Discussion of 'Limits to Inflation Targeting,' by Christopher A. Sims

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When I was invited to discuss Chris Sims' contribution to the Inflation Targeting Conference, one of the reasons I looked very much forward to preparing the discussion–besides the fact that a Sims paper is typically a very rewarding read–was that I hoped to finally learn what exactly inflation targeting is and what exactly an inflation targeting central bank is supposed to do. However, I soon realized that this would not happen. I have come to the conclusion that inflation targeting is a nebulous monetary policy prescription. This concept is not as clearly defined as I had hoped for and it certainly cannot easily be tied to very precise instructions for the central bank on how to behave. Chris Sims, though, I should note, is more willing to come forward with a definition of inflation targeting than others that write on the topic. His definition of inflation targeting is 'simply any commitment by the central bank to control the time path of the inflation rate or the price level, at least in the long run.' In my opinion, this definition could be one of any monetary policy rather than that of inflation targeting in particular. This is because undoubtedly, any central bank strives to control the time path of inflation or the price level. With this in mind, one then can interpret the limits of inflation targeting that are presented in the Sims paper as limits that any monetary policy maker, and not just an inflation targeter, will face. Thus the concerns raised in the Sims paper will apply very generally making them only the more relevant.

The Sims paper analyzes two economies in which there are limits to inflation targeting. In one case inflation targeting may open the door to unintended deflation and in the other case inflation targeting may open the door to a speculative inflation. The logical next question the paper asks is how those speculative in- and deflations can be avoided. Contrary to the existing related literature, the Sims analysis treats the central bank and the fiscal authority as independent entities, each with its own budget constraint. The main contribution of the paper is to show that a central bank that lacks fiscal backing from the treasury may be more limited in its ability to achieve its goals regarding inflation than a central bank that enjoys the full financial support of the fiscal authority.

The Sims paper effectively communicates through insightful discussions that central bank independence may interfere with a central bank's ability to fight off self-fulfilling in- and deflations. The most formal presentation of this idea is given for an economy that tries to control inflation through an inertial interest rate feedback rule, see section III of the paper. First, in this section it is shown that, contrary to the intentions of the central bank, the

*I would like to thank Martín Uribe for comments.

interest rate feedback rule may allow for speculative inflations. Then the paper shows that the usual remedy against speculative inflations, namely fractional reserve backing, may not work if the central bank does not have access to revenues created by the taxing power of the fiscal authority.

In what follows, I present a short review of the existing literature on limits to price level or inflation control and on how to rule out speculative in- and deflations. I then ask whether those strategies will also work under the assumption of central bank independence. I show that for the economy studied in greatest detail in the Sims paper, the one of section III, it is possible to rule out speculative inflations despite the fact that the central bank is independent. What is needed, should the economy embark on a speculative inflation, is a commitment by the central bank to switch to a monetary policy that first builds central bank net worth and then pegs the price level.

Can the central bank alone control the path of inflation?

Given fiscal policy, one can in general distinguish three cases: (i) the inflation path targeted by the central bank is necessarily unsustainable under all conceivable ways of conducting monetary policy; that is, it creates too little seignorage revenue to make fiscal policy sustainable. (ii) the inflation path targeted by the central bank can in principle be supported as an equilibrium outcome. But some monetary policies will imply that the inflation path is not attained and instead the economy must converge either to a self-fulfilling inflation or to a self-fulfilling deflation with probability one. For example, Loyo (2000) argues that the combination of an active interest rate feedback rule and a non-Ricardian fiscal policy led Brazil to hyperinflation in the mid 1980s. (iii) It could also be the case that some monetary policies will imply that the targeted inflation path is only one of several price paths that are consistent with the monetary-fiscal regime. Here again there are two cases. Besides the target rate of inflation, equilibria exist with self-fulfilling inflations and deflations. For examples see the work of Brock (1974, 1975), Obstfeld and Rogoff (1983), Woodford (1994; 1999), and Benhabib, Schmitt-Grohé, and Uribe (2001a). The second possibility is that besides the target path of inflation, there exist other bounded equilibria. Those can be of two types. One type is perfect-foresight equilibria converging to the steady state. Typically, not just a single one of those exists but a continuum. To name but a few, examples are contained in the work of Woodford (1994), Leeper (1991), Clarida, Galí and Gertler (2000), and Benhabib, Schmitt-Grohé, and Uribe (2001b). Another class of bounded equilibria that may exist are equilibria converging to a cycle as shown in Benhabib, Schmitt-Grohé, and Uribe (2001a,b; 2003) or chaotic equilibria (Benhabib, Schmitt-Grohé, and Uribe, 2002a). Finally, it could be the case that the monetary policy will imply that the targeted path of inflation is the only equilibrium outcome. This scenario is the one that is desired but as the above discussion demonstrates this will not always be the case.

What monetary strategies have been proposed to rule out speculative in- or deflations?

In the existing literature two strategies have been proposed to rule out self-fulfilling inflations. One strategy is to impose restrictions on preferences that imply that money is essential in the sense that utility would converge to negative infinity when real balances approach zero. This route has been studied (and criticized as economically unreasonable) in Brock (1974, 1975), Gray (1984), and Obstfeld and Rogoff (1983). The model analyzed in the Sims paper does not make this assumption. Rather it makes the more plausible assumption that once liquidity becomes too expensive agents are willing to regress to barter and not use money at all. The second strategy that is typically regarded as more compelling, for it does not rely on questionable assumptions about the nature of preferences, is to switch to a price level peg (see Wallace, 1981; and Obstfeld and Rogoff, 1983). It is the effectiveness of this second strategy that the Sims paper studies in detail in the case that the central bank lacks financial backing from the fiscal authority.

Similarly, the existing literature contains routes on how to rule out self-fulfilling deflations relying on preference specifications and on monetary policy switches. One possible route is the adoption of a price level peg. For this strategy to work, the central bank must be willing to purchase, for example, foreign exchange at a fixed price with money. Svensson (2001) has labeled this strategy of avoiding unintended deflations the 'fool proof way' and has recommended it as a promising strategy for Japan to escape its deflationary trap. An alternative route to escaping the liquidity trap has been proposed by Benhabib, Schmitt-Grohé, and Uribe (2002b). They show that the switch to a positive money growth rate peg, if accompanied by the right fiscal policy, will prevent an economy from falling into a deflationary spiral.

Would those anti-speculative strategies also work when the central bank is independent of the fiscal authority?

The fool-proof way of avoiding a self-fulfilling liquidity trap of Svensson (2001) requires that the central bank stands ready to buy (in principle, unlimited quantities of) assets in exchange for currency. From a balance sheet point-of-view, this strategy should provide little problems. It requires the central bank to buy financial assets with money. Since the central bank has access to unlimited amounts of money, this strategy is clearly feasible even in the absence of resource transfers from the fiscal authority. In the Sims paper, it is argued that this strategy may not be adopted because the central bank does not want to make its balance sheet longer. The reason given why a central bank may object to making its balance sheet longer is that it would make it more prone to variations in net worth stemming from variations in the real value of central bank assets. The Sims paper cites in particular the exchange rate risk associated with purchases of foreign-currency denominated bonds.

However, if the fool-proof way of avoiding speculative deflations is effective, it means that prices will never start falling to begin with and the central bank will never have to actually implement the price level peg. In this case the balance sheet considerations should play

no role. Second, suppose an economy is already in a liquidity trap and contemplates the implementation of a price level peg to prevent further declines in prices. In the self-fulfilling deflation, prices and nominal balances are declining at about the same rate (ignoring growth for the moment). But if a price level peg is implemented, then real balances should fall (because inflation will increase from a negative quantity to zero) and with the price level pegged this means that nominal money balances must fall, leading to outflows of central bank reserves rather than inflows. That is, the balance sheet of the central bank will become shorter and not longer. (This is the famous balance of payments crisis argument.) The central bank may even set the price level peg at exactly that level that will imply that nominal money balances are unchanged. To be able to achieve this, it would have to announce that the price level is pegged at a higher level than the price level in place immediately before the switch to the price level peg. In this case, central bank independence will again not stand in the way of the quest for price stability.

Benhabib, Schmitt-Grohé, and Uribe (2002b) show that the central bank can rule out self-fulfilling deflations by switching policy to a (positive) money growth rate peg. As will become clear from the discussion in the next section, this strategy can be successful even if net worth of the central bank is initially negative and the central bank is independent.

The central argument in the Sims paper is that a price level peg may not rule out self-fulfilling inflations under central bank independence. Specifically, it is argued that a self-fulfilling inflation may not be averted if the central bank has negative net worth. However, this result hinges critically on the particular specification of monetary policy in the Sims analysis, where it is assumed that the central banks follows an inertial interest rate feedback rule. In the example studied in section III of the Sims paper, when the economy demonetizes, that is, when real balances converge to zero, nominal balances are actually declining. So, it is a case of a self-fulfilling inflation with shrinking nominal balances. In most existing historical examples of economies in which accelerating inflation lead to demonetization of the economy, the opposite was observed. The accelerating inflation occurs in an environment in which nominal money balances are increasing albeit at a slower rate than prices.

This feature of the Sims analysis is important. For only if $\dot{M} < 0$, then net worth of the central bank is shrinking along the hyperinflationary path. To see this, let $w(t)$ denote the ratio of central bank assets to central bank liabilities, that is, in the notation of the Sims paper $w(t) = P(t)F_G(t)/M(t)$. It follows that $\dot{w}/w = \pi + \dot{F}_G/F_G - \dot{M}/M$. Using the central banks budget constraint, equation (22) in the Sims paper, and assuming that the central bank makes no transfers to the fiscal authority, $\tau_B = 0$, it follows that $\dot{w}/w = (\pi + \rho) + \dot{M}/M(1/w - 1)$. Suppose that initially the central bank's net worth is negative, so that $0 < w < 1$. Then in a self-fulfilling inflation, the balance sheet of the central bank is deteriorating only if nominal money balances are falling.[1] This seems to suggest that in cases in which in a self-fulfilling hyperinflation nominal money balances are increasing central bank independence may not be an obstacle to ruling out self-fulfilling hyperinflations.

In the section that follows, I present an example of a self-fulfilling hyperinflation in which along the hyperinflationary path nominal money balances are increasing and argue that in this case one can rule out those inflationary paths through fractional reserve backing even

[1]Note that $\pi + \rho$ denotes the nominal interest rate which in equilibrium must be non-negative.

in the case that the central bank is independent. The reason is that if nominal money balances are increasing on the way to a speculative inflation, the central bank accumulates real resources. At some point it must then be the case that the net worth of the central bank becomes non-negative. That is, we must have that at some point $PF^G/M \geq 1$. At that exact instance, the central bank could switch to a pure price level peg. This price level peg will be sustainable because the central bank could, if need be, redeem the entire stock of money for reserves.

An example of ruling out speculative inflations under central bank independence

The Household

The household's problem is almost the same as the one described in section III of the Sims paper. The main difference is that it is assumed that time is discrete whereas in the Sims paper time is continuous. Without loss of generality, one can assume that households can only hold two types of asset: money and foreign bonds, rather than three as is assumed in the Sims paper. Under this assumption the household's budget constraint can be written as[2]

$$\max \sum_{t=0}^{\infty} \beta^t \ln c_t$$

subject to

$$\frac{M_{t-1}}{P_t} + (1+\rho_{t-1})F^P_{t-1} + y_t + \tau_t = c_t(1+\psi(v_t)) + \frac{M_t}{P_t} + F^P_t \quad (1)$$

$$v_t = P_t c_t / M_t \quad (2)$$

$$\lim_{j\to\infty} \left(\prod_{s=t}^{j-1} \frac{1}{1+\rho_{t+s}} \right) \left[\frac{M_{t+j-1}}{P_{t+j}} + (1+\rho_{t+j-1})F^P_{t+j-1} \right] \geq 0 \quad (3)$$

The household takes P_t, ρ_t, y_t, and τ_t as exogenously given. The initial conditions of the household are M_{-1} and $(1+\rho_{-1})F^P_{-1}$.

The Lagrangian of the household's maximization problem can then be written as

$$\mathcal{L} = \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \lambda_t [-c_t(1+\psi(P_t c_t/M_t)) - \frac{M_t}{P_t} - F^P_t + \frac{M_{t-1}}{P_t} + (1+\rho_{t-1})F^P_{t-1} + y_t + \tau_t] \right\}$$

The first-order conditions are (1), (2), (3) holding with equality and

$$\frac{1}{c_t} = \lambda_t [1 + \psi(v_t) + v_t \psi'(v_t)] \quad (4)$$

$$1 - v_t^2 \psi'(v_t) = \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{P_t}{P_{t+1}} \quad (5)$$

$$\lambda_t = (1+\rho_t)\beta \lambda_{t+1} \quad (6)$$

[2]The notation follows that of the Sims paper.

The Fiscal Authority

We assume that the fiscal authority does not issue bonds, and simply rebates any seignorage income it receives from the central bank to private households, that is,

$$\tau_t = \tau_t^B. \tag{7}$$

This assumption about the nature of fiscal policy is consistent with the treatment of fiscal policy in the Sims paper. The Sims paper, however, is less specific and simply states that 'a passive fiscal policy keeps real debt under control regardless of the path of inflation.'[3]

The Monetary Authority

At the end of period t the central bank has real assets in the amount of F_t^G. Following the Sims paper, I assume that its period-by-period budget constraint is given by

$$F_t^G = (1+\rho_{t-1})F_{t-1}^G + (M_t - M_{t-1})/P_t - \tau_t^B. \tag{8}$$

Central bank independence is interpreted in the Sims paper to mean that τ_t^B must be non-negative, that is, the central bank cannot get backing for its liabilities in the form of transfers from the fiscal authority.[4] For simplicity, I will assume further that

$$\tau_t^B = 0. \tag{9}$$

Equilibrium

A perfect foresight equilibrium is a set of sequences $\{c_t, v_t, M_t, P_t, F_t^G, F_t^P, \lambda_t, \tau_t, \tau_t^B\}$ given exogenous $\{y_t, \rho_t\}$ and the initial values of M_{-1}, $(1+\rho_{-1})F_{-1}^G$, and $(1+\rho_{-1})F_{-1}^P$ satisfying (1)-(9), with (3) holding with equality, and one additional equation describing monetary policy.

To characterize the equilibrium dynamics, use (4) to eliminate λ_t from (5) to obtain

$$1 - v_t^2\psi'(v_t) = \beta\frac{1+\psi(v_t)+v_t\psi'(v_t)}{1+\psi(v_{t+1})+v_{t+1}\psi'(v_{t+1})}\frac{c_tP_t}{c_{t+1}P_{t+1}}.$$

Using (2) this expression can be rewritten as

$$1 - v_t^2\psi'(v_t) = \beta\frac{1+\psi(v_t)+v_t\psi'(v_t)}{1+\psi(v_{t+1})+v_{t+1}\psi'(v_{t+1})}\frac{v_t}{v_{t+1}}\frac{M_t}{M_{t+1}}. \tag{10}$$

[3] Central bank independence and non-Ricardian fiscal policy can give rise to default by the fiscal authority. See Uribe (2002) for a characterizes of the equilibrium behavior of default under central bank independence and alternative non-Ricardian policy regimes.

[4] A slightly different interpretation of central bank independence is that the central bank chooses τ_t^B subject to the constraint that it has to be non-negative. For if the fiscal authority could determine the magnitude of τ_t^B, then the fiscal authority would effectively gain control over net worth of the central bank and could, for example, finance fiscal deficits with reserves. For the arguments that follow, it is important that the central bank, and not the fiscal authority, controls the size of τ_t^B.

Consider now the case that the central bank follows a money-growth-rate peg by setting $M(0)$ and then letting M_t evolve according to the rule

$$M_{t+1} = \mu M_t; \quad \mu > 1, \tag{11}$$

where μ denotes the gross growth rate of the money supply. For this monetary policy specification, equation (10) is a first-order difference equation in one endogenous variable, v_t. The steady state of that equation solves,

$$1 - v^{*2}\psi'(v^*) = \beta\mu^{-1}.$$

For the particular functional form of $\psi(v)$ assumed in the Sims paper, i.e., $\psi(v) = \gamma v/(1+\phi v)$, we have

$$v^* = \frac{\sqrt{1-\beta\mu^{-1}}}{\sqrt{\gamma} - \phi\sqrt{1-\beta\mu^{-1}}}.$$

The existence of a steady state in which velocity is positive requires that $\gamma/\phi^2 > 1 - \beta\mu^{-1}$. One can show that if a steady state exists, it is unique. Next I wish to show that for any $v(0) > v^*$, equation (10) implies that as long as the money growth rate peg is in place $v_{t+1} > v_t$. To see this rewrite (10) as

$$[1 + \psi(v_{t+1}) + v_{t+1}\psi'(v_{t+1})]v_{t+1} = \frac{\beta}{\mu[1 - v_t^2\psi'(v_t)]}[1 + \psi(v_t) + v_t\psi'(v_t)]v_t.$$

Let $G(v_t) = [1 + \psi(v_t) + v_t\psi'(v_t)]v_t$ and $F(v_t) = \frac{\beta}{\mu[1-v_t^2\psi'(v_t)]}[1 + \psi(v_t) + v_t\psi'(v_t)]v_t$. Note that both $G(.)$ and $F(.)$ are increasing in v. Clearly, at $v = v^*$, $G(v) = F(v)$. However, for $v > v^*$, $F(v) > G(v)$ because $\frac{\beta}{\mu[1-v_t^2\psi'(v_t)]} > 1$. Thus, in order for v_t to satisfy equilibrium condition (10) in the case that $v_0 > v^*$, it must be the case that v_t is increasing over time. If this explosive path for v can be supported as an equilibrium outcome, then speculative inflations are possible in this economy. For simplicity, we assume that $\beta(1 + \rho_t) = 1$ for all t. It follows from (6) that $\lambda_t = \lambda_0$ for all $t \geq 0$. By (4) the time path for consumption is then given by $c_t = 1/\lambda_0/(1 + \phi(v_t) + v_t\psi'(v_t))$ for all t. From this relation and the definition of velocity it follows that $P_0 = v_0 M_0 \lambda_0(1 + \psi(v_0) + v_0\psi'(v_0))$. Iterating (1) forward and using (3) one obtains a present discounted value constraint of the form $\sum_{t=0}^{\infty} q_t[y_t + \tau_t - (1 + \psi(v_t))c_t - M_t/P_t(R_{t+1} - 1)/R_{t+1}] + M_{-1}/P_0 + (1+\rho)F_{-1}^P = 0$, where $q_t \equiv \prod_{s=0}^{t-1}(1+\rho_s)^{-1}$ and $R_{t+1} \equiv (1+\rho_t)P_{t+1}/P_t = 1/[1 - v_t^2\psi'(v_t)]$. Using the definition of velocity to eliminate M_t/P_t and (4), we can rearrange this expression to get $\sum_{t=0}^{\infty} q_t[y_t + \tau_t - (1 + \psi(v_t))/(1 + \psi(v_t) + v_t\psi'(v_t))/\lambda_0 - 1/(1 + \psi(v_t) + v_t\psi'(v_t))/\lambda_0/v_t(R_{t+1} - 1)/R_{t+1}] + M_{-1}/v_0/M_0/(1 + \psi(v_0) + v_0\psi'(v_0))/\lambda_0 + (1 + \rho)F_{-1}^P = 0$. Given a time path for v_t this expression uniquely determines λ_0. Finally, note that because nominal money balances are not shrinking ($\mu \geq 1$) over time, central bank net wealth is increasing, that is, $P_{t+1}F_{t+1}^G/M_{t+1} > P_t F_t^G/M_t$.

The arguments just presented establish that a self-fulfilling inflation can be supported as an equilibrium outcome. The consequence of this result is that the central bank would not have control over inflation. This is because any $v_0 \geq v^*$ constitutes a perfect foresight equilibrium. The existence of self-fulfilling inflations in economies in which monetary policy takes the form of a money growth rate peg is a well known result, see, for example, Brock (1974, 1975), Obstfeld and Rogoff (1983), and Woodford (1994). Equally well known are ways

to rule such speculative inflations out. In particular, Wallace (1981) and Obstfeld and Rogoff (1983) have suggested to use fractional backing as a way to rule out speculative inflations. Under a policy of fractional backing the central bank commits to adopt a price level target at some price level $\overline{P}$ should the price level pass a certain threshold. For this threat to be credible it must be the case that at the moment the price level target is implemented, the central bank has sufficient reserves on hand to exchange the entire money stock in circulation at the preannounced price, that is, we need that $\overline{P}F^G_{t-1} \geq M_{t-1}$, where t is the first period in which the price level peg is in place. In standard analysis the fiscal and monetary authority are treated as a unit with a single consolidated budget constraint. In this case, the solvency requirement of the central bank is of no concern. For the central bank is implicitly guaranteed support from the fiscal authority (in the form of tax revenue) to redeem money for real assets should need be.

Our concern here is how we can rule a self-fulfilling inflation in this model even if the central bank is independent. Suppose that the central bank announces that it will follow a money growth rate peg with $\mu > 1$ and that should $v_0 > v^*$, then the money growth rate peg would only stay in place until $P_t F^G_t \geq M_t$. Let T denote the first period in which $P_t F^G_t \geq M_t$, then the central bank will keep the money growth rate peg until period T, and from period $T+1$ on, it will follow a price level peg of the form $P_t = P_T$ for all $t > T$. Then we know from (5) that $1 - v_T^2 \psi'(v_T) = \beta$, which implies that $v_T < v^*$. At the same time, with $v_0 > v^*$ equilibrium condition (31) can only be satisfied if $v_T > v_{T-1} > v_{T-2} > ... > v_0 > v^*$. But both of those conditions can never be satisfied at the same time. Therefore, $v_0 > v^*$ cannot be supported as a perfect-foresight equilibrium. It follows that fractional backing is capable of ruling out a self-fulfilling inflation even in the case in which the central bank starts out with negative net worth and never receives an injection of resources from the fiscal authority.

Finally, suppose that a central bank wishes to follow an interest rate feedback rule like the one studied in the Sims paper. One possible strategy to rule out self-fulfilling inflations in this case is to commit to switching to a money growth rate peg should central bank net worth fall too low, and in addition threaten to yet switch monetary policy again to a price level target once net worth of the central bank is sufficiently large.

The reason why fractional reserve backing does not work in the economy presented in section III of the Sims paper is that under the interest rate policy, net worth of the central bank may be falling along the self-fulfilling hyperinflation (see figure 2 of the Sims paper). Specifically, the analysis of the Sims paper shows that if a central bank starts with sufficiently negative net worth, it will never be able to reach solvency when the economy falls into a speculative inflation, and hence the central bank will never be able to announce a credible price level peg. However, under a positive money growth rate peg even under a self-fulfilling inflation nominal money balances increase over time and therefore, the net worth of the central bank, $P_t F^G_t / M_t$ improves with time.

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