Credit Market Frictions and the Productivity Slowdown

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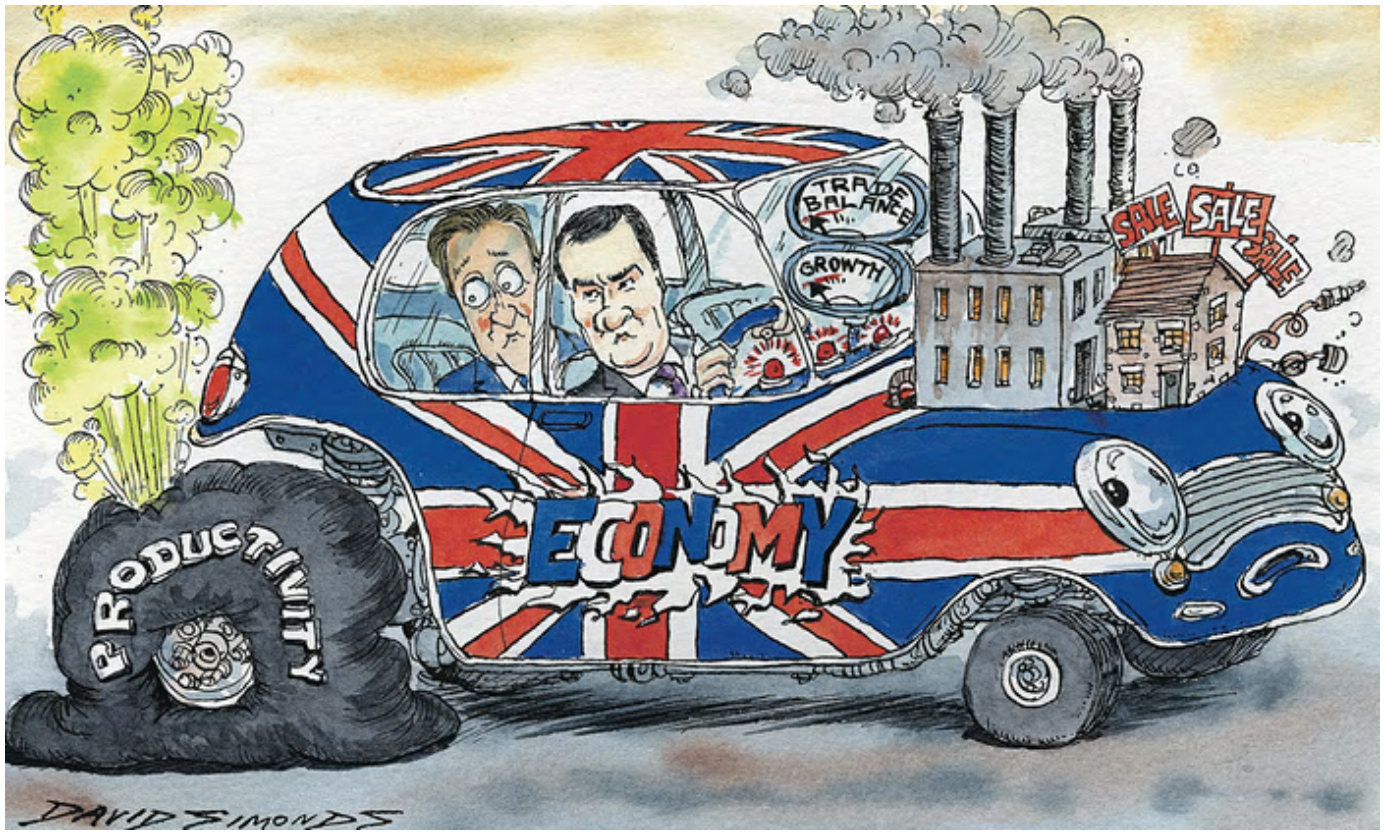
Role of credit frictions in global productivity slowdown?



- Specific UK case study, but we address global concerns about post *financial* crisis growth performance

UK Case Study: 'UK productivity puzzle'

- 16% gap at Q4 2015 between post-1979 trend and actual labor productivity

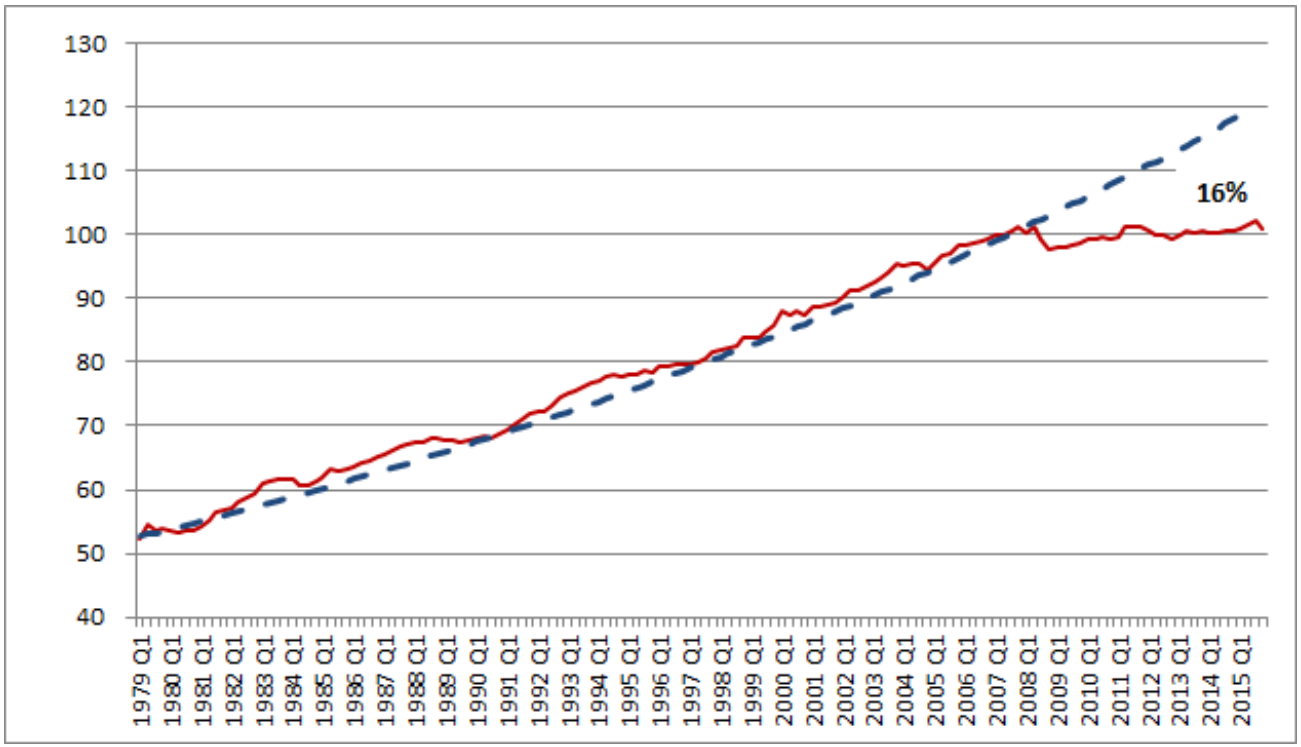


Figure: GDP/hour Q4 2007=100, trend=2.3% p.a.(Q1 1979-Q2 2008 average).

Source: ONS

UK Case Study

- Slowdown stands out in UK historical and international perspective

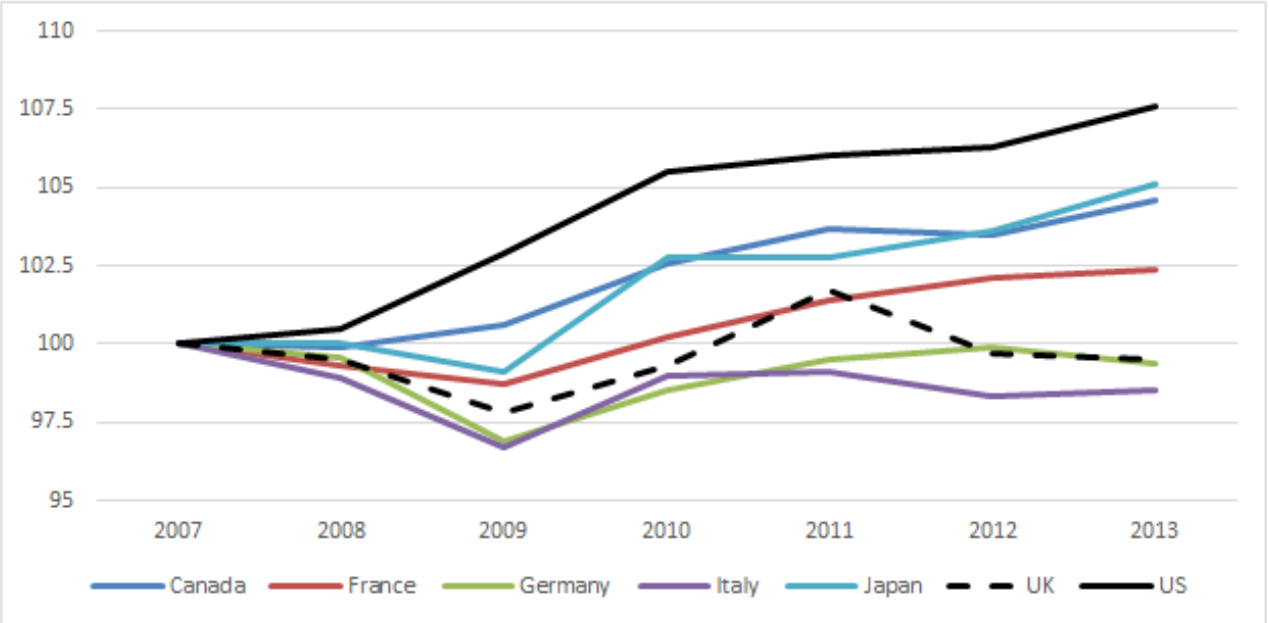


Figure: GDP/hour, 2007=100. Source: OECD and ONS

Historical

Integrated theoretical-empirical framework

- Literature on the consequences of firm-level distortions for aggregate performance (e.g. Hsieh and Klenow, 2009)
  - Large number of frictions $\rightarrow$ 'black box'
  - We want to isolate financial frictions
- Need specific theoretical framework to *motivate a way of measuring* the impact of credit on the real economy
- Take theoretical concepts to rich administrative firm-level panel data

- STEP 1: Micro-found a (measurable) proxy for firm-level credit 'conditions'
  - Model suggests focusing on *default risk*
  - Can be estimated empirically using a credit scoring algorithm
- STEP 2: Embed this in a model with heterogeneous firms
  - How has average default risk evolved? How do firm-specific shocks co-vary with firm characteristics?
  - How do changes in default risk translate into aggregate output and productivity losses?

Key result: Credit frictions matter substantially

- Credit frictions substantially depress output and labor productivity
- On average over 2004-2012 level of UK output was 7% to 9% lower due to credit market frictions
- Impact worsened during the crisis and lingered thereafter
- Frictions account for between a fourth and third of
  - the 11% productivity 'puzzle' at the end of 2012
  - the productivity fall in 2008-2009

Measuring value added, labor productivity, and TFP

- Annual Business Inquiry and the Annual Business Survey
  - Establishment level administrative surveys (ONS)
  - Census of large businesses and stratified random sample of Small and Medium Sized Enterprises (SMEs) (under 250 employees)
- Measure productivity as real gross value added per employee
- Estimate capital stock (PIM) and TFP as Solow residual
- Use sampling weights to measure *aggregate* productivity developments

Novel empirical measure of access to credit

- Estimate default risk using credit scoring model (S&P's 'PD Model') of the type routinely used by banks
  - Inputs: BvD company accounts, industry, and macroeconomic factors
  - Output: risk score (aaa, bbb, etc.)

- Match risk score to *historical* default rates to capture historical information set of lenders

Deterioration in default risk, especially among SMEs

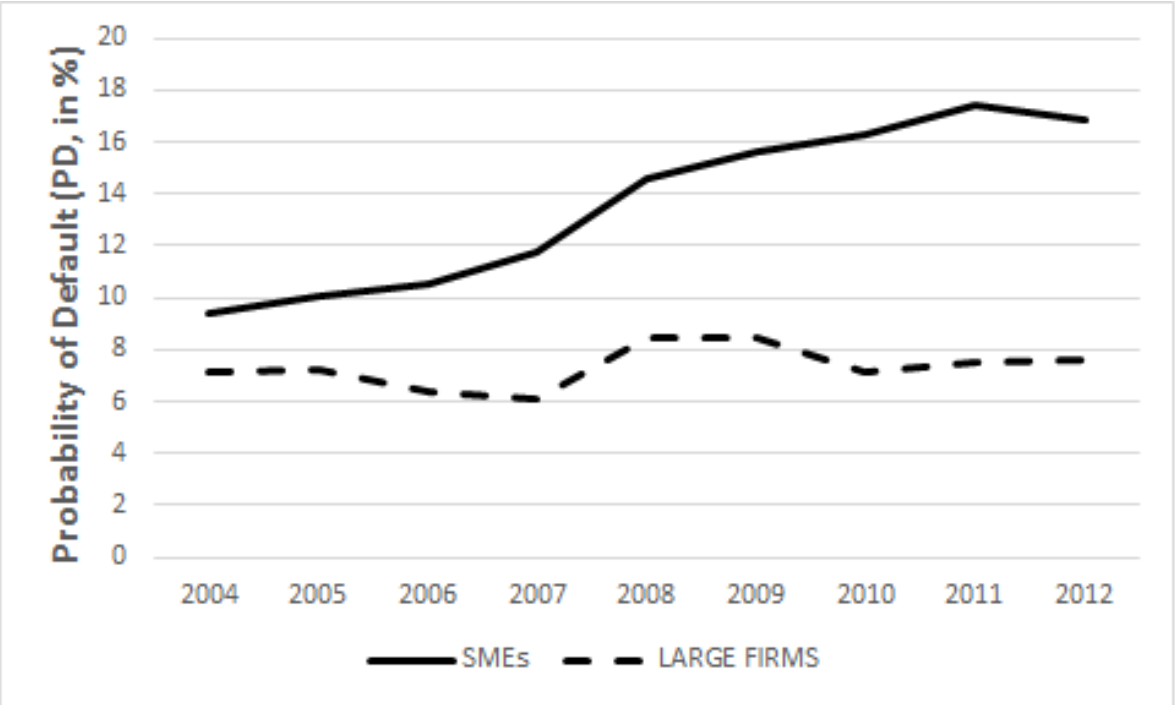


Figure: Aggregate probability of default at the 1-year horizon (in %). Source: Orbis, S&P's PD Model, authors' calculations.

- Probability of default (PD) systematically larger for SMEs
- Increase after 2007 is significant for both types of firms
- Aggregate developments largely driven by SMEs

Equilibrium credit market model

Micro-found a measurable proxy for credit access

- Firms have heterogeneous productivities θ and collateral A
- Managers exert costly effort which determines the probability of default, PD $\in [0, 1]$
- Banks compete and offer credit terms tailored to a firm's characteristics θ, A
- Access funds at cost $\rho > 1$

Equilibrium credit market model

Micro-found a measurable proxy for credit access

- Profit maximizing incentive compatible credit contract yields

$$\text{MP of capital} = \frac{\text{funding rate}}{1 - PD}$$

- Frictionless economy: marginal product of capital = funding rate ρ
- Equilibrium PD falls, ceteris paribus, if
  - Firm is more productive and has more collateral
  - There is greater competition among banks
  - Bank funding costs are lower
- Shocks to all of these factors are summarized in equilibrium PD

Firm-level implications
Optimal output and capital

- Production function for firm n

$$Y_{nt} = \theta_n \left(L_{nt}^{1-\alpha} K_{nt}^{\alpha} \right)^{\eta}$$

- Fully flexible labour while capital is determined as above
- Factors which decrease PD increase output, employment, and the use of capital
- Firm level TFP also matters alongside macro effects

$$\log\left(Y_{nt}\right) = \underbrace{\frac{\eta\alpha}{1-\eta} \log\left(1 - PD_{nt}\right)}_{\text{Time-varying PD}} + \underbrace{\log\left(\psi\left(w_t, \rho_t\right)\right)}_{\text{Factor prices: Year FE}} + \underbrace{\frac{1}{1-\eta} \log\left(\theta_n\right)}_{\text{TFP: Firm FE}}$$

Firm-level implications

Analysis validates role of a firm's PD as 'determinant' of investment and size

Table: OLS with year and firm fixed effects

	Ln(Empl)	Ln(GVA)	Ln(Purchases)	Ln(TA)
Lagged Default Probability	-0.104*** (0.026)	-0.620*** (0.045)	-0.222*** (0.041)	-0.387*** (0.037)
Observations	60,798	60,798	60,798	60,798
R2	0.981	0.944	0.963	0.983
	Ln(Net investment)	**Ln(K)**	**Ln(FA)**	**Ln(TFP)**
Lagged Default Probability	-0.932*** (0.097)	-0.082*** (0.021)	-0.382*** (0.057)	-0.463*** (0.036)
Observations	60,798	60,798	60,798	60,798
R2	0.827	0.993	0.969	0.824

- Expected default risk is significant indicator of firm performance
- Non trivial coefficients: e.g. 10pp increase in PD associated with a 9% fall in investment
- Also a higher PD decreases the probability of survival

- Aggregate expected output is a function of
  - Factor prices, aggregate technology and demand conditions
  - Aggregate default risk and the distribution of default risk across firms

$$\Theta_t = \sum_{n=1}^{N} \omega(\theta_{nt})(1 - PD_{nt})^{1+\frac{\eta\alpha}{1-\eta}}$$

- Weighted average of probabilities of repayment where weights = relative fundamental TFP
- $0 \leq \Theta_t \leq 1$ scales output up and down: No default $\rightarrow \Theta_t = 1$
- Θ_t can be estimated using
  - TFP estimates (Solow residual)
  - Employment shares (theoretical relationship with Θ_t)

Aggregate implications

Default risk affects output and labor productivity

	(1)	(2)	(3)
	Baseline: labor share = 66.7%		
	Credit Friction	Percentage Output loss	Contribution to productivity growth
2004	0.819	6.5	
2005	0.842	5.6	0.9
2006	0.805	7.0	-1.5
2007	0.795	7.4	-0.4
2008	0.764	8.6	-1.4
2009	0.734	9.8	-1.3
2010	0.729	10.0	-0.2
2011	0.702	11.1	-1.2
2012	0.704	11.1	0.1
Average	0.766	8.6	-0.6

- Increasing default risk
- Impact worsens during the crisis and lingers thereafter
- Robust patterns across estimation methods

Robustness

How much of the productivity gap can we explain?

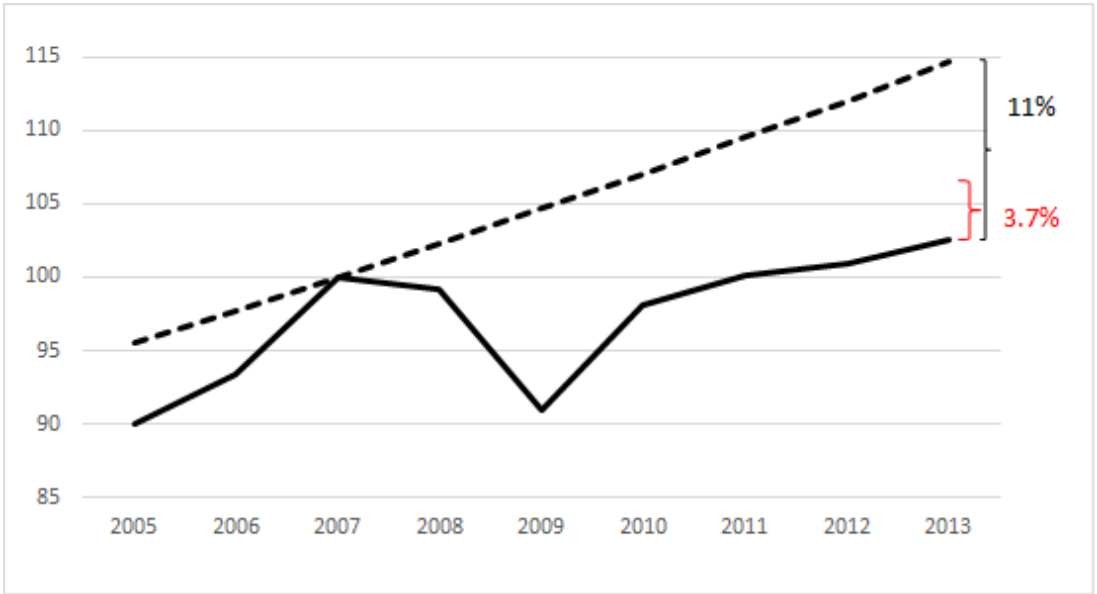


Figure: Real GVA per worker - actual versus trend, 2007=100. Source: ABI & ABS surveys, authors' calculations.

- LP would be 3.7% higher in 2012 had the level of credit frictions stayed at their level in 2007
  - That is 33.6% of the productivity shortfall at the end of 2012
- LP growth contribution 2008-09: -2.7% = 31% of the fall

Extension: SMEs versus large firms

	(1)	(2)	(3)	(4)	(5)	(6)
	SMEs (Solow residual, α=1/3)			Large firms (Solow residual, α=1/3)		
	Credit Friction	Percentage Output loss	Contribution to productivity growth	Credit Friction	Percentage Output loss	Contribution to productivity growth
2004	0.822	6.3		0.887	3.9	
2005	0.840	5.6	0.7	0.890	3.8	0.1
2006	0.799	7.2	-1.7	0.898	3.5	0.3
2007	0.802	7.1	0.1	0.892	3.7	-0.2
2008	0.769	8.4	-1.4	0.863	4.8	-1.1
2009	0.733	9.8	-1.6	0.861	4.9	-0.1
2010	0.735	9.8	0.1	0.869	4.6	0.3
2011	0.707	10.9	-1.3	0.866	4.7	-0.1
2012	0.705	11.0	-0.1	0.869	4.6	0.1
Average	0.768	8.5	-0.7	0.877	4.3	-0.1

- Default risk systematically higher among SMEs
  - Higher output losses among SMEs
  - Aggregate deterioration driven by SMEs

Demand effects

Extension: Misallocation - between firm effects

Counterfactual: Each firm gets its industry average default probability

	(1)	(2)	(3)
	Contribution to productivity growth (Counterfactual)	**Contribution to productivity growth (Baseline)**	**Contribution of allocational efficiency to productivity growth**
2005	-0.4	0.9	1.3
2006	-0.1	-1.5	-1.4
2007	-0.9	-0.4	0.5
2008	-2.1	-1.4	0.7
2009	-0.4	-1.3	-0.9
2010	-0.6	-0.2	0.4
2011	-0.8	-1.2	-0.4
2012	0.4	0.1	-0.3
Average	-0.6	-0.6	-0.01

- On average between-firm effects depressed labor productivity by only 0.01% over 2005-12
- Generalized increase in default risk matters more

Conclusions

- Global productivity slowdown is a puzzle
- Do credit frictions play a role in this?
- Developed a theoretical-empirical framework to motivate a way of measuring the impact of credit frictions on the real economy
- Proposed a new empirical measure of firm-level credit frictions which can be estimated with company accounts
- UK Case Study with rich administrative firm-level panel data
  - Substantial output and productivity losses from generalized increase in default risk
  - Worsening since 2007 - mainly due to frictions on SME credit markets
  - Misallocation effects are small in comparison

UK Case Study

- Slowdown stands out in historical perspective

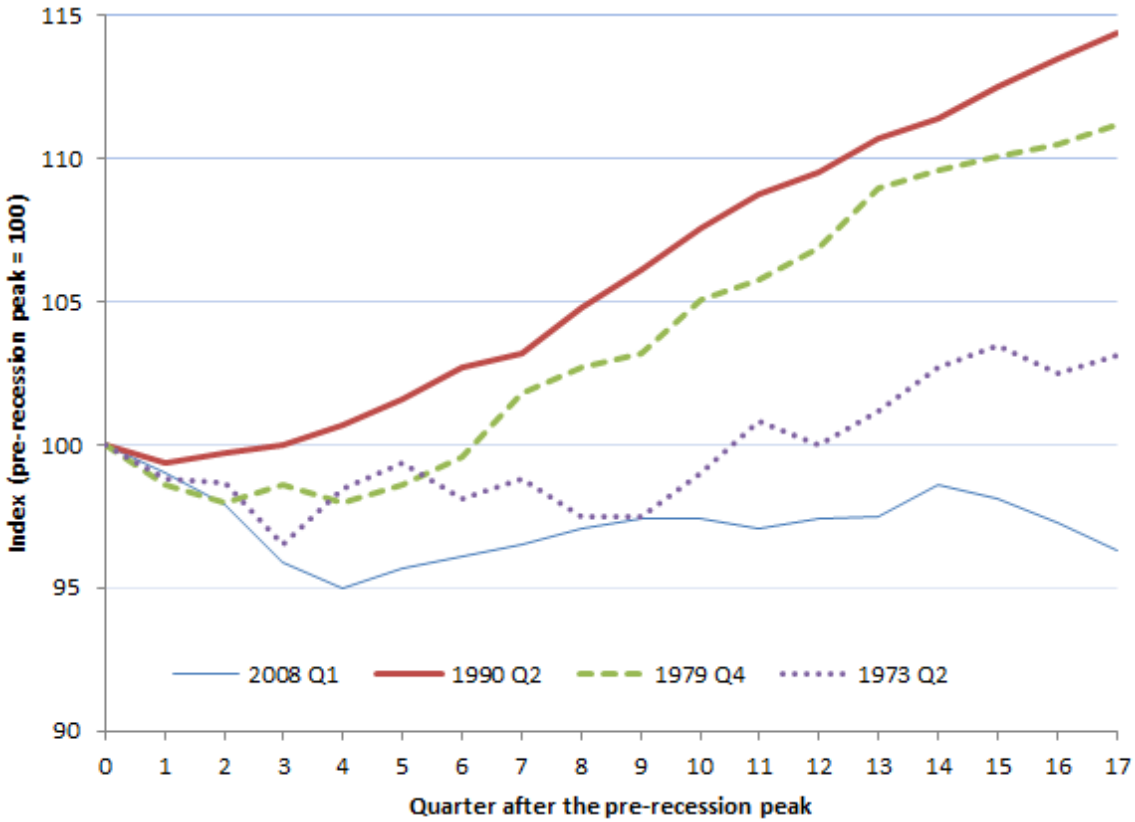


Figure: Output per worker, 2008-09 recession and previous 3 UK recessions. Pre-recession peak=100. Source: ONS.

International

Robust patterns across estimation methods

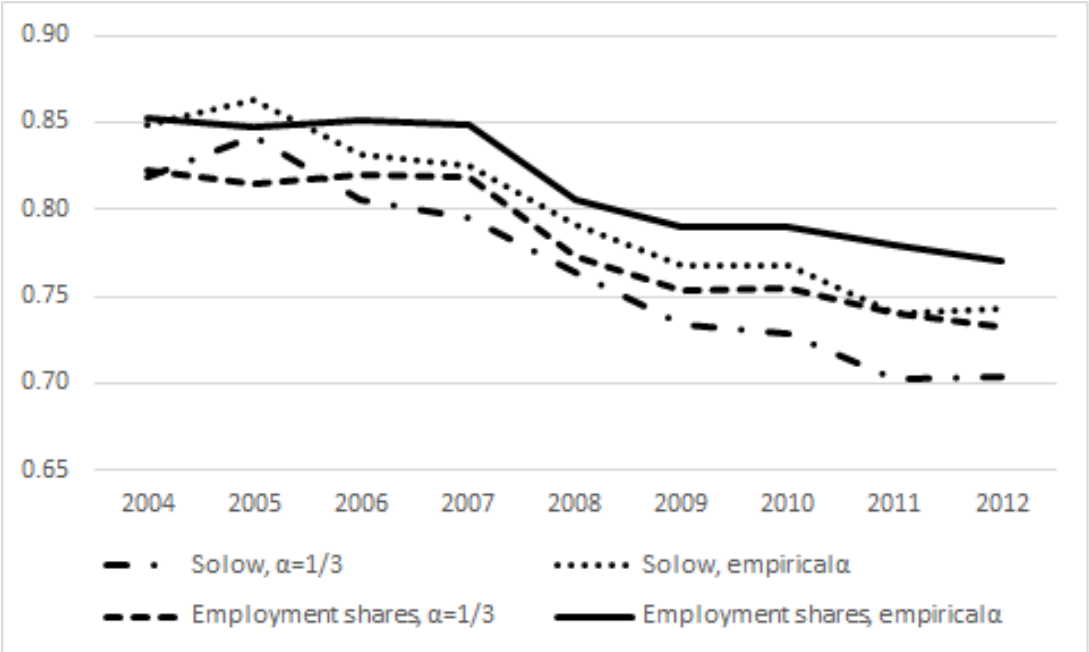
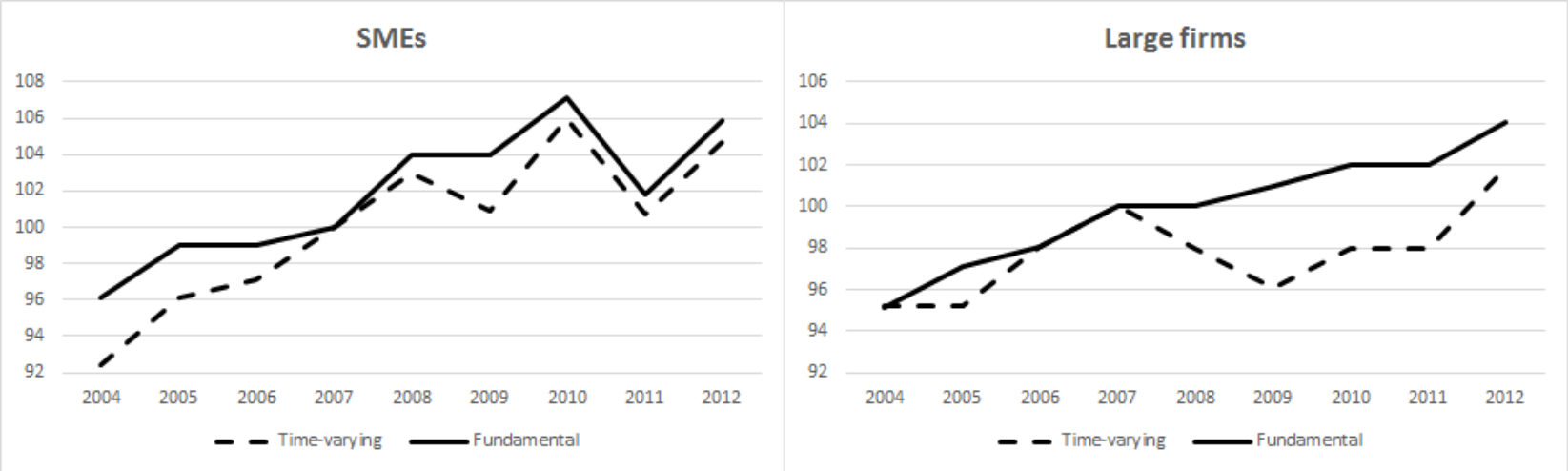


Figure: Estimates of Θ based on four estimation methods

Theta Solow residuals

SMEs versus large firms: Role of demand effects?



- Credit frictions as measured by default risk matter mainly for SMEs
- Have large firms suffered larger demand shocks? (exports etc.)
- Difference between fundamental and time-varying TFP suggests so

Size heterogeneity