Input-Output Matrix of the US Economy

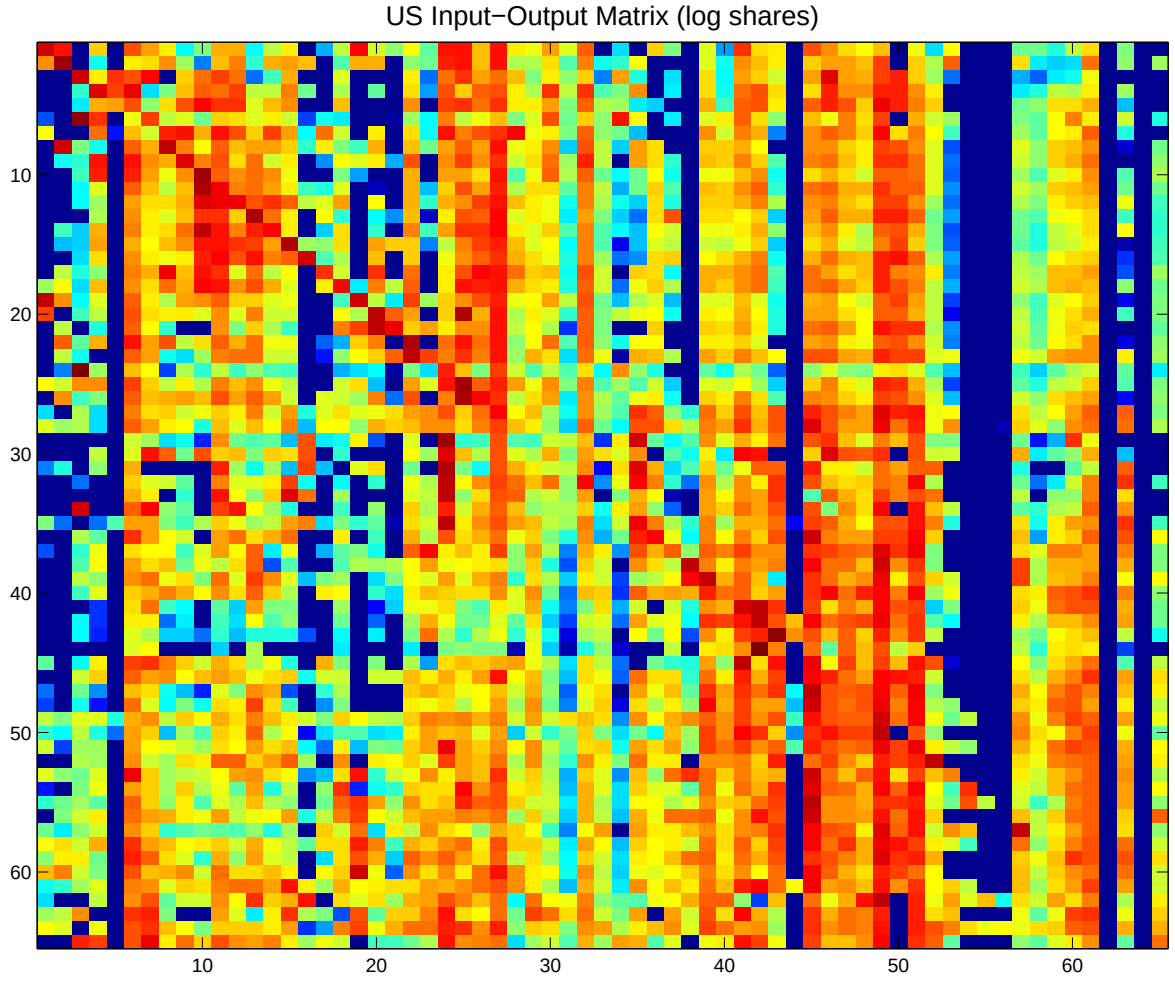

Figure: The US Input-Output Table (2006)

Financial Frictions and Production Networks

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July 13, 2013

Simple Example: consider two economies

- Vertical Economy
- Horizontal Economy

Vertical Economy

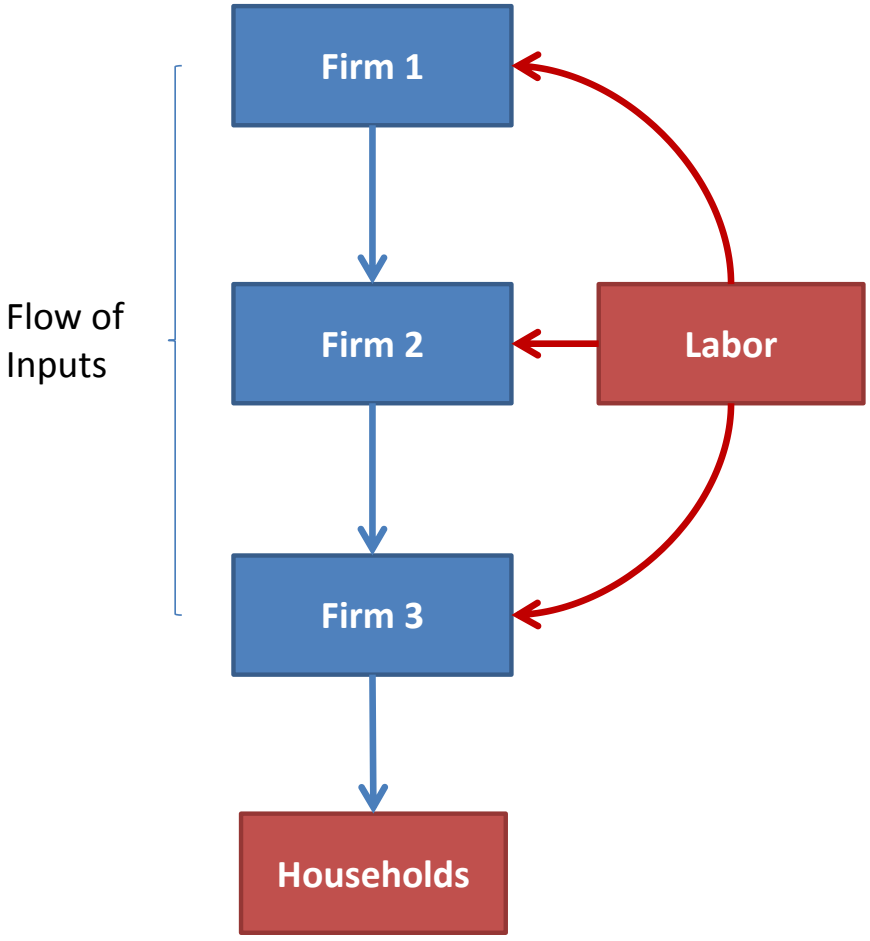

Figure: Diagram of Vertical Network

Vertical Economy

- Three firms. Inputs are labor and intermediate goods

$$
\begin{aligned}
x_1 &= z_1 \ell_1^{\alpha_1} \\
x_2 &= z_2 \ell_2^{\alpha_2} x_1^{\beta_2} \\
x_3 &= z_3 \ell_3^{\alpha_3} x_2^{\beta_3}
\end{aligned}
$$

Vertical Economy

- Three firms. Inputs are labor and intermediate goods

$$\begin{aligned} x_1 &= z_1 \ell_1^{\alpha_1} \\ x_2 &= z_2 \ell_2^{\alpha_2} x_1^{\beta_2} \\ x_3 &= z_3 \ell_3^{\alpha_3} x_2^{\beta_3} \end{aligned}$$

- Final consumption good is output of firm 3

$$Y_v = x_3 = z_3 \ell_3^{\alpha_3} \left(z_2 \ell_2^{\alpha_2} \right)^{\beta_3} \left(z_1 \ell_1^{\alpha_1} \right)^{\beta_2 \beta_3}$$

Horizontal Economy

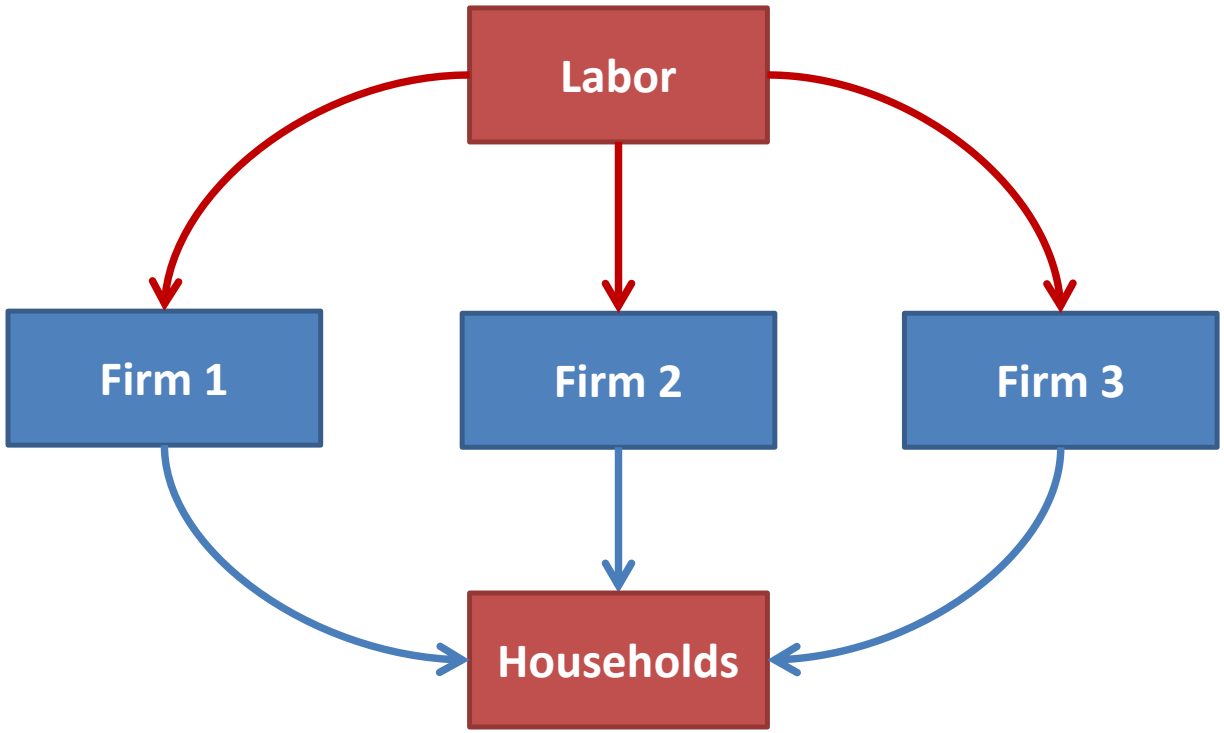

Figure: Diagram of Horizontal Network

Horizontal Economy

- Three firms. Only input is labor

$$
\begin{aligned}
x_1 &= z_1 \ell_1^{\alpha_1} \\
x_2 &= z_2 \ell_2^{\alpha_2} \\
x_3 &= z_3 \ell_3^{\alpha_3}
\end{aligned}
$$

Horizontal Economy

- Three firms. Only input is labor

$$\begin{aligned} x_1 &= z_1 \ell_1^{\alpha_1} \\ x_2 &= z_2 \ell_2^{\alpha_2} \\ x_3 &= z_3 \ell_3^{\alpha_3} \end{aligned}$$

- Final consumption basket normalized so that $Y_h = Y_v$

$$Y_h = x_1^{\beta_2 \beta_3} x_2^{\beta_3} x_3$$

Frictionless Equilibrium

In either economy

$$U(C) - V(L) = \log C - L$$

$$L = \ell_1 + \ell_2 + \ell_3 \qquad \text{and} \qquad Y = C$$

Proposition

The unique equilibrium allocation is identical across the two economies

Introducing Financial Frictions

- Firms face pledgeability constraint

$$\text{expenditure on inputs} \leq \chi \text{ revenue}$$

Introducing Financial Frictions

- Firms face pledgeability constraint

$$\text{expenditure on inputs} \leq \chi \text{ revenue}$$

horizontal economy $$w\ell_i \leq \chi_i p_i x_i$$

vertical economy $$w\ell_i + p_{i-1} y_{i-1} \leq \chi_i p_i x_i$$

Introducing Financial Frictions

- Firms face pledgeability constraint

$$\text{expenditure on inputs} \leq \chi \text{ revenue}$$

$$\text{horizontal economy} \qquad w\ell_i \leq \chi_i p_i x_i$$

$$\text{vertical economy} \qquad w\ell_i + p_{i-1} y_{i-1} \leq \chi_i p_i x_i$$

- These introduce firm level wedges

$$w = \phi_i p_i \alpha_i \frac{x_i}{\ell_i}$$

- Isomorphic to economy with taxes $(1 - \tau_i) = \phi_i$

Main Result: Network Structure Matters

1. The Aggregate Labor Wedge

$$(1 - T)\frac{Y}{L} = \frac{V'(L)}{U'(C)}$$

2. Elasticity of Aggregate Output w.r.t. constraints

3. Aggregate Liquidity needed for any allocation

Main Result: Network Structure Matters

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All are exacerbated by vertical structure!

Aggregate Labor Wedge

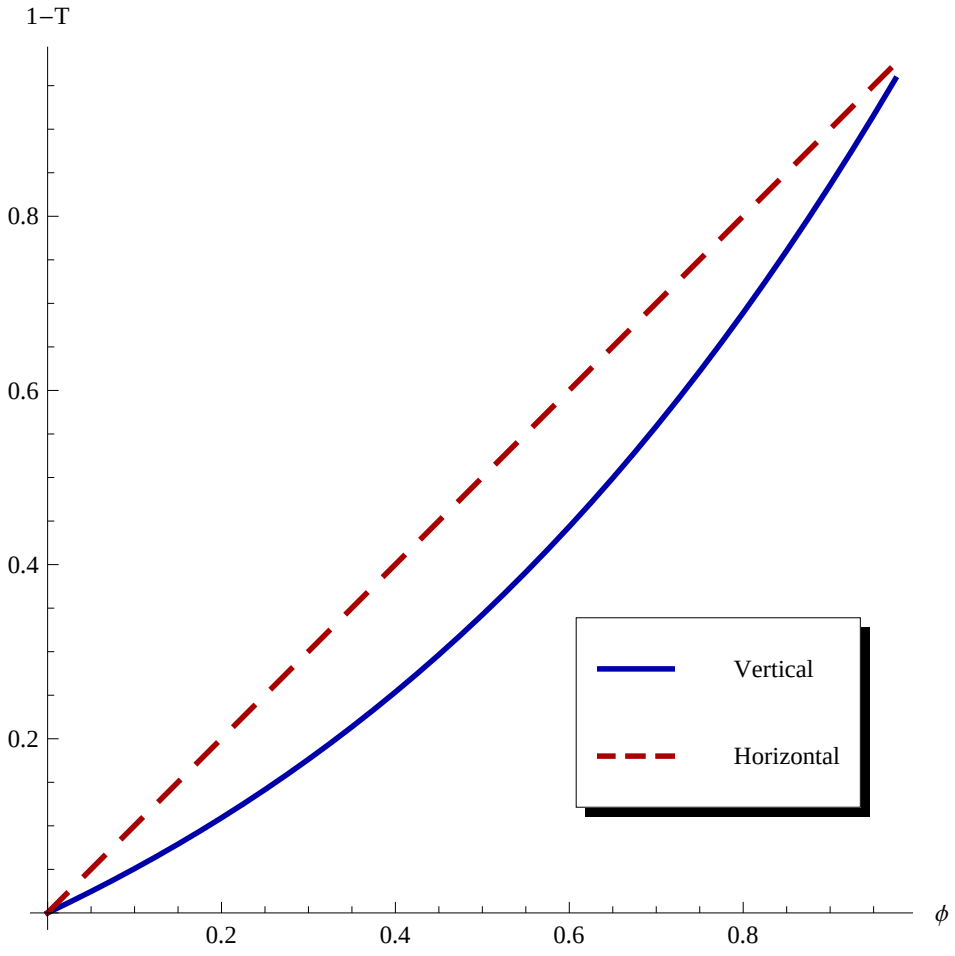

Figure: The Aggregate Labor Wedge

The Network Liquidity Multiplier

Proposition

Elasticity of aggregate output w.r.t. ϕ is greater in the vertical economy

$$\frac{d \log Y_v}{d \log \phi} > \frac{d \log Y_h}{d \log \phi}$$

The Network Liquidity Multiplier

Proposition

Elasticity of aggregate output w.r.t. ϕ is greater in the vertical economy

$$\frac{d \log Y_v}{d \log \phi} > \frac{d \log Y_h}{d \log \phi}$$

- We call the ratio between these

$$\frac{d \log Y_v}{d \log \phi} \Big/ \frac{d \log Y_h}{d \log \phi}$$

the "Network Liquidity Multiplier"

Aggregate Liquidity

Definition

Let M denote the aggregate amount of liquidity in the economy

$$M \equiv \chi_1 p_1 x_1 + \chi_2 p_2 x_2 + \chi_3 p_3 x_3$$

Aggregate Liquidity

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Let M denote the aggregate amount of liquidity in the economy

$$M \equiv \chi_1 p_1 x_1 + \chi_2 p_2 x_2 + \chi_3 p_3 x_3$$

Proposition

Take any feasible allocation $\{\ell_1, \ell_2, \ell_3, L, Y\}$.

The minimum liquidity needed to implement this allocation is greater in the vertical economy

$$M_v > M_h$$

General Network and Calibration

General Network Economy

- follow Jones (2011), Acemoglu et al (2012), Long and Plosser (1983)
- households

$$U(C) = \frac{C^{1-\gamma}}{1-\gamma} \qquad V(L) = \frac{L^{1+\epsilon}}{1+\epsilon}$$

$$C \equiv \prod_{i=1}^{n} c_i^{\beta_i}$$

- n production sectors

$$x_i = \left[z_i^{\eta_i} \ell_i^{\eta_i} \left(\prod_{j=1}^{n} x_{ij}^{w_{ij}} \right)^{1-\eta_i} \right]^{\alpha_i}$$

$$\max_{\ell_i, x_i} p_i x_i - h\ell_i - \sum_{j=1}^{n} p_j x_{ij}$$

$$h\ell_i + \sum_{j=1}^{n} p_j x_{ij} \leq \phi_i p_i x_i$$

Calibrated Financial Wedges

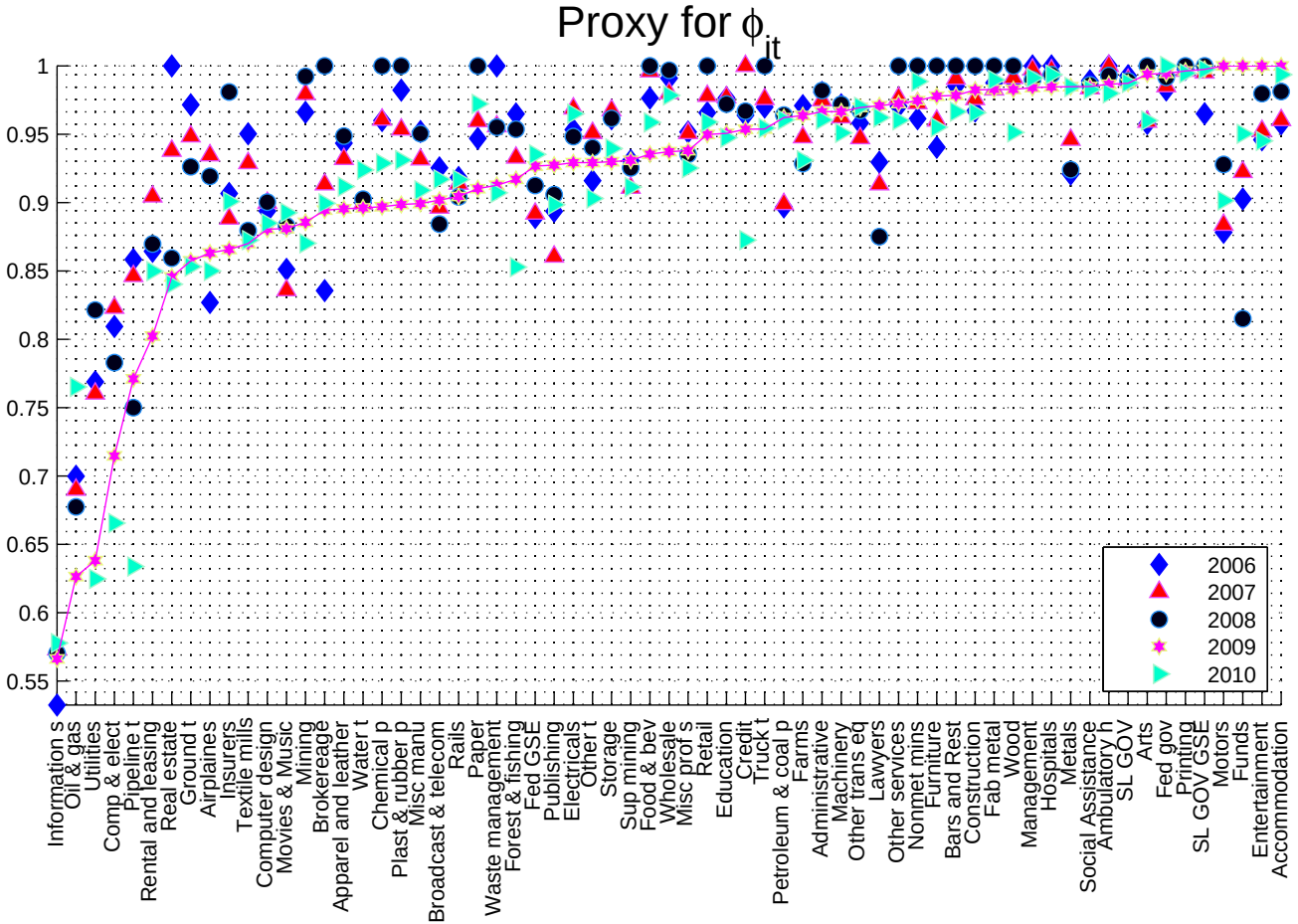
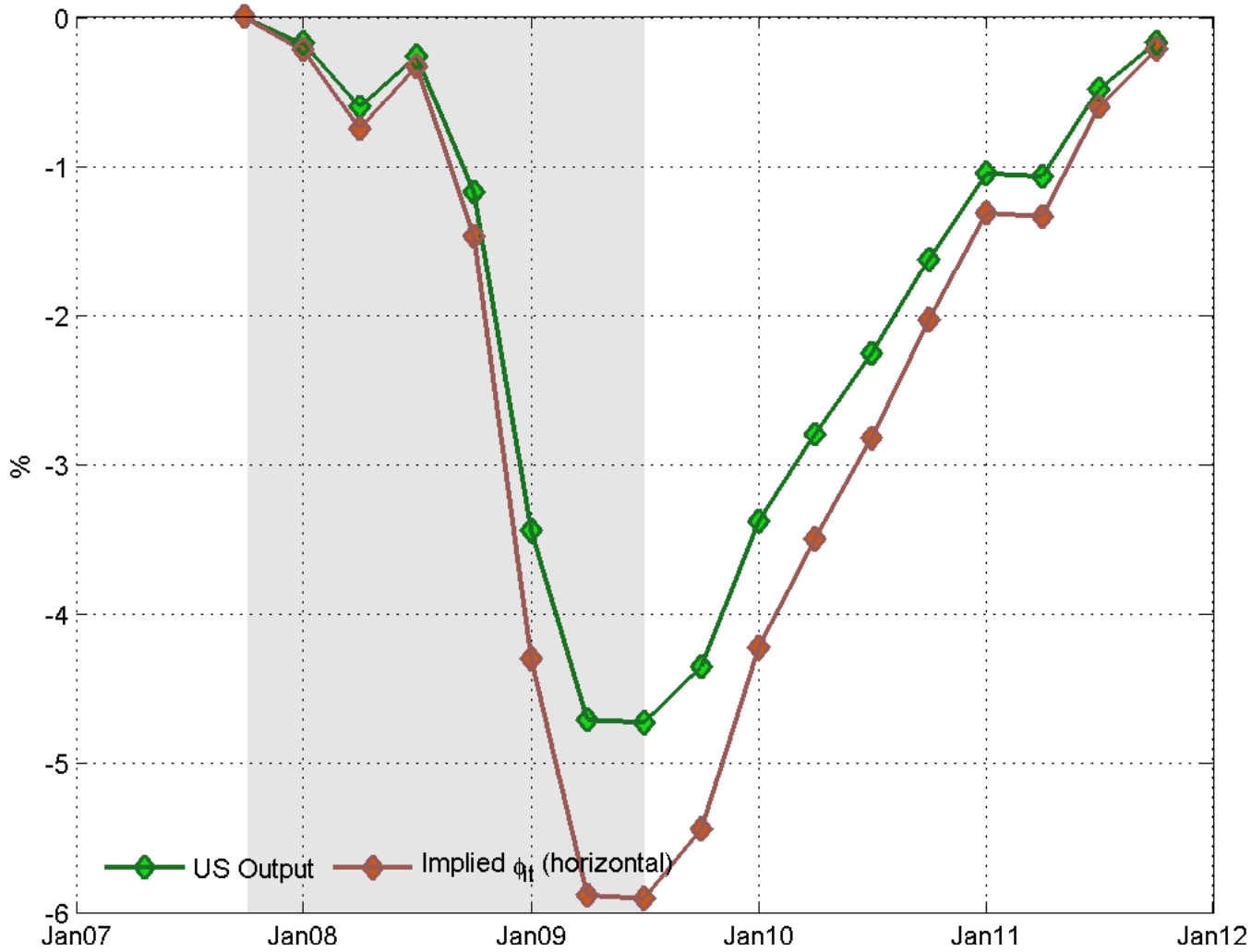


Figure: Calibrated ϕs

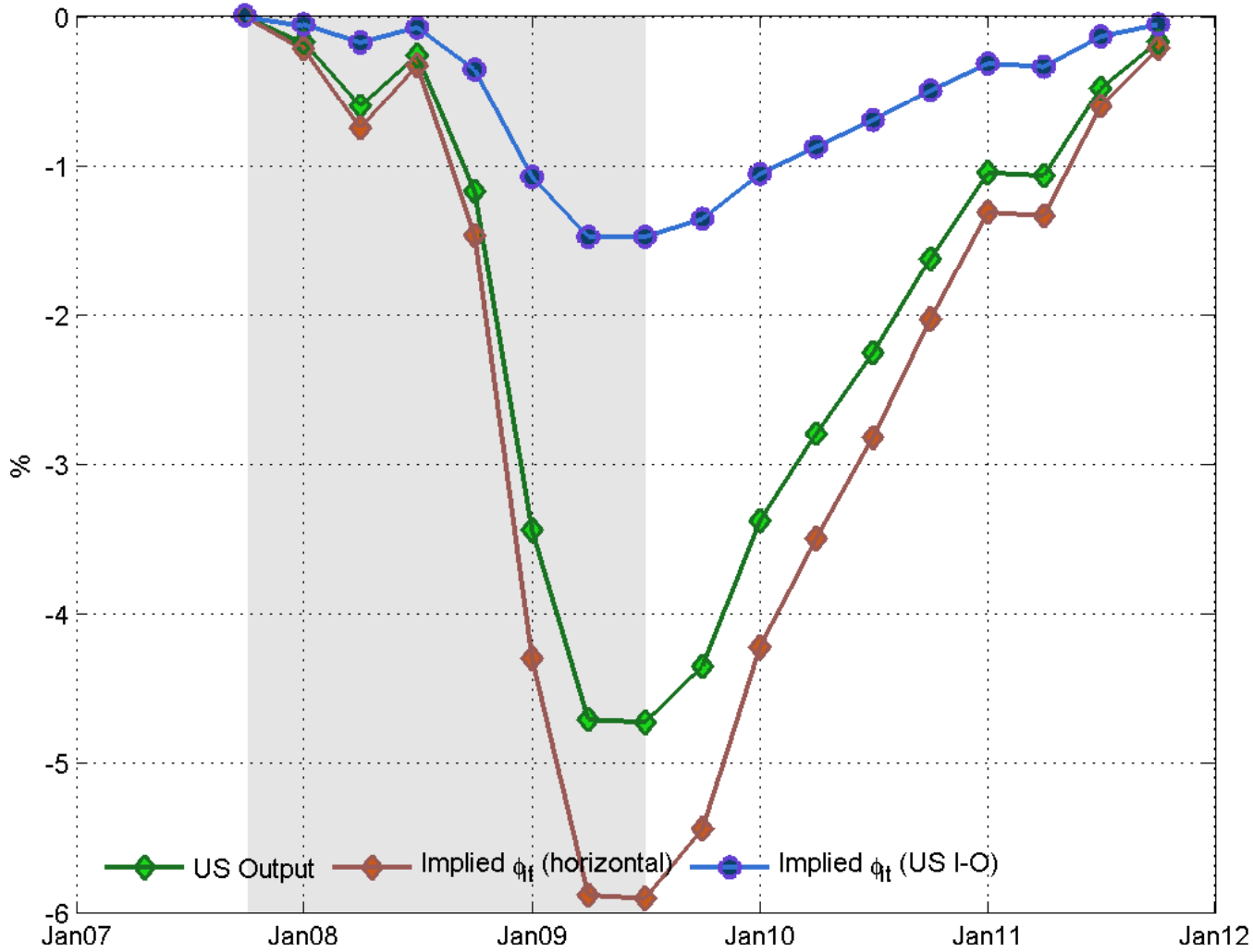
The Interconnected Economy

Sector hit	Impact 1	Impact 2	Impact 3	Impact 4
Motors	Metals	Fab. Metal	Mining	Electricals
Utilities	Oil, Gas	Pipelines	Petrol, Coal	Rails
Construction	Mining	Non Metals	Forestry	Electricals
Printing	Paper	Forestry	Storage	Transportation
Broadcast/ Telecom	Movies, Music	Arts	Electricals	Forestry

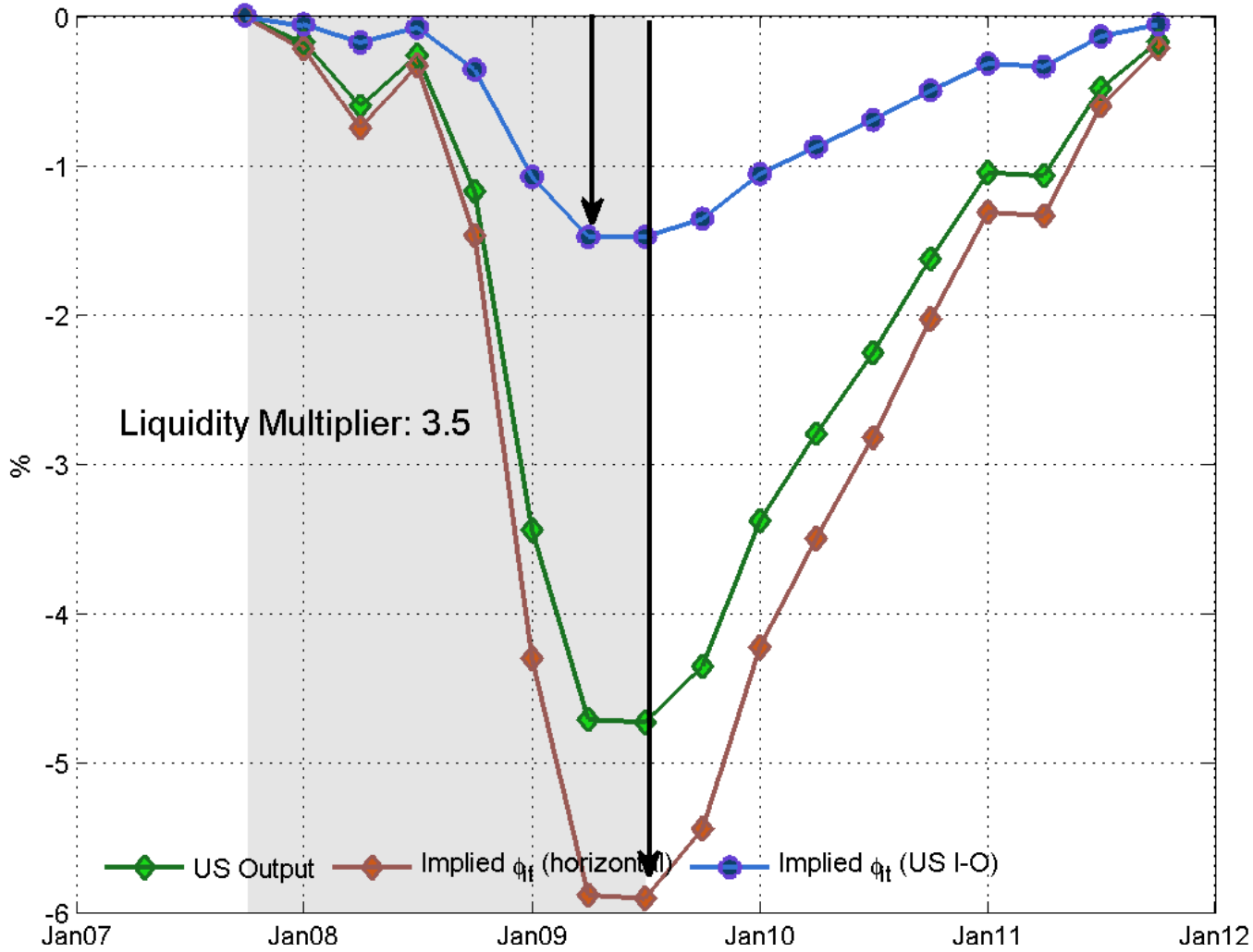
The U.S. Network Liquidity Multiplier



The U.S. Network Liquidity Multiplier



The U.S. Network Liquidity Multiplier



Extra Slides

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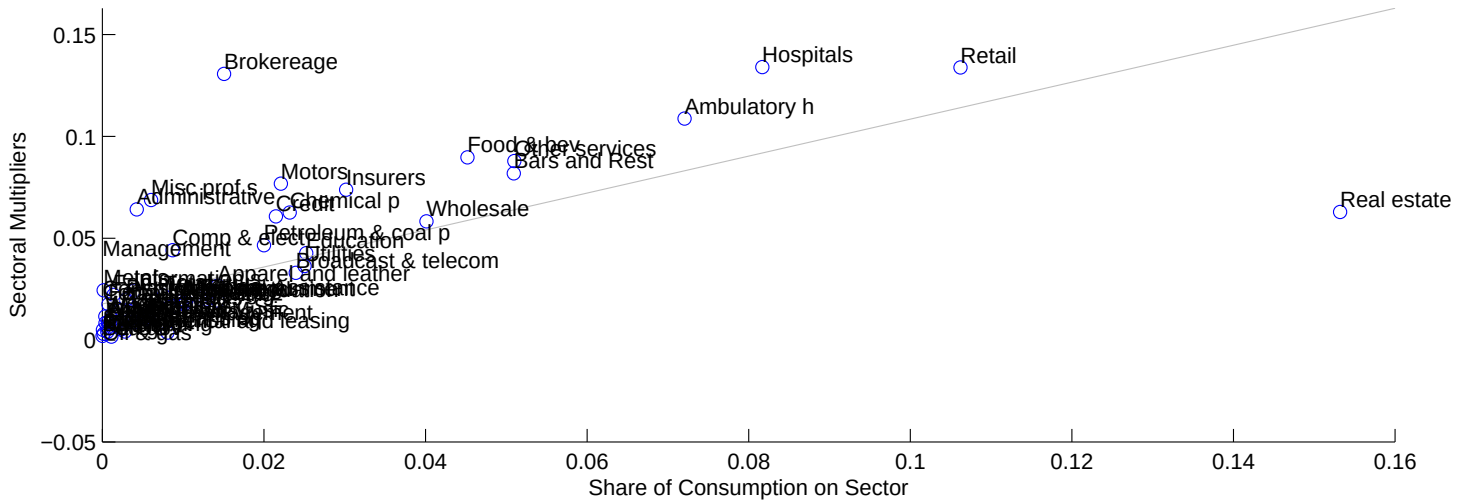
Brokereage
Hospitals
Retail
Ambulatory h
Food & bev
Other services
Bars and Rest
Motors
Insurers
Misc prof s
Administrative
Chemical p
Credit
Wholesale
Real estate
Comp & elect
Petroleum & coal p
Education
Management
Utilities
Broadcast & telecom
Apparel and leather
Finance
Sectoral Multipliers
Share of Consumption on Sector
0.15
0.1
0.05
0
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0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

Figure:

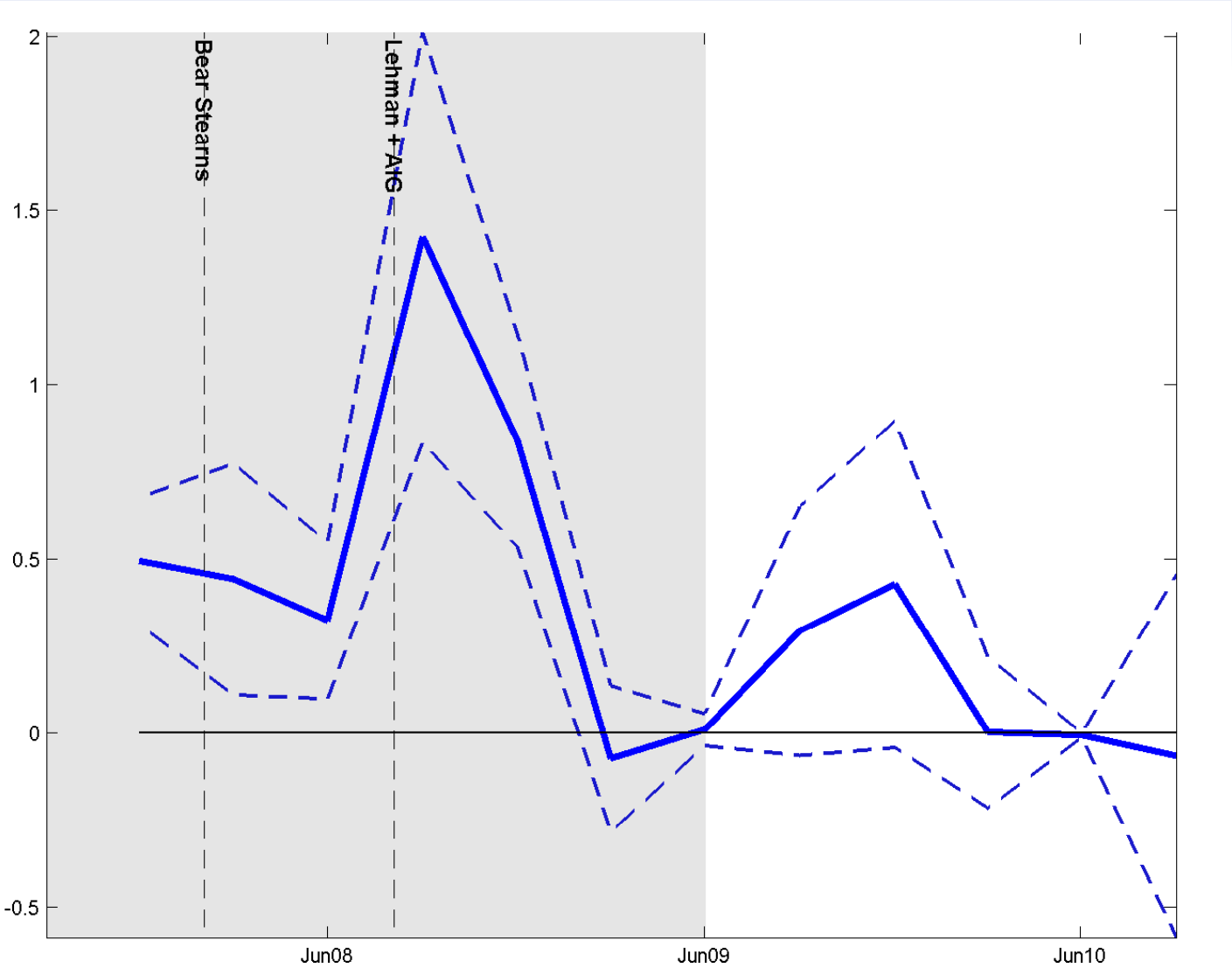
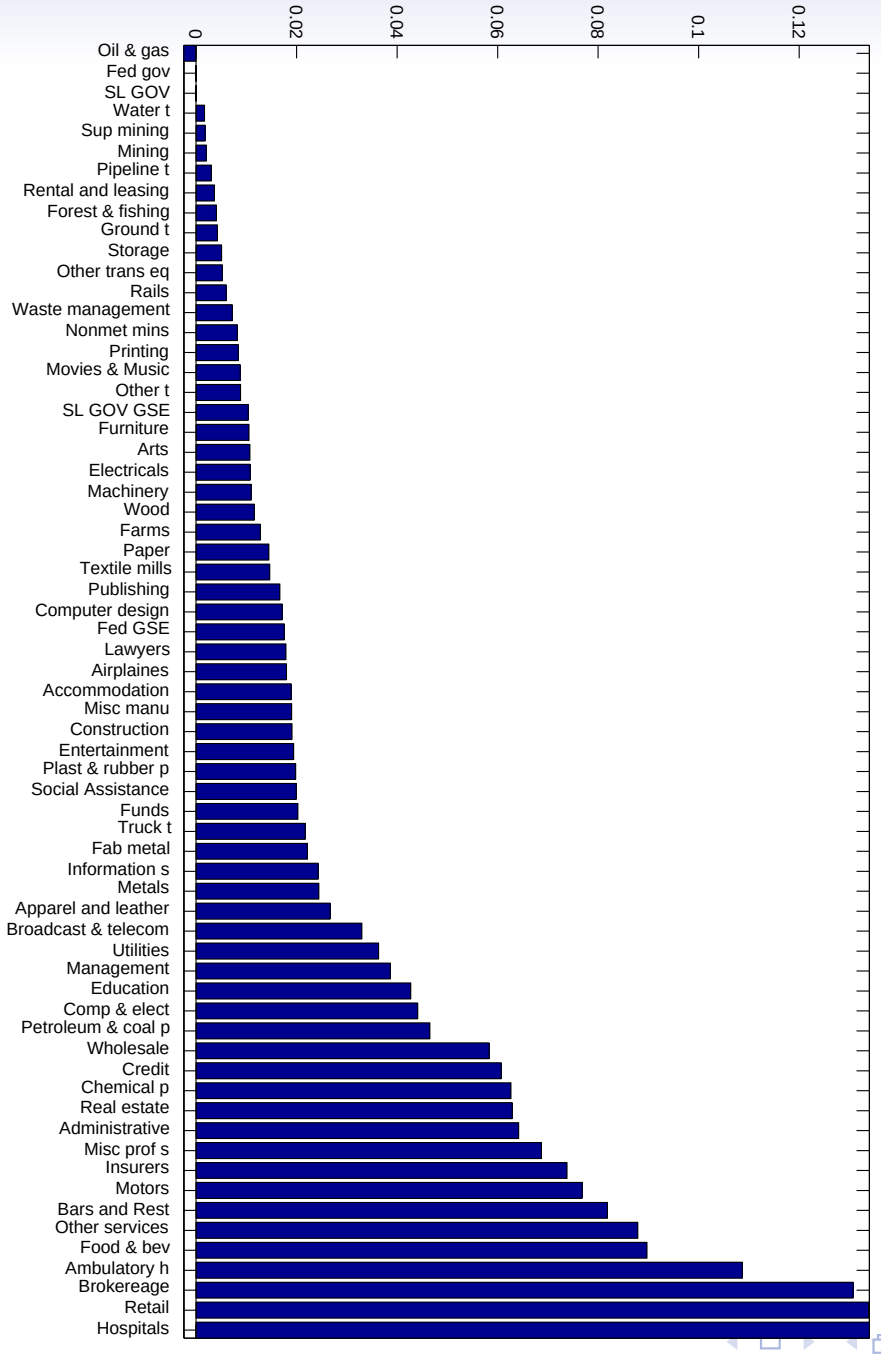


Figure:

Sector Hit	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5
Farms	Forest & fishing	Wood	Petroleum & coal p	Oil & gas	Mining
Forest & fishing	Fed GSE	Computer design	Brokereage	Management	Comp & elect
Oil & gas	Sup mining	Rental and leasing	Construction	Fab metal	Mining
Mining	Sup mining	Rails	Rental and leasing	Truck t	Management
Sup mining	Rental and leasing	Management	Machinery	Lawyers	Misc prof s
Utilities	Oil & gas	Pipeline t	Petroleum & coal p	Rails	Airplaines
Construction	Mining	Nonmet mins	Forest & fishing	Electricals	Fab metal
Wood	Forest & fishing	Other t	Management	Truck t	Farms
Nonmet mins	Mining	Truck t	Other t	Management	Storage
Metals	Mining	Wholesale	Management	Utilities	Computer design
Fab metal	Metals	Mining	Management	Wholesale	Computer design
Machinery	Wholesale	Management	Brokereage	Computer design	Funds
Comp & elect	Fed GSE	Storage	Other t	Social Assistance	Insurers
Electricals	Mining	Wholesale	Management	Other t	Nonmet mins
Motors	Metals	Fab metal	Mining	Electricals	Plast & rubber p
Other trans eq	Management	Fab metal	Computer design	Storage	Comp & elect
Furniture	Forest & fishing	Metals	Fab metal	Mining	Textile mills
Misc manu	Metals	Mining	Fab metal	Fed GSE	Paper
Food & bev	Forest & fishing	Farms	Paper	Mining	Wood
Textile mills	Chemical p	Mining	Petroleum & coal p	Oil & gas	Farms
Apparel and leather	Information s	Computer design	Management	Storage	Brokereage
Paper	Forest & fishing	Mining	Utilities	Rails	Truck t
Printing	Paper	Forest & fishing	Storage	Other t	Machinery
Petroleum & coal p	Oil & gas	Utilities	Rental and leasing	Sup mining	Pipeline t
Chemical p	Mining	Petroleum & coal p	Rails	Rental and leasing	Management
Plast & rubber p	Forest & fishing	Management	Rails	Computer design	Brokereage
Wholesale	Storage	Brokereage	Computer design	Other t	Management
Retail	Fed GSE	Information s	Brokereage	Computer design	Storage
Airplaines	Other t	Petroleum & coal p	Oil & gas	Pipeline t	Ground t
Rails	Rental and leasing	Management	Computer design	Other t	Lawyers
Water t	Other t	Petroleum & coal p	Oil & gas	Storage	Waste managemen
Truck t	Other t	Petroleum & coal p	Oil & gas	Storage	Administrative
Ground t	Fed GSE	Storage	Petroleum & coal p	Other t	Oil & gas
Pipeline t	Machinery	Construction	Misc prof s	Oil & gas	Management
Other t	Petroleum & coal p	Oil & gas	Management	Computer design	Other trans eq
Storage	Fed GSE	Computer design	Management	Education	Funds
Publishing	Other t	Printing	Storage	Paper	Ground t
Movies & Music	Other t	Storage	Fed GSE	Comp & elect	Arts
Broadcast & telecom	Movies & Music	Arts	Electricals	Forest & fishing	Misc prof s
Information s	Other t	Storage	Fed GSE	Forest & fishing	Rental and leasing
Credit	Misc prof s	Comp & elect	Ground t	Other t	SL GOV
Brokereage	Computer design	Other t	Storage	Misc prof s	Fed GSE
Insurers	Fed GSE	Comp & elect	Computer design	SL GOV	Printing
Funds	Fed GSE	Computer design	Comp & elect	SL GOV	Lawyers
Real estate	Waste management	Credit	Construction	Mining	Insurers
Rental and leasing	Storage	Insurers	Misc prof s	Other t	Fed GSE
Lawyers	Fed GSE	Storage	Computer design	Education	Other t
Computer design	Fed GSE	Other t	Storage	Ground t	Airplaines
Misc prof s	Fed GSE	Storage	Other t	Ground t	Computer design
Management	Fed GSE	Computer design	Misc prof s	Education	SL GOV
Administrative	Fed GSE	Petroleum & coal p	Management	Forest & fishing	Ground t
Waste management	Machinery	Management	Rental and leasing	Comp & elect	Insurers
Education	Information s	Fed GSE	Brokereage	Computer design	Comp & elect
Ambulatory h	Fed GSE	Information s	Brokereage	Computer design	Comp & elect
Hospitals	Fed GSE	Information s	Brokereage	Computer design	Comp & elect
Social Assistance	Fed GSE	Information s	Brokereage	Computer design	Comp & elect
Arts	Ground t	Fed GSE	Comp & elect	Other t	SL GOV
Entertainment	Fed GSE	Storage	Comp & elect	Hospitals	Motors
Accommodation	Forest & fishing	Fed GSE	Storage	Ground t	Management
Bars and Rest	Forest & fishing	Storage	Comp & elect	Ground t	Farms
Other services	Computer design	Comp & elect	Storage	Other t	Other trans eq
Fed gov	Farms	Forest & fishing	Oil & gas	Mining	Sup mining
Fed GSE	Computer design	Comp & elect	Management	Fed gov	Other trans eq
SL GOV	Farms	Forest & fishing	Oil & gas	Mining	Sup mining
SL GOV GSE	Mining	Construction	Pipeline t	Oil & gas	Other t

Figure:


0
0.02
0.04
0.06
0.08
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0.12
Oil & gas
Fed gov
SL GOV
Water t
Sup mining
Mining
Pipeline t
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Storage
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Nonmet mins
Printing
Movies & Music
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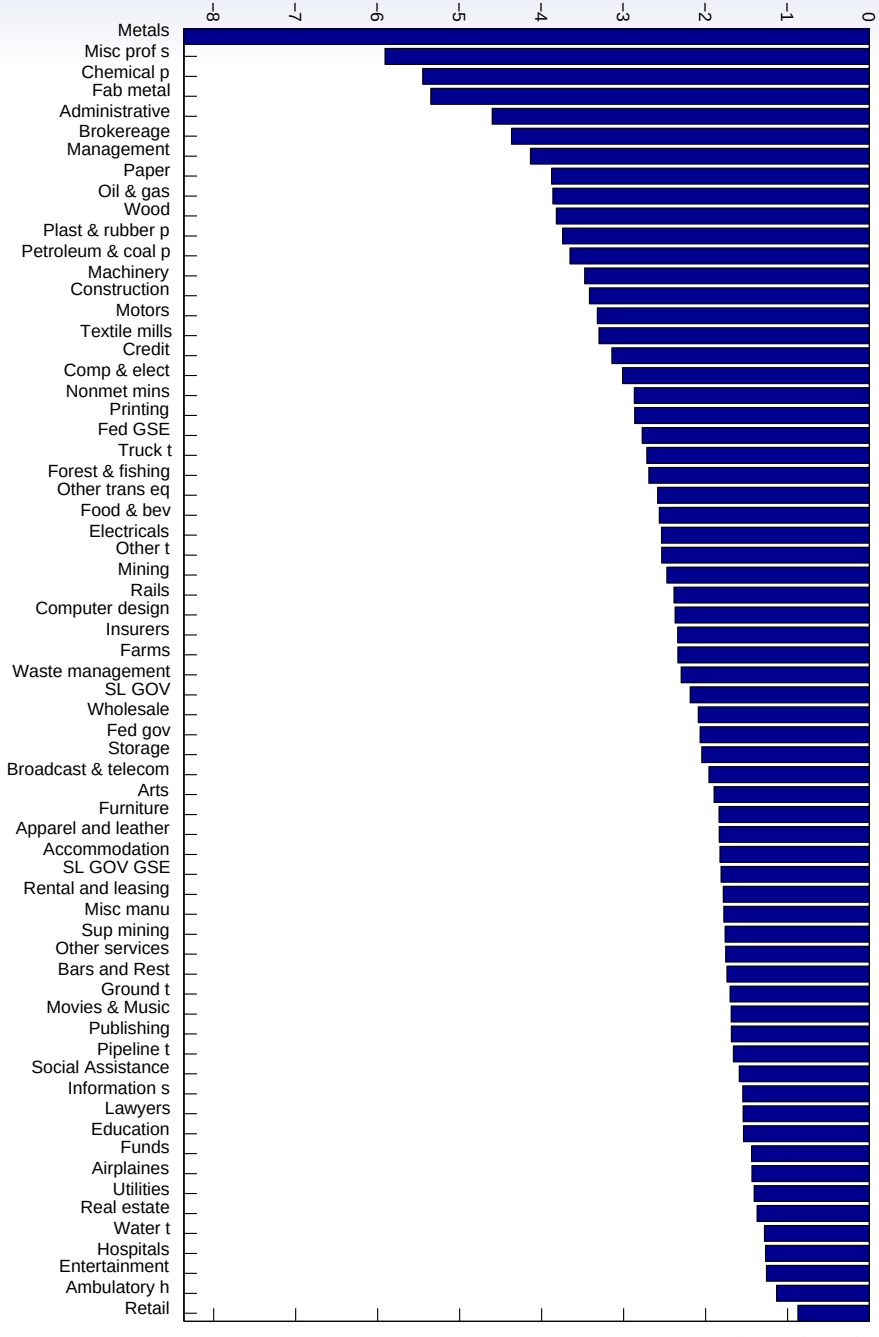
Arts
Electricals
Machinery
Wood
Farms
Paper
Textile mills
Publishing
Computer design
Fed GSE
Lawyers
Airplaines
Accommodation
Misc manu
Construction
Entertainment
Plast & rubber p
Social Assistance
Funds
Truck t
Fab metal
Information s
Metals
Apparel and leather
Broadcast & telecom
Utilities
Management
Education
Comp & elect
Petroleum & coal p
Wholesale
Credit
Chemical p
Real estate
Administrative
Misc prof s
Insurers
Motors
Bars and Rest
Other services
Food & bev
Ambulatory h
Brokereage
Retail
Hospitals


−8
−7
−6
−5
−4
−3
−2
−1
0
Metals
Misc prof s
Chemical p
Fab metal
Administrative
Brokereage
Management
Paper
Oil & gas
Wood
Plast & rubber p
Petroleum & coal p
Machinery
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Retail

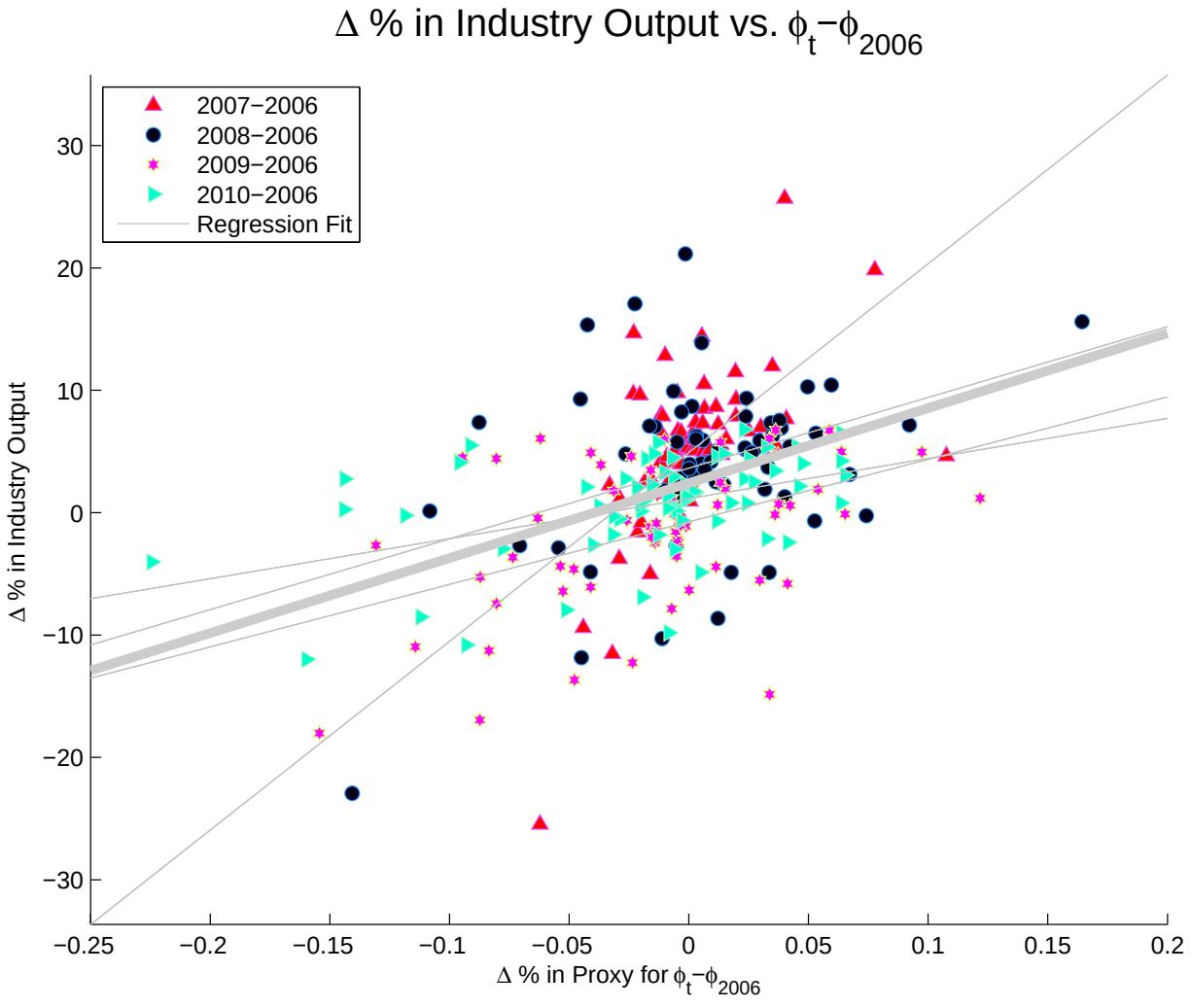
Δ % in Industry Output vs. $\phi_t - \phi_{2006}$
2007−2006
2008−2006
2009−2006
2010−2006
Regression Fit
Δ % in Industry Output
Δ % in Proxy for $\phi_t - \phi_{2006}$
30
20
10
0
−10
−20
−30
−0.25
−0.2
−0.15
−0.1
−0.05
0
0.05
0.1
0.15
0.2

Figure:

	(1)	(2)
$\phi_{i,t} - \phi_{i,2006}$	1105.1606	44.0621
	$(7.6328e-07)$	$(1.2858e-08)$
$\beta_{i,t} - \beta_{i,2006}$		777.0462
		$(8.8635e-05)$
Neighbor 1		24.7274
		$(8.1866e-06)$
Neighbor 2		14.448
		(0.010027)
Neighbor 3		19.7989
		(0.00088182)
Neighbor 4		12.355
		(0.029164)
Neighbor 5		7.148
		(0.22418)
R^2	0.087051	0.32592