A Central Bank Theory of Price Level Determination

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Motivation

- A widely accepted view is that central bank's mandate should be explicit in terms of price (or inflation) stability.
- Can the central bank really control the price level? And how?
- Literature on the **fiscal theory of price level** has concluded that "fiscal policy can be a determinant, or even the sole determinant, of the price level" (Sims, 2013):
  - **Deflationary spirals** and liquidity traps can be ruled out by the threat of a fiscal stimulus;
  - **Inflationary spirals** can be trimmed through the use of a fiscal anchor.

$\Rightarrow$ Architecture of European Monetary Union is built on precarious foundations lacking a fiscal authority behind the ECB and with too many fiscal authorities constrained by budget rules.

Contribution

- This work challenges the above results and proposes a complementary view showing that the central bank can control the price level by relying only on its means and an appropriate remittances' policy.

- By undertaking **risky** open-market operations, central bank may give up its financial independence and leave the economy exposed to self-fulfilling inflationary spirals or chronic liquidity traps.

The Problem of Price Level Determination

Consider a simple endowment monetary economy in a perfect foresight equilibrium.

- Euler equation implies:

$$1 + i_t = \frac{1}{\beta}\frac{P_{t+1}}{P_t}.$$

- Interest rate rule:

$$1 + i_t = \max\left\{\frac{1}{\beta}\left(\frac{P_t}{P^*}\right)^{\phi}, 1\right\}$$

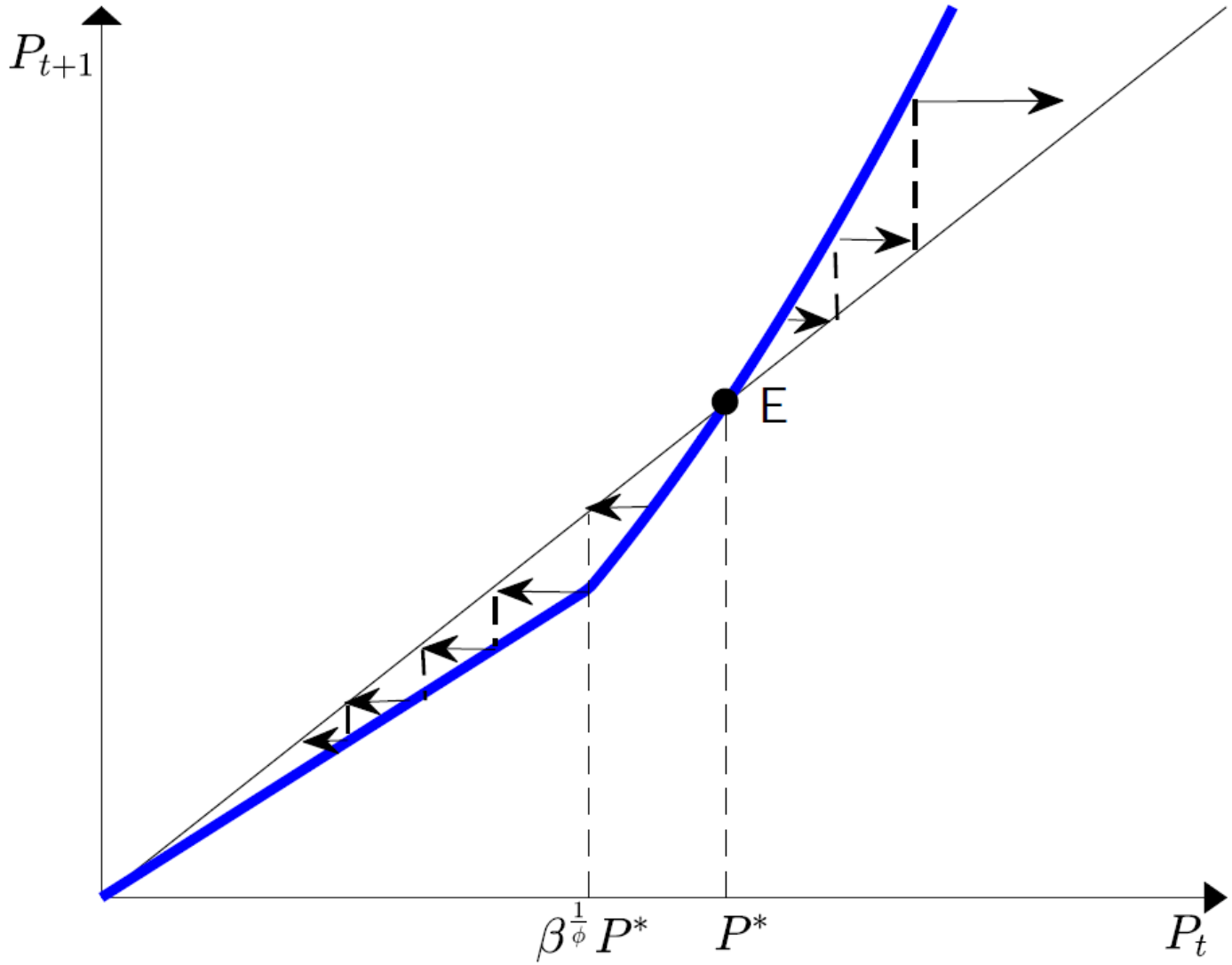
  with $\phi \geq 0$.

- Combine them:

$$\frac{P_{t+1}}{P_t} = \max\left\{\left(\frac{P_t}{P^*}\right)^{\phi}, \beta\right\}$$

  $\Rightarrow$ Non-linear difference equation with multiple solutions.

Multiple solutions



Determinacy

Key point: to get determinacy should consider other equilibrium conditions.

- Exhaustion of intertemporal budget constraint of the consumer

$$\sum_{t=t_0}^{\infty} \beta^{t-t_0} c_t = \sum_{t=t_0}^{\infty} \beta^{t-t_0} (y - \tau_t),$$

- or transversality condition

$$\lim_{t\to\infty} \left\{ \beta^{t-t_0} \frac{B_t}{P_t(1+i_t)} \right\} = 0,$$

- or

$$\sum_{t=t_0}^{\infty} \beta^{t-t_0} \tau_t = 0.$$

Prices sequences that solve the non-linear difference equation can be ruled out as equilibria if they imply violations of one of the above conditions $\Rightarrow$ it depends on the specification of $\{\tau_t\}_{t=t_0}^{\infty}$.

Three ways to achieve determinacy

Treasury's flow budget constraint:

$$\frac{B_t^F}{1+i_t} = B_{t-1}^F - T_t^F - T_t^C.$$

Central bank's flow budget constraint:

$$\frac{B_t^C - X_t^C}{1+i_t} = B_{t-1}^C - X_{t-1}^C - \tilde{T}_t^C - T_t^C.$$

Three cases:

1. FTPL consolidates the two budget constraints, sets $\tilde{T}_t^C = 0$ and specifies an appropriate path for real taxes, T_t^F/P_t;
2. Our theory maintains separation of budget constraints and specifies either T_t^C/P_t (with $\tilde{T}_t^C = 0$) in the case of government money or
3. $\tilde{T}_t^C/P_t$ (with $T_t^C = 0$) in the case of private money.

Kaldor-Woodford theory of money that "rules the roost"

- Monetary economy characterized by a currency, let's say dollars, that serves as a "unit of account" and "store of value."
- A "unit of account" is
  1. the *numeraire*, unit of measure to value goods and securities;
  2. **the liability** of an agent (and only of one agent) in the economy (central bank).

Implications:

- Price of one unit of central bank's liability is just one dollar, because that liability exactly defines what a dollar is.
- A dollar claim at the central bank is **risk-free regardless** of the resources that the central bank has in its balance sheet.
- Central bank can set independently quantity of reserves and the interest rate paid. Interest rate on reserves (by an arbitrage argument) determines any other short-term risk-less rate in the economy.
- Any other agent in the economy can issue claims **denominated** in the "unit of account", but do not define the "unit of account"$\Rightarrow$ their debt is **risk-free provided** they are solvent.

Fiscal Theory of the Price Level

Set the following tax policy:

1. a real deficit at time t_0: $\tau_{t_0} = \tau^*_{t_0} < 0$ and
2. a path of future real primary surpluses $\{\tau_t\}_{t=t_0+1}^{\infty}$ with $\tau_t = \tau^*_t$ and

$$\sum_{t=t_0+1}^{\infty} \beta^{t-t_0-1} \tau^*_t = \frac{B^G_{t_0}}{P^*}.$$

Consider that the intertemporal budget constraint at time $t_0 + 1$ requires

$$\sum_{t=t_0+1}^{\infty} \beta^{t-t_0-1} \tau_t = \frac{B^G_{t_0}}{P_{t_0+1}}$$

It follows that:

$$\left(\frac{B^G_{t_0}}{P^*} - \frac{B^G_{t_0}}{P_{t_0+1}} \right) = 0,$$

$\Rightarrow P_t = P^*$ forever.

Credibility of the commitment

- **Uniqueness** of equilibrium depends on the beliefs of the consumer on the path followed by fiscal policy even off equilibrium.
- On a deflationary path ($P_{t_0+1} < P^*$):

$$\sum_{t=t_0+1}^{\infty} \beta^{t-t_0-1} \tau_t^* = \frac{B_{t_0}^G}{P^*} < \frac{B_{t_0}^G}{P_{t_0+1}}.$$

or

$$\lim_{T \to \infty} \left\{ \beta^T \frac{B_T^G}{P_T(1+i_T)} \right\} > 0$$

- Path of primary surplus is lower than what required to pay back the outstanding obligations.
- Wealth effect on consumers creates excess demand of goods which pushes up prices.
- Need a fiscal stimulus to reflate the economy, but a commitment to have less resources than needed can only be backed by an increase in Central Bank's liabilities because of their riskless properties !

Credibility of the commitment

- On an inflationary path ($P_{t_0+1} > P^*$):

$$\sum_{t=t_0+1}^{\infty} \beta^{t-t_0-1} \tau_t^* = \frac{B_{t_0}^G}{P^*} > \frac{B_{t_0}^G}{P_{t_0+1}},$$

- Path of primary surpluses should exceed the amount of outstanding real obligations. Is it credible?
  1. Treasury may have incentive to cut primary surpluses $\Longrightarrow$ inflationary path develops;
  2. Treasury could backstop inflation at a price $P_{t_0+1} > P^* \Longrightarrow$ needs coordination with monetary authority if the latter follows an active interest rate rule;
  3. Treasury may really fulfill its commitment $\Longrightarrow$ inflationary path is ruled out.
- **Prescription**: to rule out inflationary spirals have a fiscal anchor that ties the price level at the target.

Central Bank Theory of the Price Level

- Central bank can control the price level by relying only on its means.
- There is no need to have a fiscal stimulus nor a fiscal anchor, nor any coordination with Treasury.
- How is it possible?
  1. Use power of central bank's liabilities that can be increased at will and be risk free in the unit of account;
  2. Even if solvency is not an issue for central-bank liabilities, solvency, balance sheet, remittances policy matter to determine the value of the liabilities in terms of goods–the price level.
- Role of Treasury: not different from any other debtor in the economy that should be solvent or, otherwise, default on debt. Assume that Treasury's debt is always zero in what follows.

Key ingredients

Consider central bank's flow budget constraint

$$\frac{B_t^C - X_t^C}{1+i_t} = B_{t-1}^C - X_{t-1}^C - T_t^C,$$

with $B_{t_0-1}^C = X_{t_0-1}^C = 0$.

1. Central bank issues interest-bearing reserves, X_t^C, to invest in riskless securities, B_t^C;
2. ...receives initial injection of real capital $n_{t_0}^C$

$$-\frac{T_{t_0}^C}{P_{t_0}} = \tau_{t_0} = n_{t_0}^C;$$

3. ...remits nominal profits to the treasury after period t_0

$$T_t^C = \Psi_t^C = \frac{i_{t-1}}{1+i_{t-1}}(B_{t-1}^C - X_{t-1}^C);$$

Implications

Implications of above conditions:

1. Central bank's nominal net worth is constant over time and positive

$$N_t = N_{t-1} + \Psi_t^C - T_t^C = N_{t-1} = ... = P_{t_0} n_{t_0}^C > 0.$$

2. Central bank's profits are non-negative and therefore central bank is **financially independent** from treasury

$$\Psi_t^C = \frac{i_{t-1}}{1 + i_{t-1}} (B_{t-1}^C - X_{t-1}^C) = i_{t-1} N_{t-1} = i_{t-1} P_{t_0} n_{t_0}^C \geq 0,$$

with taxes on households given by

$$\tau_t = -\frac{T_t^C}{P_t} = -i_{t-1} P_{t_0} n_{t_0}^C,$$

for each $t > t_0$.

Ruling out deflationary spirals

- Assume $P_{t_0} \leq \beta^{\frac{1}{\phi}} P^*$ and therefore economy is in a liquidity trap: i.e. $i_t = 0$ for each $t \geq t_0$, then following path of taxes is implied by remittances' rule:

$$\tau_{t_0} = -\frac{T^C_{t_0}}{P_{t_0}} = n^C_{t_0},$$

$$\tau_t = -\frac{T^C_t}{P_t} = 0 \text{ for each } t > t_0,$$

$$\Longrightarrow \sum_{t=t_0}^{\infty} \beta^{t-t_0} \tau_t > 0$$

- Or, consider demand of goods at time t_0

$$c_{t_0} = y - (1-\beta) \sum_{t=t_0}^{\infty} \beta^{t-t_0} \tau_t = y - (1-\beta) n^C_{t_0} < y,$$

- Demand of goods is below supply $\Rightarrow$ prices with $P_{t_0} \leq \beta^{\frac{1}{\phi}} P^*$ do not clear the market.

Credibility of commitment

- Deflationary equilibrium cannot form because the central bank is holding real resources that are needed for goods market to clear, consumption is below output $\Rightarrow$ Central bank's net worth should be **expropriated**.
- Credibility depends on the **financial independence** of central bank. Central bank should not be subject to raids on its capital or be questioned for its remittances policy.
- Critical role of all assumptions: initial capitalization, investment in risk-less securities, policy easing until zero-lower bound.
- **Prescription** to rule out deflations: set up a financially-independent central bank with initial level of real capital and restrict asset holdings to riskless securities.

Ruling out inflationary spirals

- Maintain all previous assumptions.
- Addition: use remittances $T_t^C = \Psi_t^C$ for each $t_0 < t < \tilde{t}$ but then threaten to switch to a real remittances' policy after and including time $\tilde{t}$

$$\frac{T_t^C}{P_t} = \frac{1-\beta}{\beta}\frac{P_{t_0}}{P^*} n_{t_0}^C.$$

- Consider value of central bank at time $\tilde{t}-1$

$$\frac{N_{\tilde{t}-1}^C}{P_{\tilde{t}-1}} = \sum_{T=\tilde{t}}^{\infty} \beta^{T+1-\tilde{t}} \frac{T_T^C}{P_T}.$$

and substitute the path of real remittances for each $t \geq \tilde{t}$ to obtain

$$\frac{P_{t_0}}{P_{\tilde{t}-1}} n_{t_0}^C = \frac{P_{t_0}}{P^*} n_{t_0}^C.$$

- The above equation determines $P_{\tilde{t}-1} = P^*$ if and only if $n_{t_0}^C \neq 0$ and therefore $P_t = P^*$ forever.

Credibility of commitment

- The central bank is committed to transferring resources by an amount that exceeds the real value of its net worth:

$$\sum_{T=\tilde{t}}^{\infty} \beta^{T-\tilde{t}+1} \frac{T_T^C}{P_T} = \frac{N_{\tilde{t}-1}^C}{P^*} > \frac{N_{\tilde{t}-1}^C}{P_{\tilde{t}-1}}.$$

- Question 1: Can the central bank at time $\tilde{t}$ generate these resources?
  - Yes, can issue an increasing amount of reserves growing at a rate equal or higher than $1/\beta$.
- Question 2: Suppose that at time $\tilde{t}-1$ the price level is $P_{\tilde{t}-1} > P^*$, is it really credible to expect that the central bank follows its threat or instead will backstop prices at $P_{\tilde{t}-1}$?
  - If commitment to an active interest rate rule ($\phi > 0$) is credible $\Rightarrow$ price level at time $\tilde{t}-1$ is either P^* or infinity. But, in the latter case (a barter economy) society will completely waste the initial real resources.
    $\Rightarrow$ real capitalization, commitment to an active interest rate rule and other elements discussed above can anchor the price level to P^*.

Unconventional Operations: The Case of Treasury Support

- If central bank undertakes **risky** operations, it can experience income losses.
- Under the remittances rule $T_t^C = \Psi_t^C$ everything goes through but...
- ...if there are income losses, the treasury is supporting the central bank which then loses **financial independence**

  $\Rightarrow$ in a deflation, the treasury may feel authorized to exercise taxation power or raids on central bank.

  $\Rightarrow$ Deflations can be equilibria.

Unconventional Operations: The case of no Treasury support

- Central bank maintains financial independence (like under the Fed's deferred-asset regime) but:
  - cannot defeat inflationary spirals since its equity can be wiped out and an inflationary spiral becomes self fulfilling;
  - if there are credit losses large enough to wipe out central bank's net worth, a liquidity trap or deflationary spirals can also be equilibria.

Conclusion

- Propose a complementary theory of price determination with respect to the fiscal theory of the price level.
- Central bank can control the price level without help of the treasury or coordination!
- All ingredients discussed are not far from how modern central bank are conceived.
- Architecture of EMU may not be inconsistent with full control of price level by ECB nor monetary economies where currency is privately issued.