What Assets Should the Central Bank Purchase in a Quantitative Easing Program?

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Motivation

Figure 1: Quantitative Easing and Federal Reserves Balance Sheet
Motivation

- Real QE: purchasing long-term government bonds
  - Offer liquidity to the financial market
  - Private bonds yields are also reduced
  - External Funding constraint are released
  - Investment are facilitated

- Purchasing private bonds may be also effective
  - More direct channel to sidestep the financial intermediation for private firms
  - Input-output linkage $\Rightarrow$ Spillover effects

- Research question:
  Whether different asset (bond) purchases have different aggregate and sectoral effects?
Main Contribution

- Build a multi-sector economy with input-output interactions
  - Heterogeneous sectors: production technology, financial constraints, price rigidity, and agency costs
  - Buy goods from each other as materials inputs

- Recent quantitative studies assume one single sector and have shown how agency costs matter

- Single sector is not able to analyze the unbalanced QE stimulus in different sectors
  - Will the sector with higher capital sensitivity benefit more from the QE?
  - Will purchasing bonds from a specific sector generate a specific stimulative pattern?

...
Evaluate different asset purchases in a two-sector model based on US calibration

- Private bonds issued by each sector
- Public bonds
Evaluate different asset purchases in a two-sector model based on US calibration

- Private bonds issued by each sector
- Public bonds

Price rigidity and agency costs are key sources of heterogeneity in sectoral effects

Input-output Interactions dampened heterogeneity in sectoral responses

The central bank faces an intertemporal trade-off

- Purchasing bonds most subject to agency cost have larger expansionary effects, but are subject to larger deleveraging effects
The economy consists of:

1) Households composed of workers and bankers
2) Production network with 4 layers
3) Firms that produce physical capital
4) Financial intermediaries
5) A government composed of fiscal and monetary authorities
Model: Households

Two types of infinitely-lived members: workers and bankers

Each banker runs a financial intermediary and faces a constant exit probability after which she becomes a worker

Exiting bankers transfer their wealth to the household and are replaced by an equal number of workers who become new bankers

New bankers are received a constant startup wealth
Competitive goods-producing firms.

- Different sectors would need different capital, labor, and material elasticity, and face different borrowing constraint.
- Representative firms in the sectors will issue long-term bonds to fund sector capital accumulation subject to the borrowing constraint.
Monopolistic retailer indexed by $r$ produces differentiated good by a repackaging technology, and faces Calvo rigidity.
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Competitive sectoral aggregators that aggregate repackaged goods into sectoral output.
Model: Production Network

- Monopolistic retailer indexed by $r$ produces differentiated good by a repackaging technology, and faces Calvo rigidity.
- Competitive sectoral aggregators that aggregate repackaged goods into sectoral output.
- Competitive final aggregator that aggregate sectoral output into final goods.
Monopolistic retailer indexed by \( r \) produces differentiated good by a repackaging technology, and faces Calvo rigidity.

Competitive sectoral aggregators that aggregate repackaged goods into sectoral output.

Competitive final aggregator that aggregate sectoral output into final goods.

Final users: Households (\( C \)), capital producers (\( I \)) and fiscal authority (\( G \)).
financial intermediaries that transfer money resources

- Different kinds of bonds will face different degrees of agency costs
- The whole economy will face a systematic agency friction.

Government: fiscal authority and central bank

- Tax, public bonds and transfer from the central bank funds fiscal authority’s expenditures
- Central bank adjusts policy rate subject to ZLB, and purchases bonds by its reserves at ZLB
Calibration: Two Sector Economy

Theoretical model is applicable to any $S$

Here we set $S = 2$

- Sector 1: Manufacturing
- Sector 2: Services
Source: input-output database (KLEM) by Dale Jorgenson,
Annual from 1960 to 2005

<table>
<thead>
<tr>
<th>Sector</th>
<th>Labor Share Estimates</th>
<th>s.e.</th>
<th>Intermediate Share Estimates</th>
<th>s.e.</th>
<th>Capital Share Estimates</th>
<th>s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>0.278*</td>
<td>0.012</td>
<td>0.597*</td>
<td>0.011</td>
<td>0.125*</td>
<td>0.013</td>
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<tr>
<td>Services</td>
<td>0.395*</td>
<td>0.011</td>
<td>0.387*</td>
<td>0.014</td>
<td>0.218*</td>
<td>0.007</td>
</tr>
</tbody>
</table>
Input-output: BEA input-output accounts,

- Annual from 1997 to 2019

<table>
<thead>
<tr>
<th>Producer</th>
<th>Manufacturing Estimates</th>
<th>s.e.</th>
<th>Consumer Services Estimates</th>
<th>s.e.</th>
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</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>0.678*</td>
<td>0.021</td>
<td>0.195*</td>
<td>0.015</td>
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<tr>
<td>Services</td>
<td>0.322*</td>
<td>0.021</td>
<td>0.805*</td>
<td>0.015</td>
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</table>
## Calibration: Some Parameters and Solving Strategy

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value or Target</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.995</td>
<td>Subjective discount rate</td>
</tr>
<tr>
<td>$h$</td>
<td>0.815</td>
<td>Habit information parameter</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.276</td>
<td>Inverse Frisch elasticity of labor supply</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.95</td>
<td>Survival rate of financial intermediary</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>$1 - 40^{-1}$</td>
<td>Coupon decay parameter / Bond duration</td>
</tr>
<tr>
<td>$\psi_s$</td>
<td>0.8</td>
<td>Fraction of investment externally financed</td>
</tr>
<tr>
<td>$\varsigma_1$</td>
<td>0.212</td>
<td>GDP share of manufacturing sector</td>
</tr>
<tr>
<td>$\xi$</td>
<td>8</td>
<td>Elasticity of substitution</td>
</tr>
<tr>
<td>$\mu_1$</td>
<td>0.25</td>
<td>Probability of no price adjustment in manufacturing sector</td>
</tr>
<tr>
<td>$\mu_2$</td>
<td>0.75</td>
<td>Probability of no price adjustment in service sector</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.579</td>
<td>Fraction of total financial assets that can be diverted by intermediary</td>
</tr>
<tr>
<td>$\theta_s$</td>
<td>1</td>
<td>Recoverability parameter for private bonds of manufacturing sector</td>
</tr>
<tr>
<td>$\theta_b$</td>
<td>1/3</td>
<td>Recoverability parameter for private bonds of service sector</td>
</tr>
</tbody>
</table>

**Solution:** Linear approximation, with Occbin (Guerrieri and Iacoviello, 2015) at ZLB
Impulse Responses at the ZLB

An economy is at the ZLB
Impulse Responses at the ZLB

An economy is at the ZLB

Two cases

• Case 1: No QE purchases

• Case 2: QE purchases
Impulse Responses at the ZLB

An economy is at the ZLB

Two cases
- Case 1: No QE purchases
- Case 2: QE purchases

Plot the difference between the two cases
Figure 2: Benchmark Calibration (Manufacturing: Services: Public = 3:3:1)
Figure 3: Higher Agency Costs in Services (Manufacturing: Services: Public = 2.4:3:1)
In an economy with heterogeneous sectors and input-output structure

- The sector with higher price rigidity tends to expand more due to QE
Summary

In an economy with heterogeneous sectors and input-output structure

- The sector with higher price rigidity tends to expand more due to QE
- Aggregate results are generally unaffected by other heterogeneity at the sectoral level except for agency costs
- Input-output linkages induce comovement and restrict the heterogeneity in sectoral responses
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- The sector with higher price rigidity tends to expand more due to QE

- Aggregate results are generally unaffected by other heterogeneity at the sectoral level except for agency costs

- Input-output linkages induce comovement and restrict the heterogeneity in sectoral responses

- Purchasing bonds with higher agency costs implies larger expansionary in the short-run and larger contractionary effect in the medium run.