Firm-level total factor productivity from the Annual Business Survey/ARDx

Russell Black (ONS, KCL)*

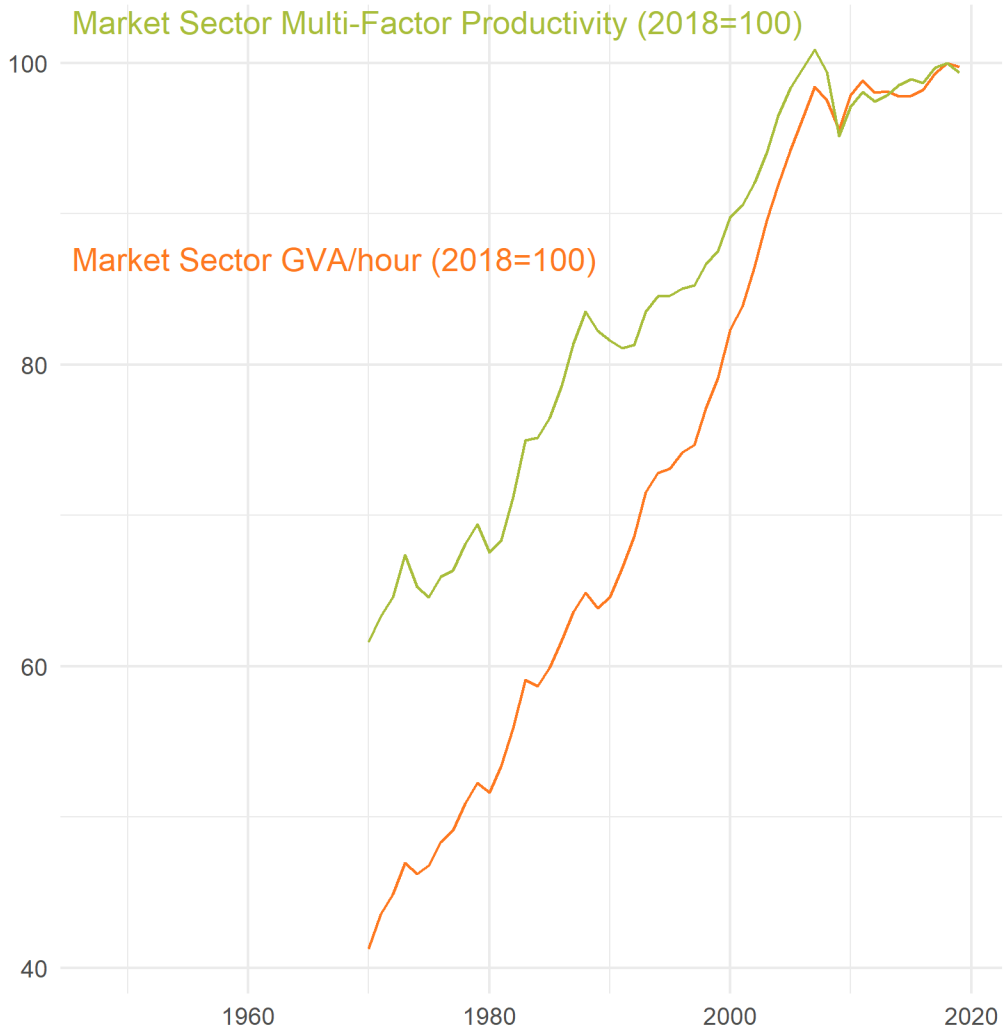
(*with thanks to Ted Dolby, Philip Wales, Cliodhna Taylor, Laura Hill, Josh Martin, Silvia Lui, Josefa Lavandero-Mason, Ben Radcliffe-Brown, Felix Ritchie, Rebecca Riley, Martin Weale)

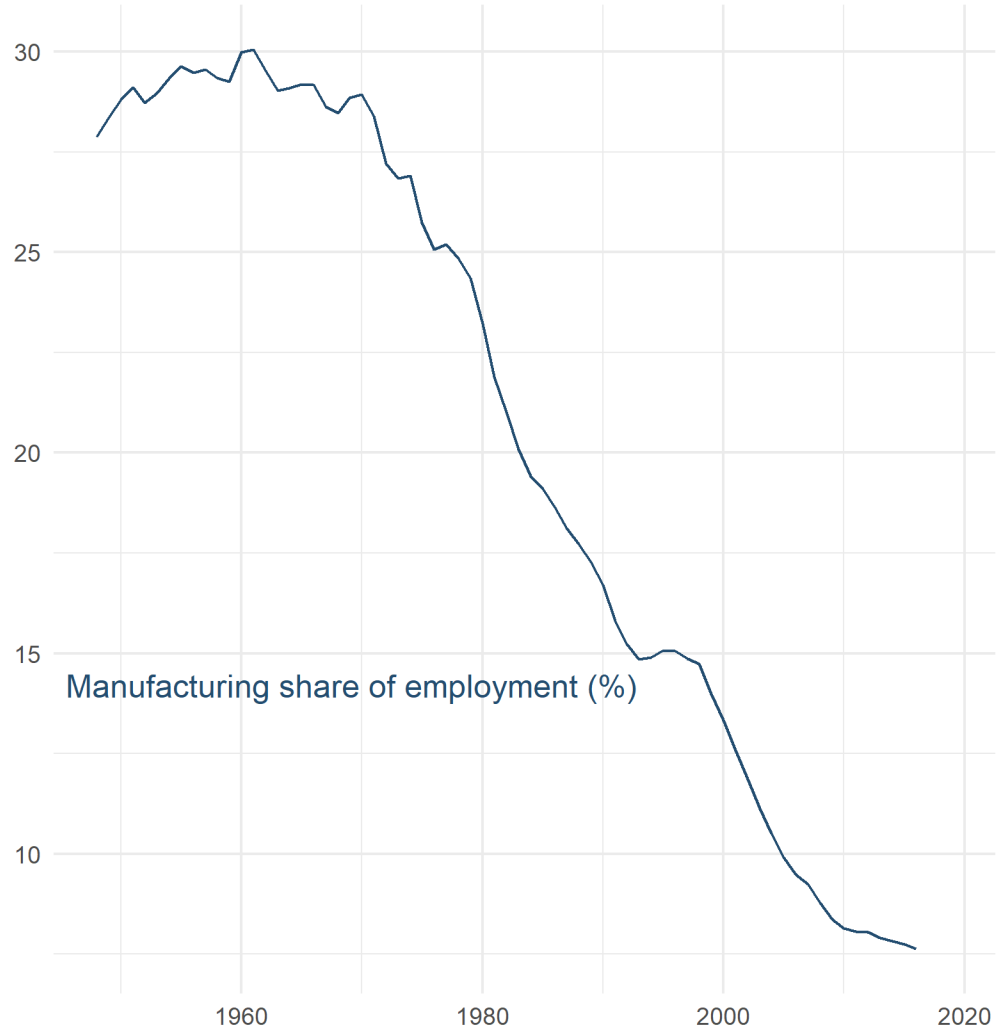
12 May 2021

Descriptive paper

- Firm-level productivity using official survey data
  - Labour productivity
  - Total factor productivity
- Changes in the productivity distribution over time

Motivation





Source: ONS, BoE Millennium of Macroeconomic Data

Motivation

- Declining dynamism (Decker et al. 2016; for the UK, Lui et al. 2020)

- Frontier growth (Andrews et al. 2015)

Motivation

- Declining dynamism (Decker et al. 2016; for the UK, Lui et al. 2020)
  - Evidence for UK from this paper: yes
- Frontier growth (Andrews et al. 2015)
  - Evidence for UK from this paper: mixed

Data

Annual Business Survey (ABS)

- c.50,000 business reporting units per year to cover the population of nonfinancial businesses, surveying turnover, intermediate consumption, capital expenditure, etc.
- Sample has more detailed coverage of large businesses – sample employs about 11m workers
- Annual Business Inquiry (1995-2008) + ABS (2009-2018)

Coverage

The exact coverage in the survey varies over the time period

Results for this presentation:

- Firms drawn from IDBR (i.e. large enough to be in VAT or PAYE)
- Non-farm, non-finance business economy (SIC07)
    - Excludes farms within section A (agriculture)
    - Excludes all of section K (finance and insurance)
    - Excludes all of section O (public admin & defence)
    - Excludes public sector components of P (education) and Q (health)
- Great Britain (excludes NI)

=> Not comparable to National Accounts, which are comprehensive

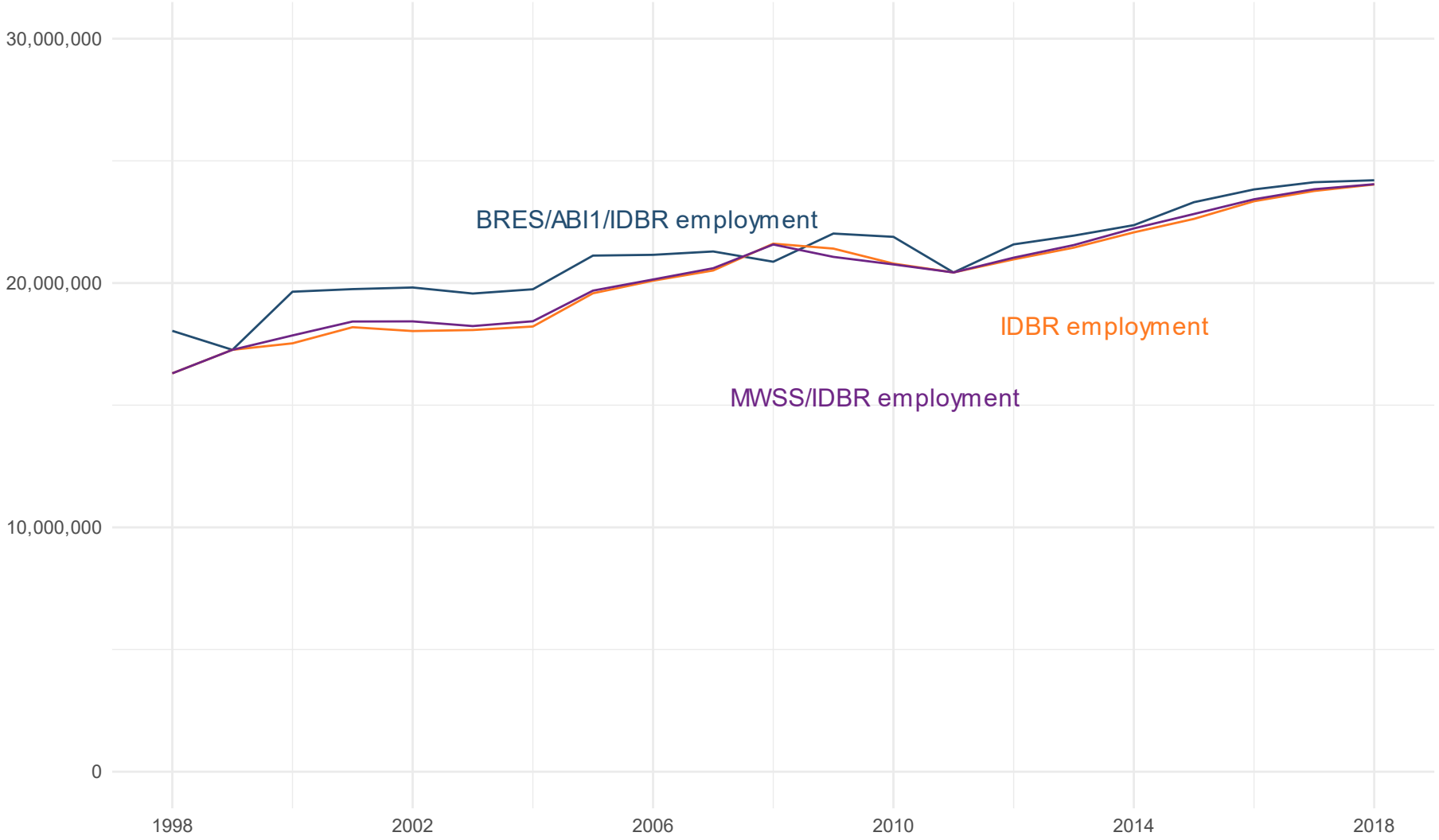
Assumptions

- Rules for SIC recoding
- Dependent on deflators
  - Output deflators at industry level
- Dependent on outlier filtering
  - Top and bottom 1 percent of observations by year by industry division
- Dependent on weighting and imputation
  - Following standard ABS weighting

Labour data

- Annual Business Survey is for financial information. Separate series of business surveys for employment information.
- IDBR, sample frame of businesses populated from PAYE and VAT (with exceptions)
- IDBR holds turnover and employment of each business, derived either from existing ONS survey returns or from tax data
- IDBR employment can be bolstered with survey data if available
    - ABI/BRES annual point-in-time value
    - MWSS (year average calculated if data for at least 10 months of calendar year)

Total weighted employment of sample, by predominant firm-level data source



Labour productivity

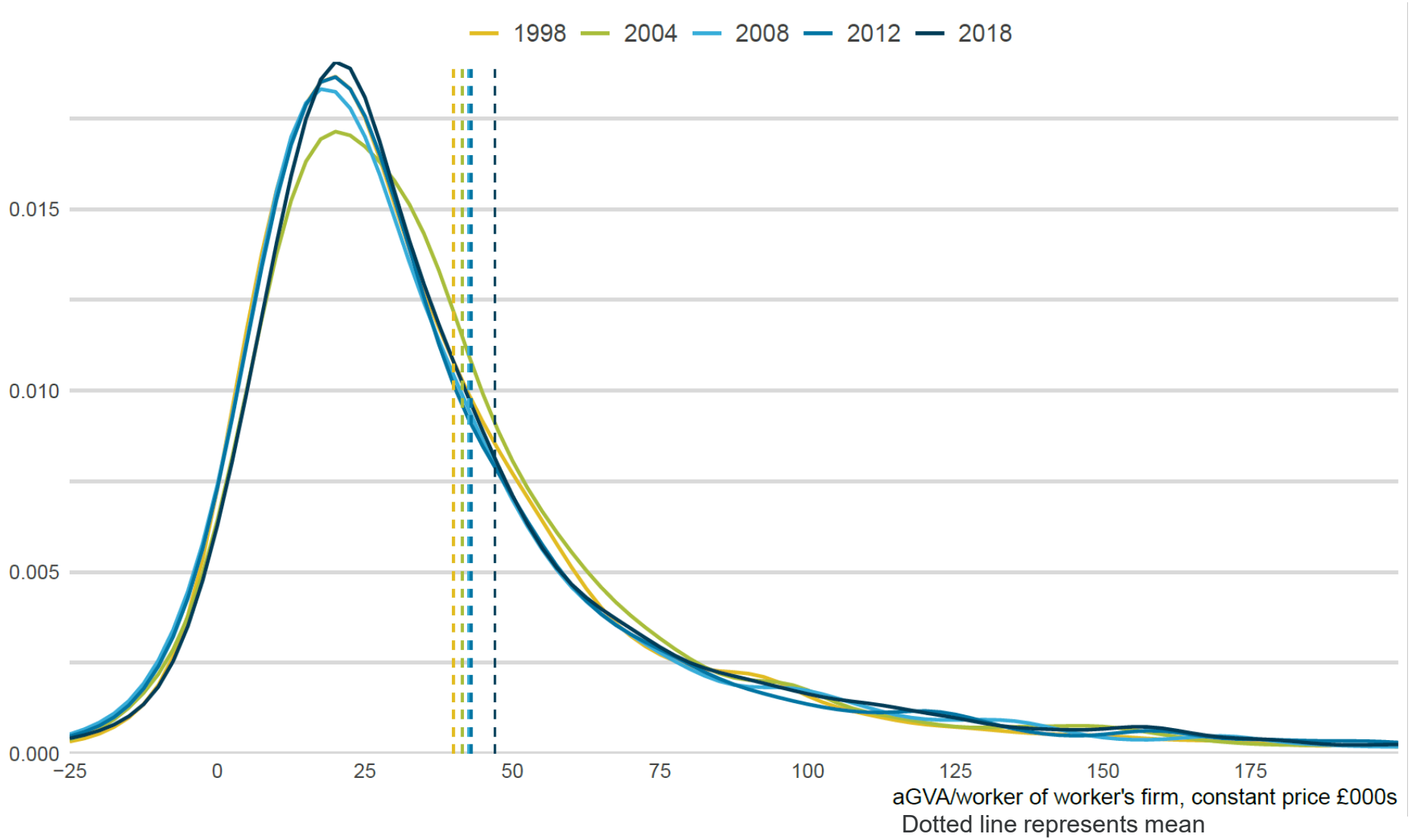
Labour productivity

- Labour productivity weighted on an employment basis within each strata

$$w_s = \frac{\sum_{j=1}^{N_s} l_j}{\sum_{j=1}^{n_s} l_j}$$

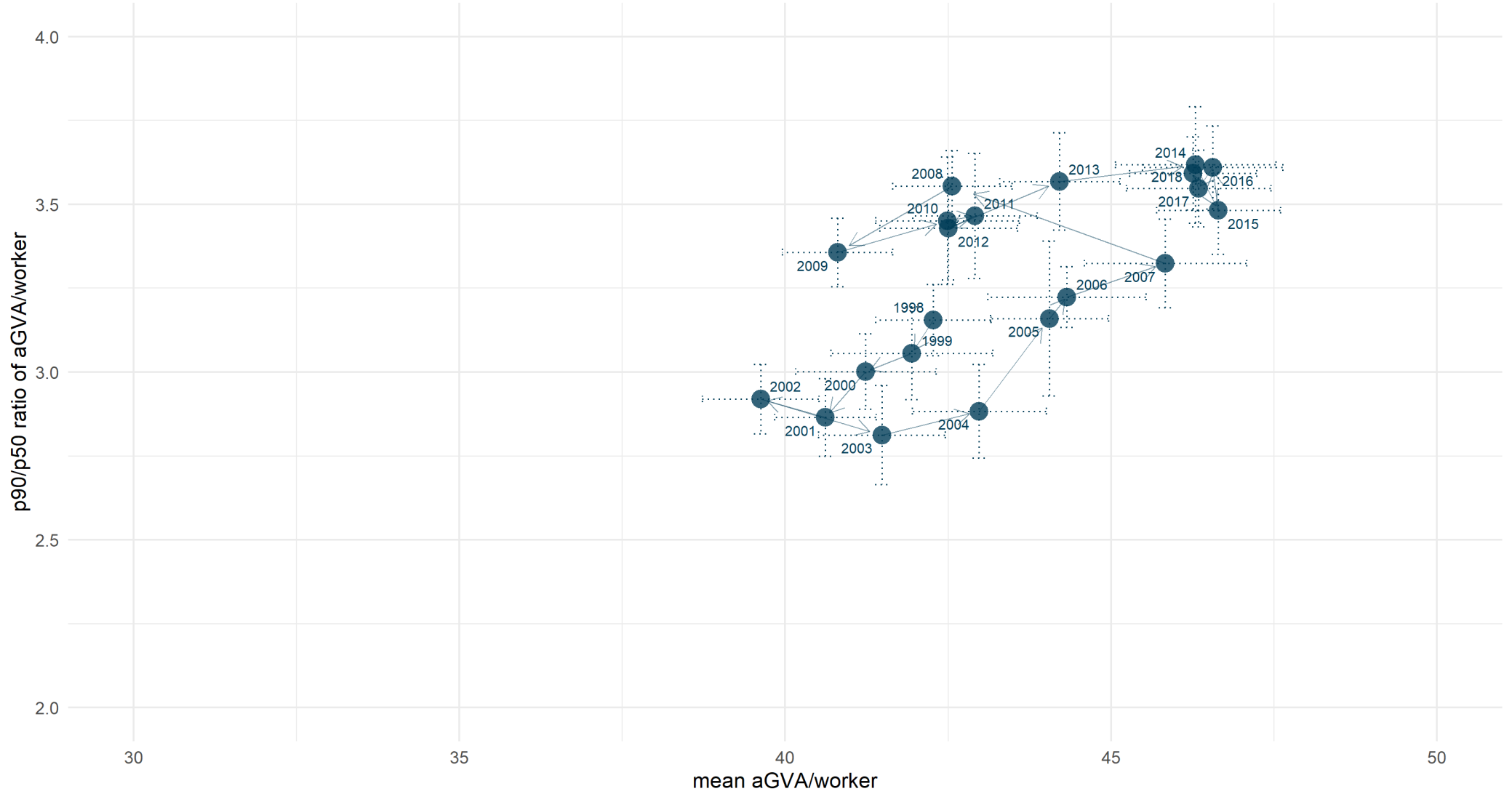
- Bootstrap standard errors based on strata

Labour productivity distribution

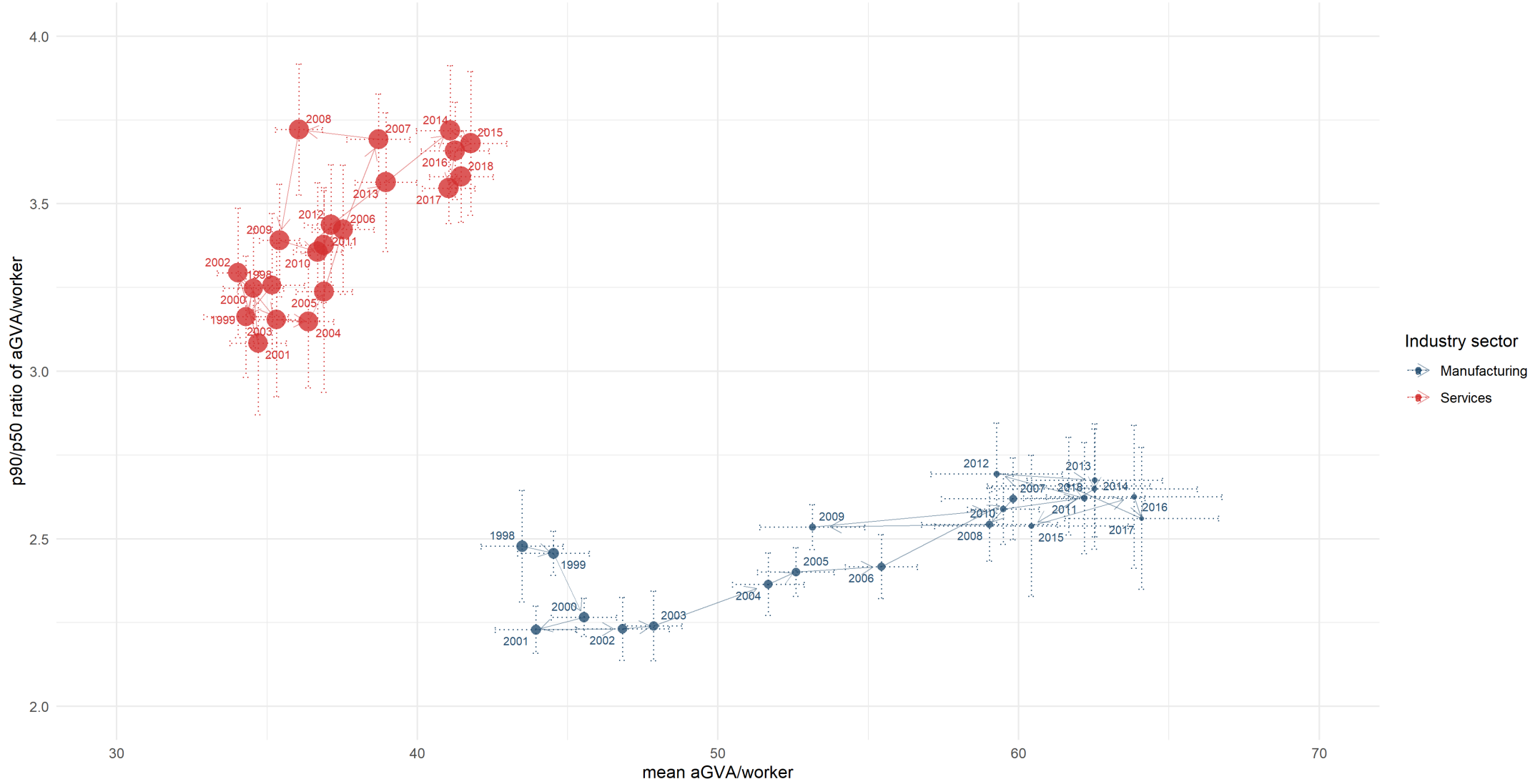


[add column on right tail?]

Labour productivity distribution – mean and frontier over time



Labour productivity distribution – mean and frontier over time



Data - capital

Firm-level capital stocks

$$K_{t+1,i} = (1 - \delta_{t,i})K_{t,i} + I_{t,i}$$

Need to impute for where there is no ABS record of investment

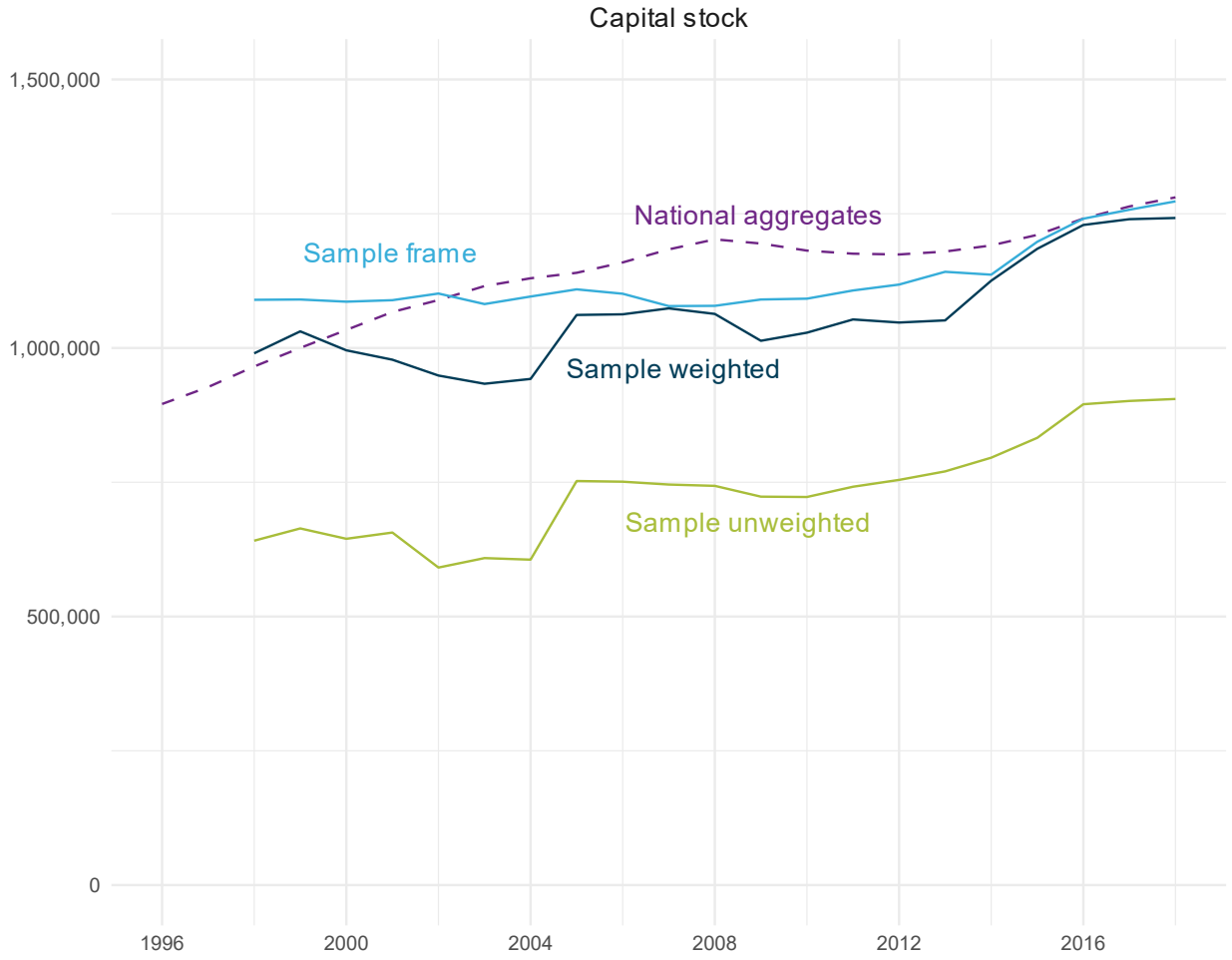
- Panel data on investment only for largest firms
- Investment is lumpy
- Long forms and short forms
  - Expansion: Detail at individual asset level only available on long forms
- Initial capital stock value
  - Mergers and acquisitions

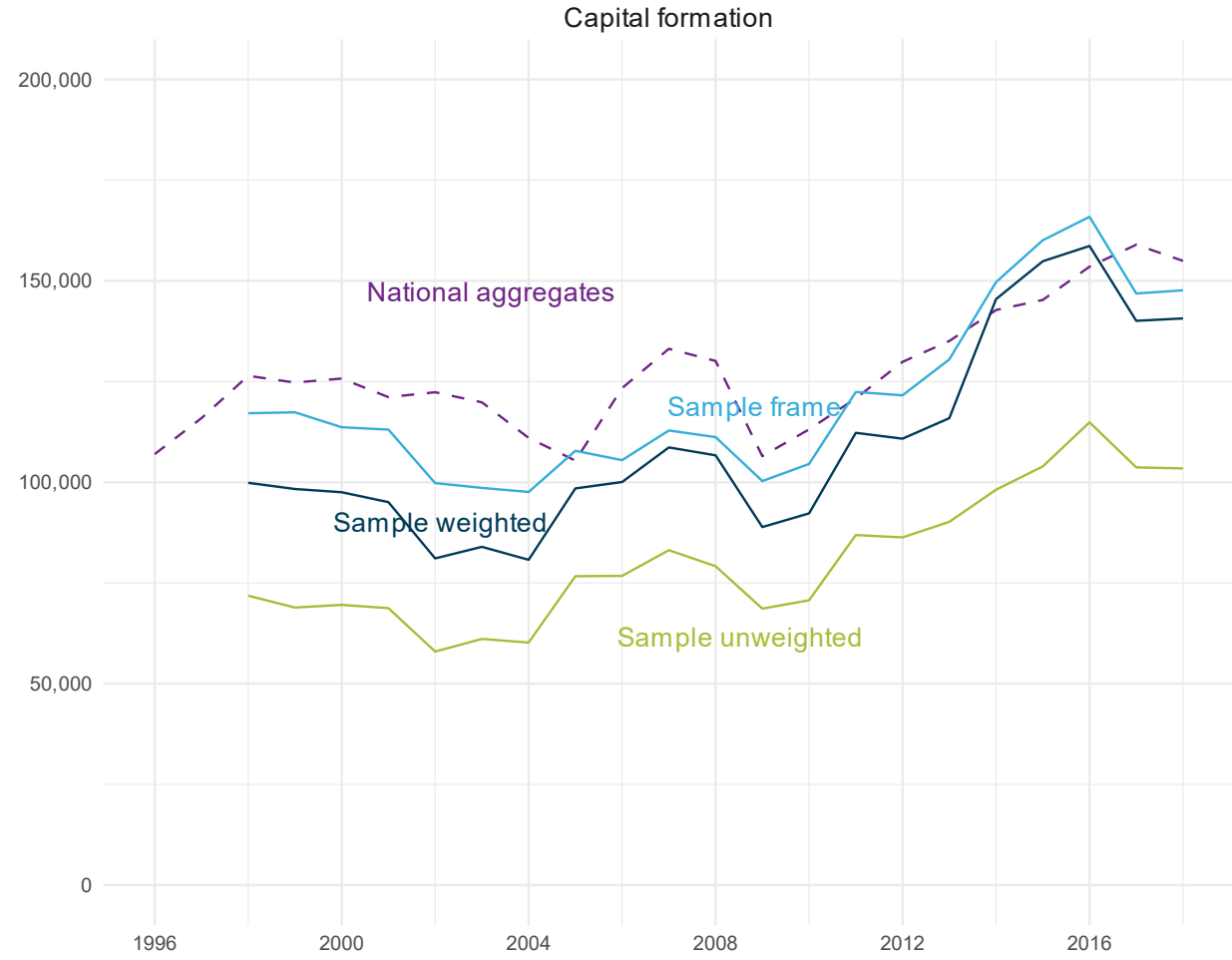
Firm-level capital stocks

Simplified capital stock

- Total net investment, no asset splits
- Imputed total investment based on industry/size band investment per worker
- Use data on ABS capital assets from National Accounts
    - Industry/time depreciation rates from National Accounts
    - Initial capital stock from National Accounts using firm's share of industry employment

Firm-level capital, £m 2018





TFP

TFP methods

- Production functions (estimated at A64 level)
  - Cobb-Douglas:

    $$Y = AK^{\alpha}L^{\beta}$$

  - Translog:

    $$\ln(Y) = ln(A) + \alpha_k ln(K) + \alpha_l ln(L) + \alpha_{kl} \ln(K) \ln(L) + \alpha_{kk} \ln(K)^2 + \alpha_{ll} \ln(L)^2$$

- Estimation
  - OLS
  - Ackerberg-Caves-Frazer (2015) GMM-based
  - Collard-Wexler-DeLoecker (2017) GMM-based

Weighting for TFP

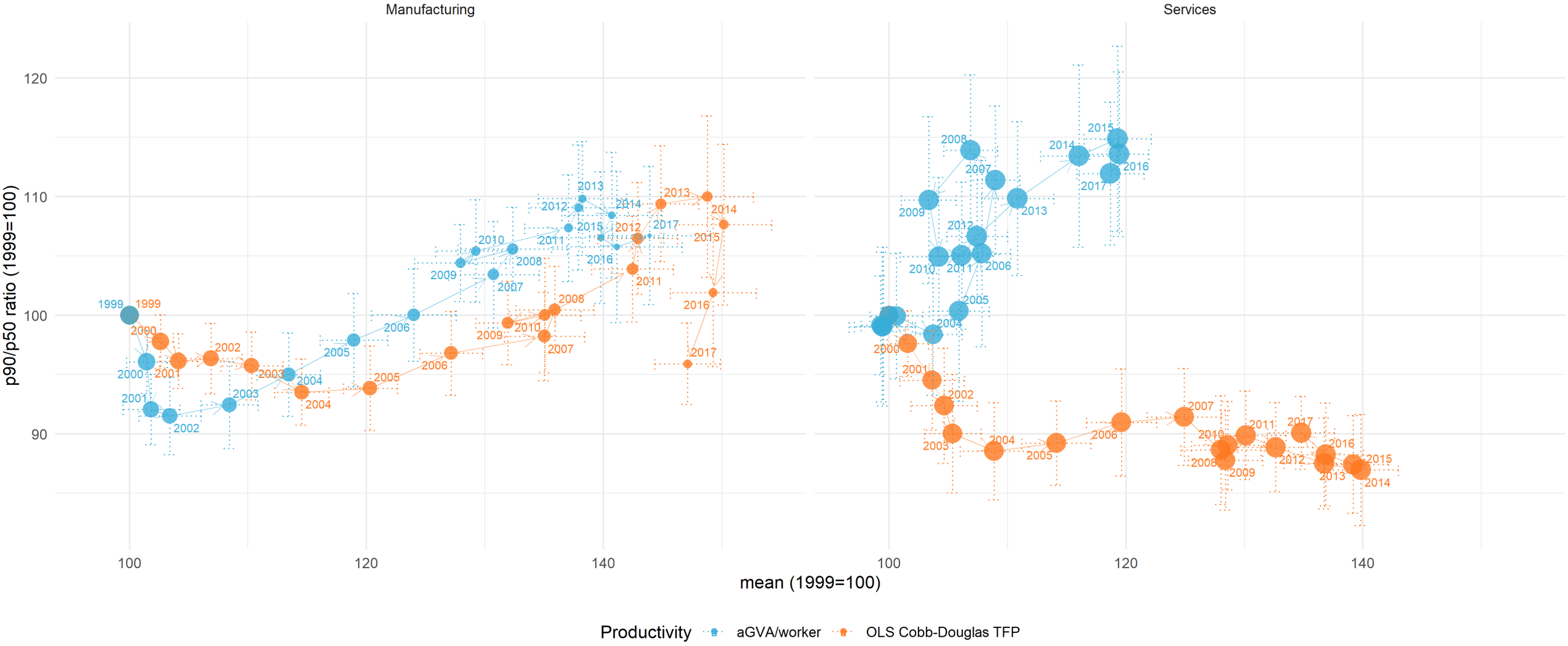
- Analogous to statistics presented for labour productivity
- Labour productivity:

$$Y_i = 1 \cdot K_i^0 L_i^1 \cdot \hat{\pi}_i^{lp}$$

- Cobb-Douglas total factor productivity:

$$Y_i = \hat{A} K_i^{\hat{\alpha}} L_i^{\hat{\beta}} \cdot \hat{\pi}_i^{cd}$$

Change in labour productivity and TFP distributions



Results

- Frontier-outpacing-middle-of-distribution is mainly in labour productivity in services
- Manufacturing: the distribution grows evenly. There is a substantial fall in terms of inputs, removing the less productive section of the distribution
- Services: the middle is using capital efficiently, even if not labour, so TFP growth is broad-based, rather than outpaced by frontier
- More advanced GMM methods for estimating TFP only suitable for capital intensive industries like manufacturing

(Total growth 1999-2018, across methods)

Measure		aGVA/worker			OLS - CD			OLS - TL			ACF - CD			CWDL - CD		
Main employment data		BRES	IDBR	MWSS	BRES	IDBR	MWSS	BRES	IDBR	MWSS	BRES	IDBR	MWSS	BRES	IDBR	MWSS
All	p10	35%	35%	42%	5%	8%	9%	13%	18%	19%	-5%	25%	130%	15%	-5%	9%
	p25	15%	14%	15%	14%	17%	18%	17%	21%	23%	-12%	0%	35%	-10%	-6%	11%
	p50	4%	4%	3%	25%	25%	25%	26%	26%	27%	0%	6%	17%	7%	-13%	-7%
	p75	11%	8%	8%	28%	26%	26%	28%	25%	26%	1%	19%	34%	11%	-17%	1%
	p90	26%	18%	19%	22%	19%	19%	21%	15%	14%	2%	20%	22%	14%	-18%	12%
	p95	28%	19%	20%	18%	12%	12%	14%	7%	8%	-9%	13%	18%	24%	-30%	15%
	mean	15%	11%	11%	24%	22%	23%	24%	20%	21%	-4%	15%	23%	16%	-18%	6%
Manufacturing	p10	17%	42%	40%	35%	48%	48%	34%	47%	52%	8%	54%	55%	22%	33%	23%
	p25	24%	38%	37%	45%	51%	52%	40%	50%	50%	36%	56%	50%	27%	37%	28%
	p50	33%	39%	37%	47%	51%	51%	46%	51%	49%	62%	52%	52%	31%	41%	34%
	p75	47%	46%	46%	53%	53%	52%	44%	40%	42%	56%	46%	51%	37%	40%	32%
	p90	53%	46%	47%	53%	44%	45%	45%	36%	36%	59%	55%	53%	54%	44%	43%
	p95	68%	57%	53%	48%	45%	44%	46%	34%	35%	56%	56%	51%	50%	48%	49%
	mean	44%	44%	44%	48%	47%	47%	43%	42%	42%	52%	52%	54%	49%	44%	42%
Services	p10	112%	100%	107%	32%	36%	36%	43%	50%	55%	-5%	35%	163%	22%	-5%	68%
	p25	30%	26%	29%	35%	38%	38%	37%	41%	45%	-11%	7%	61%	38%	-5%	63%
	p50	9%	7%	7%	40%	39%	39%	43%	43%	44%	2%	7%	21%	25%	-12%	20%
	p75	9%	6%	6%	37%	33%	33%	38%	34%	33%	4%	14%	32%	24%	-15%	11%
	p90	27%	19%	19%	29%	25%	25%	28%	25%	24%	10%	16%	22%	23%	-13%	8%
	p95	32%	21%	20%	29%	22%	23%	24%	17%	18%	358%	15%	21%	33%	-18%	20%
	mean	25%	19%	19%	37%	34%	35%	37%	33%	34%	20%	18%	32%	28%	3%	14%

Future work

- Dynamic decompositions
- Admin data/company accounts data