Overview

- Merge intertemporal approaches to current account & fiscal policy to determine price level & nominal exchange rate
- Combine two intertemporal equilibrium conditions to create a consolidated present-value condition relevant for open economies
- Simultaneously determine
  - equilibrium price level \( P \)
  - equilibrium nominal exchange rate \( e \)
- Price level & exchange rate reflect interactions between expected present values of budget surpluses & trade balances \( EPV(S) & EPV(NX) \)
  - generalizes fiscal theory of price level
- Draws on work-in-progress with Tack Yun
Recent years have seen in advanced economies persistently high levels of public debt, large holdings by some governments of international reserves, prolonged period of passive—zero lower bound—monetary policies.

Provide a rationale for accumulation of international reserves to achieve price-level & exchange-rate targets:
- more reserves $\Rightarrow$ lower price level
- because government has more assets to support outstanding public debt

If reserves exceed public debt, fiscal policy can be sustainable:
- even if expected present value of surpluses is negative
Overview

- Derive these implications using a general economic structure
  - budget constraints
  - asset-pricing relations
  - market-clearing conditions
  - transversality & other limiting conditions
  - economy at cashless limit
- Because we do not specify complete model, we are deriving *equilibrium* relationships
  - may or may not have causal interpretations
  - in spirit of “intertemporal approach to current account” literature
Introduce *composition* effects from asset demands

- $\alpha_t$: share of foreign assets held by households (rest held by government)
- $\gamma_t$: fraction of government debt held by financial sector (rest held by households)
- for now, take these asset demands as given (unmodeled)

- $\alpha_t \equiv 1$ (govt owns no foreign assets) & $\gamma_t \equiv 0$ (all govt debt held by HHs)

- obtain usual bond-valuation equation in fiscal theory
- no role for trade balances in price determination
Overview

- $0 < \alpha_t < 1$ (govt owns foreign assets)
  - trade balances & budget surpluses affect $P$ & $e$ determination
  - composition effects matter
  - alters how to think about fiscal sustainability... depends on
    - govt holdings of foreign assets
    - $EPV(S)$ & $EPV(NX)$
    - relative asset demands
- How important it is to integrate intertemporal approaches to CA & FP...
  - depends on country characteristics
  - asset demands
  - relative sizes of $EPV(S)$ & $EPV(NX)$
Benchmark Model

- Representative household’s budget constraint

\[
\frac{q_t B^H_{t+1} + e_t q^*_t B^*_{t+1}}{P_t} = \frac{B^H_t + e_t B^*_t}{P_t} + W_t H_t + R_t K_t - C_t - T_t - I_t \quad (1)
\]

- \(B^H_{t+1}\): nominal ¥ value of government bonds issued by home country
- \(B^*_t\): nominal $ value of government bonds issued by foreign country
- \(e_t\): nominal exchange rate in ¥/$
- \(q_t\): ¥ price of home country bonds
- \(q^*_t\): $ price of foreign country bonds
- \(W_t\): real wage rate; \(R_t\): real rental rate of capital
- \(H_t\): number of hours worked; \(K_t\): capital stock at beginning of \(t\)
- \(C_t\): consumption; \(I_t\): investment; \(T_t\): real taxes

- Note that \(B_t\) is bonds outstanding at the beginning of period \(t\)
Model Setup

Assumption (1)
There is an international financial market in which risk-neutral international investors trade bonds issued by different governments. In this market, uncovered interest parity holds

$$q_t^*e_t = q_tE_t[e_{t+1}]$$ (2)

Assumption (2)
Markets for factors of production and goods are perfectly competitive. Production exhibits constant returns to scale, so

$$Y_t = W_tH_t + R_tK_t$$ (3)

$Y_t$ is aggregate output in period $t$
Model Setup

- Aggregate resource constraint is
  \[ Y_t = C_t + I_t + G_t + NX_t \]  \hspace{1cm} (4)

  \( G_t \) is real government consumption; \( NX_t \) is real net exports

- Substitute (2) & (4) into (1) to yield difference equation in household’s real asset holdings, \( d_t \)
  \[ E_t[q_{t,t+1} d_{t+1}] = d_t + G_t - T_t + NX_t \]  \hspace{1cm} (5)

  where
  \[ d_t \equiv \frac{B^H_t + e_t B^*_t}{P_t}, \quad q_{t,t+1} \equiv q_t \frac{P_{t+1}}{P_t} \]

- Use one-period real discount rate, \( q_{t,t+1} \) to define
  \[ q_{t,t+k} = \prod_{j=1}^{k} q_{t+j-1,t+j}, \quad k \geq 1, \quad q_{t,t} = 1 \]
Iterate forward on (5) & impose transversality
\[ \lim_{T \to \infty} E_t[q_{t,t+T}d_{t+T}] = 0 \] to get

\[ \frac{B_t^H + e_t B_t^*}{P_t} = \sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k} - G_{t+k} - NX_{t+k})] \] (6)

- assume \( EPV(S) > EPV(NX) \)
- Budget & trade surpluses back \( B_t^H + e_t B_t^* \)
  - household’s total holdings of nominal govt bonds
- If \( EPV(S) \uparrow \) or \( EPV(NX) \downarrow \ldots \)
  - expected higher “cash flows”
  - demand for \( B_t^H + e_t B_t^* \) rises
  - mix of \( P_t \downarrow \) & \( e_t \uparrow \)
- From \textbf{only} the HH’s side, \( P_t \) & \( e_t \) move in opposite directions
Assumption (3)

The government holds dollar-denominated foreign assets, $J_t$, at the beginning of each $t \geq 0$. $J_t$ is determined in period $t - 1$ and assume that the government does not adjust the exchange rate in response to changes in $J_t$.

- Government’s flow budget constraint is

$$q_t B_{t+1}^G - e_t q^* J_{t+1} + P_t T_t = B_t^G - e_t J_t + P_t G_t$$ (7)

$B_t^G$ is ¥ value of outstanding government debt at beginning of $t$; $J_{t+1}$ is the $\$ value of foreign assets held by home country; $e_t J_{t+1}$ is ¥ value of foreign assets held by govt.
Model Setup

- Applying uncovered interest parity, (7) is

\[ E_t[q_{t,t+1}b_{t+1}] = b_t - (T_t - G_t) \]  

(8)

where \( b_t \equiv \frac{B^G_t - e_tJ_t}{P_t} \)

Assumption (4)

Total outstanding public debt—net of the government’s holdings—consists of the household’s holdings, \( B^H_t \), and the financial sector’s holdings, \( B^F_t \)

\[ B^G_t = B^H_t + B^F_t \]

- We do not model how \( B^F_t \) is determined
  - think of it as foreign lending to domestic govt
Model Setup

- Iterate forward on (8) and impose limiting condition 
  \( \lim_{T \to \infty} E_t[q_{t,t+T} b_{t+T}] = 0 \) to yield

\[
\frac{B_t^G - e_t J_t}{P_t} = \sum_{k=0}^{\infty} E_t [q_{t,t+k} (T_{t+k} - G_{t+k})]
\]  

(9)

- Budget surpluses alone back \( B_t^G - e_t J_t \)
  - government’s net nominal liabilities

- Two interpretations of (9)
  1. \( B_t^G - e_t J_t \): “net debt” of govt backed by \( EPV(S) \)
  2. \( B_t^G / P_t = EPV(S) + (e_t / P_t) J_t \)
     - \( (e_t / P_t) J_t \): income source at \( t \) (capital inflows) that supplement \( EPV(S) \) as backing for govt bonds

- By (9), \( EPV(S) \rightleftharpoons \text{mix of } P_t \downarrow \& \ e_t \downarrow \)

- From only the govt’s side, \( P_t \& e_t \) move in same direction
Model Setup

- Can instead combine HH’s and govt’s budget constraints, impose marketing clearing

\[
\frac{e_t q_t^*(J_{t+1} + B_{t+1}^*) - q_t B_{t+1}^F}{P_t} = \frac{e_t (J_t + B_t^*) - B_t^F}{P_t} + NX_t
\]

- applying uncovered interest parity

\[
E_t[q_{t,t+1} f_{t+1}] = f_t + NX_t
\]

where \( f_t \equiv \frac{e_t (J_t + B_t^*) - B_t^F}{P_t} \)

- iterate forward & impose \( \lim_{T \to \infty} E_t[q_{t,t+T} f_{t+T}] = 0 \)

\[
\frac{e_t (J_t + B_t^*) - B_t^F}{P_t} = \sum_{k=0}^{\infty} E_t q_{t,t+k} NX_{t+k}
\]

- (10) equates the value of net lending to foreigners to \( EPV(NX) \)

- conventional intertemporal approach to current account expression
Equilibrium

- Two intertemporal equilibrium conditions—(6) & (9)—imply different movements between $P_t$ & $e_t$
- Need to bring both conditions together
  - (6): value of HH asset holdings equals expected present value of govt surpluses net of trade surpluses
  - (9): value of net govt liabilities equals expected present value of primary govt surpluses
- In closed economy ($NX_t = B_t^* = J_t = 0$), these are identical
- In open economy, both must hold simultaneously, imposing additional restrictions on equilibrium price level
Price-Level Determination

Combining (6) & (9) to eliminate \( e_t \) yields

\[
\frac{B^H_t + \alpha_t B^F_t}{P_t} = \sum_{k=0}^{\infty} E_t [q_{t,t+k} (T_{t+k} - G_{t+k})] - (1 - \alpha_t) \sum_{k=0}^{\infty} E_t [q_{t,t+k} NX_{t+k}]
\]

\( \alpha_t \equiv \frac{B^*_t}{B^*_t + J_t} = \begin{cases} \text{share of foreign assets} \\ \text{held by households} \end{cases} \)

**Price-level determination**: Two results when assumptions 1–4 hold:

1. If govt holds foreign assets, equilibrium price level reflects both primary budget surpluses & trade surpluses
2. When the financial sector holds govt bonds, there are composition effects of debt on the price level
Denote by $\gamma_t$ the fraction of govt debt held by financial sector

$$\gamma_t \equiv \frac{B_t^F}{B_t^G}$$

Solving for the price level from (11) yields

$$P_t = \frac{[(1 - \gamma_t) + \gamma_t \alpha_t]B_t^G}{\sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k} - G_{t+k})] - (1 - \alpha_t) \sum_{k=0}^{\infty} E_t[q_{t,t+k}NX_{t+k}]}$$  \hspace{1cm} (12)

Treat (12) as determining the equilibrium price level at $t$

- requires assuming $\{T_t - G_t, NX_t\}$ unrelated to govt debt & price level (e.g., exogenous)
- at $t$, $B_t^G, \alpha_t, \gamma_t$ predetermined
- with $B_t^G > 0$, also assume that for all $t \geq 0$
Price-Level Determination

\[ P_t = \frac{[1 - \gamma_t + \gamma_t \alpha_t]B^G_t}{E_t PV(S) - (1 - \alpha_t)E_t PV(NX)} \]  

\[ EPV(S) > EPV(NX) \Rightarrow EPV(S) > (1 - \alpha)EPV(NX) \]

1. \( \alpha_t \) & \( \gamma_t \) yield composition effects
   - both \( \alpha_t \) & \( \gamma_t \) are predetermined
   - \( \alpha_t = 1, \gamma_t = 0 \) yields fiscal theory \( P \) determination
2. When \( 0 < \alpha_t < 1 \ldots \)
   - higher \( EPV(NX) \) raises \( P_t \)
3. When \( 0 < \gamma_t < 1 \), higher \( \gamma_t \ldots \)
   - raises \( P_t \) because \( EPV(S) > (1 - \alpha)EPV(NX) \)
4. Higher \( \alpha_t \ldots \)
   - raises \( P_t \) if \( \gamma EPV(S) > EPV(NX) \)
   - lowers \( P_t \) if \( \gamma EPV(S) < EPV(NX) \)
5. When \( \gamma_t = 0 \), higher \( \alpha_t \) decreases \( P_t \) as long as \( EPV(NX) > 0 \)
Exchange-Rate Determination

- **Exchange-rate determination**: Two results when assumptions 1–4 hold:
  1. If the govt holds foreign assets \((J_t > 0)\), nominal exchange rate reflects both primary budget surpluses & trade surpluses
  2. When the financial sector holds govt bonds \((B_t^F > 0)\), there are composition effects on of debt on the exchange rate

- Substitute (12) into (9) & solve for exchange rate

\[
e_t = (1 - \alpha_t) \frac{B_t^G}{J_t} \frac{\gamma_t \sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k} - G_{t+k})] - \sum_{k=0}^{\infty} E_t[q_{t,t+k}NX_{t+k}]}{\sum_{k=0}^{\infty} E_t[q_{t,t+k}(T_{t+k} - G_{t+k})] - (1 - \alpha_t) \sum_{k=0}^{\infty} E_t[q_{t,t+k}NX_{t+k}]} \]

- Treat (13) as determining the equilibrium exchange rate
  - requires same assumptions as for price-level
Exchange-Rate Determination

\[ e_t = (1 - \alpha_t) \frac{B_t^G}{J_t} \left[ \frac{\gamma_t E_t PV(S) - E_t PV(NX)}{E_t PV(S) - (1 - \alpha_t) E_t PV(NX)} \right] \]  

(13)

1. The nominal exchange rate also reflects two composition effects, \( \alpha_t \) & \( \gamma_t \)

2. If \( 0 < \alpha_t < 1 \), exchange rate directly affected by \( EPV(S) \) and \( EPV(NX) \)

3. If \( 0 < \gamma_t < 1 \) & \( EPV(S) > 0 \), \( e_t \) depreciates as \( \gamma_t \) rises

4. If \( EPV(S) > 0 \), higher \( EPV(NX) \) appreciates home currency

5. If \( \gamma_t = 0 \), higher \( \alpha_t \) appreciates home currency
   - so long as \( EPV(NX) > 0 \)
Case Study: Norway

- North Sea oil & natural gas generating massive revenues
  - petroleum sector 50% of exports & over 20% of GDP
  - petroleum tax payments by companies 30% of govt revenues
- Norway’s fiscal rule
  - all govt revenues from oil transferred to Government Pension Fund Global (GPFG)
  - government spending limited to expected real return—4%—from fund
  - all the fund’s capital invested abroad
Norway’s Oil Fund

Projected size of the oil fund

1) Quarterly figures to end-2012, annual figures thereafter

Sources: Ministry of Finance (National Budget 2013) and Norges Bank
Norway’s Nominal Exchange Rate

Norwegian Krona per U.S. Dollar

Norges Bank’s Balance Sheet

The size of Norges Bank’s balance sheet including the oil fund
In billions of NOK

Source: Norges Bank
Norway’s Inflation Rate

Inflation
Moving 10-year average and variation in CPI. Percent

Sources: Statistics Norway and Norges Bank
Norway & This Framework

1. \(B^G > 0\) gross debt \(\approx\) 20% GDP & shrinking
2. \(J\) large: GPFG \(\approx\) 540% GDP & growing
3. \(B^G_t - e_tJ_t < 0\) & growing
4. Share of foreign assets held by HHs, \(\alpha_t \in (0, 1)\) & shrinking(?)
5. Share of govt debt held by HHs, \(1 - \gamma_t > 0\)
6. \(\frac{B^G_t - e_tJ_t}{P_t} = EPV(S) < 0\): expect primary budget deficits!
7. Need \(EPV(NX)\) to be negative

\[P_t = \frac{[(1 - \gamma_t) - \gamma_t\alpha_t]B^G_t}{EPV(S) - (1 - \alpha_t)EPV(NX)} > 0\]
\[\Rightarrow (1 - \alpha_t)EPV(NX) < EPV(S) < 0\]

8. \(J\uparrow\) & \(B^G\downarrow\) \(\Rightarrow\) appreciates currency
9. \(EPV(S) < 0\) & \(EPV(NX) < 0\) changes comparative statics
   ▶ higher \(EPV(S)\) \(\Rightarrow\) appreciates currency
   ▶ higher \(EPV(NX)\) \(\Rightarrow\) depreciates currency
Growing govt holdings of foreign assets exerts *deflationary* pressures

If fiscal policy is passive, Norges Bank can retain control of price level
  - are oil revenues directly controlled by government?
  - are non-oil surpluses adjusted to stabilize debt?

Perhaps need to rethink meaning of “passive fiscal policy” when $B_t^G - e_t J_t < 0$

Norway presents some interesting challenges to conventional thinking
Case Study: Japan

- Gross government debt in Japan over 200% GDP
  - much of JGB held by government & “quasi-government” entities $\Rightarrow B^G$ may be much smaller
  - little of JGB held by Japanese households & foreigners
    - $\gamma_t$ may be quite large
  - BoJ owns over $1$ trillion in foreign reserves
    - $J$ large, so $\alpha_t$ small
- Every study concludes Japanese FP “unsustainable”
  - yet interest rates extremely low & JGBs riskless
- Until recently...
  - ¥ strong & steady
  - chronic trade surpluses
  - inflation extremely low (deflation)
- Many puzzles