Who controls the price level?

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"Inflation is almost always a monetary phenomenon"
M. Friedman

I. Introduction:

The monetarist theory gives a clear definition of the actions and limitations of the monetary and fiscal authorities. According to that theory, the monetary authority should set the money growth rate with a clear objective of price level stability and it should be independent of the fiscal authority to achieve its goals. Whereas the fiscal authority will be responsible for its own house and should aim at keeping a balanced budget given the price level at all time. However, Sargent and Wallace (1981) and the advocates of the fiscal theory of the price level (FTPL) indicated that this distinction between the monetary and fiscal authorities as two different parts of the government is not as strict as it seems and their relationship has important consequences on the price level.

Almost two decades ago Sargent and Wallace (1981) showed that if monetary policy is defined as open market operations, then even in a monetarist environment the fiscal authority may act in a dominant fashion and exercise significant control over the inflation rate. That is, it is possible for the monetary authority to be a 'follower' and to lose control over the price level.

Advocates of the fiscal theory of the price level, such as Woodford (1995), Leeper (1991), Sims (1993) and Cochrane (1998) take this argument one step further and argue that it is actually possible for both the monetary and the fiscal authorities to be dominant such that, fiscal and monetary authority are not bound by the solvency of its budget constraint.

The fiscal theory of the price level (FTPL) arose as an attempt to explain the weak relation between monetary aggregates and the inflation rate in today's technologically advanced environment where, it is harder to control the monetary aggregates.

The theoretical possibility of non –Ricardian policies is discussed by many economists and there are various studies on the relationship between the fiscal debt and the price level. However, there are very few empirical studies testing the FTPL. The studies by Canzoneri, Cumby and Diba (1998), Tanner and Ramos (2002) and Cochrane (1998) have conflicting results. These studies analyses the behaviour of the fiscal authority through the government budget constraint.

This study overview the theories of price level determination and focuses on the theoretical and empirical studies of the fiscal theory of price level in detail. The following section formulates the macro model that will be used to analyse different theories of price level. The theoretical discussions and the empirical studies of the fiscal theory of price level are studied in detail in Sections Three and Four respectively. Section Five is the conclusion.

II. The Model:

This is a pure exchange economy with infinitely lived agents with an endowment of y_t units of consumption good in each period. Government purchases g_t, yield no utility to the consumers. In each period t the consumer chooses the level of consumption, c_t, the nominal holdings of fiat currency, M_t, and the nominal holdings of government bonds, B_t. Fiat currency does not earn interest. However, consumers earn a gross nominal rate of interest, R_t for their holdings of nominal government bonds. Real balances, m_t are M_t / p_t and the real value for government bonds, b_t is B_t / p_t. At each period t, the consumer pays tx_t units of consumption good in lump sum taxes. Consumers have separable utility functions for money and consumer goods, and the utility is discounted at the constant rate of $\beta \in (0,1)$.

Given the initial wealth and the sequences of price, interest rate and net taxes, the representative consumer with a log linear utility function chooses the sequence of the end of period bond holdings $\{B_t\}$, the end of period money holdings, $\{M_t\}$, and the level of consumption $\{c_t\}$ to maximize his expected lifetime utility (1) with respect to the sequence of budget constraint (2), the transversality condition (3) and the nonnegativity constraints[1] [2]: $\sum_{t=0}^{\infty} \beta^t (\log c_t + \log \frac{M_t}{p_t})$

$$\text{Max } E_0 \sum_{t=0}^{\infty} \beta^t (\log c_t + \log \frac{M_t}{p_t}) \tag{1}$$

s.t

$$c_t + tx_t + b_t + m_t \leq y_t + R_{t-1} \frac{B_{t-1}}{p_t} + \frac{M_{t-1}}{p_t} \qquad t = 0, 1, 2,\ldots. \tag{2}$$

$$\lim_{T \to \infty} \left(\prod_{s=0}^{T-1} R_s^{-1} \right) W_T = 0 \tag{3}$$

$M_t \geq 0$, $c_t \geq 0$

and the period t+1 nominal wealth, $W_{t+1} = M_t + R_t B_t$ (4)

The first order conditions are[3], for t = 0, 1, 2,…

$$\frac{1}{R_t} \frac{c_{t+1}}{c_t} = \beta E_t \left[\frac{p_t}{p_{t+1}} \right] \tag{5}$$

$$m_t = c_t \left(\frac{R_t}{R_t - 1} \right) \tag{6}$$

and

$$c_t = y_t - tx_t - \frac{B_t}{p_t} - \frac{M_t}{p_t} + R_{t-1} \frac{B_{t-1}}{p_t} + \frac{M_{t-1}}{p_t} \tag{7}$$

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[1] Note that the utility function is twice differentiable, strictly increasing, strictly concave and B_t can be either positive (the government is borrowing from the household) or negative (the government is loaning to the household).

[2] In the initial period 0, the government has initial outstanding liabilities M_{-1} and B_{-1}.Therefore the period 0 nominal wealth is: $W_0 = M_{-1} + R_{-1} B_{-1}$

[3] Note that under the assumption of separable utility and unitary consumption growth, $c_t = c_{t+1}$, equation (5) implies the Fisher Equation: $R_t = \frac{1}{\beta} E_t \left[\frac{p_{t+1}}{p_t} \right]$

Government expenditure is financed by direct lump sum taxes and by money and bond seignorage. Hence, the sequence of government budget constraints is defined as:

$$g_t - tx_t = m_t - \frac{M_{t-1}}{p_t} + b_t - R_{t-1}\frac{B_{t-1}}{p_t} \qquad \text{for } t = 0, 1, 2,\ldots \tag{8}$$

There is no capital accumulation. In this pure exchange economy, the sequence of aggregate resource constraint is defined as, the total endowment in each period being consumed by the fiscal sector and the private agents:

$$y_t = c_t + g_t \qquad \text{for } t = 0, 1, 2,\ldots \tag{9}$$

In equilibrium the resource constraint (9) and the budget constraints (7) and (8) have to be satisfied. Note that any two of these constraints imply the third constraint. Therefore, it is possible to work with any two of equations (7), (8) and (9).

The optimisation problem includes the transversality condition.[4] The sequence of single period budget constraint, the sequence of aggregate resource constraint and the transversality condition lead to the intertemporal budget constraint[5]

$$\frac{W_t}{p_t} = \sum_{j=0}^{\infty}\left(\prod_{s=t}^{t+j-1} r_s^{-1}\right)(tx_{t+j} - g_{t+j} + \Omega_{t+j}\, m_{t+j}) \tag{10}$$

where,

$$\Omega_{t+j} = \frac{R_{t+j} - 1}{R_{t+j}} \quad \text{and} \quad r_s = \frac{p_s}{p_{s+1}}\, R_s.$$

The intertemporal budget condition (10) implies the equality between the real value of household sector wealth and the present value of the expected future government surpluses.[6] The importance of this equation for equilibrium depends on the fiscal/ monetary policy.

The equilibrium is defined as a sequence of $\{c_t\}$, $\{R_t\}$, $\{p_t\}$, $\{M_t\}$, $\{B_t\}$, $\{g_t\}$, $\{tx_t\}$ and $\{W_{t+1}\}$ that are consistent with the monetary –fiscal policy and satisfy equations (5), (6), (8), (9), (10) together with the initial conditions and the exogenous output sequence $\{y_t\}$[7].

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[4] The transversality condition requires the household to fully utilize lifetime wealth. A violation of this condition implies that there is still room for a household to increase its lifetime utility.

[5] The intertemporal budget constraint is obtained from the single budget constraint by summing it up for each time period over the infinite horizon

[6] The same equation can be derived from the government budget constraint. Following Leeper (1991) the relation between equations (7), (8) and (9) allows us to represent equation (10) in terms of government debt and surplus. Using the transversality condition –which recognizes the fact that the fiscal authority can sell as much bond as he wants as long as the present value of debt is equal to zero- and equation (8) the government intertemporal budget constraint is defined as:

$$\frac{B_t}{p_t} = \sum_{j=0}^{\infty}\left(\prod_{s=t}^{t+j-1} r_s^{-1}\right)(tx_{t+j+1} - g_{t+j+1} + \frac{M_{t+j+1} - M_{t+j}}{p_{t+j+1}}) \tag{10`}$$

The real value of government debt is equal to the present discounted value of future government revenue –which is the tax revenues net of expenditures and seignorage -

Defining S_t as the present value of government surplus from money seignorage and tax revenue net of expenditures, equation (10`) can be written as:

$$\frac{B_t}{p_t} = S_t \tag{10``}$$

[7] Under perfect foresight equilibrium, which we will assume for the empirical tests, the equilibrium sequences are such that the money and bond supplied by the government equal to the money and bond demanded by the household.

The fiscal –monetary policy is defined as sequences $\{g_t\}$, $\{R_t\}$, $\{B_t\}$, $\{M_t\}$ and $\{tx_t\}$ such that the government flow budget constraint (equation (8)) is satisfied in every period. The policy can be Ricardian or non –Ricardian according to the relation between the real value of the government debt and the price level.[8] The policy is defined as Ricardian, if it ensures that the government budget constraint is satisfied for all price sequences. In case of a Ricardian policy the monetary and fiscal policy variables are determined endogenously by prices guaranteeing the solvency of the intertemporal government budget constraint. Therefore, the intertemporal budget constraint is satisfied for all price levels. However, for non –Ricardian policy the intertemporal budget constraint is an equilibrium condition, not satisfied for every price sequence. For non –Ricardian policies the policy authority is not constrained by the solvency of the intertemporal government budget constraint. Solvency will, however, emerge as part of the economy's equilibrium solution.

Defining the intertemporal government budget constraint as $\frac{B_t}{p_t} = S_t$, it is seen that a non-Ricardian fiscal policy argues that the out of equilibrium real values of the surplus are not equal to the real values of debt.[9] This does not mean that the government does not care about the budget constraint. It is simply that for non-Ricardian polices the level of surplus is set before the price level is determined. Any threat to the solvency of the budget constraint is confronted by the market mechanism moving the price level.

"Under a non –Ricardian rule, the government moves before the "Walrasian auctioneer" does, so that the auctioneer is forced to call prices that are consistent with the real surpluses announced by the government." (Bassetto, 2001)

Under a Ricardian rule, it is important to indicate whether the monetary or fiscal authority is dominant, in the sense that the authority sets its policy variables exogenously. Leeper (1991) defines a policy as active if the authority sets its policy variable without constraining itself by the actions of the other authority. Similarly, a policy is referred to as passive if the policy authority is required to set its policy variable in response to the actions of the other authority to satisfy the intertemporal budget constraints in the system.[10]

"Because an active authority is not constrained by current budgetary conditions, it is free to chose a decision rule that depends on past, current, or expected future variables. A passive authority is constrained by consumer optimisation and the active authority's actions, so it must generate sufficient tax revenues to balance the budget." (Leeper, 1991)

Monetarist Theory

The monetarist theory of price level determination is based on the argument that the monetary authority has total control over prices. Under a Ricardian monetary – fiscal policy, where the monetary authority is dominant, the fiscal authority determines the sequences of $\{g_t\}$, $\{tx_t\}$ and $\{B_t\}$ such that the government budget constraint is satisfied at all price levels. Therefore, with a monetary policy controlling

[8] Woodford (1994)

[9] A Ricardian fiscal policy argue that the fiscal policy sets the sequence of $\{B_t\}$ or $\{tx_t\}$ such that the real value of surplus defined as money seignorage and primary surplus is equal to B /p for all price levels.

[10] When a monetary/fiscal authority follows an active policy it is regarded that the monetary/fiscal authority is dominant.

the sequences of money supply $\{M_t\}$, the price level path is determined from the money market equilibrium condition, independent of the fiscal policy variables.

The monetarist theory on price level determination is defined by active monetary and passive fiscal policy operating within a Ricardian framework. Thus, following the basic model developed previously, under a constant level of consumption, equations (5) and (6) and the monetary policy setting the money supply determines the price level sequence independent of the fiscal policy variables:

$$p_t = \left(\frac{\beta M_{t-1} p_{t-1}}{M_{t-1} - c p_{t-1}} \right) \tag{11}$$

As is seen from equation (11) additional constraints are needed to uniquely determine the price level.

Unpleasant Monetarist Arithmetic

Sargent & Wallace (1981) showed that it is possible for the fiscal authority to affect the level of prices even with Ricardian policies. The "Unpleasant Monetarist Arithmetic" of Sargent and Wallace (1981) is a result of a Ricardian policy with active fiscal and passive monetary policies. They argue that if the fiscal authority acts in a dominant fashion and, for example, sets a constant level of government expenditures net of taxes (g –tx) and keeps the real value of government bonds (B/p) at a predetermined level, a Ricardian environment requires the monetary authority to be a follower.[11] That is, the monetary policy responds to a dominant fiscal policy by setting a growth rate of money to generate the money seignorage necessary to satisfy the government budget constraint.[12] Hence, contrary to the standard monetarist argument, an "…… expansionary fiscal policy is inflationary" (Sargent and Wallace, 1981). Carlstrom and Fuerst (1999) define this model of fiscal dominancy as a weak form of the fiscal theory of the price level (FTPL) due to the fact that although the price level is still driven by the monetary authority, the growth rate of money is now a function of the fiscal policy variables, g, tx and B.[13]

In their paper, Sargent and Wallace define the monetary policy as money supply targeting rules. However, for our purposes it will be more convenient to define it as an interest rate targeting policy that is formulated to satisfy the government budget constraint. Hence, the interest rate rule for the monetary authority is defined by the government budget constraint given the household demand conditions and the fiscal policy.

Recall that for a constant level of primary surpluses, $D = (g - tx_t)$ and a constant real government debt b, the government flow budget constraint is:[14]

$$D = m_t - m_{t-1}\left(\frac{p_{t-1}}{p_t} \right) + b - R_{t-1}\left(\frac{p_{t-1}}{p_t} \right) b \tag{8`}$$

Given fiscal policy variables and the demand conditions, (5) and (6), equation (8) solves for the path of the interest rate as a function of the fiscal policy variables:[15]

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[11] A policy authority following an active policy is regarded as dominant and the policy authority forced to follow a passive policy is regarded as a follower.

[12] Sargent and Wallace define monetary policy as money growth rate policies, $M_t = \theta M_{t-1}$.The analysis is based on constant government expenditures, constant rate of interest being greater than the growth rate of population and constant nominal bonds, which is determined historically.

[13] Dominant fiscal policies argue for central bank independence since in that model "The central bank is driven by the fiscal authority" (Carlstrom and Fuerst, 1999)

[14] Under the aggregate resource constraint: $y_t = c_t + g_t$ the household and government budget constraints are the same.

$$R_t = 1 + \frac{R_{t-1} - 1}{(R_{t-1} - 1)\left(\frac{D}{c} - \frac{b}{c}\left(1 - \frac{1}{\beta}\right) - 1\right) + \frac{1}{\beta}} \tag{12}$$

However, stability analysis and the comparative statics show that the fiscal policy does not affect the (stable) steady state equilibrium interest rate.

Note that the rate of inflation, $\pi_t = \frac{p_t}{p_{t-1}}$ is now a function of the fiscal policy variables, D and b, as well as the monetary policy variable, R:

$$\pi_t = \beta + \frac{\beta(R_{t-2} - 1)}{(R_{t-2} - 1)\left(\frac{D}{c} - \frac{b}{c}\left(1 - \frac{1}{\beta}\right) - 1\right) + \frac{1}{\beta}} \tag{13}$$

"One of the most important implications of this theory is the possibility that tight money today could increase *today's* price level! That is, a low money supply today necessitates increased inflation tomorrow, implying – if money demand is sufficiently elastic – a high price level today…….Low money today directly lowers current prices. But there is an additional, indirect effect – the higher future inflation necessary for budget balance increases the nominal interest rate, lowering real money demand today. The latter effect drives up today's prices and overwhelms the former if money demand is sufficiently interest elastic." (Carlstrom and Fuerst, 1999)[16]

Fiscal Theory of Price Level

Ricardian policies do not permit a dual dominancy of monetary and fiscal authorities. However, the fiscal theory of price level argues that in a non –Ricardian policy environment it is possible for both the fiscal and the monetary authorities to follow an active policy.

The fiscal theory of price level is a rather new approach to monetary economics developed by Woodford (1995), Leeper (1991) and Sims (1993) to answer the following questions:

- How is the price level determined in the case of endogenous money, which occurs with free banking and interest rate pegging?
- Is it true that monetization is not a significant financial tool for governments who depend less on money seignorage?

The weak relation between monetary aggregates and the inflation rate in the U.S. and the fact that the U.S. inflation rate is stable even though the U.S. follows an endogenous money policy are the two facts that Woodford (1995) tries to explain.[17] The model is formed to capture the impact of fiscal policy on the price level, which is believed to be the missing point of the conventional monetarist view. Woodford does not argue that the equilibrium conditions of the quantity theory of price level are

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[15] A detailed analysis is given in appendix A

[16] For that to hold the household money demand must be a function of future price levels as well as today's level of prices.

[17] Cochrane (1998) presents the US the growth rate of base money, M1 and M2 together with the consumer price index. He argues, that the"… variation in inflation has essentially nothing to do with the history of monetary aggregates. The swings of inflation in the 1970's and especially the dramatic end of inflation in the 1980's occurred without any obvious corresponding changes in monetary growth."

irrelevant, but rather incomplete.[18] Contrary to the monetarist view that inflation is being driven only by monetary aggregates, he argues that the price level is determined from the government budget constraint as the ratio of the nominal value of debt to the present value of expected future surpluses.

Woodford argues that the LM equation defines the equilibrium interest rate differential (in case money is exogenous) or the money supply (in case money is endogenous) rather than the equilibrium price level as monetarist theory suggests.[19] Hence, with monetary policy following a pegged interest rate policy and fiscal policy being non-Ricardian, the price level will be determined by the present value of government liabilities.[20] This condition implies that "the current money supply and its expected future path are irrelevant for the determination of the equilibrium price level" Woodford (1995). A monetary shock will effect the price level eventually "…..only as a result of the eventual effects of monetary policy upon the size of the total government liabilities, which then affects the price level through the fiscal policy rule. And even in this case, it is arguable that such effects upon the price level as occur are due to fiscal effects of policy change, rather than upon the mere fact that households are forced to hold a different quantity of money; for the price level grows in proportion to the growth of total government liabilities, and not in proportion to growth of the monetary component of those liabilities." (Woodford, 1995)

Given the private sector's problem, the monetary policy as an interest rate peg, and fiscal policy as an exogenous budget debt/surplus value, equation (5) drives the interest rate rule:

$$R_t = \frac{1}{\beta}\frac{p_{t+1}}{p_t} \tag{5`}$$

And, the money supply is driven by equation (6`):

$$\frac{M_t}{p_t} = c\left(\frac{p_{t+1}}{p_{t+1} - \beta p_t}\right) \tag{6`}$$

Hence, the intertemporal government budget constraint together with the demand conditions and the monetary policy solves for the price level:[21]

$$p_t = p_{t-1}\left(\frac{\sum_{j=0}^{\infty}\beta^{j+1}(c-D)-b}{\sum_{j=0}^{\infty}\beta^{j}(c-D)-\frac{b}{\beta}-c}\right) \tag{16}$$

Contrary to the monetarist view that inflation is being driven only by monetary aggregates, in a non –Ricardian environment with active fiscal and monetary policies, the price level is only a function of fiscal policy variables. It is determined from the government budget constraint as the ratio of the nominal value of debt to the present

[18] Under the quantity theory of money there are an infinite number of price path solving for the equilibrium conditions.

[19] "With an interest elastic demand and fixed supply, money demand can still determine the expected rate of inflation or expected price level, but it does not determine the (ex-post) price level. The government budget constraint then determines the price level" Cochrane (1998)

[20] Woodford, notes that the impact of fiscal policy on the equilibrium value of money is consistent with the findings of Sargent since the value of money, which is a part of government debt, depends upon the expectations of the households on the debt flow to back it.

[21] A detailed analysis is given in appendix A

value of expected future surpluses[22] [23] [24].

Ricardian policies assume that the Ricardian Equivalence Theorem holds. That is, the fiscal policy does not create any wealth effects.[25] However, this is not the case for non –Ricardian policies. In the case of active monetary and fiscal policies, the fiscal policy does create a wealth effect since an increase in the value of government bonds affects the households' lifetime budget set.

"The way the fiscal disturbances affect the price level is through a wealth effect upon private consumption demand. A tax cut not balanced by any expectation of future tax increases would make households perceive themselves to be able to afford more lifetime consumption, if neither prices nor interest rates were to change from what would have been their equilibrium values in the absence of the tax cut. This would lead them to demand more goods than they choose to supply (both immediately and in the future). The resulting imbalance between the demand and supply of goods drives up the price of goods until the resulting reduction in the real value of households' financial assets causes them to curtail demand (or increase supply) to the point at which equilibrium is restored." (Woodford, 1998)

In his studies Woodford takes these strong arguments on the impact of fiscal policy, one step further and argues that the fiscal theory of price level works under any type of monetary regime unless there is a Ricardian fiscal policy, which is a 'special' case.

III. Theoretical Studies on Fiscal Theory of Price Level

One significant force behind the FTPL is the ability and will of the fiscal authorities to use money financing. Hence, it is reasonable to ask if governments with less dependence on money financing could still choose to impose a higher price level. The studies of Leeper (1991) and Bergin (2000) have important results on that issue.

Leeper (1991) argues that the average level of money seignorage is not a factor on deciding the financing method of the debt. Hence, it may be misleading to argue that economies with a low dependence of money seignorage do not choose money financing. He specifies cases where money financing is an option for governments even when all their debt is backed by taxes. In this study he solves the private sector's optimisation problem given the monetary (interest rate as a function of inflation rate) and the fiscal (the real tax revenue as a function of the previous period government debt) policy functions and defines a system of inflation, π_t (which is a function of the previous period inflation rate) and real debt, b_t as a function of consumption, nominal interest rate and nominal rate of inflation. Leeper (1991) uses this 2 equation system to discuss different scenarios of price level determination, one of which shows that, with active fiscal and passive monetary policy –i.e., under a pegged interest rate and constant tax revenue- the price level is determined by the government budget

[22] The price level is determined from the intertemporal government budget constraint (equation (10)):

$$p_t = W_t \left(\sum_{j=0}^{\infty} \left(\prod_{s=t}^{t+j-1} r_s^{-1} \right) (tx_{t+j} - g_{t+j} + \Omega_{t+j} m_{t+j} \right)^{-1}$$

[23] Recall that the monetarist theory solved for a path of the price level. Additional constraints have to be imposed on the model for equation (13) to solve for today's price level. However, the FTPL solves for today's price level without imposing additional restrictions on the path of prices.

[24] The comparative statistics shows that a positive fiscal shock has a positive impact on the price level

[25] "Government bonds are not net wealth" (Barro, 1984).

constraint.[26] "Under pegged nominal interest rates and active fiscal behaviour, monetary policy's effect on prices depends on how the fiscal authority adjusts direct taxes in response to real debt movements. When taxes are unresponsive to debt, unanticipated monetary contractions immediately raise nominal interest rates and real debt and lower real balances. Prices respond with a lag. If future direct taxes rise (fall) with increases in real debt, the contraction lowers (raises) current inflation." (Leeper, 1991)

Bergin (2000) follows the same approach to address the importance of money financing in the case of a monetary union. He formulates a two-country model with a common central bank. In this model, the central bank controls the money supply through open market operations. The national governments receive transfers from the central bank and adjust lump-sum taxes to finance their deficits.[27] The rational expectations equilibrium conditions of the model lead to important arguments for a monetary union. First of all, under certain risk sharing assumptions, it is not required for all the member countries to have fiscal solvency for price stability. It is argued that under perfect insurance the debt of a country is absorbed by the surplus of another country. It is important to point out the fact that this proposition leads to important wealth effects. Bergin (2000) also argues that one bad apple could spoil the whole bundle. Even if the common central bank refuses to issue new money, the governments with large debt would still follow irresponsible polices and campaign for higher price levels. This is a problem for other countries too since an increase in the unbacked debt of a government not only increases the price level in that country but it increases price levels all through the monetary union.

In contrast to these arguments, the study by Dupor (2000) on open market models indicates that the FTPL is not sufficient to pin down the equilibrium price level. He studies the determination of the exchange rate in a two-country set up with dominant fiscal policy and nominal interest rate pegging. His model allows for households to exchange goods, money and government bonds under a no –arbitrage condition in the bonds market. His solutions for the cases of substitutable and non-substitutable currencies indicate that, " the nominal exchange rate is indeterminate if both governments peg the interest rate on domestic bonds." (Dupor, 2000) This conclusion for the indeterminacy of the price levels of each country and the exchange rate is in contrast to the arguments of the FTPL.

To see if the FTPL is an acceptable model, Carlstrom and Fuerst (1999) analyses the reliability of the assumptions of two different versions of the FTPL, which they name 'strong form' and 'weak form' FTPL. Both forms of the FTPL assume a dominant fiscal policy for price level determination. However, they differ in the way the monetary policy is applied. "Weak form FT posits that inflation is indeed a monetary phenomenon, but that money growth is dictated by the fiscal authority. Strong form FT, on the other hand, argues that even if money growth is unchanged, fiscal policy independently affects the price level and the inflation rate" (Carlstrom and Fuerst, 1999). Working with separable preferences and an interest rate pegging policy, the partial and general equilibrium analyses of the weak and strong form FT indicate that, strong form FT requires unrealistically large interest elasticity of money

[26] "..an active authority is not constrained by current budgetary conditions, it is free to choose a decision rule that depends on past, current or expected future variables. A passive authority is constrained by consumer optimisation and active authority 's actions, so it must generate sufficient tax revenues to balance the budget" Leeper (1991)

[27] It is assumed that the transfers to the national governments are symmetric

demand and output elasticity of money demand for fiscal policy to be able to determine the price path.

The dependability of the FTPL for real world analyses is also questioned in the study of Kocherlakota and Phelan (1999). They argue that that it is more reasonable to believe in the monetarist theory of price determination since it is not 'logical' for governments to choose an inflationary outcome.[28]

McCallum (2001) is against FTPL due to the definition of the fiscal policy that is used.[29] He argues that the fiscal policy variable is actually the bond supply to the public, not the primary deficit or surplus. He shows that there is a monetarist type solution for the price level in an FTPL framework, where the bond supply is taken as the fiscal policy variable.

Cushing (1999) is another attack on the FTPL. He modifies the original model used by the advocates of FTPL and assumes that the households face a certain probability of death.[30] Households do not leave bequests but they receive payments from insurance companies. The insurance companies finance these premium payments by collecting the financial assets of the deceased. The equilibrium conditions of this model create a system of money supply, bond supply and the price level, which is a function of the interest rate, government spending, probability of death, money supply and bond supply. Cushing solved the model for the cases of Ricardian and non –Ricardian consumers and concluded that the price level is indeterminate.[31]

In their study on the FTPL, Schmitt-Grohe and Uribe (2000) are rather careful on the conditions where this theory might work. They model a cash-in-advance economy, to study the dependability of the balanced budget requirement as an anchor for price stability. Under the assumption that the government is not allowed to finance the deficit with money seignorage, the price level is determinate in case the primary rather than the secondary budget surplus/deficit is taken to be exogenous.

To conclude, the FTPL is a controversial theory.

IV. Empirical Studies on Fiscal Theory of Price Level

These theoretical models of the price level determination were tested by many empirical studies. Some of these studies followed a time series and others followed a structural approach.

Structural studies use the government budget constraint to model the inflation rate as a function of government debt. Metin (1998), Ruge-Marcia (1999) and Cardosa (1992) are some recent examples of this type of empirical study.

Metin (1998) estimated the following equation for the inflation rate in Turkey as a function of the Turkish budget deficit and output growth:[32] [33]

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[28] Their arguments on FTPL are based on certain examples for monetary and fiscal policy.

[29] His results are independent of the elasticity of money demand and any specific form of price path that has been required in previous studies.

[30] The probability of death is used to differentiate between Ricardian and non-Ricardian policies as well as to create a divergence between the asset holdings of agents. For the Ricardian consumer the probability of death is zero

[31] He argues that the FTPL is based on the two unrealistic assumptions; i) the government debt converges and ii) the future inflation is constant.

[32] The price level equation is a result of the modification of the government budget constraint;

$$\frac{G-T}{PY}=\frac{\Delta H}{PY} \qquad \text{(M1)}$$

$\Delta p = a + \delta B - \Delta y$

where, Δy is the output growth rate. B is the scaled budget deficit; $B = \frac{G-T}{H}$, where G is public sector expenditures, T is revenues, and H is base money.

The regression results and tests for cointegration indicated that government deficits have a significant positive impact on the inflation rate.[34]

Ruge-Murcia (1999) used annual data for Brazil over the sample period 1940 – 1988, finding that the level of expenditure is an important factor for the level and volatility of the inflation rate.[35] [36]

Although these studies are for countries with huge government debt, there are studies for the U.S. indicating that non monetary factors have a significant impact on the price level.

Ahking and Miller (1985) used a multi- equation time series approach to study the relation between inflation and the public debt. In this study, they followed a three-stage procedure where base money growth, government deficits and inflation were treated as endogenous variables. The three–stage OLS analyses for the U.S. economy showed that government deficits have an important effect on the inflation rate.[37] [38]

Dhakal, Kandil, Sharma and Trescott (1984) focused on demand-pull/ cost-push theories for the causes of inflation.[39] First, they estimated a vector autoregression (VAR) model of the money stock M1, producer price index, interest rate and the gross national product to test the validity of the monetarist approach to explaining the inflation rate. Second, they created three new models by adding the government debt, wage rate and energy prices sequentially to the original model to search for the non-

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where, Δ is the difference operator,G is public sector expenditures, T is revenues, H is base money, P is prices and Y is real income.

In steady state,

$$\Delta H^* = \frac{\Delta H}{PY} - H^*(\Delta p + \Delta y) \qquad \text{(M2)}$$

where, p and y are log(P) and log(Y) respectively.

Solving equation (M2) for $\frac{\Delta H}{PY}$ and using it in equation (M1) gives the budget constraint;

$$\frac{G-T}{PY} = \Delta H^* + H^*(\Delta p + \Delta y) \qquad \text{(M3)}$$

Then, equation (M3) is solved for price level.

[33] Annual data over the sample period 1950-1987.

[34] "…..an increase in the scaled budget deficit immediately increases inflation." Metin (1998)

[35] In that study Ruge- Marcia developed a dynamic model for inflation in case of monetization of the government debt, which is defined as the difference between government expenditures and the tax revenue. Tax revenue is modelled as a backward looking process such that it is influenced by the past inflation rates. He assumed a Cagan model for money demand and that the money supply is an endogenous process indexed to the government debt. The government debt is endogenous and assumed to be partially financed by an increase in money supply. The government expenditure is regarded as the fiscal policy variable and is assumed to follow a stationary second order autoregression process. Following a rational expectations approach the model is solved for the inflation rate, which is a function of past inflation rates and the discounted values of current and expected future government expenditures.

[36] It is assumed that the money supply and budget deficit are endogenous but government expenditure is an exogenous variable.

[37] Annual data over the sample period of 1950-1980

[38] "…the deficits cause inflation in the 1950's and the 1970's but not in the 1960's. The quantitative effect of deficits on inflation is small in the 1970's but not in the 1950's" (Ahking and Miller, 1985)

[39] Quarterly data over the period of 1957-1991

monetarist determinants of inflation.[40] For each of these four models they used the results of Granger causality tests and the specific gravity criterion of Caines, Keng and Sethi (1987) to solve the identification problem. However, the results could not resolve the conflict between the monetarist view and recent developments on inflation rate determination. The monetarist model indicates that the money supply has a strong effect on the price level. However, the VAR results also indicate that government debt, the wage rate and energy prices Granger cause the inflation rate. The VAR analysis indicates that the public debt has a significant effect on the inflation rate through aggregate demand, even when monetization was not an issue.

The study by Cardoso (1992) on the economies of Brazil and Mexico indicates that fiscal policy is important for the stability of inflation in open economies. The empirical analysis of an open economy model showed that fiscal consolidation is very important for the success of disinflationary programs for economies with large fiscal debt.[41] Moreover, it indicated that the existence of a huge external debt is a leading factor of the inflationary impact of government debt.

The importance of the definition of the government debt for the effectiveness of fiscal policy is the central point in the study of Abizadeh and Yousefi (1998). They argued that the inconclusive results of empirical studies on the impact of the budget deficit on the inflation rate is due to the limited definition of public debt for closed economy models.[42] They analysed an open economy IS –LM model by VAR. The need to solve for multicollinearity between monetary and non monetary variables of inflation, led to a linear model of the domestic inflation rate (P_t) as a function of lagged real gross domestic product (Y_{t-1}), the real deficit (DF_t), the foreign rate of inflation (q_t) and the domestic money supply ($M1_t$):[43]

$$P_t = f\,[Y_{t-1}, DF_t, q_t, M1_t\,]$$

The OLS and ML estimation results showed that "…budget deficits have no significant bearing on the rate of inflation".[44]

Cochrane (1998b) criticizes this monetarist view and argues that the fiscal authority has a clear objective to minimize the volatility of inflation rate.

He argues that the composition of the government debt is crucial for the effect of surpluses on the price level and extends the one period debt version of the fiscal theory of price level to include long –term debt. Hence, the government debt is a function of nominal bond prices and so it is also a function of expected future price levels. His analysis shows that the fiscal authority is able to postpone inflation by choosing an appropriate debt structure. A fiscal authority following an optimal passive policy can smooth inflation with a long maturity debt structure rather than with a short maturity structure if the present value of the surplus is more volatile than

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[40] An increase in energy prices and wage rate are the cost-push factors of inflation. Such a policy increases the cost of production, leading to a lower level of output. The consequent decline in output will result with an increase in the price level. However, any change in the budget deficit is a demand-pull factor of inflation. An increase in budget deficit implies higher government spending and lower taxes creating a positive impact on demand.

[41] The definitions for inflation rate, interest rate, balance of payments and the domestic credit creation together with the assumption that the public debt is financed by domestic credit (without bond financing) and external borrowing (no private external borrowing), the inflation rate is defined as a function of money supply, the share of the primary budget deficit in output and the share of net exports in output.

[42] In open economy models, the government spending is financed by the tax revenue, the money and bond seignorage and the net transfer payments to other governments.

[43] The principal components method used to solve the problem of multicollinearity

[44] Annual data for U.S. over the sample period 1951-1986

the level of surplus.[45] Similarly, the fiscal authority following an optimal active policy will have the ability to exchange future inflation with a decrease in today's price level by devaluing long-term bonds unexpectedly.[46]

Cochrane (1998b) argues that the fiscal authority follows an optimal policy to smooth the inflation rate. The fiscal authority has control over the maturity structure and the level of debt and has partial control over the surplus. The surplus structure, s_t is a function of the cyclical portion –which the fiscal authority cannot control, and the controllable component. Given the equation for the price level,[47] the optimal fiscal policy is the one where the government chooses the maturity structure and the level of nominal debt sequence to minimize the inflation rate.

A comparison of the artificial time series generated by this optimal fiscal policy with the actual U.S. data shows some similarities. However, it is not a perfect match. Cochrane (1998b) argues that the reason is that the optimal fiscal model is too successful in reducing the variation of the inflation rate.

Cochrane (1998a) studies the history of the U.S. inflation rate from an FTPL view, using a structural VAR model of prices, debt and the surplus, which is modelled as a sum of a controllable (long run) component and a cyclical component.

The results of this analysis for the inflation rate are the same as those in the previous paper by Cochrane. The model fits nicely to the US data. Based on this finding Cochrane argues that, the government adjusts its budget to smooth the rate of inflation in case of a cyclical surplus shock. The government "…sells extra debt in recessions, raising revenue by so doing because it implicitly promises to raise subsequent surpluses" (Cochrane, 1998)

At another extreme, the study by Canzoneri, Cumby and Diba (1998) supports the monetarist view of the US inflation rate. They focus on the two opposite approaches to price level determination, –money or fiscal dominant regimes.[48] The basic assumptions of these regimes are important for the effect of monetary / fiscal policies on the price level.[49] Hence, in order to choose the monetary policy for price stability it is necessary to decide on the right nominal anchor for the economy: fiscal dominance (FD) or monetary dominance (MD). VAR methods are used to distinguish between MD and FD regimes, and to see which regime the country has been following. They argue that the basic difference between the monetarist view and the FTPL lies in the way they look at the government budget constraint. In their closed

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[45] Cochrane describes the optimal passive policy as the one in which "…the government determines only the steady state level of debt and its maturity structure, and the government does not adjust debt in response to surplus shocks"

[46] Cochrane describes the optimal active policy as the one in which the government "….changes the amount and maturity structure in response to surplus shocks"

[47] Cochrane argues that the sequence of prices are a solution to the present value identity (except the case of no new debt) for a given sequences of debt and surplus. The present value identity is the equality of the real value of outstanding debt to the present value of net surpluses;

$$B_{t-1}/p_t + \sum_{j=1}^{\infty} \beta^j E_t (1/p_{t+j}) B_{t-1}(t+j) = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}$$

Iterating this identity forward with geometric weights together with the equation of surplus leads to the price equation (*)

[48] Fiscal dominant regime is defined as the one in which the price level is determined independently of the monetary aggregates, by the solvency of the government budget constraint. In contrast, in the money dominant regime the price level is determined by the supply and demand of money.

[49] Applying a money supply rule would cause an over determined price level in case of FD regime. However, an interest rate targeting rule results with an undetermined price level in case of an MD regime

economy model, the primary deficit is financed by bond or money seignorage. After scaling the variables of the customary government budget constraint by GDP, the model can be represented as:

$$w_j = s_j + \alpha_j w_{j+1}$$

where, the ratio of liabilities to GDP, w_j, is equal to ratio of the surplus to the GDP, s_j, plus the discounted value, α_j, of the ratio of next period's liabilities. Under MD and FD there is a positive correlation between s_j and w_j. However, the relation between s_j and w_{j+1} distinguishes between FD and MD. Under the assumption that the debt is following a backward looking process, monetarist theory predicts a fall in w_{j+1} in case of an increase in surplus. In contrast, in the fiscal regime a positive innovation in s_j can have a zero, positive or negative effect on w_{j+1}, depending upon whether s_j has a zero positive or negative correlation with future surpluses and discount factors. For the empirical tests, the authors look at the impulse responses and the forecast variances for the effect of the ratio of current surplus/GDP on the ratio of next period liabilities/GDP. The results indicate that the surplus is not exogenous but is affected by the current level of liabilities and although the current surplus/GDP ratio is not negatively correlated with future surpluses, the liabilities/GDP has negative reaction to a positive shock in surplus/GDP[50]. Hence, it is concluded that, "the post war US data strongly favours the MD regime over the FD regime".[51]

Erdogdu (2001) also supports the money dominant regime for U.S. However, using the same approach as Canzoneri, Cumby and Diba (1998), Tanner and Ramos (2002) conclude that Brazil follows a fiscal dominant regime.

Tanner and Ramos (2002) first define the government budget constraint as primary budget deficit (PDEF) being a function of real liabilities (LIAB): $PDEF_t = \kappa + \beta LIAB_{t-1}$.[52] The problem with this backward looking approach (today's primary deficit is a function of yesterday's liabilities) is that in some cases, it cannot distinguish between a monetary dominant (ex –post adjustments of primary deficits to liabilities) and a fiscal dominant (ex –ante adjustments of liabilities to primary deficits) regime. Therefore, besides this one equation approach, they adopt a forward –looking approach and estimate a VAR system composed of two variables, primary deficits (first differences) and real liabilities (first differences). This model is again based on the definition of the intertemporal government budget constraint, that is "today's operational deficit is equal to the sum of discounted changes in the primary deficit" (Tanner and Ramos, 2002).

The estimates of Tanner and Ramos (2002) for these models using monthly data for the period 1991 –2000 concluded that Brazil follow a monetary dominant regime only for the period 1995 –1997 and this period became a fiscal dominant regime afterwards.

V. Conclusion:

In order to solve a problem, the first step is to determine the factors that caused it. Since, inflation is one thing the economists agree on that it has to be under control, the

[50] Cochrane (1998b) criticises this argument and argues that the negative effect of higher surpluses on the real debt is not a monetary outcome but the result of a conscious decision by the fiscal policy.

[51] The VAR result indicated that the surplus is not exogenous but affected by the current level of the liabilities and although the current surplus/GDP ratio is not negatively correlated with future surpluses, the liabilities/GDP has negative reaction to a positive shock in surplus/GDP.

[52] Tanner and Ramos (2002) discusses different scenarios for different values of κ, β

recent literature asks the question "who is responsible for inflation rate" one more time.

In theoretical level understanding the fiscal theory of price level is crucial for countries with high, chronic inflation rate, since the theory questions the power of the monetary authority and moreover, arises the question "is an independent central bank enough for price stability?"[53]. Therefore, it is not just an academic curiosity to search for non –Ricardian environments, but it is practically important for countries with high, chronic inflation rate to check for fiscal dominance.

[53] Ercan Uygur (2001) asks this question for Turkey.

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APPENDIX. Price Level Determination

Appendix solves the model given in Part Two for the cases of

1. Unpleasant Monetarist Arithmetic: Ricardian policy; active fiscal and passive monetary policy
2. Fiscal Theory of Price Level: Non Ricardian policy; active fiscal and active monetary policy

and analyses the long run effect of a fiscal shock on price level in each of these cases.

In case of an active fiscal policy the fiscal authority will set his policy variables $\{g_t\}$, $\{tx_t\}$ and $\{b_t\}$ independent of the solvency of the government budget constraint. I will assume that they are set as constants. Assuming a constant output level, it follows that the consumption level must also be constant. So, the first order conditions of the household optimisation problem imply:

$$\frac{1}{R_t} = \beta \frac{p_t}{p_{t+1}} \tag{5'}$$

$$m_t = c\left(\frac{R_t}{R_t - 1}\right) \tag{6}$$

where c is the constant consumption level.

Note that under the aggregate resource constraint, equation (9), the household and government budget constraints are represented by the same equation:

$p_t(g_t - tx_t) = M_t - M_{t-1} + B_t - (R_{t-1})\, B_{t-1}$

Unpleasant Monetarist Arithmetic:

Under a Ricardian environment, an active fiscal policy leaves the monetary authority with the burden of the solvency of the government budget constraint. Hence, the monetary policy is driven by the fiscal policy variables.

For a constant level of primary surpluses, $D = (g - tx_t)$ and constant real valued government debt, b, the government's flow budget constraint is[54]:

$$D = m_t - m_{t-1}\left(\frac{p_{t-1}}{p_t}\right) + b - R_{t-1}\left(\frac{p_{t-1}}{p_t}\right) b \tag{8'}$$

Given fiscal policy and the demand conditions –equation (5) and (6), equation (8') becomes a function of R, D and b.

$$D = c\left(\frac{R_t}{R_t - 1}\right) - c\left(\frac{R_{t-1}}{R_{t-1} - 1}\right)\left(\frac{1}{\beta R_{t-1}}\right) + b\left(1 - R_{t-1}\left(\frac{1}{\beta R_{t-1}}\right)\right) \tag{8''}$$

Equation (8'') is solved for the path of the monetary policy variable, the interest rate, as a function of D and b:

$$R_t = 1 + \frac{R_{t-1} - 1}{(R_{t-1} - 1)\left(\frac{D}{c} - \frac{b}{c}\left(1 - \frac{1}{\beta}\right) - 1\right) + \frac{1}{\beta}} \tag{12}$$

Then the rate of inflation, $\pi_t = \frac{p_t}{p_{t-1}}$ follows from (5) and (15):

[54] Under the aggregate resource constraint: $y_t = c_t + g_t$ the household and government budget constraints are same.

$$\pi_t = \beta + \frac{\beta(R_{t-2}-1)}{(R_{t-2}-1)\left(\frac{D}{c}-\frac{b}{c}\left(1-\frac{1}{\beta}\right)-1\right)+\frac{1}{\beta}} \tag{13}$$

Suppose, $\phi = \frac{D-b(1-\alpha)-c}{c}$ and $\alpha = \frac{1}{\beta}$. Thus, $R_t = 1 + \frac{R_{t-1}-1}{(R_{t-1}-1)\phi+\alpha}$

The steady state interest rates must, from (12), solve:

$(R\phi-\phi+\alpha)(R-1) = (R-1)$

There are two steady state values of interest rate:

$R_1 = 1$ and $R_2 = \frac{1+\phi-\alpha}{\phi}$

To check for the stability of the steady state, $\frac{dR_t}{dR_{t-1}} = \frac{\alpha}{(\phi R_{t-1}+\alpha-\phi)^2} > 0$

$\left.\frac{dR_t}{dR_{t-1}}\right|_{R=R_1} = \frac{1}{\alpha} = \beta < 1$ and $\left.\frac{dR_t}{dR_{t-1}}\right|_{R=R_2} = \alpha = \frac{1}{\beta} > 1$

Hence, $R_1 = 1$ is a stable and R_2 is an unstable equilibrium.

Fiscal Theory of the Price Level

As opposed to unpleasant monetarist argument the fiscal theory of the price level argues that the price level is determined by the fiscal policy, even if the monetary authority follows an active policy.

In a non –Ricardian environment, an active fiscal policy requires that the households will hold government bonds. However, if households know that the government will roll over its debt without ever retiring it, they will not demand any bonds. The condition to prevent zero demand is for the households to know that the government will finance its future debt with future surplus. Therefore, in order to prevent ponzi games the transversality condition has to hold. Therefore, the FTPL works with the intertemporal government budget constraint.

The central bank sets the rate of interest such that:

$$R_t = \frac{1}{\beta}\frac{p_{t+1}}{p_t} \tag{5'}$$

The money supply is:

$$\frac{M_t}{p_t} = c\left(\frac{p_{t+1}}{p_{t+1}-\beta p_t}\right) \tag{6'}$$

Recall that the government budget constraint together with the transversality condition derives the intertemporal budget constraint:

$$\frac{p_{t-1}}{p_t}\left(\frac{M_{t-1}}{p_{t-1}}+(R_{t-1})b\right) = \sum_{j=0}^{\infty}\left(\prod_{s=t}^{t+j-1}\frac{1}{R_s}\frac{p_{s+1}}{p_s}\right)\left(\frac{R_{t+j}-1}{R_{t+j}}\frac{M_{t+j}}{p_{t+j}}-D_{t+j}\right) \tag{14}$$

Let $\Omega = \frac{p_{t-1}}{p_t}\left(\frac{M_{t-1}}{p_{t-1}}+R_{t-1}b\right)$, $\Gamma = \prod_{s=t}^{t-1}\frac{1}{R_s}\frac{p_{s+1}}{p_s}\left(\frac{R_t-1}{R_t}\frac{M_t}{p_t}-D_t\right)$ and

$\Psi = \sum_{j=1}^{\infty}\left(\prod_{s=t}^{t+j-1}\frac{1}{R_s}\frac{p_{s+1}}{p_s}\right)\left(\frac{R_{t+j}-1}{R_{t+j}}\frac{M_{t+j}}{p_{t+j}}-D_{t+j}\right)$. Thus, equation (14) is: $\Omega = \Gamma + \Psi$

Given the fiscal policy $D_t = D_{t+1} = D$ and equations (5') and (6');

$$\Omega = \frac{cp_t}{p_t - \beta p_{t-1}} + \frac{b}{\beta},\ \Gamma = c - D \text{ and } \Psi = \sum_{j=1}^{\infty} \beta^{j}(c - D) \tag{15}$$

Thus equation (14) reduces to:

$$\frac{cp_t}{p_t - \beta p_{t-1}} + \frac{b}{\beta} = c - D + \sum_{j=1}^{\infty} \beta^{j}(c - D)$$

The price level evolves according to:

$$p_t = p_{t-1}\left(\frac{\sum_{j=0}^{\infty} \beta^{j+1}(c - D) - b}{\sum_{j=0}^{\infty} \beta^{j}(c - D) - \frac{b}{\beta} - c} \right) \tag{16}$$

and the rate of inflation is:

$$\pi_t = \left(\frac{-b + (c - D)\sum_{j=0}^{\infty} \beta^{j+1}}{-\frac{b}{\beta} - c + (c - D)\sum_{j=0}^{\infty} \beta^{j}} \right) \tag{17}$$

Therefore, a positive fiscal shock (decrease in taxes) increases inflation rate:

$$\frac{d\pi}{dD} = \frac{c\sum_{j=0}^{\infty} \beta^{j+1}}{\left(-\frac{b}{\beta} - c + (c - D)\sum_{j=0}^{\infty} \beta^{j} \right)^2}$$