Simulation of a firm’s default in an economy with non-consumable money

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The wide economic problem

- How do credits in non-consumable money impact existence of default of a firm?

  - Theoretical complications:
    - Profit maximization in terms of non-consumable money is nonsense in a finite-time.
    - Micro-foundations for demand for credits in terms of non-consumable money are not well-investigated.

  - Empirical complications:
    - Credits exist for labor and firms.
    - Credits in money co-exist with defaults in terms of money.
    - Defaults always have impact on labor supply, consumption, labor demand (employment), production.
      - Impact of credits on product is beyond the current model.
    - Debts spill over from borrowers to creditors.
The narrow problem

- Micro-foundations of demand for **non-consumable money** money are based on a trade-off between: payment repayment and a punishment for a not-payed debt.
  
  - Zero utility if money is left after trade.
  - Disutility if a debt left non-payed due.
  - Motivation to pay back credit is supported by an exogenous utility.

- How does existence of a punishment impact evaluation of a firm in terms of Tobin’s Q?
Our approach


1. The model supplies micro-foundations for demand for money to investigate interactions of real (goods and labor) and credit markets.

2. Our conceptual innovation:
   2.1 a rejection of profit maximization paradigm in terms of non-consumable money:
      ▶ how to consume cash-flow as non-consumable money?
   2.2 a suggestion of payoff maximization in terms of well-being (self-respect) of an owner/manager.

3. Our result: too big demands for credits and loose credit discipline
   3.1 have impact on goods, labor, credit markets;
   3.2 may have spill over effect to initialize an insolvency of a creditor.
   3.3 Real wage and Tobin’s Q depend on a presence of default.
Literature

1. Dichotomy in theory, micro NOR macro:
   - micro: an agent level;
   - macro: aggregated (scale) level;
   - existence of money is supported by infinite time, bequest or consumable money.

2. Huge literature on money, without a clear answer:
   - Khan paradox: why to hold non-consumable money if one’s life is finite.

   - Our extension: production and tools for analysis of interactions of real and financial markets.

   The more general framework is the Debt-deflation theory of Irving Fisher.
Novelty of our model

- Micro-foundations for interactions between the three markets:
  - labor,
  - goods,
  - credits.

- Impact of default on:
  - real wage,
  - Tobin Q,
  - labor supply,
  - supply of a good.
Structure of the model

No barter trade.

- Complete information, one-period, Walrasian economics with production, non-consumable money and default in an equilibrium.

- Agents are:
  - workers (W),
  - producers (E),
  - a dummy bank.

- Bank passively
  - supplies fixed money, $M, 0 < \infty$;
  - fixes marginal punishments for default: $k_E, k_W$.

- Agents need money to trade and submit bids for the bank.

- W&E simultaneously operate at
  - goods,
  - labor,
  - credit market.
Payoffs and actions

Agents need cash for transactions and ask a bank for credits. A budget constraint depends on a bid of another.

Worker:
- has 24 hours;
- bids for credits, \( b_w \in [0, M] \);
- supplies labor, units of time, \( t \in [0, 24] \);
- pays \( b_w \) units of money for a good;
- enjoys labor and consumption of a good.

Producer:
- has fixed output \( \hat{x} \);
- hires a worker and pays in money for a worker’s time;
- sells a good, \( x \in [0, \hat{x}] \), total production is fixed;
- bids for credits, \( b_E \in [0, M] \);
- enjoys consumption of the good and managing time of the worker.

Neither can consume money.
Pricing in the model

Labor market: \( w = \frac{b_E}{t_w} \)
  - Ratio of total monetary demand for labor to total supply of labor time.

Goods market: \( p = \frac{b_w}{x} \)
  - Ratio of total monetary demand for the good to supply of the good

Credit market: \( 1 + \rho = \frac{M}{d_E+d_w} \)
  - \( d \). - a promiss of · to pay back quantity \( d \).
  - Ratio of demand for credits to supply of credits.
Payoff of a worker $j$

Utility: positive from consumption and leisure, and disutility from default.

$$u^j_W(b^j, t, d^j_W) = \beta \ln\left(\frac{b^j}{b}\right) + (1 - \beta) \ln(24 - t^j) +$$

$$k_W \times \min\{0, h\frac{t^j}{t} - b^j + \frac{d^j_W}{d_E + d_W} nM - d^j_W\}$$

- $n$ - number of agents, $n \to \infty$,
- $x$ - purchased quantity,
- $h\frac{t^j}{t}$ - labor income,
- $b^j$ - payment for a good,
- $\frac{d^j_W}{d_E + d_W} nM$ - size of a loan,
- $d^j_W$ - debt to bank.
Payoff of an entrepreneur $i$

Utility: positive from consumption of the good and working time of the worker, disutility from default.

\[
u^i_E(x_i, h_i, d_{i,E}) = \alpha \ln(\hat{x} - x_i) + (1 - \alpha) \ln\left(\frac{h_i}{h}\right) + \kappa_E \times \min\{0, b \frac{x_i}{x} - h_i + \frac{d_{i,E}}{d_E + d_{W}} nM - d_{i,E}\} \tag{1}
\]

- $h_j$ - payment for a labor,
- $b \frac{x_i}{x}$ - income from selling the good,
- $\frac{d_{i,E}}{d_E + d_{W}} nM$ - size of a loan,
- $d_{i,E}$ - debt to bank.
Role of punishment for default, $k_E, k_W$

Each agent compares a punishment for default (marginal gain from a state of default) with marginal gain from consumption.

Cases:

1. Marginal gain from default is bigger, then better to decrease consumption and to pay the debt.

2. Marginal gain from default is smaller, better to claim default.

No ways to discriminate default reasons:

- from a bad occasion (intentional/non-intentional moral hazard),
- a strategic one (adverse selection).
Endogenous variables of the model

Goods market:
▶ price,
▶ monetary demand,
▶ real supply.

Labor market:
▶ wage,
▶ monetary payment,
▶ labor time.

Credit market:
▶ interest rate,
▶ bids for loans,
▶ individual and total defaults.
Structure of an equilibrium

Every outcome depends on punishments for default.

**Table:** Cases of defaults with bounds

<table>
<thead>
<tr>
<th>High $k_e$, small $k_w$</th>
<th>High $k_e$, high $k_w$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker has default</td>
<td>Classical case</td>
</tr>
<tr>
<td>$M/k_E$</td>
<td>Neither has default</td>
</tr>
<tr>
<td>Small $k_e$, small $k_w$</td>
<td>Small $k_e$, high $k_w$</td>
</tr>
<tr>
<td>Both have default</td>
<td>Entrepreneur has default</td>
</tr>
</tbody>
</table>

$M/k_j$ - marginal indirect utility of type $j$, $j \in \{W, E\}$. 
Parameters for simulation

We present only an entrepreneur side, similar analysis can be pursued for demand side.

- Equal preferences: \( \alpha = \beta = 1/2 \).
- Money supply \( M = 10 \).
- Fixed total production \( \hat{x} = 1 \).
- Tobin’s Q is a ratio of revenue from sales to labor costs (short-run costs).
  - Costs can be expanded by including payments for credits.
Paramaters Description for two following heat maps

- Preferences: $\alpha = \beta = 1/2$.
- Money supply $M = 10$.
- Fixed total production $\hat{x} = 1$.

Red zones for default: spill overs from borrowers to the bank.

Classical case (monetarist and Keynesian), when big punishments prevent over-borrowing: $k_E, k_W$: no defaults, interest rate is zero, wages are equal to half money supply, and all credits are payed back.
Heat maps: Wage and real wage

**Table: Wage and real wage**

<table>
<thead>
<tr>
<th>Nominal wage</th>
<th>Log Price</th>
</tr>
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<tbody>
<tr>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>0.26</td>
</tr>
<tr>
<td>1.0</td>
<td>0.52</td>
</tr>
<tr>
<td>1.5</td>
<td>0.78</td>
</tr>
<tr>
<td>2.0</td>
<td>1.04</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Real wage</th>
<th>Log Price</th>
</tr>
</thead>
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<tr>
<td>0.0</td>
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Price and a ratio of revenue over costs for an entrepreneur, (Tobin’ Q)
Spill over of default of a borrowing firm to default of a creditor

Small punishments are equivalent to generous credit pump. We demonstrate micro-foundations how resulting default of a borrowing firm spills over to a creditor. Horizontal line - total money supply. Red line - the threshold for the spill-over.
Equal Tobin’s Q for $M = 10$

Small punishments are equivalent to generous credit pump. Axes are sizes of punishments. The straight lines are lines of constant Tobin’s Q.
Conclusion: now

- Micro-foundations for money holding do have impact on the popular indicator for measuring performance of firms in corporate finance.

- The result is important for corporate evaluation.

- Investigation of micro-foundations of money on corporate finance within general equilibrium is under-investigated.