Macroeconomic and Monetary Policy Implications of Limited Participation

Juan M. Morelli
Federal Reserve Bank of New York

Introduction

1. Households' participation in equity markets in the US is limited
    - Only 27% held equity in 1980s (direct or indirectly)
      Mankiw & Zeldes ('91); Vissing-Jorgensen (2002)
2. Unconditional consumption volatility is larger for participants than nonparticipants
   Guvenen ('09); Chien, Cole & Lustig ('11)
3. Share of participants doubled, rising above 50% in the early 2000s
   Calvet et al (2004); Favilukis (2013)

This paper: Study how change in participation affects the transmission of MP shocks

$\rightarrow$ Dynamic model with limited participation (LP) + New empirical evidence

Summary of Findings

Theoretical Model: Business cycles model with three main features

- LP as a relevant source of heterogeneity across households
- Nominal rigidities & investment allow for real effects of MP and asset price fluctuations
- Recursive preferences for richer discounting process for households

Quantitative Analysis: Jointly match conditional & unconditional moments

- Study effects of higher participation at the individual and aggregate levels
- Higher participation **dampens** effects of MP shocks on consumption and investment

Empirical Evidence: Effects of LP on consumption and investment

- Analysis using micro-level data on consumption and MP shocks
- Aggregate time-series analysis on for investment and industrial production

Model Mechanisms

1. Participants (P) bear more aggregate risk than non-participants (NP) since they have levered exposure to fluctuations in the value of equity

   $\rightarrow$ P's consumption is more responsive to shocks than NP's

2. As participation rises, the participant's per capita exposure to risk falls since same amount of risk is spread over a larger set of households

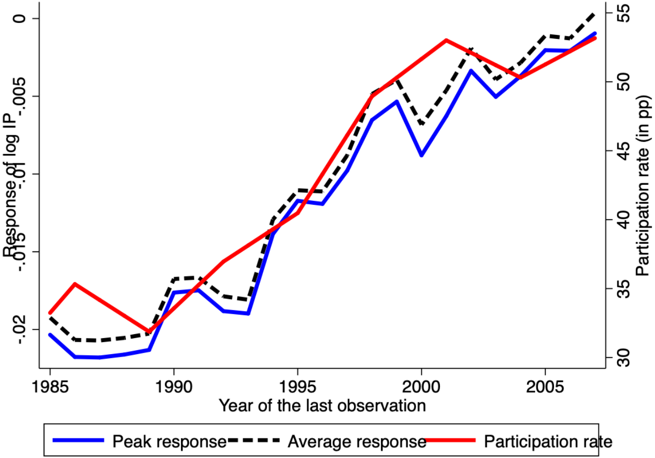
   $\rightarrow$ P's consumption less responsive to shocks

3. Since P owns firms, higher participation mitigates changes in cost of capital

   $\rightarrow$ Translates into milder fluctuations in investment and the price of equity

Empirical Motivation

- Rolling window for monthly LPs: $Y_{t+h} = \beta^y_{0h} + \beta^y_{1h} MP_t + \sum_{k=1}^{3} \rho^y_k Y_{t-k} + X^y_{t-1} + \epsilon^y_{t+h}$
  - Window y of length 20 years, Y_t is log industrial production, X^y_t contains 3 lags of log CPI



Environment: Two-period Model

1. Stylized model: Illustrate how variations in participation affect shocks' transmission
2. Infinite horizon model: Quantitative analysis in calibrated model

- Two-period economy ($t \in \{0, 1\}$) with households, firms, monetary authority
- Economy populated by two types of representative households, $i = \{p, np\}$
  - Participant (P) trades nominal bonds and risky equity, measure φ
  - Nonparticipant (NP) trades only bonds, measure $1 - \varphi$
  - In baseline model, participation is exogenous (lifted in robustness)
- Productive firms make investment decisions, retailers set prices
- Monetary authority sets monetary policy
- Uncertainty: productivity (TFP) shocks at $t = 1$

Households

- Recursive preferences over consumption (c_{it}), inelastic labor supply (ℓ_{it}) (lifted later)
- Equity: claim on payoffs from productive firms and retailers (normalized to 1)
- Problem of the participant:

$$V_{p0} = \max_{c_{p0}, c_{p1}, b_{p1}, \theta_{p1}} \left[c_{p0}^{1-\rho} + \beta \left(\mathbb{E}_0 \left(c_{p1}^{1-\gamma} \right) \right)^{\frac{1-\rho}{1-\gamma}} \right]^{\frac{1}{1-\rho}},$$

$$\text{s.t. } c_{p0} + \frac{b_{p1}}{P_0} + \theta_{p1} Q_{d0} = w_0 \ell_{p0} + \theta_{p0}(d_0 + Q_{d0}) + T_0$$

$$c_{p1} = w_1 \ell_{p1} + \theta_{p1} d_1 + \frac{b_{p1}}{P_0} \frac{R_0}{\Pi_1}$$

  - ρ inverse IES; γ risk-aversion; β time-discount
  - Q_{d0} price of an equity claim; d_t dividends; w_t wages; T_0 lump-sum transfers (real terms)
  - P_t nominal price index; Π_t inflation rate; R_0 nominal rate

- Nonparticipant: Similar problem, but with $\theta_{np1} = 0$

Firms

Intermediate Good Producers

- Combine labor (L_{jt}) and capital (K_{jt}) to produce intermediate goods (Y_{jt}):

$$Y_{jt} = z_t K_{jt}^{\alpha} L_{jt}^{1-\alpha}, \quad \alpha \in (0,1),$$

  with z_t (TFP) known at $t = 0$ but stochastic at $t = 1$

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- LoM for capital: $K_{j1} = (1 - \delta_0) K_{j0} + I_{j0} - \Phi(I_{j0}, K_{j0})$, with $\Phi(\cdot)$ adj. costs

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- Payoffs: $d_{j0}^{f} = \pi_{j0}^{f} - I_{j0}, \quad d_{j1}^{f} = \pi_{j1}^{f} + (1-\delta_1)\, K_{j1}, \quad \pi_{jt}^{f} \equiv \frac{P_{mt}}{P_t} Y_{jt} - w_t L_{jt}$
- Discounting: Firms discount payoffs using the participant's SDF, Λ_{p1}

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Retailers: Monopolistically competitive, purchase Y_{jt}, repackage, sell at differentiated price

- Face demand function: $Y_{it} = \left(\frac{p_{it}}{P_t}\right)^{-\theta_p} Y_t$, with $\theta_p > 1$
- Set prices at $t = 0$ s.t. quadratic costs with slope ξ_p; fully flexible prices at $t = 1$

Monetary Block and Market Clearing

Monetary Authority (as in Mankiw & Weinzierl (2011))

- Money aggregate used to buy consumption goods, constant velocity: $M_t = C_t P_t$
- No interest rate at $t = 1$, so MA sets R_0 at $t = 0$ and M_1 at $t = 1$
  - Since R_0 is fixed by policy, M_0 is simply such that quantity equation holds.
  - Prices fully flexible at $t = 1$, but rule for M_1 is not neutral at $t = 0$ due to inflation risk

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Market Clearing

- Debt market: $\varphi b_{p1} + (1 - \varphi) b_{np1} = 0$
- Labor market: $L_t = \ell_{pt} = \ell_{npt} = 1$
- Aggregate resource constraints: $Y_0 = C_0 + I_0$ and $Y_1 = C_1 - (1 - \delta_1) K_1$
  - Dividends: $d_0 = Y_0 - w_0 L_0 - I_0 - \frac{\xi_p}{2} (\Pi_0 - 1)^2 Y_0$ and $d_1 = Y_1 - w_1 L_1 + (1 - \delta_1) K_1$
  - Transfers: $T_0 = \frac{\xi_p}{2} (\Pi_0 - 1)^2 Y_0$

Optimality Conditions

- Household's i Euler equations on bonds: $1 = \mathbb{E}_0 \left[\Lambda_{p1} \frac{R_0}{\Pi_1} \right]$
- Household's i SDF: $\Lambda_{i1} \equiv \beta \frac{c_{i1}^{-\rho}}{c_{i0}^{-\rho}} \left(\frac{c_{i1}}{\mathbb{E}_0 \left(c_{i1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}}} \right)^{\rho-\gamma} = \beta c_{i0}^{\rho} \mathbb{E}_0 \left(c_{i1}^{1-\gamma} \right)^{\frac{\gamma-\rho}{1-\gamma}} c_{i1}^{-\gamma}$

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- IGPs' optimal labor: $\mathrm{mc}_t \equiv \frac{P_{mt}}{P_t} = \frac{1}{1-\alpha} w_t \frac{L_{jt}}{Y_{jt}}$ (i.e., VMPL = real wages)
- IGPs' optimal capital and investment:

$$
\begin{aligned}
\mathcal{Q}_{kj,0} =& \mathbb{E}_0 \left[\Lambda_{p1} \left(\mathrm{mc}_1 \alpha z_1 K_{j1}^{\alpha-1} L_{j1}^{1-\alpha} + (1-\delta_1) \right) \right] \\
1 =& \mathcal{Q}_{k0} \left[1 - \Phi'(I_{j0}, K_{j0}) \right]
\end{aligned}
$$

- New Keynesian Phillips curve: $\mathrm{mc}_0 = \frac{\theta_p - 1}{\theta_p} + \frac{\xi_{p0}}{\theta_p} (\Pi_0 - 1) \Pi_0, \quad \mathrm{mc}_1 = \frac{\theta_p - 1}{\theta_p}$

Main Mechanisms in Stylized Model

- Goal: Study how higher φ alters the transmission of MP shocks via Tobin's Q ($\mathcal{Q}_{k0}$)
  - W/o investment: Only individual consumption responds to MP shocks
  - With investment: MP shocks affect investment (& output) through changes in $\mathcal{Q}_{k0}$
- Decomposition for Tobin's Q:

$$Q_{k0} = \underbrace{\mathbb{E}_0\left(\Lambda_{p1}\right)}_{\text{FO}}\mathbb{E}_0\left(MPK_1\right) + \underbrace{\text{cov}_0\left(\Lambda_{p1}, MPK_1\right)}_{\text{RA}},$$

  - FO (first-order discounting): standard discounting channel
  - RA (risk adjustment): depends on covariance between SDF and marginal product of capital

Four Propositions Behind Mechanisms

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Proposition 3: With risk and $\gamma > \rho$, *higher* φ *increases Tobin's Q* if the FO $>>$ RA

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Proposition 4: Higher φ *dampens* Tobin's Q response to R_0 if propositions 1 and 3 hold and the cross-derivative of Tobin's Q to R_0 and φ is positive (or small in magnitude)

$$\text{Dampening if } \frac{\partial^2 \ln Q_{k0}}{\partial R_0 \partial \varphi} > 0 : \;\; \frac{\partial^2 \ln Q_{k0}}{\partial R_0 \partial \varphi} = \frac{1}{Q_{k0}} \left(\overbrace{-\frac{1}{Q_{k0}} \underbrace{\frac{\partial Q_{k0}}{\partial R_0}}_{<0} \underbrace{\frac{\partial Q_{k0}}{\partial \varphi}}_{>0}}^{>0} + \underbrace{\frac{\partial^2 Q_{k0}}{\partial R_0 \partial \varphi}}_{?} \right)$$

– Numerical example: Dampening of MP shock due to *milder discounting* with $\uparrow \varphi$

Adding Debt to the Stylized Model

- Firm issues a fixed amount $\bar{D}$ of nominal debt to finance its activities (Guvenen (2009))

$$\text{debt repayment at } t = 0: \; -\frac{R_{-1}}{\Pi_0}\frac{\bar{D}}{P_{-1}} + \frac{\bar{D}}{P_0}; \qquad \text{at } t = 1: \; -\frac{R_0}{\Pi_1}\frac{\bar{D}}{P_0}$$

- Participant's budget constraint reflects indirect exposure to debt through equity claim:

$$c_{p0} + \frac{\tilde{b}_{p1}}{P_0} = w_0 L_0 \left(1 - \frac{1}{\varphi}\right) + \frac{1}{\varphi}(Y_0 - I_0) - \frac{1-\varphi}{\varphi}\frac{b_{np0}}{P_{-1}}\frac{R_{-1}}{\Pi_0}$$

where $\tilde{b}_{p1} \equiv b_{p1} - \frac{1}{\varphi}\bar{D}$ captures nominal "effective borrowing"

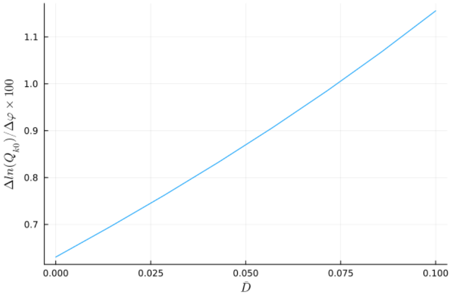
$\rightarrow$ Model is *isomorphic* to baseline with P facing initial nominal debt $b_{p0} = -\frac{1-\varphi}{\varphi} b_{np0}$

- New channel: Initial interest payments imply transfers from the P to the NP
  - P has negative WEs $\rightarrow$ depresses her consumption, Tobin's Q, investment, and capital
  - NP has positive WE $\rightarrow$ boosts her consumption and savings

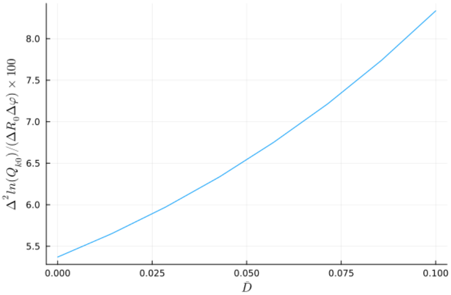
Numerical Example Go

- Numerical example that matches some data moments, assume *fixed* M_1 MP rule
- Introduce variations $\Delta R_0 = 0.01$ and $\Delta\varphi = 0.01$; compute elasticities as $\bar{D}$ rises

(a) $\mathcal{Q}_{k0}$ semi-elasticity to φ (Prop 3)



(b) $\mathcal{Q}_{k0}$ cross-semi-elasticity (Prop 4)



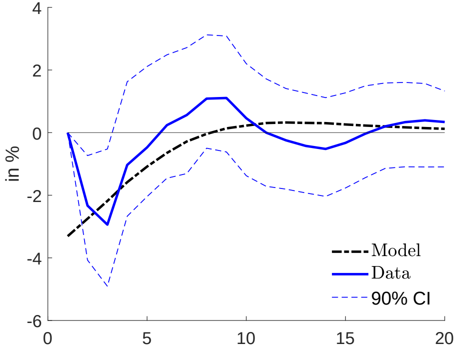
Stylized model delivers dampening result... stronger with higher debt

Infinite Horizon Model

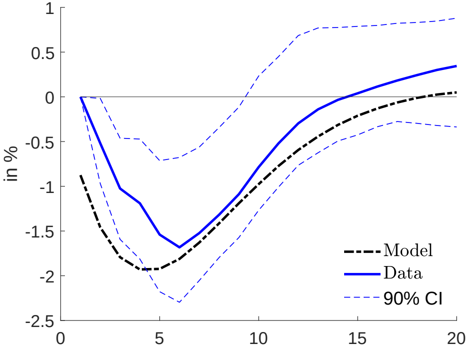
- Develop infinite horizon model to quantify effects of participation in a framework better suited to match conditional and unconditional macro and financial moments
- Main changes
  - Sources of risk: permanent TFP shocks, transitory MP and investment shocks
  - Endogenous labor supply (GHH): $u\left(c_{it}, \ell_{it}\right) = \left(c_{it} - \vartheta_0 \frac{\ell_{it}^{1+\vartheta}}{1+\vartheta}\right) \rightarrow$ homog. labor supply
  - Default risk: reduced-form debt-elastic borrowing rate $R_{bt}(D_{i,t+1}) = R_t + \Psi(D_{i,t+1})$
- Moments matched Go
  - Conditional on MP shock: Equity price response & elasticity of investment to Tobin's Q
    $\rightarrow$ Disciplines how MP shocks affect SDF $\rightarrow \mathcal{Q}_{k0} \rightarrow I_t$
  - Unconditional: business cycles and asset pricing moments + participant's leverage
    $\rightarrow$ Disciplines quantity of risk and households' differential exposures to risk
- Measure effect of $\uparrow \varphi$ on individual and aggregate responses to shocks

Untargeted: Tobin's Q & Investment Response to MP Shock

Targeted elasticity of investment to Tobin's Q (0.6), but not individual responses to MPS



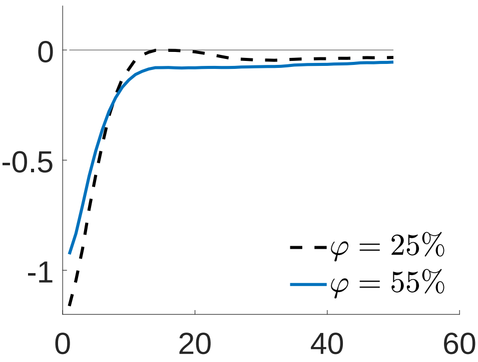
(a) Tobin Q (in %)



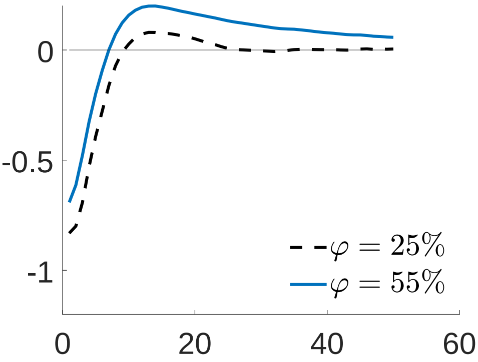
(b) Investment (in %)

Model's IRFs generally within CIs from the data (1973:Q1-1989:Q4)

Cross-Sectional Responses to MP Shock



(a) Participant (in %)

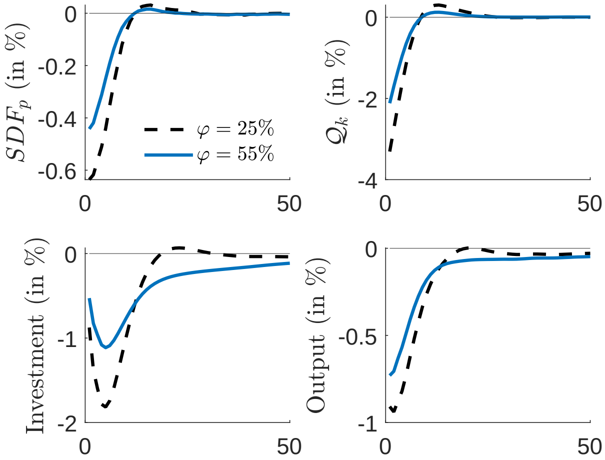


(b) Nonparticipant (in %)

P's consumption more responsive; Higher φ dampens individual responses

Unclear what happens with aggregate consumption: $C_t = \varphi c_{pt} + (1 - \varphi) c_{npt}$

Higher Participation: From Participant's SDF to Investment

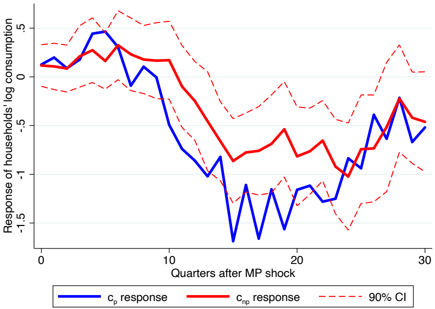


More stable SDF → lower response of Tobin's Q → milder investment response

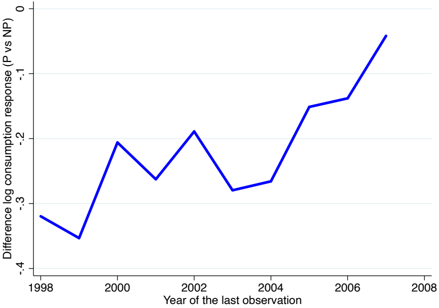
Empirical Validation: Diff. Consumption Response to MP

Micro-level consumption data (CEX) + MP shocks $\rightarrow$ local projections

(a) Responses of c_p and c_{np}, full sample



(b) Diff. response, 15-YR rolling window



P's consumption relatively more responsive, but milder difference post-2000

Empirical Validation: Dampening in Consumption Response

Exploit variation in state-level participation rates; cutoffs 25th, 50th, 75th percentiles

$$\Delta \ln C_{it} = \alpha_t + \alpha_k + \beta_0 + \beta_1 \mathcal{I}_{kt}^{X\%} + \beta_2 (FF_t \cdot \mathcal{I}_{kt}^{X\%}) + \Gamma' X_{ikt} + \epsilon_{it}$$

	Baseline	Extended
$\mathcal{I}_{kt}^{25\%} \times FF_t$	-11.85**	-9.36**
	(5.30)	(4.53)
$\mathcal{I}_{kt}^{50\%} \times FF_t$	-5.71	-5.26
	(4.76)	(3.43)
$\mathcal{I}_{kt}^{75\%} \times FF_t$	0.50	2.07
	(4.29)	(3.92)
State and time FE	✓	✓
HH Controls $\times FF_t$	✓	✓
Share manufactures $\times FF_t$	✓	✓
MP Shock	FF4	FF4
N	147,661	147,668

States with low participation 0.82 pp sharper drop in consumption after 1SD MPS

Further Analysis and Robustness

1 - Study impact of model variations on dampening response to MP shocks

- Sensitivity analysis: No investment adj. costs; No debt-elastic rate; Lower leverage
- Extensions: Endogenous ptp.; Passive traders; Government debt; Htg. preferences

2 - Study effects of higher participation on response to TFP and investment shocks

- Results: TFP shocks are dampened, investment shocks amplified

3 - Additional empirical validation

- Differential consumption response (P vs NP) milder in 2000-2007 than 1990-1999
- SVAR-IV and Cholesky estimated IRFs suggest milder response of output and investment to MP shocks in sample post rise in participation

APPENDIX

Appendix: Parameter Values in TANK Model

Parameter	Value	Parameter	Value	Parameter	Value
α	0.35	φ_p	0.25	ξ_p	25
β	0.96	z_0	1.0	θ	6
ρ	1.0	K_0	0.5	R_0	1.03
γ	5.0	ν	6	M_1	0.46
$\delta_0 = \delta_1$	0.60	$\sigma_{\ln z}$	0.3		

Back

Calibrated Parameters in Infinite Horizon Model Back

Parameter	Description	Target	Value
Conditional: Monetary policy shocks			
ϕ_k	Investment rate cost	Investment-Tobin Q elasticity	11
ψ	Borrowing cost elasticity	Equity price elasticity	1.8e-05
Unconditional: Business cycles			
ρ_z	TFP persistence	Output persistence	0.30
σz	TFP volatility	Output volatility	0.007
δ	Capital depreciation rate	Investment over output	0.021
ρ_ν	Persistence investment shock	Persistence of investment	0.70
σ_ν	Volatility investment shock	Relative volatility investment	0.11
ξ_w	Wage friction	Correlation output and profits	13
Unconditional: Asset prices			
$\gamma_p = \gamma_{np}$	Household risk aversion	Equity premium	9
β	Discount rate	Real risk-free rate	0.994
λ_d	Payouts exponent	Relative volatility equity payouts	9.5
Unconditional: Cross-section			
b_{np}	Nonparticipant savings	Participant's leverage	37

Target Moments in Infinite Horizon Model

Back

Target	Model	Data
Conditional: Monetary policy shocks		
Investment-Tobin Q elasticity	0.60	0.57
Equity price elasticity	-3.0	-3.0
Unconditional: Business cycles		
Output persistence	0.80	0.85
Output volatility	2.1	2.0
Investment over output	18.16	16.28
Persistence of investment	0.90	0.88
Relative volatility investment	2.3	2.6
Correlation output and gross profits	62	76
Unconditional: Asset prices		
Equity premium	4.5	3.9
Real risk-free rate	2.2	2.1
Relative volatility equity payouts	13.5	13.6
Unconditional: Cross-sectional		
Participant's leverage	0.24	0.25