

CONSUMPTION NETWORK EFFECTS

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Motivation

- Consumption may be influenced by socially proximate agents (Veblen, 1899; Duesenberry, 1948)
- It is hard to find clean evidence of "peer effects"
 - peers definition
 - identification
- Policy relevance
 - social multiplier effects
 - intertemporal and/or intratemporal distortions

Our goals

- **Test** if and how much social interactions matter for explaining consumption
- Investigate the possible **mechanisms** behind our findings
 - Keeping Up with the *Jensens* (KUJ)
 - Conspicuous Consumption (CC)
 - Risk Sharing
- Understand **aggregate implications** of consumption network effects

Our paper

- Previous work: Maurer and Meier (2008); Charles et al., (2009); Kuhn et al. (2011); Ravina (2010); Bertrand and Morse (2015); Agarwal et al. (2016); among many
- Our contribution
 - Co-workers as a reference group
 - Adult-life equivalent of class-mates
 - Spend more time with co-workers than with family members
 - Evidence from sociology - friendship as determinant of co-worksip (Granovetter, 1995)
 - Data
 - Administrative tax records on Danish households
 - Use network structure to tackle identification problem - spouses add *nodes* to otherwise isolated networks
 - Use a household consumption survey to investigate mechanisms

Outline of Talk

- Data
- Mechanisms
- Identification
- Results
- Implications

Data (1)

- Administrative longitudinal tax records for the Danish population (1980-1996)
- Match these data with IDA, an employer-employee data set, which includes demographics and firm ID (plant level) $\Rightarrow$ Co-workers
 - Peers are co-workers in the same plant, weighted by "similarity distance" (education and occupation) ([Details](#))
- Match tax records also with the DES, a CEX-type cross-sectional survey (1994-96)

Data (2)

- Household heads aged 18-65 (Descriptives)
 - Focus on couples where both spouses working
 - Drop couples where spouses are working in the same plant
 - (Peer variables includes *all* households - no selection)
- Consumption *not* measured in administrative tax data.
 - We use the dynamic budget constraint to calculate total spending
 - Between 1980 and 1996, households paid a tax on assets
 - Consumption is calculated as the difference between after-tax annual income (from all sources) and asset changes

$$C_{ht} = Y_{ht} - \Delta A_{ht}$$

- Similar to Browning and Leth-Petersen (2005) (Details)
- We use the DES primarily to investigate the "mechanisms" behind our findings

- Why should peer consumption affect individual consumption?
 - Preference shifters
 - Budget constraint shifters

General Representation of Preferences

- Follow Blundell et al. (1994). Problem of consumer is to:

$$\max \sum_{t=0}^T U_t$$

- where U_t is the conditional indirect utility function

$$U_t = F_t \left(V_t \left(p_t, C_{it}, z_{it}^1 \right), z_{it}^2 \right) + H \left(z_{it}^3 \right)$$

- $C_{it} = p_t' q_{it}$
- $z_{it} = (z_{it}^1, z_{it}^2, z_{it}^3)$ is a vector of conditioning goods (peer consumption $\bar{C}$ may be one of those)
- $V_t(\cdot)$ governs within-period allocation of C_{it} to goods q_{it}
- U_t determines intertemporal allocation

Intratemporal vs. Intertemporal choice

- Intratemporal choice is given by **demand functions**. From Roy identity:

$$\left(q_{it}^k\right)^* = -\frac{\partial V(.) / \partial p_t^k}{\partial V(.) / \partial C_{it}}$$

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$$\left(q_{it}^k\right)^* = -\frac{\partial V(.) / \partial p_t^k}{\partial V(.) / \partial C_{it}}$$

- Intertemporal choice is given by **Euler equation** :

$$\begin{aligned}\frac{\partial U_{t+1}(.)}{\partial C_{it+1}} &= (1+r)^{-1} \frac{\partial U_t(.)}{\partial C_{it}}, \text{ or} \\ \frac{\partial F_{t+1}}{\partial V_{t+1}} \frac{\partial V_{t+1}}{\partial C_{it+1}} &= (1+r)^{-1} \frac{\partial F_t}{\partial V_t} \frac{\partial V_t}{\partial C_{it}}\end{aligned}$$

Tests

- From:

$$U_t = F_t \left(V_t \left(p_t, C_{it}, z_{it}^1 \right), z_{it}^2 \right) + H \left(z_{it}^3 \right)$$

- **Three cases** of interest:

Tests

- From:

$$U_t = F_t \left(V_t \left(p_t, C_{it}, z_{it}^1 \right), z_{it}^2 \right) + H \left(z_{it}^3 \right)$$

- Three cases of interest:

1. $\bar{C}$ enters only in $z^3 \Rightarrow$ traditional atomistic agent model

	$\bar{C} \in z^3$		
$\bar{C}$ in demand functions	No		
$\bar{C}$ in Euler equation	No		



Details

- From:

$$U_t = F_t \left(V_t \left(p_t, C_{it}, z_{it}^1 \right), z_{it}^2 \right) + H \left(z_{it}^3 \right)$$

- Three cases of interest:

2. $\bar{C}$ enters z^2 but not $z^1 \Rightarrow$ intertemporal distortions (KUJ) (Browning and Meghir, 1991)

	$\bar{C} \in z^3$	$\bar{C} \in z^2, \bar{C} \notin z^1$	
$\bar{C}$ in demand functions	No	No (Controlling for C)	
$\bar{C}$ in Euler equation	No	Yes	

Tests

- From:

$$U_t = F_t \left(V_t \left(p_t, C_{it}, z_{it}^1 \right), z_{it}^2 \right) + H \left(z_{it}^3 \right)$$

- Three cases of interest:

3. $\bar{C}$ enters in $z^1 \Rightarrow$ intratemporal distortions (CC)

	$\bar{C} \in z^3$	$\bar{C} \in z^2, \bar{C} \notin z^1$	$\bar{C} \in z^1$
$\bar{C}$ in demand functions	No	No (Controlling for C)	Yes
$\bar{C}$ in Euler equation	No	Yes	Yes



Details

Risk Sharing

- **Full risk sharing** implies my consumption and average consumption of reference group move in locksteps (Townsend, 1994; Mace, 1991)
- Suppose partial risk sharing implemented through side transfers
 - People with $\Delta Y > 0$ ($\Delta Y < 0$) make (receive) a transfer
- We have two measures of consumption:
 - from tax records: $C^T = Y - \Delta A$ (no side transfers recorded)
 - from survey: $C^S = p'q$ (reflecting side transfers)
- Test whether $cov(C^S - C^T, \Delta Y) < 0$ and $cov(C^S - C^T, \overline{\Delta Y}) > 0$.

Empirical Strategy

- 1 Estimate Euler equation and test for consumption network effects
- 2 Estimate demand equations and test for exclusion of consumption network effects (conditioning on total spending)
- 3 Estimate risk sharing regressions

Identification: Linear-in-means model (1)

Standard Manski's problem (1993) enriched to allow for multiplexity

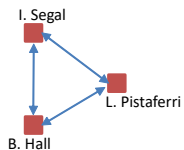
$$\Delta c_{i,t} = \alpha + \theta_1 \Delta \overline{c_{i,t}^w} + \theta_2 \Delta \overline{c_{i,t}^h} + \gamma_1 \overline{X_{i,t}^w} + \gamma_2 \overline{X_{i,t}^h} + \delta_1 X_{i,t}^w + \delta_2 X_{i,t}^h + \varepsilon_{i,t}$$

- Where i, t, w, h indicate household, time, wife and husband respectively.
 - $\overline{c_{i,t}^w}, \overline{c_{i,t}^h}$: (average) logged (per adult equivalent) consumption levels of the wife's and husband's co-workers;
 - $\overline{X_{i,t}^w}, \overline{X_{i,t}^h}$: (average) characteristics of the wife's and husband's co-workers;
 - $X_{i,t}^w, X_{i,t}^h$: the wife's and husband's observable characteristics (permanent income determinants)
- Main parameters of interest:
 - θ' s: *endogenous effect*
 - γ' s: *contextual effects*
 - δ' s: ancillary parameters of interest
 - *Correlated effects through $\varepsilon_{i,t}$*
 - First-differencing has already eliminated fixed unobserved heterogeneity (correlated effects induced by sorting into firms/networks)

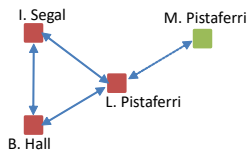
Identification: Linear-in-means model (2)

- Identification of the parameters of interest in this model is notoriously problematic:
 - **Reflection problem** → Simultaneity
 - Correlated effects
- Our approach (Bramoullé et al., 2009; Calvó-Armengol et al., 2009; De Giorgi et al., 2010):
 - Assume networks do not perfectly overlap
 - Construct the network of co-workers (distance-1 peers), co-workers' spouses (distance-2), co-workers of co-workers' spouses (distance-3), and so on.
 - "Valid" instruments for co-workers' ("distance-1") consumption: The X 's of distance-3 peers.

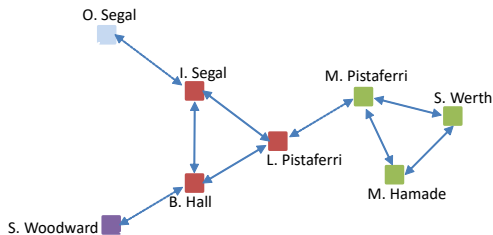
Identification: the Stanford Example –Luigi's coworkers



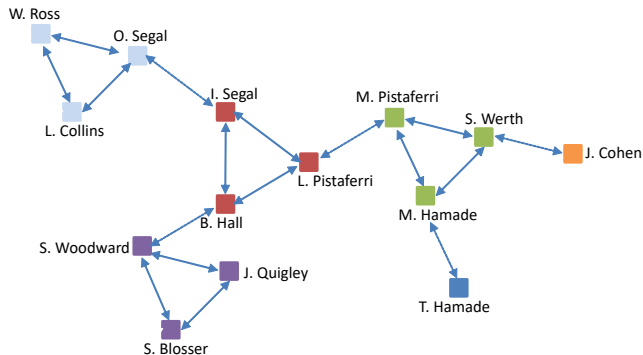
Identification: the Stanford Example –Luigi (d-1)



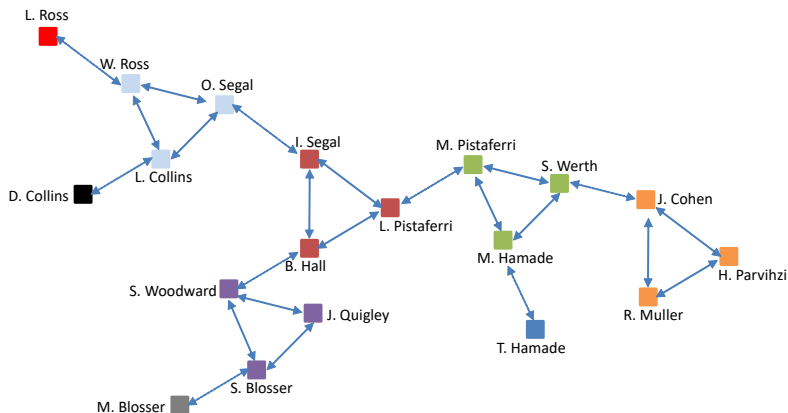
Identification: the Stanford Example –Luigi (d-2)



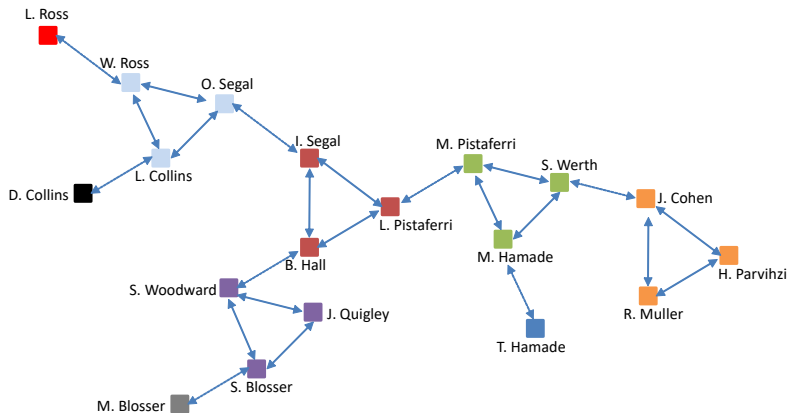
Identification: the Stanford Example –Luigi (d-3)



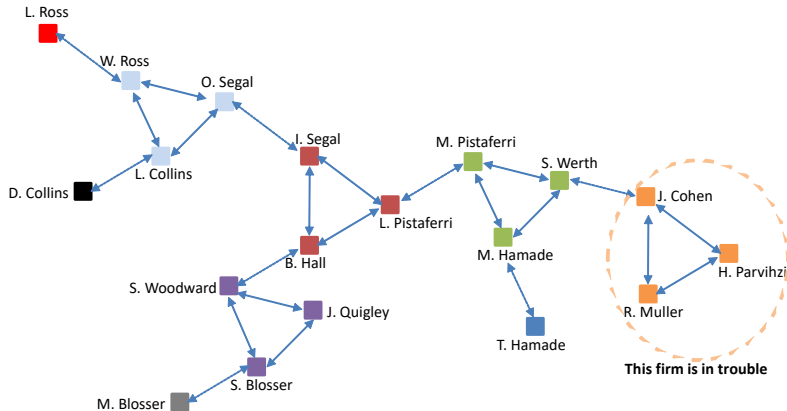
Identification: the Stanford Example –Luigi (d-4)



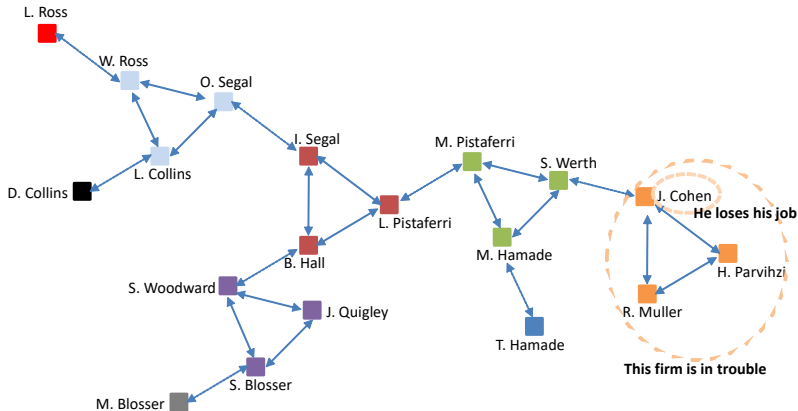
Identification: A graphical example



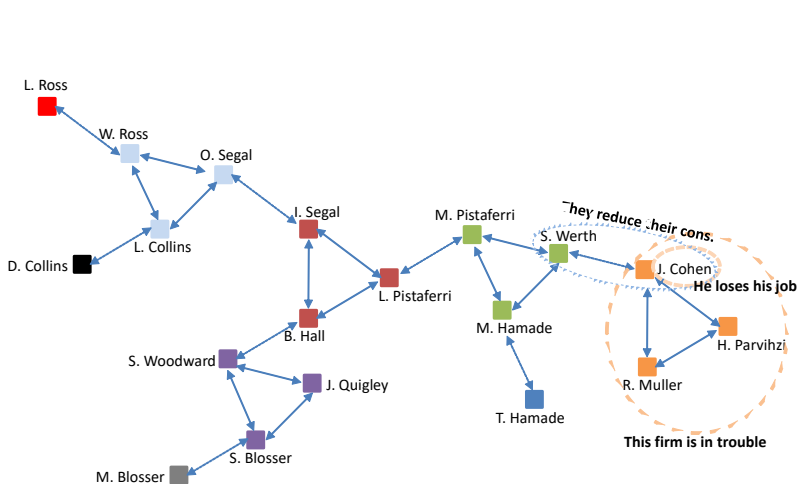
Identification: A graphical example



Identification: A graphical example



Identification: A graphical example



Identification: A General Model (1)

- Identification strategy extends Bramoullé et al. (2009), Calvó-Armengol et al. (2009), De Giorgi et al. (2010): It relies on the network structure
- In matrix notation, individual level analysis:

$$\Delta \mathbf{c} = \theta \mathbf{G} \Delta \mathbf{c} + \gamma \mathbf{G} \mathbf{X} + \delta \mathbf{X} + \varepsilon$$

where $\mathbf{G}$ is a $n \times n$ adjacency matrix with generic element

$g_{ij} = \mathbf{1}\{1/(n_f - 1) \text{ if } i, j \text{ co-workers}\}$, with n_f the size of i 's firm, and $i, j = 1, \dots, n$

- Reduced form (no worker is isolated) of above model is:

$$\Delta \mathbf{c} = (\mathbf{I} - \theta \mathbf{G})^{-1} (\gamma \mathbf{G} + \delta) \mathbf{X} + (\mathbf{I} - \theta \mathbf{G})^{-1} \varepsilon$$

Identification: A General Model (2)

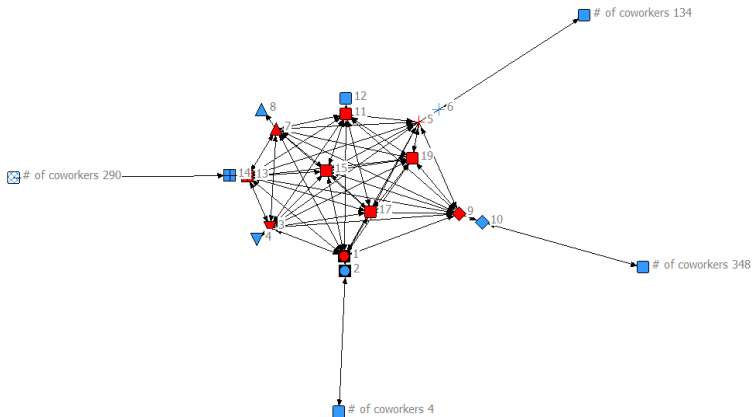
- Recall that $(\mathbf{I} - \theta \mathbf{G})^{-1} = \sum_{k=0}^{\infty} \theta^k \mathbf{G}^k$, for $|\theta| < 1$. Expand (2^{nd} term) and rearrange to yield:

$$\Delta \mathbf{c} \approx \delta \mathbf{X} + (\gamma + \theta \delta) \mathbf{G} \mathbf{X} + (\gamma + \theta \delta) \theta \mathbf{G}^2 \mathbf{X} + \theta^2 \gamma \mathbf{G}^3 \mathbf{X} + \mathbf{v}$$

- As long as $(\gamma + \theta \delta) \neq 0$ and $\mathbf{G}, \mathbf{G}^2, \mathbf{G}^3$ linearly independent (partially overlapping networks) — then the 3 parameters of interest are identified
- Note:
 - In our context identification requires availability of co-workers of co-workers' spouses (or distance-3 nodes, as we consider husband and wife to be distance-1 peers)
 - Our case is more complex as we have multiplexity within the household (husband and wife separate networks)

- [Technical Details](#)

An actual network in our data



Results: Euler Equation Estimates

	Table 4: Baseline Results				
	OLS-FD (1)	IV-FD (2)	IV-FD (3)	IV-FD (4)	IV-FD (5)
Wife's peers ln C	0.11*** (0.002)	0.26** (0.113)	0.30* (0.163)	0.27** (0.114)	0.31* (0.164)
Husband's peers ln C	0.13*** (0.003)	0.39*** (0.111)	0.37** (0.182)	0.39*** (0.111)	0.37** (0.182)
Local unempl. rate				YES	YES
P-value equal effects H/W	0.000	0.504	0.819	0.530	0.853
Demographic IV's		YES		YES	
Firm IV's		YES	YES	YES	YES
F-stat first stage wife		44.16	78.34	48.55	76.34
F-stat first stage husband		43.14	59.88	47.32	59.50
Observations	2,671,889	2,671,889	2,671,889	2,671,889	2,671,889

Dependent variable: Log of adult equivalent consumption. **Individual controls:** Age, Age sq., Years of schooling, Occupation dummies, Industry dummies, Public sector dummy, Firm size, Firm growth, Firm type dummies. **Household controls:** Year dummies, Region dummies, # kids 0-6, # kids 7-18.. **Contextual controls:** Age, Age², Years of schooling, Share of female peers, share of female peers, shares of peers by occupation, # kids 0-6, # kids 7-18. **Demographic IV's:** Age, Age sq., Years of schooling, # kids 0-6, # kids 7-18, share of female peers, shares of peers by occupation. **Firm IV's:** Public sector dummy, Firm size, Firm growth, Firm type dummy.. *, **, ***=significant at 10%, 5%, 1%.

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Implied "random peer" elast.	[0.0012]	[0.0027]	[0.0032]	[0.0028]	[0.0033]
Husband's peers ln C	0.13*** (0.003)	0.39*** (0.111)	0.37** (0.182)	0.39*** (0.111)	0.37** (0.182)
Implied "random peer" elast.	[0.0018]	[0.0053]	[0.0050]	[0.0053]	[0.0050]
Local unempl. rate				YES	YES
P-value equal effects H/W	0.000	0.504	0.819	0.530	0.853
Demographic IV's		YES		YES	
Firm IV's		YES	YES	YES	YES
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Results: (Restricted) Euler Equation Estimates

Model	Table 5: Baseline results				
	(1) OLS-FD	(2) IV-FD	(3) IV-FD	(4) IV-FD	(5) IV-FD
All peers In C	0.12*** (0.002)	0.32*** (0.061)	0.33*** (0.078)	0.33*** (0.061)	0.34*** (0.078)
Local Unemployment Rate				YES	YES
Demographic IV's		YES		YES	
Firm IV's		YES	YES	YES	YES
F-stat first stage		62.87	111.5	62.0	109.5
Number of obs.	2,671,889	2,671,889	2,671,889	2,671,889	2,671,889

Dependent variable: Log of adult equivalent consumption. **Individual controls:** Age, Age sq., Years of schooling, Occupation dummies, Industry dummies, Public sector dummy, Firm size, Firm growth, Firm type dummies. **Household controls:** Year dummies, Region dummies, # kids 0-6, # kids 7-18.. **Contextual controls:** Age, Age², Years of schooling, Share of female peers, share of female peers, shares of peers by occupation, # kids 0-6, # kids 7-18. **Demographic IV's:** Age, Age sq., Years of schooling, # kids 0-6, # kids 7-18, share of female peers, shares of peers by occupation. **Firm IV's:** Public sector dummy, Firm size, Firm growth, Firm type dummy. *, **, ***=significant at 10%, 5%, 1%.

Results: (Restricted) Euler Equation Estimates

Table 5: Baseline results					
Model	(1) OLS-FD	(2) IV-FD	(3) IV-FD	(4) IV-FD	(5) IV-FD
All peers In C	0.12*** (0.002)	0.32*** (0.061)	0.33*** (0.078)	0.33*** (0.061)	0.34*** (0.078)
Implied "random peer" elast.	[0.0014]	[0.0038]	[0.0039]	[0.0039]	[0.0040]
Local Unemployment Rate				YES	YES
Demographic IV's		YES		YES	
Firm IV's		YES	YES	YES	YES
F-stat first stage		62.87	111.5	62.0	109.5
Number of obs.	2,671,889	2,671,889	2,671,889	2,671,889	2,671,889

Dependent variable: Log of adult equivalent consumption. **Individual controls:** Age, Age sq., Years of schooling, Occupation dummies, Industry dummies, Public sector dummy, Firm size, Firm growth, Firm type dummies. **Household controls:** Year dummies, Region dummies, # kids 0-6, # kids 7-18.. **Contextual controls:** Age, Age², Years of schooling, Share of female peers, share of female peers, shares of peers by occupation, # kids 0-6, # kids 7-18. **Demographic IV's:** Age, Age sq., Years of schooling, # kids 0-6, # kids 7-18, share of female peers, shares of peers by occupation. **Firm IV's:** Public sector dummy, Firm size, Firm growth, Firm type dummy. *, **, ***=significant at 10%, 5%, 1%.

Results: Robustness

Table 6: Robustness							
Model	(1) Baseline	(2) Stayers	(3) Transition FE	(4) 1% Trim	(5) Unweighted	(6) Sector shocks	(7) Placebo [‡]
All peer's In C	0.33*** (0.078)	0.36*** (0.090)	0.29*** (0.063)	0.30*** (0.072)	0.44*** (0.083)	0.33*** (0.073)	0.01 (0.196)
Firm IV's Year × Sector FE	YES	YES	YES	YES	YES	YES YES	YES
F-stat first stage	111.5	59.03	58.83	101.9	88.22	127.8	
Number of obs.	2,671,889	2,045,787	2,671,889	2,628,110	2,171,426	2,671,889	2,671,889

Dependent variable: Log of adult equivalent consumption. **Individual controls:** Age, Age sq., Years of schooling, Occupation dummies, Industry dummies, Public sector dummy, Firm size, Firm growth, Firm type dummies. **Household controls:** Year dummies, Region dummies, # kids 0-6, # kids 7-18.. **Contextual controls:** Age, Age², Years of schooling, Share of female peers, share of female peers, shares of peers by occupation, # kids 0-6, # kids 7-18. **Demographic IV's:** Age, Age sq., Years of schooling, # kids 0-6, # kids 7-18, share of female peers, shares of peers by occupation. **Firm IV's:** Public sector dummy, Firm size, Firm growth, Firm type dummy.. *, **, ***=significant at 10%, 5%, 1%.

[‡] Based on 100 replications.

Results: Summary

- OLS biased because of usual reasons: Self-selection, endogeneity, reflection, measurement error
- Our specifications (FD IV + a vast array of controls) should address all these issues at once
- No meaningful differences emerge between husband's and wife's network effects
- Evidence for heterogeneity (Summary)
- Estimate a consumption network effect of ≈ 0.33
 - Given network size, this implies a consumption elasticity of ≈ 0.004 w.r.t. a change in a "random peer" consumption
 - At average consumption (\$50k), a 10% increase in peer consumption (\$5k) would increase my consumption by \$20
 - Propagation
 - Aggregate effects depend on "degree of connectedness"

Demand Function Evidence

- We have found evidence of **intertemporal distortions**
 - Consistent with "keeping-up-with-the-Jensens" effect
- Is there also evidence for **intratemporal distortions**?
 - "Conspicuous" consumption
 - Test: Is peer consumption having a "price" effect on demand for goods?
- Restrict to two types of commodities:
 - Visible (dresses, cars, tobacco, etc.), with budget share ω^V
 - Not-visible (home insurance, underwear, food at home, etc.), ω^N
 - Use Heffetz (2007) ranking mapped to DES (Ranking)

Results: Demand (Budget Share) regressions

Data

Table 8: Demand Estimation

	Visible cons. (1)	Not-visible cons. (2)	Visible cons. (3)	Not-visible cons. (4)	Visible cons. (5)	Not-visible cons. (6)
lnC	-0.046 (0.157)	0.102 (0.144)	0.015*** (0.005)	-0.009** (0.004)	0.026* (0.014)	-0.016 (0.012)
Avg. lnC	-0.059 (0.155)	0.109 (0.142)	0.002 (0.013)	0.0001 (0.011)	0.002 (0.007)	-0.021 (0.060)
lnC × Avg. lnC	0.005 (0.013)	-0.009 (0.012)				
Observations	2,436	2,438	2,436	2,438	454	452

Note: *,**,***= significant at 10%, 5%, 1%. The dependent variables are budget shares for three consumption groups: Visible, Not-visible and Neutral. The omitted category is Neutral. Individual controls: Age, Age sq., Years of schooling, Occupation dummies, Industry dummies, Industry*Year dummies, Public sector dummy, Firm size, Firm growth, Firm type dummies. Household controls: Year dummies, Region dummies, Region*Year dummies, #kids 0-6, # kids 7-18..

- Appears **consistent with KUJ** only - Peer consumption does not affect demand for visibles/invisibles, controlling for "budget"
- No evidence of "reshuffling"

Results: Demand (Budget Share) regressions by goods

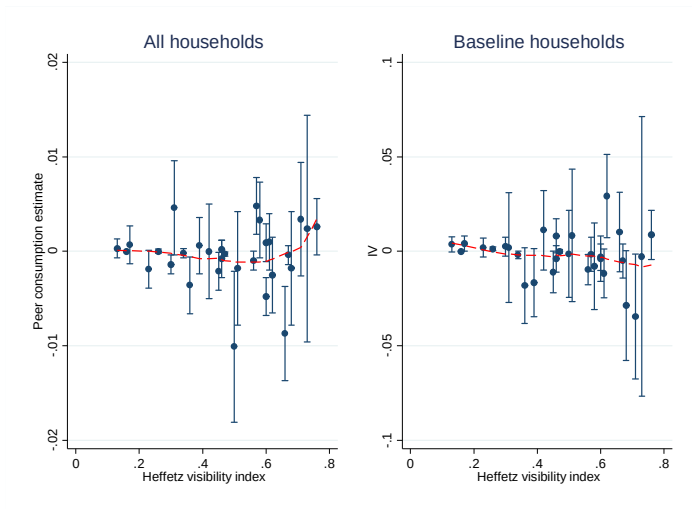


Figure: The relationship between the shift in budget shares due to peer consumption and the Heffetz visibility index

Results: Mechanism – Risk Sharing

- Full risk sharing ($\theta = 1$ in Euler equation regressions) rejected
- Partial risk-sharing?

Regressor	(1)	(2)	(3)
$\Delta \ln Y$	0.228*** (0.071)	0.269** (0.110)	0.275** (0.110)
$\overline{\Delta \ln Y}$			-0.094 (0.082)
Observations	2,432	824	824

Dependent variable is the difference between log DES consumption and log tax registry consumption, both expressed in real terms and in adult-equivalent terms. Controls include Age, Age sq., Years of schooling, Occupation dummies, # kids 0-6, # kids 7-18, Firm size, Firm type, Firm's employment change, Public firm, Year dummies, Sector dummies, Sector*Year dummies, Municipality dummies..

- No: Correlations with $\Delta \ln Y$ and $\overline{\Delta \ln Y}$ should go the other way around

Policy implications: A Simple Macro Experiment

- A tax/transfer imposed on a group may reverberate through the entire distribution, depending on the degree of **connectedness**
- We consider transferring the equivalent of a 1% of aggregate consumption equally among:
 - households in the top or bottom 10% of the consumption distribution
 - a 10% random sample of households
 - households in the bottom 10%, financed by "tax" on top 10%
- Abstract from MPC heterogeneity, i.e., transfer as a "coupon"

Table 8: Counterfactual Policy Simulations

Transfer recipients	Implied multiplier	Mean Consumption (log)	Std.Dev. Consumption (log)	90/10 Ratio	50/10 Ratio	90/50 Ratio
Baseline	--	11.850	0.729	1.1431	1.0782	1.0602
Top 10%	1.012	11.856	0.736	1.1433	1.0782	1.0604
Random 10%	1.017	11.873	0.718	1.1409	1.0768	1.0596
Bottom 10%	1.034	11.924	0.601	1.1298	1.0657	1.0601
Balanced budget	1.021	11.917	0.593	1.1271	1.0657	1.0576

- Implied multiplier: (Post-transfer aggr. cons./Pre-transfer aggr. cons.)
- Smallest multiplier found when targeting top 10%
- Largest multiplier found when targeting bottom 10% - despite no MPC heterogeneity.
- Balanced budget policy also expansionary, and most effective in reducing consumption inequality

Conclusions

- We investigate the size and nature of social interactions in consumption
- Estimate of peer effect ≈ 0.33 . Given network size, a 0.004 elasticity with respect to a random peer's consumption. Social multiplier depends on degree of connectedness of group targeted by a policy.
- Our identification strategy robust to many sources of bias
- Find support for KUJ as a possible mechanism
- Other stories:
 - Information - Not clear in which direction effect would go
 - Great deals - Buy things you wouldn't buy otherwise, or reduce spending on goods you would buy anyway
 - Partly captured by contextual effects - e.g., hanging out with highly educated guys
 - Complementarity of leisure - Look at "entertainment goods"

Descriptives

	Mean	Std.Dev.		Mean	Std.Dev.
<u>Outcomes:</u>					
In Consumption (Ad.Eq.)	12.07	0.66	Income	515,877	186,305
(\$)	10.08	0.66	(\$)	70,388	25,420
Consumption	358,893	324,117	Assets	226,567	758,139
(\$)	48,969	44,224	(\$)	30,914	103,443
<u>Socio-Demographics:</u>					
Age			Sector: Manufacturing		
Husband	42.53	9.42	Husband	25.14	
Wife	40.06	9.10	Wife	12.75	
Years of schooling			Sector: Service		
Husband	12.06	2.33	Husband	15.63	
Wife	11.70	2.33	Wife	12.22	
Occupation: Blue			Sector: Construction		
Husband	43.04		Husband	10.30	
Wife	31.63		Wife	0.99	
Occupation: White			Sector: Other		
Husband	15.83		Husband	48.93	
Wife	45.20		Wife	74.05	
Occupation: Manager			Tenure (in 1996):		
Husband	41.14		Husband	4.79	4.92
Wife	23.18		Wife	4.68	4.94
<u>Workplace characteristics:</u>					
Size (in 1,000)			Type: Publicly traded		
Husband	0.26	0.65	Husband	0.46	
Wife	0.33	0.82	Wife	0.24	
Growth rate			Type: Limited liability		
Husband	-0.009	0.32	Husband	0.08	
Wife	-0.013	0.42	Wife	0.04	
Public sector			Type: Other		
Husband	0.32		Husband	0.46	
Wife	0.61		Wife	0.72	
Number of households: 757,439					

Networks descriptives

Table 2: Network Statistics

	Number of peers	Std.dev.
Distance 1		
Husband	73.30	179.77
Wife	95.07	233.34
Distance 2		
Husband	89.27	212.77
Wife	118.78	285.88
Distance 3		
Husband	12,535	33,285
Wife	14,871	40,534

Table 3: Distance-3 Peer Averages

Variable	Wife side	Husband side
Age	38.88 (3.29)	38.53 (3.15)
Share of blue collars	0.43 (0.36)	0.36 (0.35)
Share of white collars	0.25 (0.28)	0.38 (0.32)
Share of managers	0.32 (0.33)	0.26 (0.32)
Share of females	0.39 (0.24)	0.64 (0.22)
Years of schooling	11.85 (1.33)	11.80 (1.37)

Disposable Income from Income Tax Register Information

The income-tax registers contain information about annual gross taxable income, tax and wealth. A measure of disposable income is formed using total gross taxable income, as it appears on the yearly tax form, less payments of taxes. From this rental value of the house for households in owner occupied houses is deducted, as this is an income component introduced by the tax authorities for collecting taxes, and is hence not associated with any cash-flow. Furthermore, net payments from capital pensions, and income from shares, and inheritance are added, as these income components are taxed separately. Finally, as we are looking for a money-in-the-pocket measure, child benefits, which are tax exempt, are also added.

$$\begin{aligned}\text{Disposable income} = & \text{Gross taxable income according to the final tax form} \\ & \text{(including social welfare, unemployment insurance,} \\ & \text{alimony, public pensions, capital income other than} \\ & \text{income from shares)} \\ & + \text{Payments from capital pensions} \\ & + \text{Child benefits} \\ & + \text{Income from shares} \\ & + \text{Inheritance} \\ & - \text{Total final taxes according to tax statement} \\ & - \text{Taxes on payment from capital pension} \\ & - \text{Rental value of house} \\ & - \text{Tax on income from shares} \\ & - \text{Inheritance tax}\end{aligned}$$

There are several wealth variables in the income tax registers. Definitions, however, vary from one year to the other, and wealth information can consistently be divided only in to three categories: cash holdings, cash value of the house, holdings of other assets. A substantial part of private saving is done in the form of pension contributions. Accumulated pension contributions are not taxable before they are paid out (and then enter as normal income) and do therefore not enter this wealth measure. The contents of the wealth categories in terms of the variables that are available in the income tax registers are listed in Table A1.

Table A1
Wealth Components

<i>Assets:</i>	
Cash holdings	
Cash holdings in bank, bonds, deposited mortgage deeds	
Cash value of house	
Other assets	
Value of shares	
Value of shares, main shareholder in company	
Own capital in domestic company	
Own capital in foreign company	
Other foreign wealth	
Other taxable assets (*)	
<i>Liabilities:</i>	
Sum of liabilities	

Heterogeneity

- We interact main effect with network size, age, education, tenure, GDP growth

- We interact main effect with network size, age, education, tenure, GDP growth
 - Peer effects flat w.r.t. network size
 - Peer effects increase significantly with age, but only at young age
 - Peer effects decline with schooling
 - Peer effects are statistically insignificant for new employees; positive, large and significant for those with positive tenure
 - Network effects are larger and significant when economy is booming, smaller and insignificant during recessions

Heffetz' classification

Category	Normalized Mean		
	Index	(S.E.)	[Rank]
Cig (cigarettes)	0.76	(0.01)	[1]
Car (cars)	0.73	(0.01)	[2]
Clo (clothing)	0.71	(0.01)	[3]
Fur (furniture)	0.68	(0.01)	[4]
Jwl (jewelry)	0.67	(0.02)	[5]
Ot1 (recreation 1)	0.66	(0.01)	[6]
FdO (food out)	0.62	(0.01)	[7]
AlH (alcohol home)	0.61	(0.01)	[8]
Brb (barbers etc)	0.60	(0.01)	[9]
AlO (alcohol out)	0.60	(0.01)	[10]
Ot2 (recreation 2)	0.58	(0.01)	[11]
Bks (books etc)	0.57	(0.01)	[12]
Edu (education)	0.56	(0.01)	[13]
FdH (food home)	0.51	(0.01)	[14]
Hom (rent/home)	0.50	(0.02)	[15]
Cel (cell phone)	0.47	(0.02)	[16]
Air (air travel)	0.46	(0.01)	[17]
Htl (hotels etc)	0.46	(0.01)	[18]
Bus (public trans.)	0.45	(0.02)	[19]
CMn (car repair)	0.42	(0.01)	[20]
Gas (gasoline)	0.39	(0.02)	[21]
Med (health care)	0.36	(0.01)	[22]
Cha (charities)	0.34	(0.01)	[23]
Lry (laundry)	0.34	(0.02)	[24]
Utl (home utilities)	0.31	(0.02)	[25]
Tel (home phone)	0.30	(0.02)	[26]
Fee (legal fees)	0.26	(0.01)	[27]
CIn (car insur.)	0.23	(0.01)	[28]
HIn (home insur.)	0.17	(0.01)	[29]
LIn (life insur.)	0.16	(0.01)	[30]
Und (underwear)	0.13	(0.01)	[31]

Test # 2: "Status" (4)

- Take demand for visibles:

$$\omega_{it}^V = \alpha_0^V + \beta^V \ln C_{it} + \gamma^V \overline{q_t^V} + \varepsilon_{it}^V$$

- Problem: we do not observe $\overline{q_t^V}$, we only observe $\overline{C_t} = \overline{q_t^V} + \overline{q_t^N}$.

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- Rewrite equation for ω_{it}^V as:

$$\omega_{it}^V = \alpha_0^V + \beta^V \ln C_{it} + \gamma^V \overline{C_t} + \left[\varepsilon_{it}^V - \gamma^V \left(\overline{C_t} - \overline{q_t^V} \right) \right]$$

- Estimates of γ^V (and γ^N) biased.

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- Estimates of γ^V (and γ^N) biased.
- But extent of bias can be estimated from combination of tax record and consumption survey data

$$p \lim \hat{\gamma}^j = \gamma^j \left(\frac{\text{var}(\ln C_{it}) \text{cov}(\overline{C_t}, \overline{q_t^V}) - \text{cov}(\ln C_{it}, \overline{C_t}) \text{cov}(\ln C_{it}, \overline{q_t^V})}{\text{var}(\ln C_{it}) \text{var}(\overline{C_t}) - \text{cov}(\ln C_{it}, \overline{C_t})^2} \right)$$

- for $j = \{V, N\}$.
- The term in parentheses can be estimated:
 - $\text{var}(\ln C_{it})$, $\text{var}(\overline{C_t})$ and $\text{cov}(\ln C_{it}, \overline{C_t})$ come from the tax records
 - $\text{cov}(\overline{C_t}, \overline{q_t^V})$ and $\text{cov}(\ln C_{it}, \overline{q_t^V})$ can be estimated from the survey for the very few cases in which we can match survey participants to peers in the survey

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 - We estimate the term in parenthesis to be 0.93, so unlikely to matter much

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- for $j = \{V, N\}$.
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 - $\text{cov}(\bar{C}_t, \bar{q}_t^V)$ and $\text{cov}(\ln C_{it}, \bar{q}_t^V)$ can be estimated from the survey for the very few cases in which we can match survey participants to peers in the survey
 - We estimate the term in parenthesis to be 0.93, so unlikely to matter much
- Note that test of reshuffling based on $(\hat{\gamma}^V \hat{\gamma}^N) < 0$ still valid because common bias term does not alter sign of product.

Identification in the multiplexity case (1)

- *Household Level Variables:* $\mathbf{c}$, the $(N \times 1)$ vector of household consumption.
- *Individual Level Variables:*
 - $\mathbf{X}$, a $(2N \times k)$ matrix of an individual characteristics. Order husband and wife characteristics as: $\mathbf{X} = \begin{pmatrix} \mathbf{X}_h & \mathbf{X}_w \end{pmatrix}'$.
 - Let $\mathbf{S}_h$ ($\mathbf{S}_w$) be a transformation $(2N \times N)$ matrix that maps households into husbands (wives), i.e., $\mathbf{S}_h = \begin{pmatrix} \mathbf{I} & \mathbf{0} \end{pmatrix}'$.
 - Let $\mathbf{D}$ be the social network $(2N \times 2N)$. The generic element of $\mathbf{D}$ is:

$$d_{i^l j^m} = \begin{cases} 1 & \text{if } i^l \text{ connected to } j^m \text{ (for } l, m = \{h, w\}) \end{cases}$$

- The number of connections for a generic individual i^l is $n_{i^l} = \sum_{m=\{h,w\}} \sum_{j=1}^N d_{i^l j^m}$.
- Call $\mathbf{n}$ the $(2N \times 1)$ vector with generic element n_{i^l} . The row-normalized adjacency matrix is: $\mathbf{G} = \text{diag}(\mathbf{n})^{-1} \mathbf{D}$ with generic element $g_{i^l j^m} = n_{i^l}^{-1} d_{i^l j^m}$.
- Given this notation, $\mathbf{S}_h' \mathbf{G} (\mathbf{S}_h + \mathbf{S}_w) = \mathbf{G}_h$ is the husband-induced household network. Symmetrically, $\mathbf{S}_w' \mathbf{G} (\mathbf{S}_h + \mathbf{S}_w) = \mathbf{G}_w$ is the wife-induced household network.

Identification in the multiplexity case (2)

- Our model is:

$$\mathbf{c} = (\theta_1 \mathbf{G}_h + \theta_2 \mathbf{G}_w) \mathbf{c} + (\mathbf{S}'_h \mathbf{G} \gamma_1 + \mathbf{S}'_w \mathbf{G} \gamma_2 + \mathbf{S}'_h \delta_1 + \mathbf{S}'_w \delta_2) \mathbf{X} + \varepsilon$$

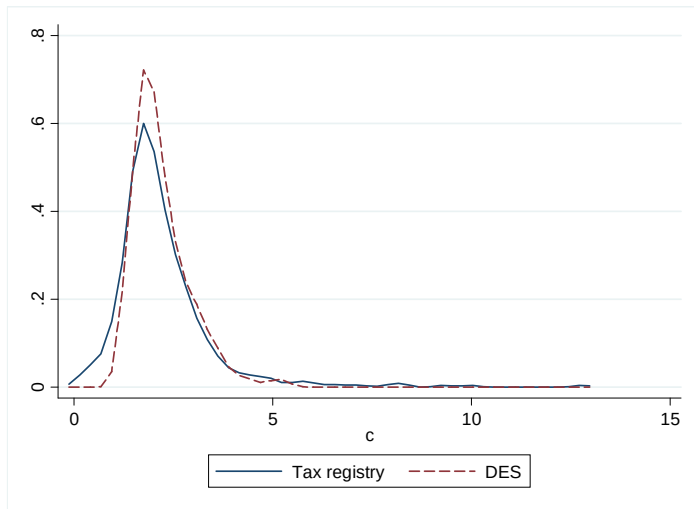
- If $(\mathbf{I} - (\theta_1 \mathbf{G}_h + \theta_2 \mathbf{G}_w))$ is invertible, we can use the Neumann series expansion of a matrix (Meyer 2000, p. 527) to write:

$$(\mathbf{I} - (\theta_1 \mathbf{G}_h + \theta_2 \mathbf{G}_w))^{-1} = \sum_{k=0}^{\infty} (\theta_1 \mathbf{G}_h + \theta_2 \mathbf{G}_w)^k$$

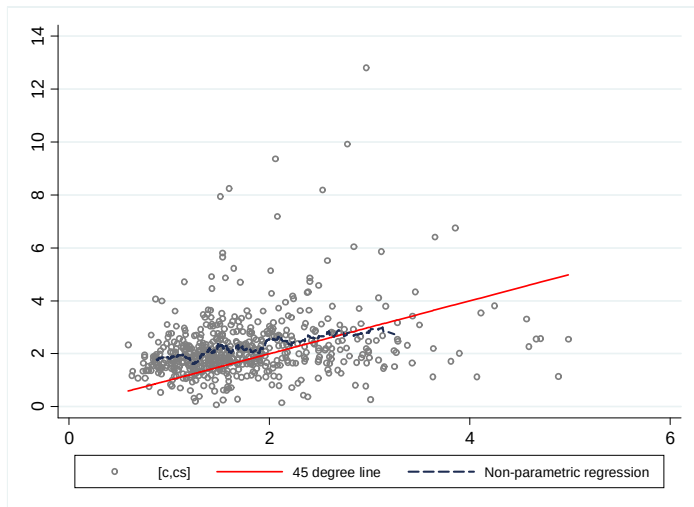
- which is satisfied as long as $|\theta_1| + |\theta_2| < 1$.
- Reduced form is obtained using the result above for $k = 1$:

$$\begin{aligned} \mathbf{c} \approx & (\mathbf{S}'_h \mathbf{G} \gamma_1 + \mathbf{S}'_w \mathbf{G} \gamma_2 + \mathbf{S}'_h \delta_1 + \mathbf{S}'_w \delta_2) \mathbf{X} \\ & + (\theta_1 \mathbf{G}_h + \theta_2 \mathbf{G}_w) (\mathbf{S}'_h \mathbf{G} \gamma_1 + \mathbf{S}'_w \mathbf{G} \gamma_2 + \mathbf{S}'_h \delta_1 + \mathbf{S}'_w \delta_2) \mathbf{X} + \mathbf{v} \end{aligned}$$

Total Expenditure in the Tax Registry and in the DES (1)



Total Expenditure in the Tax Registry and in the DES (2)



Peers definition

- In the baseline results peers are co-workers in the same plant...
 - ...weighted by "similarity distance", where distance is defined with respect to education *and* occupation (blue collar, white collar, manager)

$$d_{ij} = (|E_i - E_j| + |O_i - O_j|)$$

- $E = \{1...5\}$ and $O = \{1...3\}$.
- We create quadratic weight variable $\omega_{ij} = (1 + d_{ij})^{-2}$ and construct:

$$\overline{\log C_i} = \left(\sum_{j \neq i} \omega_{ij} \right)^{-1} \sum_{j \neq i} \omega_{ij} \log C_j$$

- We also consider alternative definitions

Insurance within the firm?

- Suppose that firms pass-through some of their permanent shocks onto workers' earnings, or: $\Delta \ln y_{ijt} = \alpha u_{jt} + \varepsilon_{ijt} + \Delta \zeta_{ijt}$
- In a simple version of the PIH:

$$\Delta \ln c_{ijt} = \alpha u_{jt} + \varepsilon_{ijt}$$

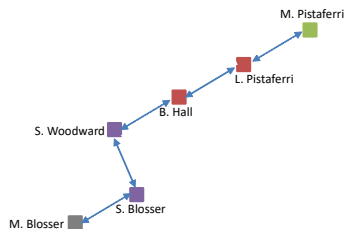
- If our estimate reflects no causal network effects, but simply common pass-through of firm shocks, OLS does not suffer from reflection bias:

$$\hat{\theta} = \frac{\text{cov}(\Delta \ln c_{ijt}, \Delta \ln c_{kjt})}{\text{var}(\Delta \ln c_{kjt})} = \frac{\alpha^2}{\alpha^2 + (\sigma_\varepsilon^2 / \sigma_u^2)}$$

- In the Italian case (Guiso, Pistaferri and Schivardi, 2004) $\hat{\alpha} = 0.07$, $(\sigma_\varepsilon^2 / \sigma_u^2) = 0.56$. This would imply $\hat{\theta} = 0.0086$. In the Norwegian case (Fagereng, Guiso and Pistaferri, 2015), $\hat{\alpha} = 0.07$, $(\sigma_\varepsilon^2 / \sigma_u^2) = 0.47$. This would imply $\hat{\theta} = 0.01$.
- But the actual OLS estimate (0.12) is 12-14 times larger.

Identification: A simple example (1)

- Take simplified "Stanford" network:



$$\Delta_{CP} = \alpha + \theta \Delta_{CH} + \gamma x_H + \delta x_P + \varepsilon_P$$

$$\Delta_{CH} = \alpha + \theta \left(\frac{\Delta_{CP} + \Delta_{CB}}{2} \right) + \gamma \left(\frac{x_P + x_B}{2} \right) + \delta x_H + \varepsilon_H$$

$$\Delta_{CB} = \alpha + \theta \Delta_{CH} + \gamma x_H + \delta x_B + \varepsilon_B$$

Identification: An Example (2)

- Δ_{CH} is endogenous in Δ_{CP} equation, i.e., $E(\varepsilon_P | \Delta_{CH}) \neq 0$:

$$\Delta_{CP} = \alpha + \theta \Delta_{CH} + \gamma x_H + \delta x_P + \varepsilon_P$$

$$\Delta_{CH} = \alpha + \theta \left(\frac{\Delta_{CP} + \Delta_{CB}}{2} \right) + \gamma \left(\frac{x_P + x_B}{2} \right) + \delta x_H + \varepsilon_H$$

$$\Delta_{CB} = \alpha + \theta \Delta_{CH} + \gamma x_H + \delta x_B + \varepsilon_B$$

- In fact: Write reduced form for Δ_{CH} :

$$\Delta_{CH} = f(x_P, x_H, x_B, \varepsilon_H, \varepsilon_P, \varepsilon_B)$$

so Δ_{CH} moves with ε_P .

- Also, reduced form for Δ_{CB} is:

$$\Delta_{CB} = g(x_P, x_H, x_B, \varepsilon_H, \varepsilon_P, \varepsilon_B)$$

Identification: An Example (3)

- Need an instrument for Δc_H in Δc_P 's equation

Identification: An Example (3)

- Need an instrument for Δc_H in Δc_P 's equation
- What are the variables that explain Δc_H (condition I for an IV to be valid) and do not belong to Δc_P (condition II for an IV to be valid)?

$$\Delta c_P = \alpha + \theta \Delta c_H + \gamma x_H + \delta x_P + \varepsilon_P$$

$$\Delta c_H = \alpha + \theta \left(\frac{\Delta c_P + \Delta c_B}{2} \right) + \gamma \left(\frac{x_P + x_B}{2} \right) + \delta x_H + \varepsilon_H$$

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- List includes:
 - 1 $\Delta c_P \rightarrow$ of course not
 - 2 $\Delta c_B \rightarrow$ No, because in the reduced form
 $\Delta c_B = g(x_P, x_H, x_B, \varepsilon_H, \varepsilon_P, \varepsilon_B)$
 - 3 $x_P, x_H \rightarrow$ No, because they are "included" variables
 - 4 $x_B \rightarrow$ Yes! Distance-3 peer's exogenous characteristics.

Case 1: Additive separability

- Suppose:

$$U_t = F_t(V_t(p_t, C_{it})) + H(\bar{C}_{it})$$

- Then, since $\partial V(.) / \partial \bar{C}_t = 0$, both demand functions and the Euler equation are independent of peer consumption
- This is the "atomistic agent model"

Case 2: Weak separability (1)

- Suppose:

$$U_t = F_t(V_t(p_t, C_{it}), \bar{C}_t)$$

- Example of functional form:

$$U_t = (1 + \delta)^{-t} \underbrace{\frac{(C_{it}/a(p_t))^{1-\gamma} - 1}{1-\gamma} \frac{1}{b(p_t)}}_{V_t(p_t, C_t)} \prod_{n=1, n \neq i}^N C_{nt}^{\theta}$$

- **Intertemporal distortions:** Euler equation changes with peer consumption:

$$\Delta \ln \frac{C_{it+1}}{a(p_{t+1})} \cong \gamma^{-1} \left((r - \delta) - \Delta \ln b(p_{t+1}) + \theta \Delta \ln \frac{\bar{C}_{t+1}}{a(p_{t+1})} \right)$$

- If $\theta = 0 \rightarrow$ No intertemporal distortions

Case 2: Weak separability (2)

- Since $V_t(.)$ still independent of $\bar{C}_t$, demand functions still (conditionally) independent on peer consumption
 - The demand for q_{it}^k depends on peer consumption $\bar{C}_t$ *only* through the "income effect" C_{it}
 - **Simple test:** Check if peer consumption enters demand functions conditioning on total spending in the period
 - Stronger peer effects $\rightarrow$ higher C_{it} to allocate to the various goods
 - But controlling for C_{it} , demographics, and prices $\rightarrow \bar{C}_t$ should not affect q_{it}^k .

Case 3: Non-separability (1)

- Suppose:

$$U_t = F_t \left(V_t \left(p_t, C_{it}, \overline{C}_t \right) \right)$$

- Example of functional form:

$$U_t = (1 + \delta)^{-t} \frac{\left(C_{it} / a \left(p_t, \overline{C}_t \right) \right)^{1-\gamma} - 1}{1 - \gamma} \frac{1}{b \left(p_t, \overline{C}_t \right)} \prod_{n=1, n \neq i}^N C_{nt}^{\theta}$$

- Now peer consumption exerts both "income" and "price" effects
- There are both intertemporal and intratemporal distortions
- **Conspicuousness** : Reshuffling between "visible" and "non-visible" goods

- Bias

Risk Sharing (1)

- Another reason for correlated consumption across co-workers could be risk sharing (within the firm)
 - **Full risk sharing** implies $\gamma^{-1}\theta = 1$ in Euler equation regression
 - This is similar to Townsend (1994)
- Suppose risk sharing implemented through side transfers
 - Giacomo receives (makes) a transfer from (to) Luigi if the latter is lucky (unlucky)
- Our measure of consumption from tax records is: $C_{it}^T = Y_{it} - \Delta A_{it}$
 - Problem: Side transfers are unreported in tax records
- Hence, C_{it}^T understates C_{it}^{true} for the unlucky guys ($\Delta Y_{it} < 0$) and overstates it for the lucky guys ($\Delta Y_{it} > 0$).

Risk Sharing (2)

- In the consumption survey we observe (for a much smaller sample) an alternative measure of consumption: $C_{it}^S = \sum_k p_t^k q_{it}^k$
- Under **partial risk sharing**, $(C_{it}^S - C_{it}^T)$ should be systematically **negatively** correlated with ΔY_{it} (which we take from tax records) and systematically **positively** correlated with $\overline{\Delta Y}_{it}$ if risk sharing explains our results:

$$(C_{it}^S - C_{it}^T) = \alpha + \underbrace{\beta}_{<0} \Delta Y_{it} + \underbrace{\gamma}_{>0} \overline{\Delta Y}_{it} + v_{it}$$

- Otherwise, C_{it}^S and C_{it}^T are just two error-ridden measures of true consumption and their difference should be orthogonal to all observables

Results: Contextual Effects

Table 5: Baseline Results (cont.)

	W's peers	H's peers
Age	-0.026***	-0.024***
Age ² /100	0.028***	0.027***
Education	-0.009***	-0.011***
Female	0.007	-0.009
Blue collar	0.050***	0.036***
White collar	0.021***	0.022**
# kids 0-6	0.006*	0.023***
# kids 7-18	0.009***	0.028**

IVFD specification. *, **, ***=significant at 10%, 5%, 1%.

Results: Other Effects

Table 5: Baseline Results (cont.)

	Wife	Husband
Age	0.026	0.051***
Age ² /100	-0.038***	-0.067***
Education	0.017***	0.027***
Firm size	0.222	0.779***
Firm's empl. ch.	0.034	-0.301
Public firm	0.010*	0.005
# kids 0-6	-0.137***	
# kids 7-18	-0.123***	

IVFD specification. *, **, ***=significant at 10%, 5%, 1%.