Lecture II:
Fiscal and Monetary Theories of Inflation
Two Polar Regimes

- **“Ricardian” Regime**: Fiscal policy adjusts to ensure government’s solvency (IBC). Monetary policy sets interest rates and/or money supply consistent with inflation objective.

- **Non-Ricardian Regime**: Fiscal policy sets \( g \) and \( \tau \) inconsistently with IBC. The price level adjusts so as to ensure that IBC holds.

  \( \rightarrow \) case of **fiscal dominance**: monetary policy typically can only choose between inflation now vs. inflation later.
Fiscal-Monetary Policy Links

Basic government accounting with central bank

Take Eq. (1.16) and add central bank “receipts” (RBC):

\[
B_t^T + G_t^P - T_t = R_{t+1}^{-1} B_{t+1}^T + RBC_t
\]

\[
. : G_t^P = R_{t+1}^{-1} B_{t+1}^T - B_t^T + T_t + RBC_t
\]

Central bank transfer to Treasury

Where the subscript “T” accounts for total government bonds.
Fiscal-Monetary Policy Links

Central Bank Accounting:

Typical Central Bank Balance Sheet

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<tr>
<th>Assets</th>
<th>Liabilities</th>
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<tr>
<td>International Reserves (&quot;NFA&quot;)</td>
<td>High Powered Money (&quot;H&quot; or &quot;M&quot;)</td>
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<tr>
<td>Net Domestic Assets (&quot;NDA&quot;)</td>
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\[ \frac{R_{t+1}^{M} B_{t+1}^{M} - B_{t}^{M}}{p_{t}} + RBC_{t} = \frac{(M_{t+1} - M_{t})}{p_{t}} \]  

(1.24)

Change in Government bond holdings in the hands of the central bank (central bank financing of Treasury)

Central bank finances its spending with issuance of high powered money

Divide by \( p \) only if everything is expressed in real terms
Fiscal-Monetary Policy Links

Government bond holdings in the hands of households is of course total government bond issuance less the stock of government bonds sitting in the central bank balance sheet (under the item “NDA”). Hence:

\[ B = B^T - B^M \]

Solving (I.24) for RBC, plugging into (I.23) and using the above, we end up with the consolidated budget for the government (i.e. Treasury + Central Bank):

\[ B_t + G_t^P - T_t = R_{t+1}^{-1} B_{t+1} + (M_{t+1} - M_t) / p_t \]  \hspace{1cm} (I.25)

\[ . \cdot : G_t^P - T_t = R_{t+1}^{-1} B_{t+1} - B_t + (M_{t+1} - M_t) / p_t \]
Eq. (1.25) says that the consolidated government’s primary deficit can now be financed with either net bond issuance (i.e. discounted of interest payments) to the households plus money issuance – the so-called “seigniorage” financing.

- Clearly, bond financing can be expensive: the government has to pay interest rate $r$ on its bond issuance.

- And we have seen in Figure 4, that $r$ can be high!
Fiscal-Monetary Policy Links

- But this doesn't mean (as we will see more shortly) that seignorage financing is not costly!

- To start examining this, re-write (I.25) as:

\[
G_t^P - T_t = R_{t+1}^{-1}B_{t+1} - B_t + \frac{p_{t+1}}{p_t} \frac{M_{t+1}}{p_{t+1}} - \frac{M_t}{p_t}
\]

\[
= R_{t+1}^{-1}B_{t+1} - B_t + R_{t+1}^{m^{-1}} \frac{M_{t+1}}{p_{t+1}} - \frac{M_t}{p_t}
\]

Real return on money balances \( R_{t+1}^m = \frac{p_t}{p_{t+1}} \)

Real money balance
Prima-facie, even without taking into account other (allocative) costs of price instability, the above eq. shows that money financing can be costly.

E.g. if there is deflation (i.e. \( p_t > p_{t+1} \)), \( R_{t+1}^m = \frac{p_t}{p_{t+1}} \) the rate of return paid on money can be high.

So, money financing is not so trivially on a purely accounting basis!
This raises the fundamental question of why people hold money.

And another, no less tricky question, of what is “money”.

In this lecture, we shall confine ourselves to the former question.

Under complete markets, fiat money can only be a store of value that, in the limit (i.e. $T \to \infty$, imposing the transversality condition), is valueless.
So, motivating money holdings would require some “friction”.

Here we will review a model in which holding money saves transactions costs – “shopping time”

The model follows L-S, chapter 24.

This basic set-up will be used to discuss various fiscal-monetary models of inflation.
Utility:

\[
\sum_{t=0}^{\infty} \beta^t u(c_t, l_t)
\]

Constraints:

\[
c_t + \frac{b_{t+1}}{R_t} + \frac{m_{t+1}}{p_t} = y_t - \tau_t + b_t + \frac{m_t}{p_t} \]

\[
1 = l_t + \delta_t
\]

where \( \delta \) is shopping time ("s" in L-S but we use little delta to avoid using "s" which we used before for fiscal surplus).

As before: endowment economy with no uncertainty.
So, we can now set up the Lagrangian and solve it:

\[
\delta_t = 1 - l_t = H \left( c_t, \frac{m_{t+1}}{p_t} \right) = \frac{c_t}{m_{t+1} / p_t} \varepsilon_t
\]
Money, Deficits and Inflation in General Equilibrium

FOC with respect to \( c_t, l_t, b_{t+1}, m_{t+1} \) yield:

\[
R_t = \frac{1}{\beta} \frac{u_c(t) - u_l(t)H_c(t)}{u_c(t + 1) - u_l(t + 1)H_c(t + 1)} \tag{1.26}
\]

\[
\frac{R_t - R_{mt}}{R_t} \lambda_t = -\mu_t H_{m/p}(t) \tag{1.27}
\]

\[
\frac{R_t - R_{mt}}{R_t} \left[ \frac{u_c(t)}{u_l(t)} - H_c(t) \right] + H_{m/p}(t) = 0 \tag{1.28}
\]

(Homework: Provide the intuition for all these expressions)
Applying the implicit function theorem to the above yields:

\[
\frac{m_{t+1}}{p_t} = F(c_t, R_{m_t} / R_t)
\]

Recalling that \( R_{m_t} = \frac{p_{t-1}}{p_t} \) and \( R_t = \frac{(1+i_t)}{p_t / p_{t-1}} \), it thus follows that:

\[
\frac{m_{t+1}}{p_t} = F(c_t, R_{m_t} / R_t) = F(c_t, i_t)
\]  \hspace{1cm} (1.29)

where \( F_c > 0, F_i < 0 \).

Thus this micro founded model delivers the familiar money demand (“LM” curve) function.
As we did in the discussion of the Ricardian equivalence in our first lecture, now introduce the government. Recall the budget constraint in (I.25):

$$G_t^P = T_t + R_{t+1}^{-1}B_{t+1} - B_t + (M_{t+1} - M_t) / p_t$$

Where $M$ is money supply. Equating $M$ to money demand $m$ in (I.26) and assuming exogenous sequences for government spending and taxation, and initial asset holdings, we can solve the model.
Let’s characterize the stationary equilibrium of this economy.

- Let \( \{G_t = g_t^P, T_t = \tau_t, B\} \) be set by the government, \( \{B_0, M_0\} \) inherited from the past (all small caps denote equilibria).

- Let the resource constraint be \( c_t + g_t = y_t \); and let \( R\beta = 1 \).

- The equilibrium is given by a price system so that for \( \{c_t, M_t, B_t\}^\infty_{t=1} \), the household optimal problem and the government budget constraint are satisfied.

- Equilibrium \( R_m \) (1-inflation rate) and \( p_0 \) are then pinned-down.
We seek an equilibrium for which \( X_t = X \), where \( X \) is any of exogenous or endogenous variables in equilibrium.

As shown in L-S (eq. 24.2.22), this equilibrium delivers the following expression linking the fiscal position and the rate of inflation, \( p_{t+1}/p_t \) in stationary equilibrium:

\[
g_t^P - \tau_t + B_t \frac{(R - 1)}{R} = f(R_m)(1 - R_m)
\]  

(1.30)

Overall Government Deficit  Seignorage financing
Money, Deficits and Inflation in General Equilibrium

- Note that $f(R_m) = \frac{m_{t+1}}{p_t}$ and that $1 - R_m = \frac{p_{t+1} - p_t}{p_{t+1}}$.

- We can thus decompose total seignorage financing as the product of the inflation tax base component and the inflation rate component.

- Important: note from above that the inflation tax base is dependent on the inflation rate: rising inflation lowers money demand $m_{t+1}$!

- Hence, there is potential for multiple equilibria!
Illustration of the relationship between deficit and inflation, the *seignorage Laffer curve* (L-S, 24.2.7):

i) Put functional forms in $u$ and $H$ to compute $f(Rm) = F(c, Rm/R)$
ii) Set $\beta$ to pin-down $R = 1/\beta$.
iii) Set $c$ to pin down $l = 1 - c$.
iv) Set coefficient of risk aversion $\sigma$ and the (inverse of) the leisure elasticity coefficient ($\alpha$).
v) Then plot $Rm = 1$-(gross)inflation rate against the deficit.

Homework: do it for various $\sigma$. Then, fix $\sigma = 2$ and change $\beta = 0.9$
Using this model’s stationary equilibrium solution we can now

- Effects of an increase in Mo

To see this, consider the solution at t=0:

\[ \frac{M_0}{P_0} = f(R_m) - (g^p - \tau_0 + B_0) + B / R \]

where \( f(R_m) = \frac{m_{t+1}}{p_t} \)
Using this model’s stationary equilibrium solution we can now study the effect of various policy experiments.

- **Effects of an increase in Mo, all else constant**

To see this, consider the solution at $t=0$:

$$\frac{M_0}{p_0} = f(R_m) - (g_t^p - \tau_t + B_0 \frac{(R-1)}{R}) \quad (1.31)$$

where $f(R_m) = m_{t+1} / p_t$
Money, Deficits and Inflation in General Equilibrium

Since \((g_t^P - \tau_t + B_0 \frac{(R - 1)}{R})\) will not change, from (I.30) it must also be that \(R_m\) will not change.

Hence, \(\frac{M_o}{P_o}\) will not change \(\rightarrow \Delta M_o = \Delta P_o\).

So, there is concomitant jump in the price level as \(M\) increases.
Using this model’s stationary equilibrium solution we can now study the effect of various policy experiments

- Effects of a persistent fiscal deficit

From (1.30) and the seignorage Laffer curve, it is clear that a permanent increase in the fiscal deficit will increase \((1 - R_m)\), i.e. the steady-state inflation rate, \textit{if one is on the right side of the Laffer curve}.  

However, there may be an equilibrium that the tax base increases, so the bigger deficit is financed with higher M/P.
Fiscal Requirement for Price Stability

Setting $1 - R_m = 0$ in (1.30), clearly requires the overall (not the primary!) fiscal deficit to be zero.

With $R$ given, this of course has implications for the required primary deficit too:

$$g_t^p - \tau_t + B_t \frac{(R - 1)}{R} = 0$$

$$\therefore (\tau - g) = \frac{R - 1}{R} B = \frac{r}{(1 + r)} B$$
Money, Deficits and Inflation in General Equilibrium

- Limits to what Monetary Policy Can Do ("Unpleasant Monetarist Arithmetics")

Suppose that $g_t^p - \tau_t$ rises. Then from (I.30) permanent inflation $1 - R_m$ will rise.

The central bank then tries to mitigate the impact on Po, engaging into open market operations: buy high-powered money (reducing $M$ in $t=1$) and selling bonds (increasing $B$).

\[
\frac{M_0}{P_0} = \frac{M_1}{P_0} - (g^p - \tau_0 + B_0) + \frac{B}{R}
\]

Effect is ambiguous: at best lower po but higher B (due to interest payments on debt) increases 1-Rm
Optimum Quantity of Money ("Friedman rule")

The idea is that reducing shopping time increases welfare. Hence monetary policy should satiate households with money.

Since $R_m \in (1, \beta^{-1})$, the Friedman rule implies that the opportunity cost of holding money should be as low as possible.

Here it is therefore bound by the return on (safe) bonds. So, $R_m \equiv R$. 
To see what implications this has for nominal interest setting (e.g. the instrument controlled by central banks), recall:

\[ R_m = p_t / p_{t+1} \]

\[ R_t = 1 + r_t \equiv 1 + i_t - E_t(1 - R_m) = i_t + R_m \]  \hspace{1cm} (1.32)

with \( R_m \equiv R_t \), this implies that \( i_t \equiv 0 \).

This is the well-known “Friedman rule”.

The Fiscal Theory of the Price Level

Recall that in solving the model B (the real value of public debt) is determined by the government and, given $g$, $\tau$, $R$, $B_0$ and $M_0$, inflation $(1-R_m)$ and $P_0$ are then determined.

Under the FTPL, B is **endogenous**: while the government can decide on nominal debt, the price **level** will adjust to as to make B consistent with the inter-temporal budget constraint.

Again, we can use eqs. (I.30) & (I.31) to see how it works.
Money, Deficits and Inflation in General Equilibrium

- Re-arrange (I.30) to write:

\[
\frac{B}{R} = \frac{1}{R - 1} \left[ \tau - g^p + f(R_m)(1 - R_m) \right]
\]

\[
B = \frac{R}{R - 1} \left[ \tau - g^p \right] + \frac{R}{R - 1} f(R_m)(1 - R_m)
\]

\[
B = \sum_{t=0}^{\infty} R^{-t} \left[ \tau_t - g_t^p \right] + \frac{R}{R - 1} f(R_m)(1 - R_m)
\]

- So, given \( \left\{ g_t, \tau_t \right\}_{t=0}^{\infty}, R, R_m \), one can pin down real public debt, B.
So, the extra requirement here is that policy can determine seignorage \((1-R_m)\) or, equivalently, given (I.32), to peg the nominal interest rate \(i_t\).

Once this is done and, with \(B_0\) and \(M_0\) given, the price level is pinned down by computing \(p_0\) from re-arranging (I.31):

\[
\frac{M_0}{P_0} + B_0 = \sum_{t=0}^{\infty} R^{-t} (\tau_t - g_t) + \sum_{t=0}^{\infty} R^{-t} f(R_m)(1 - R_m)
\]
Note also that the path of money supply also gets determined using:

\[
\frac{M_1}{P_0} = f(R_m)
\]

Given \( M_0 \), then, \( M_0, M_1, \ldots \) is now determined. So, once the price level is pinned down by the fiscal theory of the price level, the path of money supply is now also endogenously determined.

A corollary is that one does not need money for the price level to be determined.
So, we currently have two different fiscal theories of inflation!

The earlier Sargent and Wallace one shows that the inflation rate adjusts to the overall fiscal deficit \((g-\tau+rB)\) in stationary equilibrium. So, fiscal policy is dominant.

The price level \((p_0, p_1, \ldots)\) is pinned down by money supply: as we saw, this is the so-called “Ricardian regime”.

Monetary policy can only influence the timing of inflation (now vs. future), but not long-run inflation.

So, no “true” inflation targeting under fiscal dominance.
New Fiscal Theory of the Price Level (Cochrane, Sims, Woodford), the steady-state inflation rate is chosen by policy (e.g. by nominal interest rate pegging); for a given nominal debt, inflation will then increase or reduce real debt.

Then with inflation and real debt determined, \( p_0 \) is pinned-down.

Under FTPL, the inter-temporal budget constraint holds only at the equilibrium value of the price level.

Under traditional Sargent-Wallace theory, it holds for all \( P_t \).
Since we only observe equilibrium outcomes, it is virtually impossible to distinguish empirically the two theories.

One advantage of the new fiscal theory of the price level is to rule out multiple equilibria in the traditional theory arising from the right hand side of (I.30): $f(Rm)(1-Rm)$.

The extra restriction that seignorage (or its inverse $1-Rm$) is set by policy (i.e. nominal interest peg) takes care of multiplicity: $P_0$, $P_1$, etc. can be uniquely obtained.
Cagan’s Inflation Model

- Milton Friedman: “Inflation is always and everywhere a monetary phenomenon”

- Historically, high and hyper-inflations have always been associated with rapid growth of base money.

- Cagan (1956) is a classic study of 8 hyperinflations (defined as $\pi > 50\%$ per month) that took place between 1920 and 1946.

- Those hyperinflations were associated with major macro disruptions such as the financing of war expenses.
Cagan’s Inflation Model

- As most things in economics, there is considerable controversy on what was the cause/ultimate driving force of those inflationary outbursts.
- Some say seignorage financing (e.g. due to war-related fiscal burdens and disruptions in national tax collection systems).
- Others emphasized the exchange rate (reportedly the view of much contemporary commentators on the German hyper inflation of 1922-23).
- Either way, inflation was highly correlated with money growth.
Cagan’s Inflation Model

From Franco, 2013

### Casos clássicos (critério 50% ao mês)

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<tr>
<th>Países</th>
<th>Período (Início-Fim)</th>
<th>Duração (meses)</th>
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Cagan’s Inflation Model

From Franco, 2013

### Novas ocorrências – América Latina

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[^1]: MEMO (critério Stanley Fischer)

Stanley Fischer “Modern high and hyperinflations” JELit (3) 2002
Cagan’s main pioneering contribution was study the role of inflation expectations in the inflationary process.

As we shall see, he modeled expectations in an adaptative way.

And concluded that, indeed, money growth was the culprit.

But again, in fundamental-based models of inflation, at the root of rapid money growth is the existence of non-trivial public deficits.
Let’s now take a look at the Cagan model

[We shall follow closely Wash (2010, section 4.4)]

Following Cagan, the setting is in continuous rather than discrete time:

\[ g - \tau + rb = \Delta^f = \frac{\dot{H}}{H} \cdot \frac{H}{PY} = \theta h \quad (1.35) \]

- rate of inflation tax base
- money growth
Now recall the money demand function in (I.29):

\[
\frac{m_{t+1}}{p_t} = F\left(c_t, R_{m_t} / R_t\right)
\]

where \(c = y + g\) in a closed endowment economy (i.e. without output being determined by investment).

Cagan noted that the peculiar nature of high/hiper-inflations is that \(R\) and \(\Delta y\) are about stable viz prices. So, the above becomes:

\[
\frac{m_{t+1}}{p_t} = F\left(R_{m_t}\right)
\]
Cagan’s Inflation Model

Cagan’s novelty: demand for base money \((H)\) as a ratio to nominal GDP \((=PY)\) becomes a function of *expected* inflation:

\[
h = \exp(-\alpha \pi^e) \tag{I.35}
\]

(I.35) into (I.34):

\[
\Delta^f = \theta \exp(-\alpha \pi^e)
\]
Cagan’s Inflation Model

Stationary Equilibrium

\[ dh = 0. : \pi = \theta - \mu \]  \hspace{1cm} (I.37)

\[ \pi^e = \pi \] \hspace{1cm} (I.38)

Hence:

\[ \Delta^f = \theta e^{-\alpha(\theta - \mu)} \] \hspace{1cm} (I.39)
Cagan’s Inflation Model

- Solving for $\Theta$ gives the rate of money growth consistent with raising $\Delta_f$ of seignorage revenues.

- (1.39) gives the condition for max seignorage revenues:

$$\theta = \frac{1}{\alpha}$$

- For money growth rates above that, the inflation tax base contracts faster with money growth so overall seignorage falls.
Cagan’s Inflation Model

Money Supply-Inflation Relationship in Cagan’s Model
(taken from Wash, 2010)
This figure says that with zero money growth, $\theta=0$, there is no seignorage (cf. eq. I.39).

In this case, inflation is actually negative if $\mu>0$ from I.37.

Holding $\mu$ constant (justifiable in the short run under high inflations, as discussed), then the 45 degree line plots the one to one relationship between money growth and inflation.

Points A and D are two possible solutions: both are steady state inflation rates consistent with a given deficit.
Cagan’s Inflation Model

- Given $\Delta$, whether the economy is in a high- vs. low inflation equilibrium will depend on form of expectations adjustment.

- As mentioned, Cagan assumes *adaptive expectations*:

  \[
  \frac{\partial \pi^e}{\partial t} = \pi^e = \eta(\pi - \pi^e) \quad (I.40)
  \]

  Inflation forecast error

- The equation that closes the model is obtained by differentiating (I.35):

  \[
  h = \exp(-\alpha \pi^e) = -\alpha \pi^e \exp(-\alpha \pi^e)
  \]

  \[
  \therefore \quad \frac{\dot{h}}{h} = -\alpha \pi^e = \theta - \mu - \pi \quad (I.41)
  \]
Cagan’s Inflation Model

(I.40) and (I.41) are a differential equation system in $\dot{h}/h$ and $\dot{\pi}^e$

First, use (I.41) to substitute out expected inflation in (I.40) and solve for actual inflation to obtain:

$$\pi = \theta - \mu + \alpha \pi^e = \frac{\eta(\theta - \mu - \alpha \eta \pi^e)}{1 - \alpha \eta}$$

(I.42)

This shows that equilibrium inflation will be a negative function of expected inflation for a given real money growth $\theta - \mu$.

**Intuition**: as $\pi^e$ rises, the inflation tax base shrinks requiring lower $\pi$ to re-establish the lower inflation equilibrium.
Then solve for changes in expected inflation:

\[
\pi^e = \eta(\theta - \mu - \pi^e) = k \frac{-\eta \pi^e}{1 - \alpha \eta}
\]  

(1.43)

This equation delivers the condition for a non-explosive, lower inflation equilibrium: if \( \alpha \eta < 1 \) the coefficient will be positive (assuming \( \Theta > \mu \)) implying that changes in expected inflation will be dampened as expected inflation gets higher.

If \( \alpha \eta > 1 \), then the equilibrium is explosive.
This explosive equilibrium can occur if money demand is (negatively) too sensitive to expected inflation and/or expected inflation is too sensitive to the gap between actual and expected inflation.

This is intuitive, if money demand is too elastic to expected inflation, then the inflation tax base is lower. So, for a given fiscal deficit, from equation I.35 one can see that faster money growth will be needed. So, inflation will rise, that will fuel higher inflation expectation, lowering the inflation tax based, thus calling for more inflation, etc.

This vicious circle is often observed in hyper-inflations.
Note, however, that if you are not in this perverse equilibrium, then adaptative expectations allows some “free-riding” in deficit financing.

This is because expected inflation lags behind actual inflation, so the demand for money will not be as low (i.e. the inflation tax base will be higher), allowing a given deficit to be financed with lower inflation.

The downside is that reducing inflation takes longer: you can cut the deficit but agents’ expected inflation will converge only gradually to the new wanted inflation rate.
Limitations and Extensions of the Cagan Model

- In practice, expectations are arguably far more forward-looking: the feedback between expected and actual inflation is closer to zero on average: little scope for fooling agents and systematic “free riding” in deficit financing via seignorage.

- Avoiding the explosive inflation equilibrium can be achieved by credible policies which dampen inflation expectations.

- Still there may be perverse feedbacks between fiscal deficits and money growth.

- E.g. the so-called Keynes-Tanzi effect: real revenue loss due to lags in tax collection (taxi becomes cheaper than bus).
Cagan’s Inflation Model

- There is more to this money-fiscal feedback than the Keynes-Tanzi effect.

- For instance, *tax drag*: as inflation rises, if the tax system is not indexed, people move into higher tax brackets, thus raising revenues.

- G can also be corroded by inflation (e.g. delay in paying suppliers).

- So, overall the effect of inflation on public deficits is ambiguous (see C-T, 2005 for a fuller discussion)
Cagan’s Inflation Model

Some bottom-line:

- The reverse effects of inflation on the general government balance seem weak.

- Hence it is reasonable to assume that – in economies where the central bank is not institutionally strong – the causality tends to run in the direction of fiscal deficits to inflation, rather than the other way around.

- In this case, money supply is still the fuel, but the ultimate driving force comes from fiscal imbalances.