Outside the corridor:
Fiscal multipliers and business cycles into an agent-based model with liquidity constraints

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OECD 2014 NERO Meeting
Dimensions of Fiscal Policy

Paris, June 16, 2014
Goal and Motivation

- The Great Recession has renewed attention for the macroeconomic effects of fiscal policy.
- Auerbach and Gnordnichenko (2011): the size of fiscal multipliers can vary during business cycles.
- Effects of fiscal policy may depend on the "credit regime" (e.g. Ferraresi, Roventini, Fagiolo, 2012).
- Our contribution: Investigate how the size of fiscal multipliers can vary in a ABM model with financial market imperfections.
  - We show that the size of the fiscal multiplier is an increasing function of the degree of credit rationing in the economy.
  - In addition, the effects of fiscal policy are stronger into more leveraged economies.
A simple endowment economy

$N$ households. Each household $i$ is entitled to a time-invariant share $\alpha_i$ of total household income, $Y_{t-1}^H$:

$$y_{it} = \alpha_i Y_{t-1}^H$$

Taxes are collected at the beginning of the period using a proportional tax rate $0 < \tau < 1$:

$$T_t = \tau Y_{t-1}^H$$

Net disposable income of household $i$:

$$y_{it}^d = (1 - \tau)\alpha_i Y_{t-1}^H$$
Household desired consumption is determined using a simple habit formation rule. In each period household desired consumption $Z_{it}$ is determined according to

$$Z_{it} = \rho Z_{i(t-1)} + (1 - \rho)C_{i(t-1)}$$

where $C_{i(t-1)}$ is actual consumption at time $t - 1$.

$0 < \rho < 1$ is an auto-regressive coefficient determining the relative importance of past desired and actual consumption choices in the determination of today’s desired consumption.
Savers and Borrowers

- It is possible to identify two classes of agents: savers and borrowers.
  - Savers are households whose current wealth $W_{it}$ is larger than desired consumption (i.e. $Z_{it} \leq W_{it}$).
  - Borrowers have wealth $W_{it}$ that is lower than desired consumption $Z_{it}$ (i.e. $Z_{it} > W_{it}$).
- Savers can finance their consumption with their own wealth. Their consumption is therefore always equal to their desired level: $C_{it} = Z_{it}$
- In contrast, borrowers need financing from the credit sector to satisfy their consumption plans.
Wealth evolution

- Let $\beta_{it}$ be the marginal propensity to consume out of wealth. For borrowers $\beta_{it} > 1$, and for lenders $\beta_{it} \leq 1$.
- The law of motion of borrowers’ wealth is

$$W_{it} = (1 - \tau)\alpha_i Y_{t-1} - (1 + r^b_t)(\beta_{it} - 1)W_{it-1},$$

while for savers it is

$$W_{it} = (1 - \tau)\alpha_i Y_{t-1} + (1 + r^s_t)(1 - \beta_{it})W_{it-1}.$$

- $r^b_t$ and $r^s_t \leq r_b$ are the borrowers’ and lenders’ interest rates, determined with a markup/down from central bank interest rate $r_t$

$$r^b_t = r_t(1 + \mu^b) \quad r^s_t = r_t(1 - \mu^s)$$
The Credit Sector

- In the credit sector there is a representative bank that stocks the wealth of all agents and grants credit to borrowers.
- Total credit supply is set as a multiple of the net worth of the bank \( E_t^B \)
  \[ TS_t = k E_t^B \]
  where \( k > 0 \) is the credit multiplier.
- Credit is allocated to agents on a pecking-order that depends on the on the ratio between household’s wealth \( W_{it} \) and her credit demand \( CD_{it} = Z_{it} - W_{it} \):
  \[ \frac{W_{it}}{CD_{it}} \]
Credit Rationing

- If $TS_t \geq \sum_i CD_{it}$, all borrowers are able to get credit from the bank.
- If $TS_t < \sum_i CD_{it}$, some borrowers will be partially or totally rationed on the credit market.
- The lower is the position of the household in the pecking order, the higher is her probability of being credit-rationed.
- Borrowers who are denied credit are not able to satisfy their consumption plans, and their actual consumption is equal to

$$C_{it} = W_{it} < Z_{it}$$
Debt must be fully repaid at the beginning of each period. Households whose resources are lower than debt plus interests, go bankrupt:

\[(1 - \tau)\alpha_i Y_{t-1}^H < (1 + r_b^b)(\beta_{it} - 1)W_{it-1}\]

Once bankruptcy occurs the wealth of the household is reset to zero and the bank incurs a credit loss equal to

\[BD_{it} = (1 + r_b)(C_{it-1} - W_{it-1}) - (1 - \tau)\alpha_i Y_{t-1}\]

Bankrupted households are denied access to the credit market for \(T_{def}\) periods.
Government Expenditure and Income Determination

- The government sets consumption level and the tax rate according to different fiscal rules.
- Aggregate income $Y_t$ is determined as the sum of households and government consumption, respectively $C_t$ and $G_t$, plus the consumption of bankers (equal to bank profits $\pi_t^B$). Formally, we get:

$$Y_t = C_t + G_t + \pi_t^B$$

- Total households income $Y_t^H$ is total income minus the income of bankers, i.e. $Y_t^H = Y - \pi_t^B$. 

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Sequence of Events

- Aggregate income of the previous period is distributed
- Taxes are collected and disposable income of households is determined
- Debt is repaid. Household’s wealth is determined. Bankrupted households are identified
- Desired consumption of the period is determined. Households credit demand is determined
- Government consumption and the government balance is determined
- Total credit supply is determined. The total credit supply available for households credit is determined
- Credit is allotted to consumers. Actual private consumption is determined
- Aggregate income of the period is determined
The Steady State

- Before carrying simulation experiments we identify the steady state conditions of the model.
- The model has no growth; hence in steady state levels of all microeconomic variables (households’ wealth, income and consumption, debt, profits of the bank) and of all macroeconomic variables (aggregate consumption, aggregate government expenditure, tax revenues, aggregate income) are constant.
- The steady state of desired consumption is equal to:

$$Z_{it} = C_{i t-1} = C_{i t-2} = \ldots = C^*_i$$
We focus on steady states of the model where credit rationing is absent. Steady state level of wealth:

\[ w^*_i = \frac{\alpha_i (1 - \tau) Y^H_*}{1 - (1 + r^b_t)(1 - \beta^*_i)} \]

\[ w^*_i = \frac{\alpha_i (1 - \tau) Y^H_*}{1 - (1 + r^s_t)(1 - \beta^*_i)} \]

for borrowers and savers respectively.

Stability conditions:

\[ | (1 + r^b_t)(1 - \beta^*_i) | < 1 \]
\[ | (1 + r^s_t)(1 - \beta^*_i) | < 1 \]
Aggregate consumption must be constant in steady state. Thus, steady state individual consumption, $C_i^*$, is a fraction of steady state aggregate consumption $C^*$

$$C_i^* = \gamma_i^* C^*, \quad \sum_{i=1}^{N} \gamma_i^* = 1$$

Exploiting $C_i^* = \beta_i^* w_i^*$ and $C^* = (1 - \tau) Y^H$ individual consumption shares $\gamma_i^*$ and individual marginal propensity to consume $\beta_i^*$ are related as follows:

$$\beta_i^* = \frac{\gamma_i^* r^b_t}{[\gamma_i^* r^b_t + (\gamma_i^* - \alpha_i)]}$$  

$$\beta_i^* = \frac{\gamma_i^* r^s_t}{[\gamma_i^* r^s_t + (\gamma_i^* - \alpha_i)]}$$

for borrowers and savers respectively.
Simulation Experiments

- We introduce a bankruptcy shock in the steady state. A given (small) fraction of the borrowers’ population goes bankrupt.
- We repeat the above experiment under different fiscal rules:
  1. Constant government expenditure and constant tax rate
  2. Balanced budget with endogenous govt. expenditure
  3. Balanced budget with endogenous tax rate
- We track the evolution of output (and of other macro variables)
Results

- General result: Fiscal policy dampens the effects of the shock on the economy and lowers its persistence.

![Graph showing Aggregate Income as a fraction of Steady State Income over time for different values of a parameter. The graph illustrates the dampening effect of fiscal policy on the economy's response to a shock.]
We calculate fiscal multipliers in each experiment

\[ k_{kj}(t) = \frac{Y_k(t) - Y_j(t)}{G_k(t) - G_j(t)} \]

\( k_{kj}(t) \) is the fiscal multiplier at time \( t \) corresponding to the experiment with government expenditure level \( k \) with respect to the experiment with government expenditure \( j \).
The shock leads to government deficit which is then re-absorbed when the economy recovers.
- Fiscal multipliers are highest at the through of the recession
- After some threshold additional doses of government expenditure do not yield significant increases in output (multipliers lower than 1)
Fiscal multipliers are inversely related to the degree of credit rationing in the economy.
- Fiscal multipliers are higher into more leveraged economies
- A similar result holds for different levels of inequality in income
Balanced budget fiscal multipliers are very low
With balanced budget rules the economy is not able to fully recover from the shock and moves to a new steady state with a lower level of income.
Conclusions

- Simple ABM model to study the time evolution of fiscal multipliers
- The value of fiscal multipliers depends on the degree of credit constraints in the economy
- Some government deficit is necessary to allow the economic recovery after a shock. In contrast, balanced budget fiscal policies do not manage to yield full recovery
To Do - Admittedly a long list...

- Introduce a fiscal reaction function:

\[ L = \frac{\psi}{2}(\pi - \bar{\pi})^2 + \frac{1}{2}(Y - \bar{Y})^2 + \frac{\chi}{2}(d - \bar{d})^2 \]

- Drop demand driven model: add prices/inflation and the modeling of aggregate supply

- Study the interaction between monetary and fiscal policy

- Add fiscal rules in a multi-country setting (EMU)