Measuring trends and persistence in capital and labor misallocation

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Introduction

Research question

- What is the extent and nature of misallocation of capital and labor in the Dutch economy, and how has it evolved over time?

Motivation

- Several papers misallocation is a serious problem and has increased since the Great Recession
  Gopinath et al. (2017), Dias (2018), Restuccia and Rogerson (2017)

Main contribution

- Extent previous research by analyzing nature, and persistence of misallocation by applying models from the earnings literature.

Main messages

Main take-aways from our study

- Misallocation of capital in the Netherlands has increased over the period 2001–2017;
- Misallocation of labor has remained more or less stable in our sample;

- Capital wedge is relatively large for small, highly productive firms;
- Capital wedge is relatively small for large, unproductive firms;

- Misallocation of labor is temporary for most firms, and dies out relatively quickly;
- Misallocation of capital is more permanent, and the temporary component dies out slowly;

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Labor productivity: stylized facts Netherlands

1. Slowdown labor productivity since mid 1990s in much of the Western world;
2. Slowdown in growth of total factor productivity key contributor (& stagnant capital deepening);
3. Mostly caused by within-sector deceleration, not by sectoral-composition;

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Background

(Some) causes slow growth total factor productivity

- Decline in the rate of technological progress → techno-optimists versus techno-optimists
  e.g. Gordon (2016) and Vijg (2011) versus Mokyr (2002), Brynjolfsson and McAfee (2012, 2013);

- Mismeasurement → intangible assets & ict-goods;

- Technology diffusion had declined → “frontier” and “laggard” firms
  e.g. McGowan et al. (2018), Andrews et al. (2016);

- Inefficiencies in the allocation of capital and labor across firms → **misallocation**
  e.g. Hsieh and Klenow (2009), Gopinath et al. (2017);

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Measurement of misallocation

Intuition

- "Frictions" in labor, product and credit markets hinder reallocation and dampen labor productivity dynamics
  Gopinath et al. (2017)
- Significant aggregate productivity gains from re-allocation of resources from low- to high productivity firms

Hsieh and Klenow model: assumptions

- Firms are heterogeneous in their performance & factor-market distortions they face
- Firms supply heterogeneous good which is priced individually in the market
- Firms produces according to Cobb-Douglas production function

Hsieh and Klenow (2009) framework

Key equations Hsieh and Klenow (2009)

Production function: $Y_i = TFPQ_i L_i^{\alpha} K_i^{1-\alpha}$,

Profit maximization: $\pi_i = (1 - \tau_i^Y) P_i Y_i - wL_i - (1 + \tau_i^K) RK_i$,

Profit maximizing price: $P_i = \frac{\sigma}{\sigma - 1} MC_i$,

Marginal costs: $MC_i = \left(\frac{RK_i}{\alpha}\right)^{\alpha} \left(\frac{wL_i}{1-\alpha}\right)^{1-\alpha} \frac{(1+\tau_i^K)^{\alpha}}{TFPQ_i(1-\tau_i^Y)}$

Note

- “Wedges” on output (τ_i^Y) and capital (τ_i^Y) are non-standard elements.
- Firms have constant markups depending linearly & solely on σ
- $TFPQ_i \uparrow \Rightarrow MC_i \downarrow \Rightarrow P_i \downarrow \Rightarrow Y_i \uparrow$;
- $\tau_i^Y \mid \tau_i^K \uparrow \Rightarrow MC_i \uparrow \Rightarrow P_i \uparrow \Rightarrow Y_i \downarrow$

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Hsieh and Klenow (2009) framework

Misallocation measures Hsieh and Klenow (2009) : first order conditions

$$P_{is,t}\frac{\partial Y}{\partial L} = MRPL_i = (1-\alpha)\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{P_iY_i}{L_i}\right) = \left(\frac{1}{1-\tau_i^Y}\right)w,$$

$$P_{is,t}\frac{\partial Y}{\partial K} = MRPK_i = \alpha_s\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{P_iY_i}{K_i}\right) = \left(\frac{1+\tau_i^K}{1-\tau_i^Y}\right)R,$$

$$TFPR_i = P_i TFPQ_i \propto (MPRL_i)^{1-\alpha}(MRPK_i) \propto \frac{(1+\tau_i^K)^\alpha}{(1-\tau_i^Y)}$$

Note:

- In the absence of distortions $MRPK_i$ & $MRPL_i$ would be equated across all firms;
- If std($MRPK$) $\neq 0$ | std($MRPL$) $\neq 0$ $\Rightarrow$ std($TFPR$) $\neq 0$;
- Std($MRPK$), std($MRPL$), τ_i^K and τ_i^Y our measures of misallocation;

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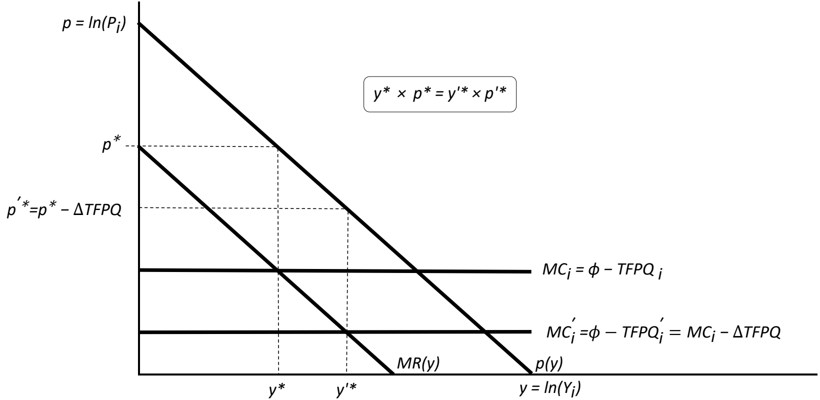
Hsieh and Klenow (2009) framework: graphical

Effect of a change in *TFPQ*



- All "wedges" are zero
- firms with higher $TFPQ_i$ produce more at lower price (p'^*)
- Consequence: economy wide $TFPQ$ is at efficient level ($TFPQ_{efficient}$)

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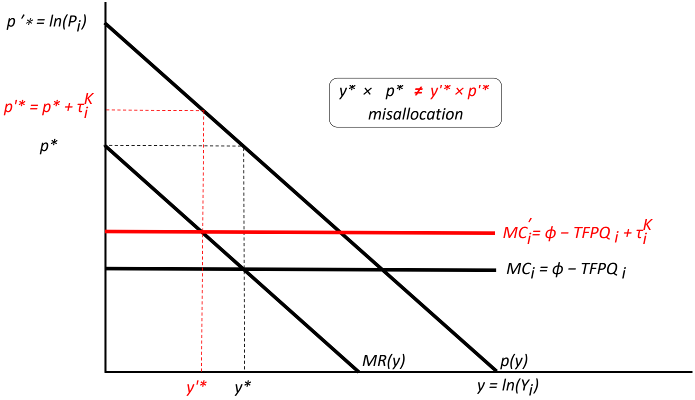
Hsieh and Klenow (2009) framework: graphical

Effect of a wedge on capital (τ^K)



- τ^K is disturbing allocation, $TFPR'^* \neq TFPR^* \Rightarrow \text{std}(TFPR) \neq 0$
- Reason: p'^* is too high and y'^* is too low given firm's $TFPQ$
- Consequence: economy wide $TFPQ$ is lower than $TFPQ_{efficient}$

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Database

Tax-data from Statistics Netherlands (CBS)

- Population of Dutch firms that declare corporate income tax in period 2001–2017;
- Matched with firm-level data of Dutch business registry;
- Fine grained industrial division: NACE 5-digit
  - 2-digit: retail trade (47); 5-digit e.g.: Retail sale of fruit and vegetables, (4721), Retail sale of books (4761)
  - 2-digit: civil engineering (42); 5-digit e.g: Construction of roads and motorways (4210), Construction of utility projects for electricity and telecommunications (4250)
  - 93/240 industries in manufacturing/services sector;
- Number of employees, size-class, balance sheet items, profit & loss account.

Analyzed database

- Repeated cross-section (highly unbalanced), restricted to non-agricultural non-financial sector;
- "Standard" cleaning (e.g. Gamberoni et al., 2016 and Gopinath et al., 2017);
- Number of firm-year observations: 1,831,575 || firms: 342,245 || 110 thousand p/y;

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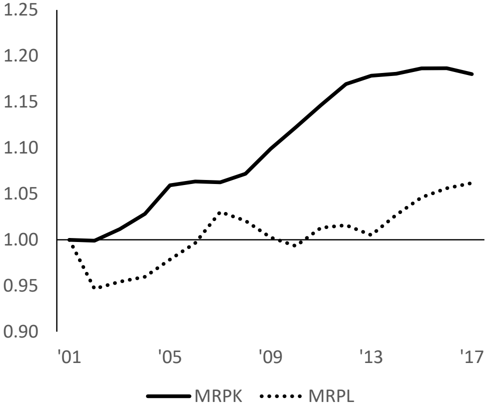
First look: standard deviation MRPK & MRPL

Increase std($MRPK$) $>>$ std($MRPL$)



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First look: total factor productivity loss

Total TFP Loss

- $TFPQ_{efficient} \Rightarrow \text{std}(MRPK) = \text{std}(MRPL) = \text{std}(TFPR) = 0$

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Misallocation per firm-characteristic

Manufacturing versus services sector

e.g. Dias et al. (2016), Buso et al. (2013), de Vries (2014);

- Capital & labor distortions services sector $\gg$ manufacturing sector;
- Caused by lower competition, limited trade-ability, high regulatory barriers.

Large versus micro firms

e.g. Gopinath et al. (2017), Calligaris et al. (2017);

- Capital & labor distortions large firms $\ll$ small
- Convergence between capital & labor distortions large firms $\rightarrow$ small firms;
- Large firms tend to be older & can self-finance. Less exposed to financial constraints.

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Nature of misallocation: ordered probit

Multivariate ordered probit

$$p_{ij} = \Pr(y_i = i) \quad = (\kappa_{i-1} < x_j\beta + \mu \leq \kappa_{i-1})$$
$$= \Phi(\kappa_i - x_j\beta) - \Phi(\kappa_{i-1} - x_j\beta)$$

where, $\Phi(.)$ is the standard normal cumulative distribution function.

Dependent variables

- Deciles of $\tau^{K*}_{is,t}$ and $\tau^{L*}_{is,t}$ distribution, the absolute levels of capital and labor;
- Rewritten versions of $\tau^{K}_{is,t}$ and $\tau^{Y}_{is,t}$ (Hsieh and Klenow, 2009), assuming:
  - $1 - \tau^{Y}_{is,t} = 1/(1 + \tau^{L*}_{is,t})$
  - $1 + \tau^{K}_{is,t} = (1 + \tau^{K*}_{is,t})/(1 + \tau^{L*}_{is,t})$.
- Decile 1-2 "very low", 3-4 "low", 5-6 "average", 7-8 "high" , 9-10 "very high"
- Regressors: firm-characteristics, year and **firm's position in the productivity distribution**: "laggards" (1^{st}), "average" (2^{nd}–9^{th}), "frontier" (10^{th})

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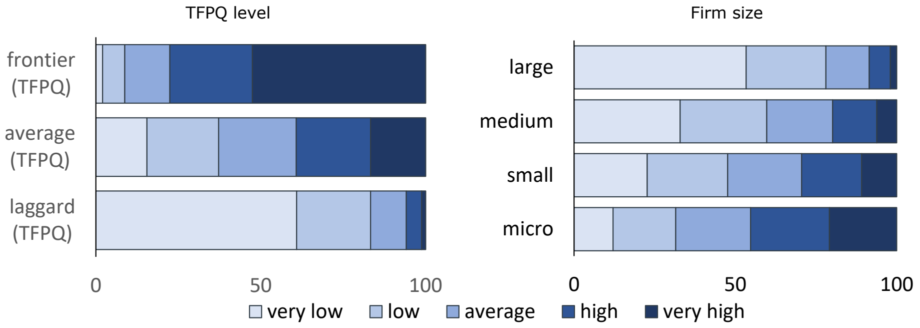
Ordered probit τ_i^K

Regressors: dummyset TFPQ (frontier/average/laggard), dummyset size-class (micro, small, medium, large), dummyset year (2001–2017), dummyset NACE Rev.2 (2-digit)



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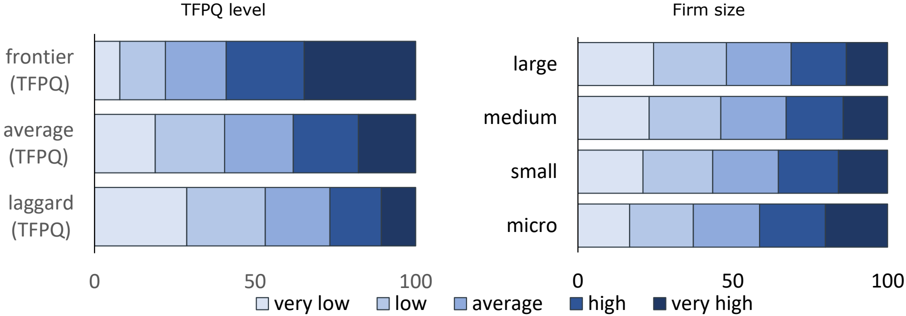
Nature of misallocation: labor distortion

Ordered probit τ_i^L

Regressors: dummyset TFPQ (frontier/average/laggard), dummyset size-class (micro, small, medium, large), dummyset year (2001–2017), dummyset NACE Rev.2 (2-digit)



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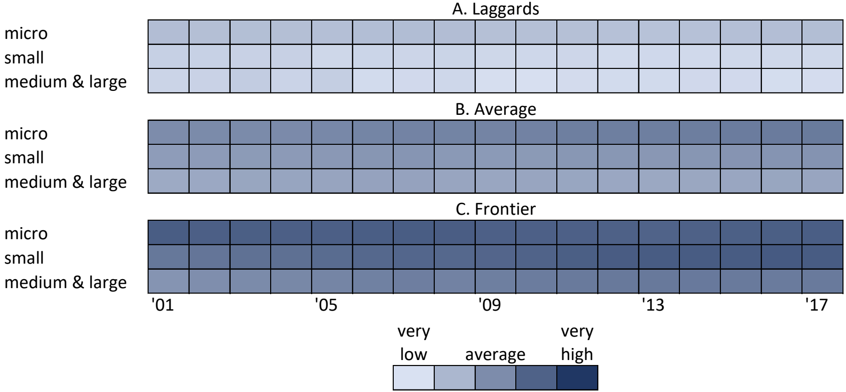
Nature of misallocation: capital distortions

Ordered probit τ_i^K with interactions dummys

Regressors: dummyset of TFPQ (frontier/average/laggard) $\times$ size-class (micro, small, medium, large) $\times$ year (2001–2017) and dummyset NACE Rev.2 (2-digit)



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Nature of misallocation: labor distortions

Ordered probit τ_i^L with interactions dummys

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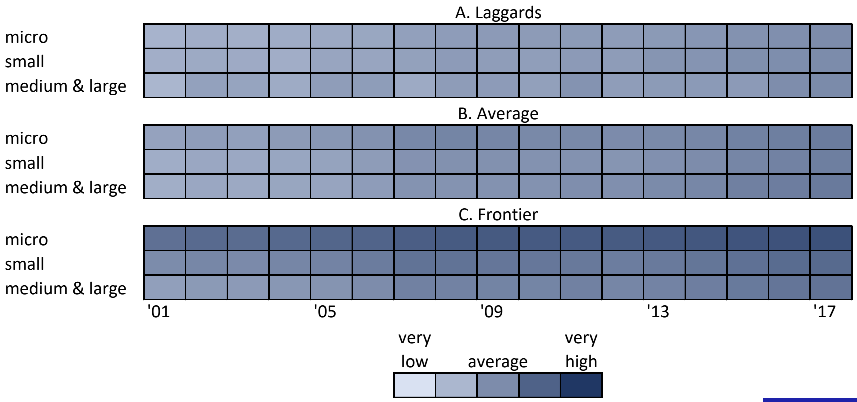

Persistence of misallocation: permanent and transitory components

How persistent is misallocation?

- Exploit empirical specifications from literature on individual earnings (Ng, 2008; Guvenen, 2009, Doris et al., 2013)
- Split *MRPK*/*MRPL* ($y_{i,t}$) in permanent ($y^P_{i,t}$) and transitory ($y^T_{i,t}$) component.

Formula's Doris et al., 2013

$$
\begin{aligned}
y_{i,t} &= y^P_{i,t} + y^T_{i,t} \\
y_{i,t} &= p_t \eta_i + \lambda_t v_{i,t} \\
v_{i,t} &= \rho v_{i,t-1} + \varepsilon_{i,t}
\end{aligned}
$$

$$
\begin{aligned}
V_{t,\infty} &= p_t^2 \sigma_\eta^2 + \lambda_t^2 \sigma_{v1}^2, & t = 1, \\
V_{t,\infty} &= p_t^2 \sigma_\eta^2 + \lambda_t^2 (\rho^{2t-2} \sigma_{v1}^2 + \sigma_\varepsilon^2 \textstyle\sum_{w=0}^{t-2} \rho^{2w}), & t > 1.
\end{aligned}
$$

Doris et al., 2013 intuition

- General Method of Moments (GMM) estimator;
- Firm-level heterogeneity in permanent component ("fixed effect");
- Transitory component is a homogeneous AR(1) process.

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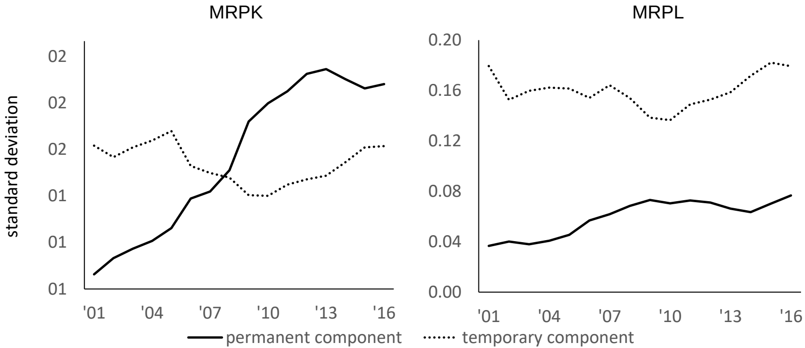
Permanent & transitory component MRPK and MRPL



- MRPK has become more permanent;
- MRPL has remained mostly transitory;
- **Model fit**: Monte Carlo simulation able to reproduce observed trends

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Persistence capital distortions per firm-characteristic

Manufacturing versus services sector

- Permanent component in both manufacturing & services has risen;
- Since '09 permanent component $\gg$ temporary component;
- Diference permanent–transitory has risen most in services sector.

Large firms versus micro firms

- Negative relation firm-size – capital distortions caused by diff. in permanent component;
- Small firms have more permanent distortions than large firms.

Laggards versus frontier firms

- Permanent component increased for all productivity categories;
- Frontier firms have most permanent distortions. Implies high wedges have become more permanent.

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Not all distortions are misallocation. . .

Haltiwanger, Kulick, Syverson (2018), David and Venkateswaran (2019), Bils, Klenow and Ruane (2018)

Distortion	% less misallocation
Capital adjustment costs	5
Alternative functional form	
Firm-level production function	1
"CES" versus "CD"	0*
Heterogeneous markups	25
TOTAL	31

* assuming that technology has same impact on all firms (see e.g. Acemoglu and Restrepo, 2017)

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Summing up

Main take-aways from our study

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Future work

Ideas

- Methodology could be applied to other countries as well
- Look more at interaction between balance sheet strength and misallocation (zombie-firms);
- Expand model permanent and transitory component