Firm size, heterogeneous strategic complementarities, and real rigidity

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1. Abstract

- Recent research finds that only large firms exhibit strategic complementarities in price setting. Using firm survey data, we show that cost pass-through decreases significantly with firm size.
- To examine the implications for inflation, we develop a DSGE model that features heterogeneous complementarities across firm size. While standard DSGE models with homogeneous firms generate real rigidity in relative prices, real rigidity is much weaker in our model. Large firms that exhibit strategic complementarities align their goods prices with those of small firms that more fully pass through costs.
- Our findings challenge the notion of strategic complementarities as a source of real rigidity.

2. Empirical evidence

- Data from the Atlanta Fed's Business Inflation Expectations survey.
- Panel regression of price growth on cost growth by firm size.

Variables	Main sample	Same firm size
$\Delta cost_{f,t} \times I_{f,t}$ (small firms)	3.093***	3.192***
	(1.069)	(1.104)
$\Delta cost_{f,t} \times I_{f,t}$ (medium firms)	2.965***	2.823***
	(0.752)	(0.930)
$\Delta cost_{f,t} \times I_{f,t}$ (large firms)	0.891	0.859
	(0.740)	(0.762)
Firm fixed effects	yes	yes
Time fixed effects	yes	yes
Sample size	724	641
Wald test $\beta_1=\beta_2=\beta_3$	6.843**	6.016**

3. A DSGE model with firm heterogeneity in productivity and in strategic complementarity in price setting

- Each firm belongs to one of k groups with TFP level z_i and parameter governing the super-elasticity of demand $\epsilon_i \leq 0$, for $i = 1, \dots, k$.
- $\epsilon_i < 0$: Kimball (1995)-type non-CES demand; $\epsilon_i = 0$: CES demand.
- Optimal price setting by firms in group *i*:

$$\hat{p}^*_{i,t} = \beta[\xi + (1-\xi)\omega_i]E_t\,\hat{p}^*_{i,t+1} + \beta\,(1-\xi)\sum_{j\neq i}\omega_j E_t\,\hat{p}^*_{j,t+1} + \frac{1-\beta\xi}{\Gamma_i}\widehat{mc}_t$$

(1) Strategic complementarities reduce the marginal cost elasticity, as

$$\Gamma_i = 1 + (-\epsilon_i)\,\mu_i\,(p^*_i/d)^{\theta(1+\epsilon_i)}$$

(2) Heterogeneity introduces a spillover effect from other firm types.

- The slope of the Phillips curve is a revenue (ω_i)-weighted average of components $\kappa_i = (1-\beta\xi)\,(1-\xi)/(\xi\Gamma_i)$:

$$\hat{\pi}_t = \beta E_t\,\hat{\pi}_{t+1} + \underbrace{\left(\sum_{i=1}^{k}\omega_i\,\kappa_i\right)}_{=\kappa}\widehat{mc}_t$$

4. Calibration

- Choose commonly used values of parameters unrelated to firm size and set the number of firm groups $k = 3$.
- Assume $\epsilon_1 = 0$, normalize $z_1 = 1$, and obtain values of other firm-size-specific parameters by targeting payroll and revenue shares by firm size from the US Census Bureau's Statistics of US Businesses.
- Larger firm groups have higher productivity and stronger strategic complementarity, in line with empirical evidence.

Parameter or variable	Description	Value for firm group *i*		
		1	2	3
n_i	Share of establishments, %	85.04	3.95	11.01
ω_i	Revenue share, %	40.03	14.44	45.54
z_i	Relative TFP level	1	1.46	1.80
$-\theta\epsilon_i$	Superelasticity of demand	0	5.63	7.65
p^*_i	Steady-state relative price	1.14	0.85	0.78
μ_i	Steady-state average markup	1.11	1.21	1.36

- Curvature $\sigma = \sum_{i=1}^{k}\omega_i\,(-\theta\epsilon_i) = 4.30$, consistent with micro evidence.

5. Heterogeneity in strategic complementarities weakens real rigidity

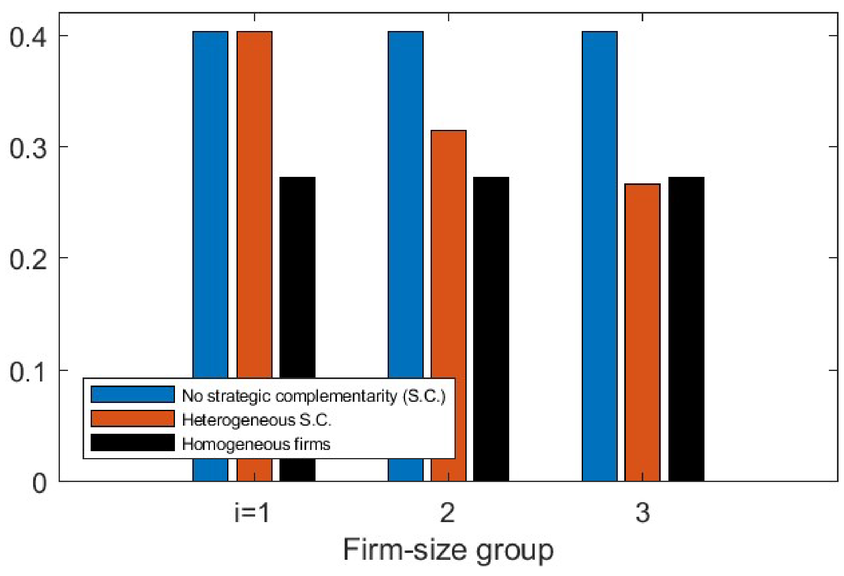
- Proposition: Suppose firm productivity is homogeneous, that is $z_i = 1$ for all $i = 1, \dots, k$, and consider the models with heterogeneous and homogeneous strategic complementarities that have the same curvature $\sigma = \sum_{i=1}^{k}\omega_i\,(-\theta\epsilon_i)$. Then the slope of the Phillips curve is larger in the model with heterogeneous strategic complementarities.
- Using calibration values of ϵ_i and ω_i, the slope $\kappa = 0.198$ with heterogeneity versus $\bar{\kappa} = 0.182$ if $\epsilon_i = \bar{\epsilon}$ for all i.

6. Results in the calibrated model with heterogeneous firm productivity and strategic complementarities

- Introducing heterogeneous firm productivity further weakens real rigidity, because the goods of larger firms have a lower price elasticity of demand
- The slope increases to $\kappa = 0.219$, versus $\bar{\kappa} = 0.182$ for homogeneous firms.

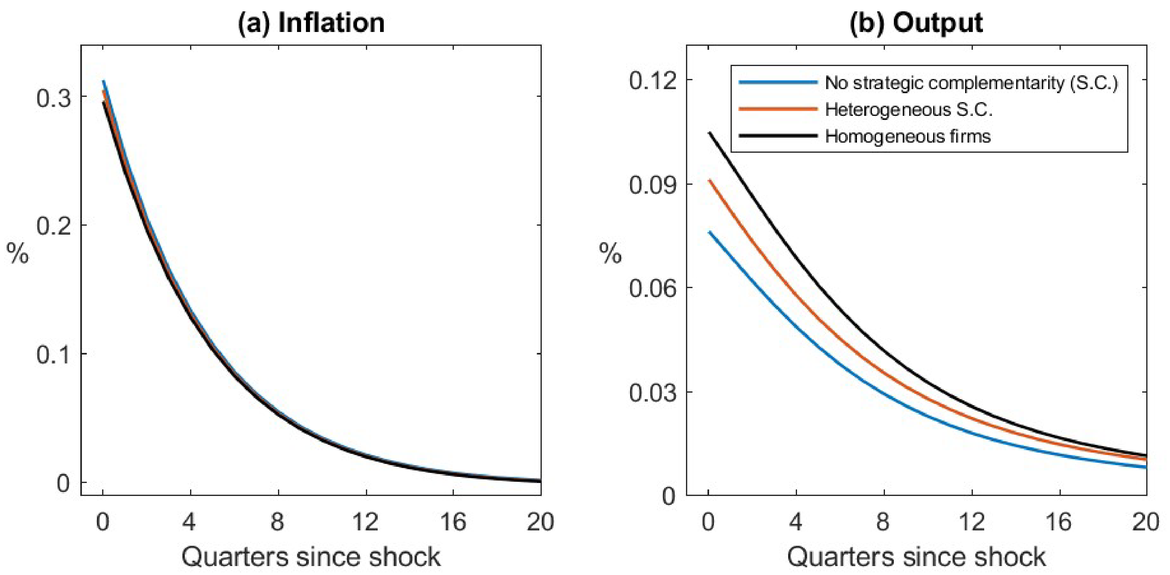
Figure: Marginal cost elasticities

- Larger firms have a smaller marginal cost elasticity $(1-\beta\xi)/\Gamma_i$ in the calibrated model, in line with the empirical evidence on cost pass-through.



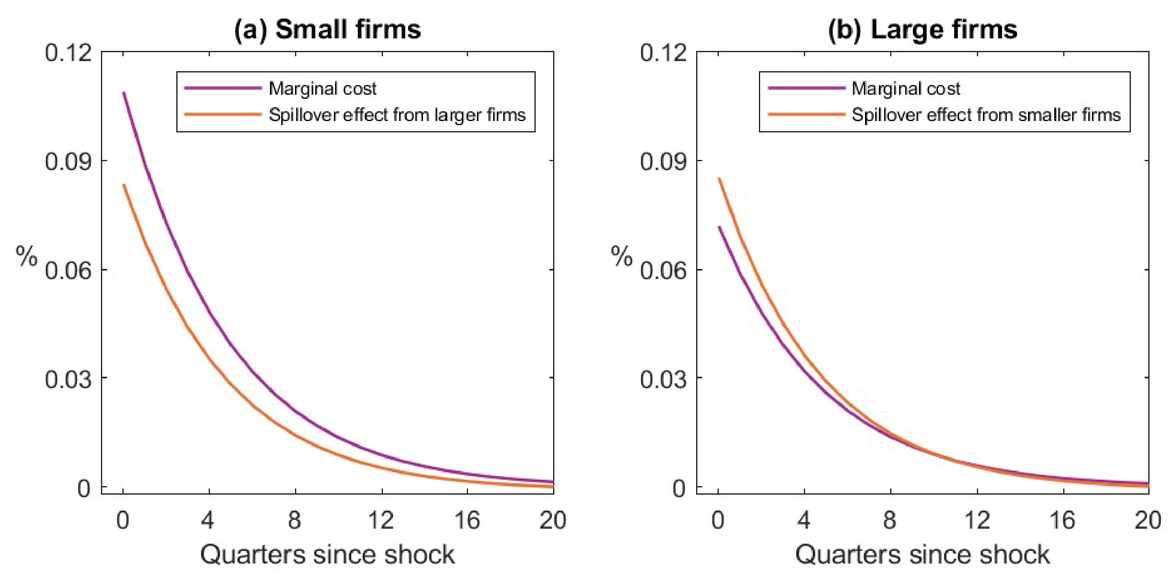
- Weaker real rigidity due to heterogeneous strategic complementarities reduces monetary non-neutrality by about half in the calibrated model.

Figure: Impulse responses to an expansionary monetary policy shock



- Small firms, facing a constant elasticity of demand, pass through marginal costs more fully than large firms, who exhibit strategic complementarity.
- An expansionary policy shock raises marginal costs and hence the goods prices of small firms, which spill over to the goods prices of large firms due to strategic complementarities.

Figure: Contributions to the impulse responses of optimized goods prices



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Inflation: Drivers and Dynamics 2025 Conference

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