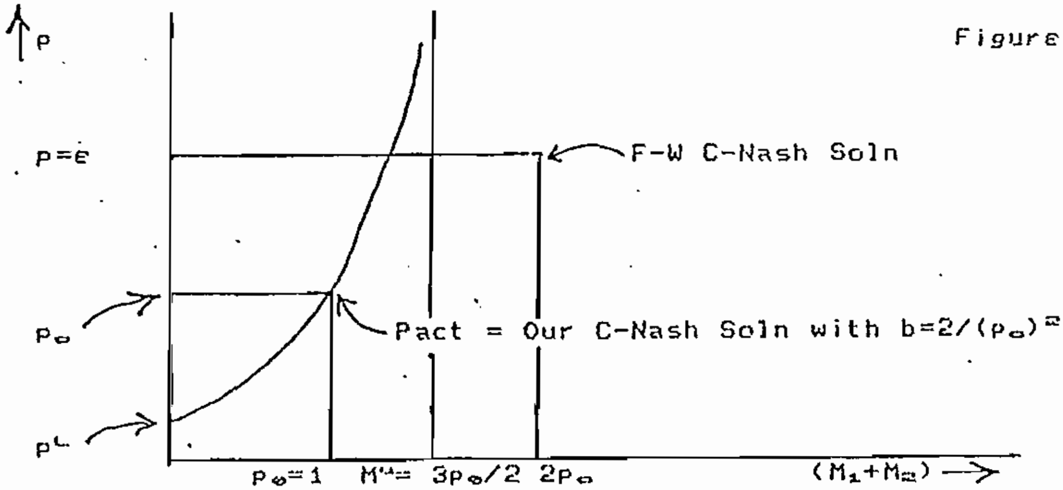

Figure 3