Resource Reallocation and Aggregate Productivity: Firm dynamics in Korean Manufacturing

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CONTENTS

- Sources of aggregate productivity growth

  1. **Allocative efficiency gains** associated with shifting labor and capital out of small, less-productive firms into large, more-productive firms

  2. **Technical efficiency gains** associated with innovation, better management, etc

- Estimate the aggregate productivity growth in the Korean manufacturing industry in recent two decades

  - Investigate the role of each source in the aggregate productivity growth

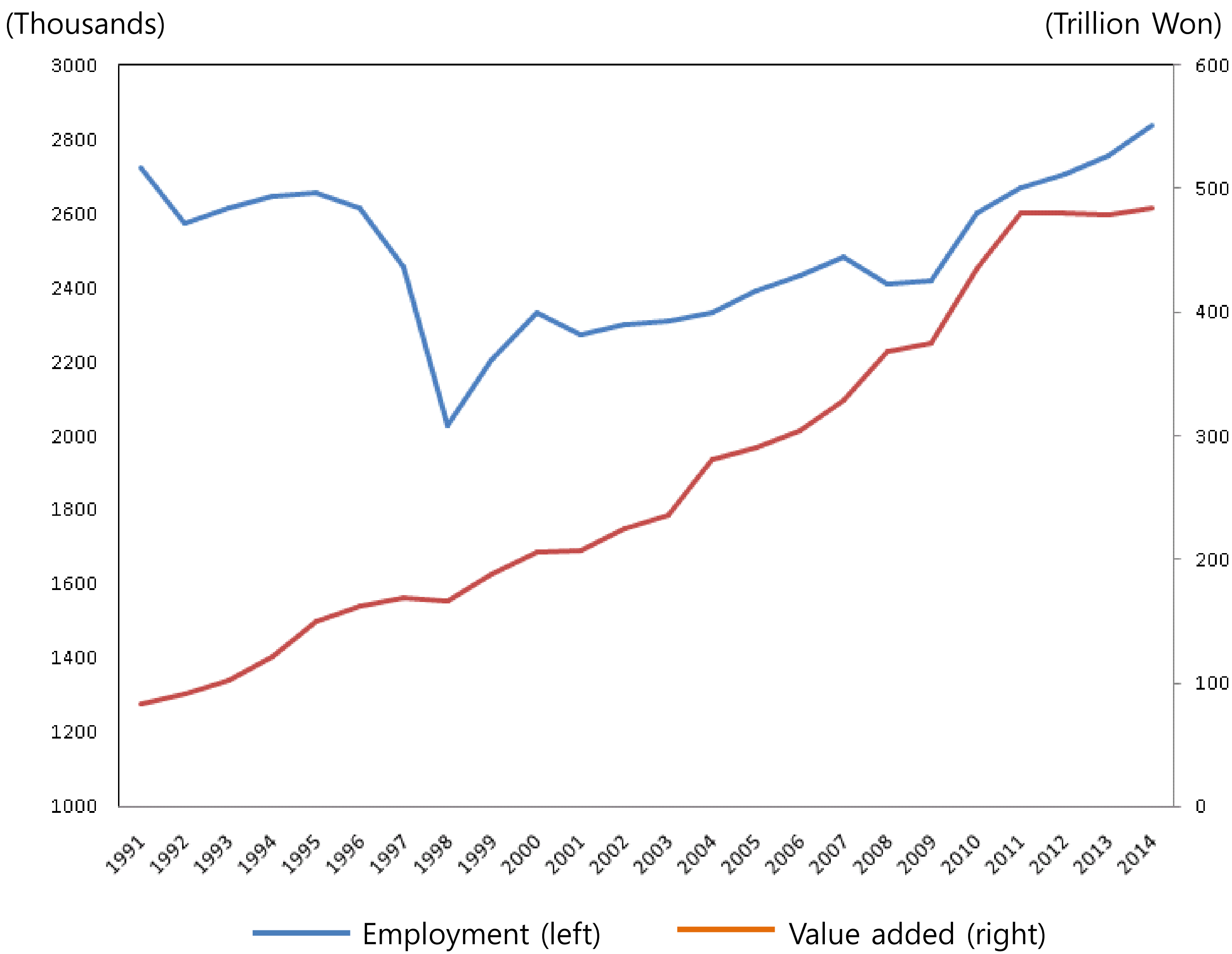
- Plant-level data from 1995 to 2013 in the Korean Mining and Manufacturing Survey
  - censored census
  - establishments with at least 10 employees in manufacturing industries
  - unbalanced panel of 52,496 plants (1995) => 65,272 (2013)

In 2012, compared to the manufacturing industry, the data represent

Number of plants	Employees	Gross output
17%	72%	87%

Source: 1) Gross output: Input-Output table from the Bank of Korea
2) Number of plants and employees: Bank of Korea

1991~2014 Manufacturing Employment and value added growth



Source: Statistics Korea『Korean Mining and Manufacturing Survey』,

- Estimate manufacturing plant's contribution to the change in aggregate final demand

- Use Petrin and Levinsohn (2012)'s definition of APG (aggregate productivity growth) and quantify the contribution of resource reallocation and technical efficiency to the APG.

    - Decompose at any level of aggregation (age, size, industry)

- Petrin, White, Reiter (2011) find that APG in U.S. manufacturing between 1976 and 1996 was 2.2% on average and the contribution of resource reallocation was larger than the contribution of technical efficiency growth.

- Kwon, Narita, Narita (2015) find that the contribution of resource reallocation declined during 1990s and was negative when a financial crisis occurred in the late 1990s.

- Aggregate productivity growth (APG) : the change in final demand minus the change in the aggregate expenditures on labor and capital.

$$APG \equiv \sum_i P_i dY_i - \sum_i \sum_f W_{if}\, dX_{if}$$

where Y_i: final demand, X_{if}: inputs, W_{if}: input costs

Using the national accounting identity, $\sum_i P_i Y_i = \sum_i VA_i$,

$$APG = \sum_i dVA_i - \sum_i \sum_f W_{if}\, dX_{if}$$

APG = (1) productivity gains from technical efficiency (TE)
+ (2) resource reallocation across plants (RE)
+ (3) net entry of plants (NE)

$$APG_t = TE_t + RE_t + NE_t$$

$$TE_t = \sum_{i \in C_t} \bar{D}_{it} \Delta \ln A_{it}$$

where A_{it}: TFP

D_{it} =gross output/aggregate value added: Domar weight

$$\bar{x}_{it} := \frac{x_{i,t-1} + x_{it}}{2}$$

TE is the sum of weighted plant-level changes in TFP using the ratio of plant-level revenue to aggregate final demand as the weight.

$$APG_t = TE_t + RE_t + NE_t$$

$$RE_t = \sum_f RE_{ft} = \sum_f \sum_{i \in C_t} \overline{D}_{it} \left(\varepsilon_{if} - \bar{s}_{ift}\right) \Delta \ln X_{ift}$$

where

D_{it} =gross output/aggregate value added: Domar weight

$\varepsilon_{if} := \frac{\partial Y_i / Y_i}{\partial X_{if} / X_{if}}$: elasticity of output to input, X_{if}

$f \in \{labor(L), capital(K), materials(M)\}$

$s_{ift} := W_{ift} X_{ift} / Y_{it}$: ratio of costs to gross output

- RE is the weighted sum of the change in input.
  - The weight $\left(\varepsilon_{if} - \bar{s}_{ift}\right)$ is the gap between the marginal product and the unit cost of input.
  - RE increases when inputs are reallocated to plants with larger gap from plants with smaller gap.

Methodology: Decomposing aggregate productivity growth

$$APG_t = TE_t + RE_t + NE_t$$

$$NE_t = \sum_{i \epsilon \varepsilon_t} D_{it} \left[1 - \sum_f s_{ift}\right] - \sum_{i \in \chi_{t-1}} D_{i,t-1} \left[1 - \sum_f s_{if,t-1}\right]$$

where

D_{it} =gross output/aggregate value added: Domar weight

$s_{ift} \coloneqq W_{ift} X_{ift} / Y_{it}$: ratio of costs to gross output

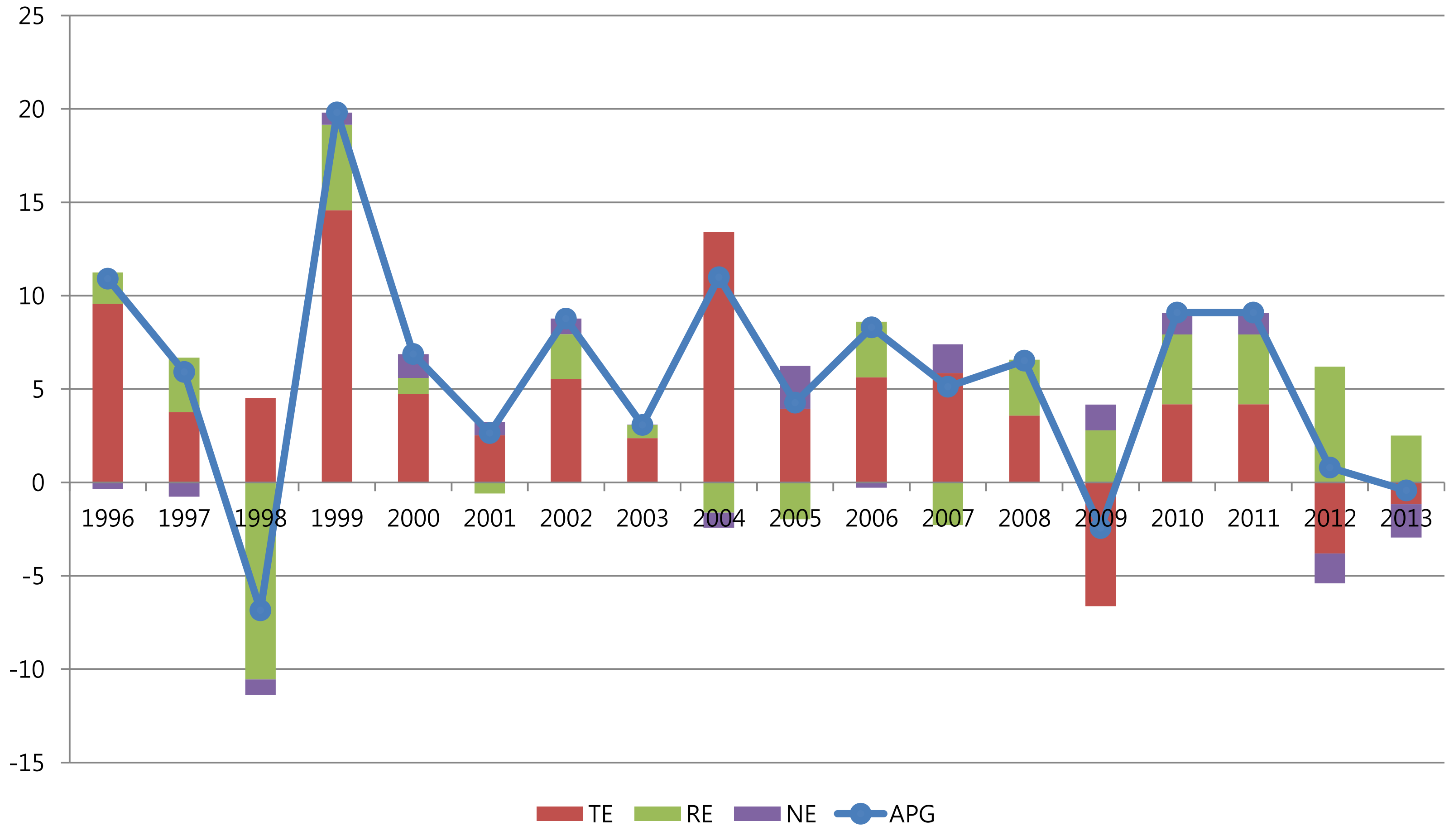
NE is output (net of input use) added by the net entry of plants

Estimation of Productivity

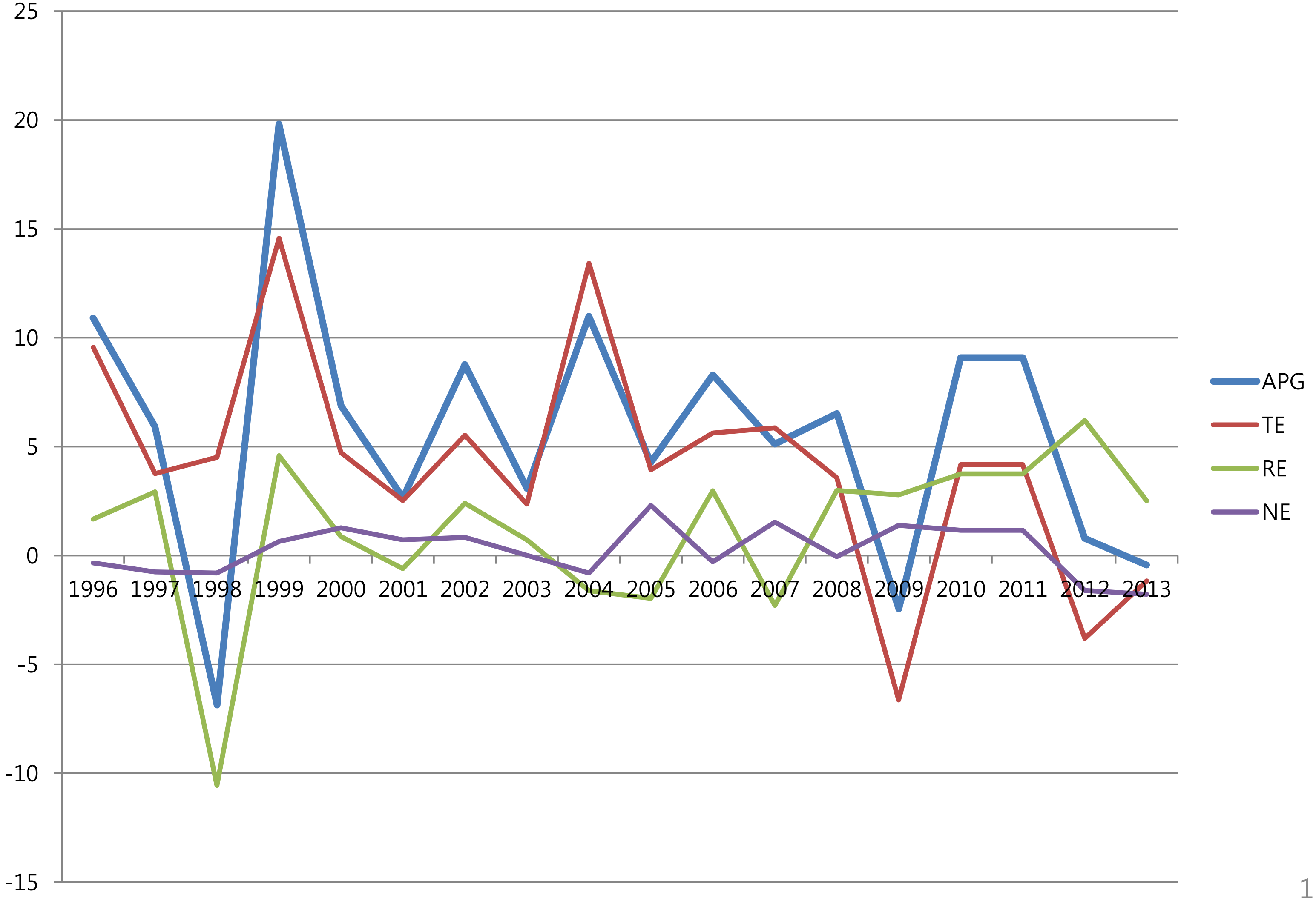
$$\ln Y_{it} = \ln A_{it} + \alpha_K \ln K_{it} + \alpha_L \ln L_{it} + \alpha_M \ln M_{it}$$

- Estimate α_K, α_L and α_M , the elasticity parameters of capital, labor and materials, for each 3 digit industries (82 industries)
  - apply Wooldridge, Levinsohn and Petrin (2009) method to control simultaneity issue and selection bias
  - Estimated parameters are the elasticity of output to input, $\varepsilon_{if} = \alpha_f$.

1995~2013 Manufacturing
Aggregate productivity growth decomposition



1995~2013 Manufacturing Aggregate productivity growth decomposition



Baily, Hulten, Campbell (1992) is commonly used to compute aggregate productivity growth.

$$BHC_t = \sum_{\forall i} D_{it} \ln A_{it} - \sum_{\forall i} D_{it-1} \ln A_{it-1}$$

$$BHC_t = TE_t + BHC\_RE_t + \mathrm{BHC}\_NE_t$$

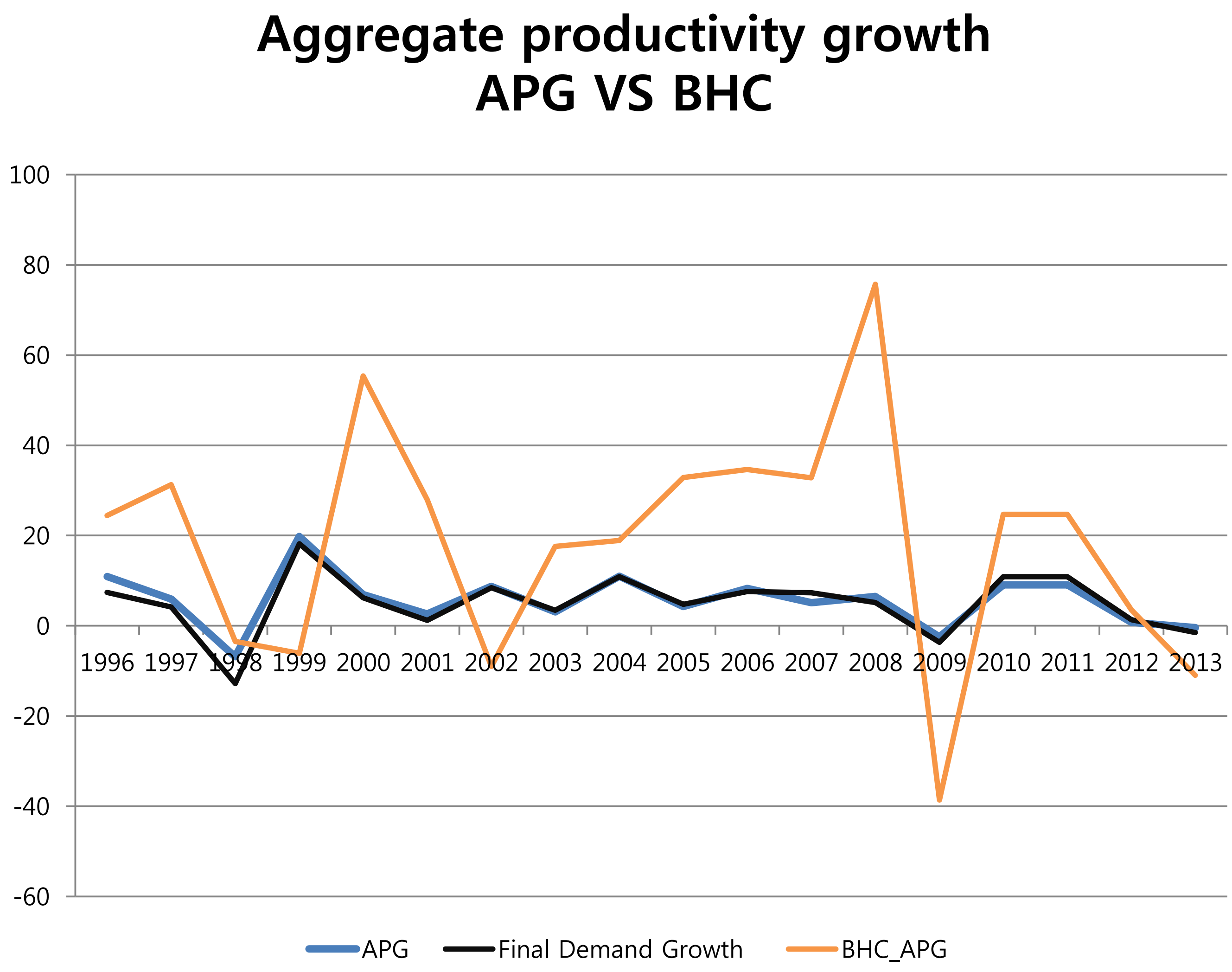
$$TE_t = \sum_{i \in C_t} \bar{D}_{it} \, \Delta \ln A_{it}$$

$$BHC\_RE_t = \sum_{i \in C_t} \overline{\ln A}_{it} \, \Delta D_{it}$$

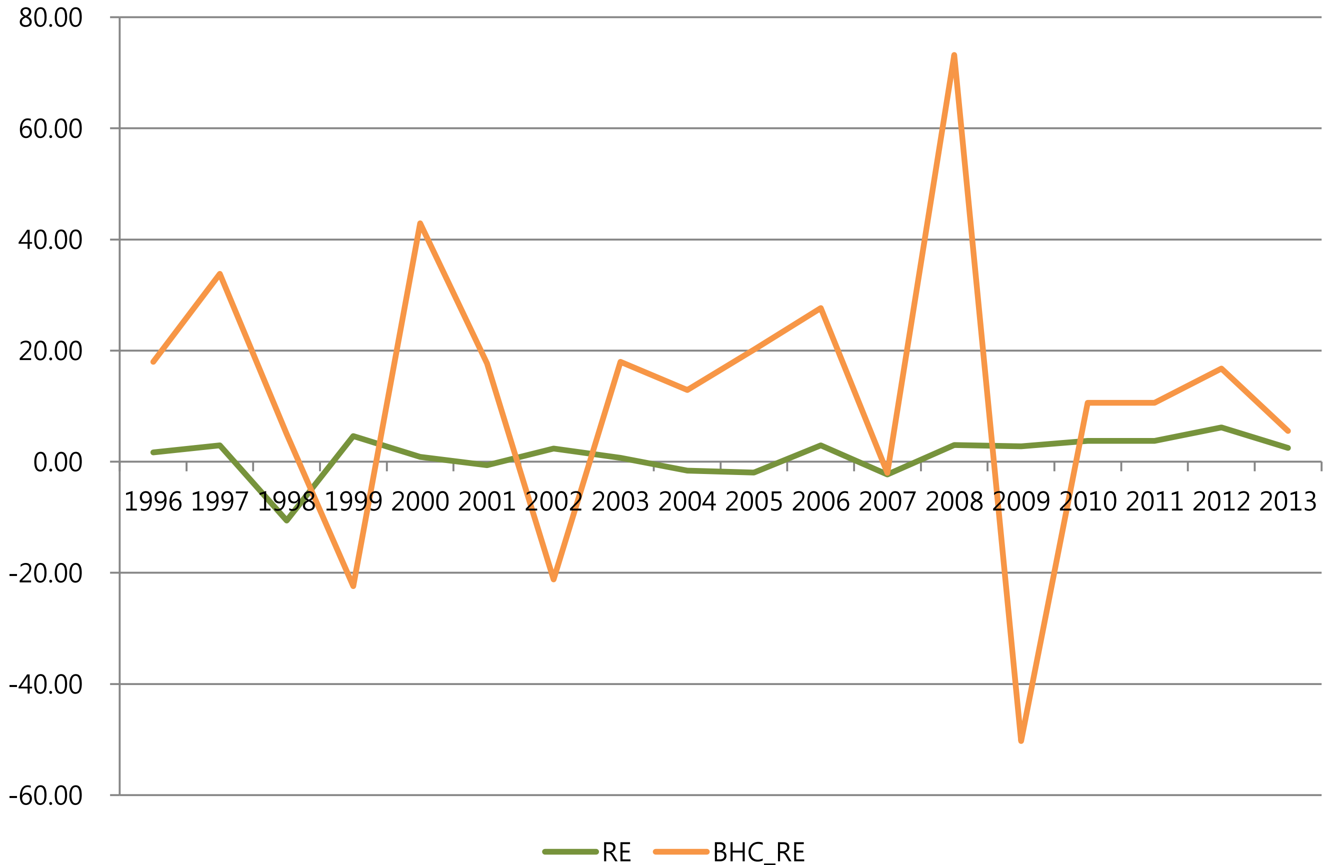
$$BHC\_NE_t = \sum_{i \epsilon \varepsilon_t} D_{it} \ln A_{it} - \sum_{i \in \chi_{t-1}} D_{it-1} \ln A_{it-1}$$

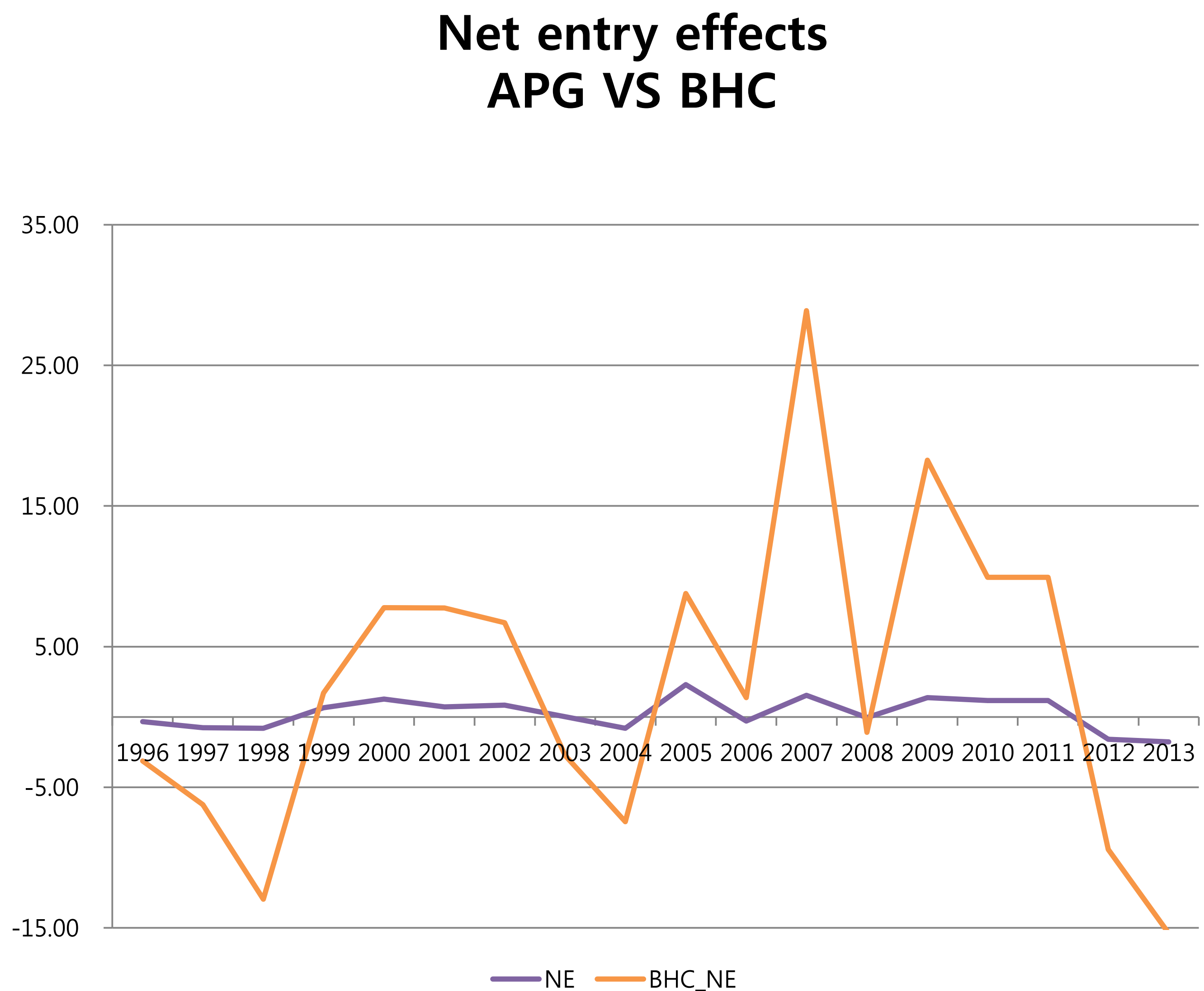
- BHC reallocation is the weighted change in shares with the weight of plant-level TFP.

Results: APG VS BHC

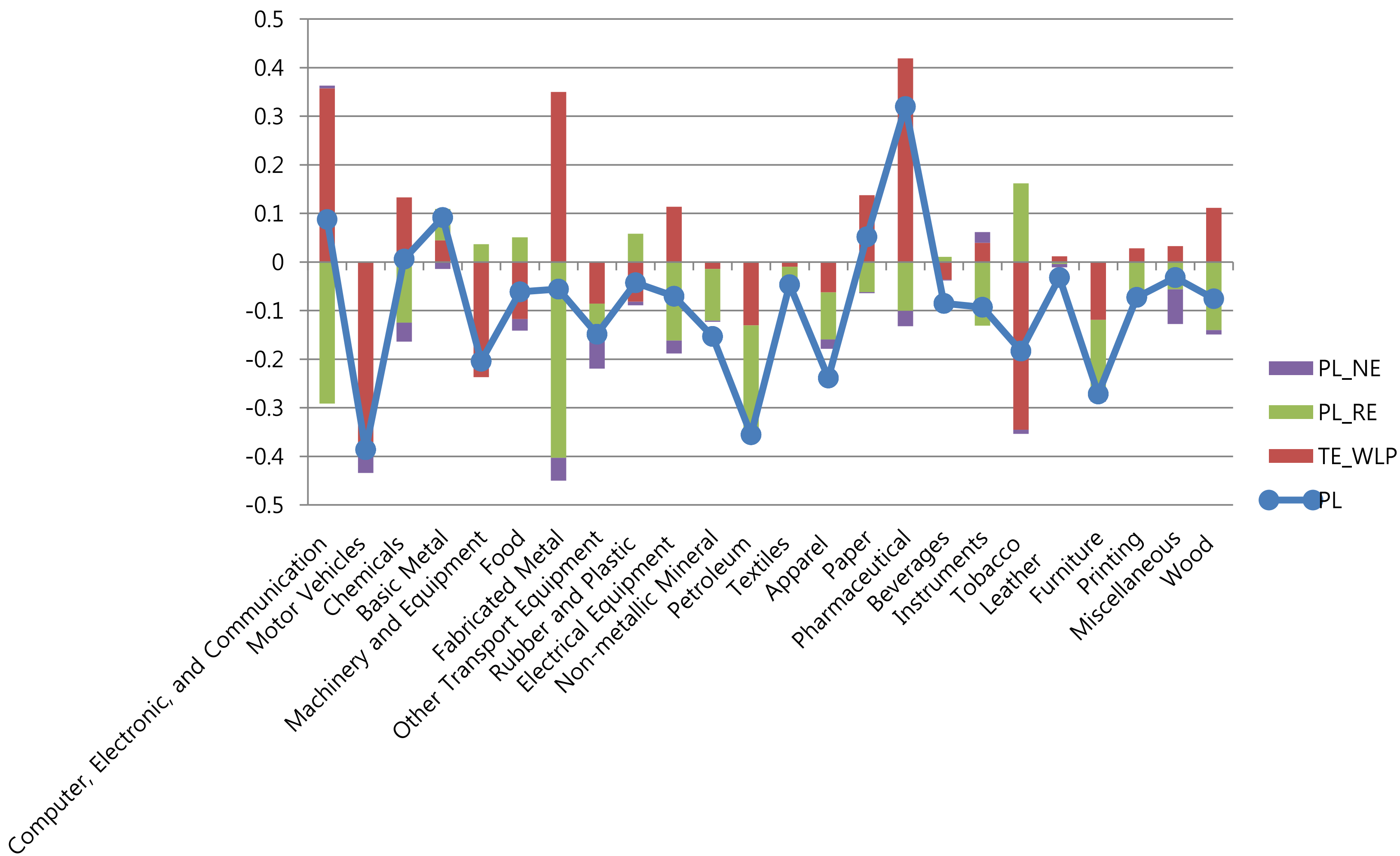


Reallocation effects
APG VS BHC

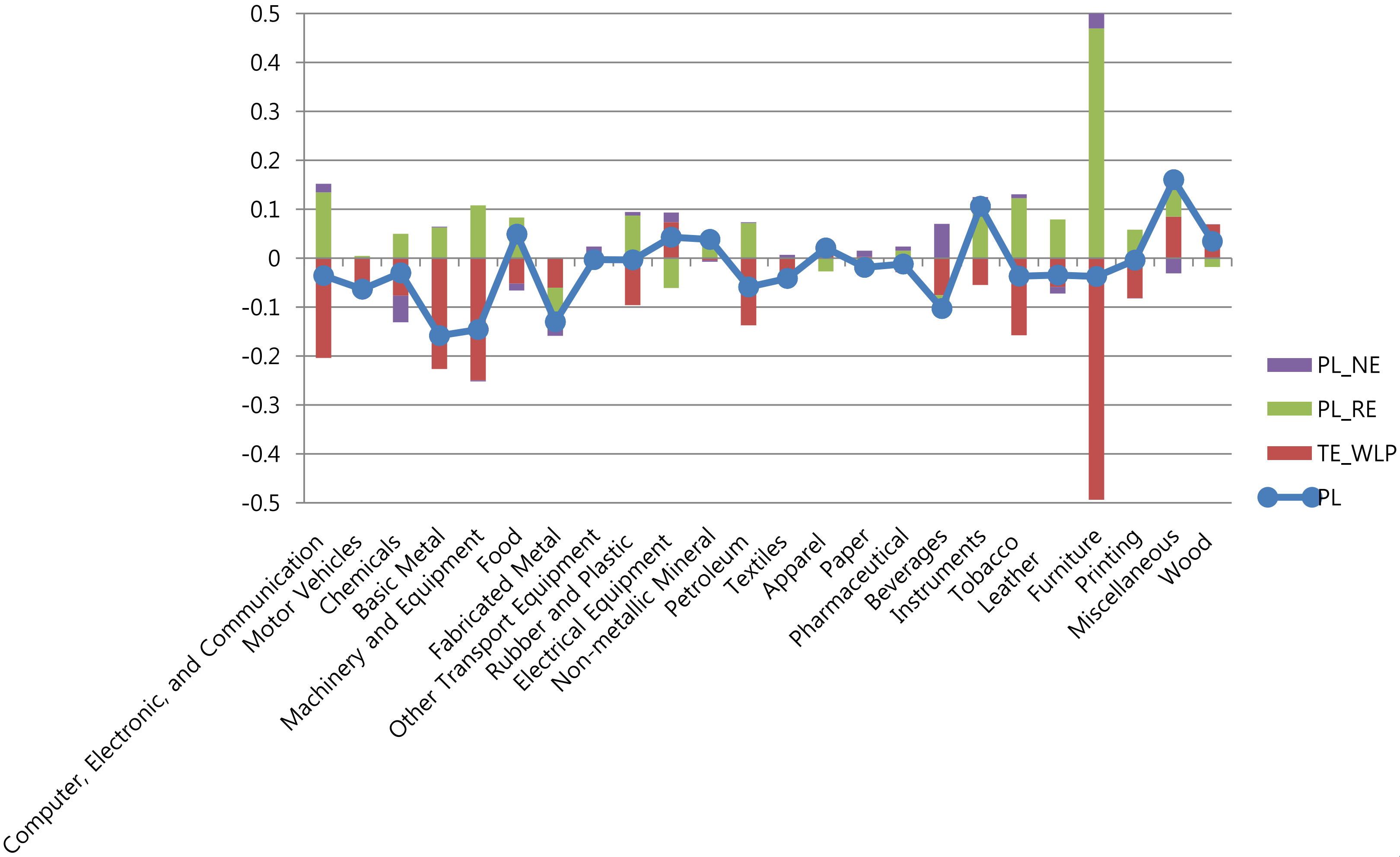



Net entry effects
APG VS BHC
35.00
25.00
15.00
5.00
-5.00
-15.00
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
NE
BHC_NE

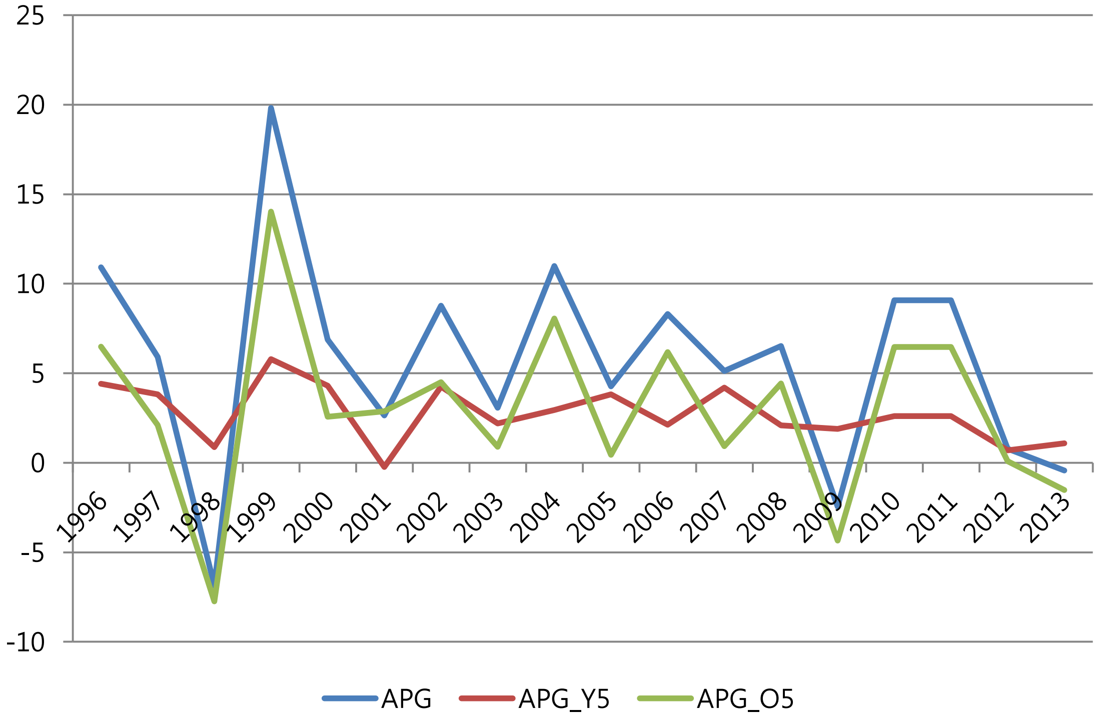
APG decomposition during Asian Financial Crisis (1997~1998)



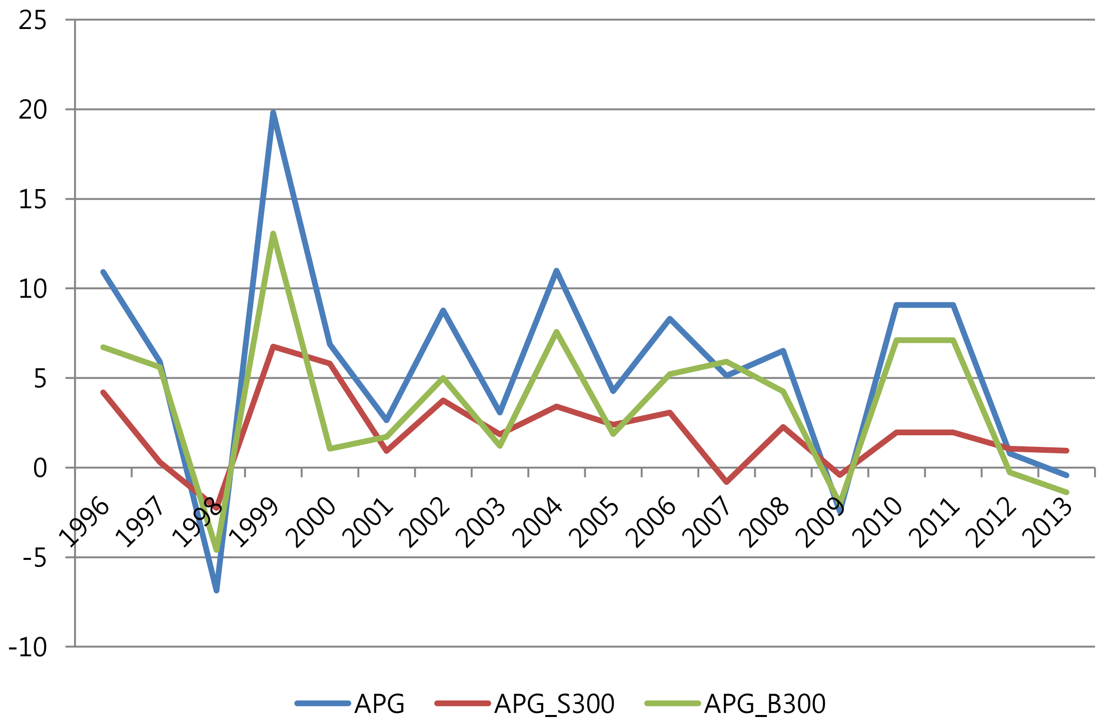
APG decomposition during Global Financial Crisis (2008~2009)



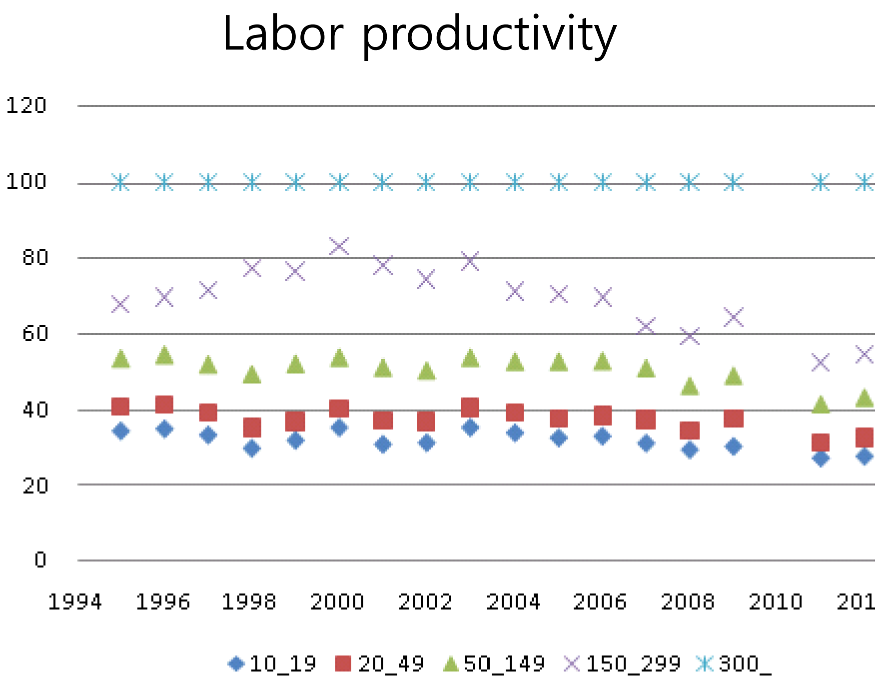
Aggregate productivity growth
Young (up to 5 years old) VS Old

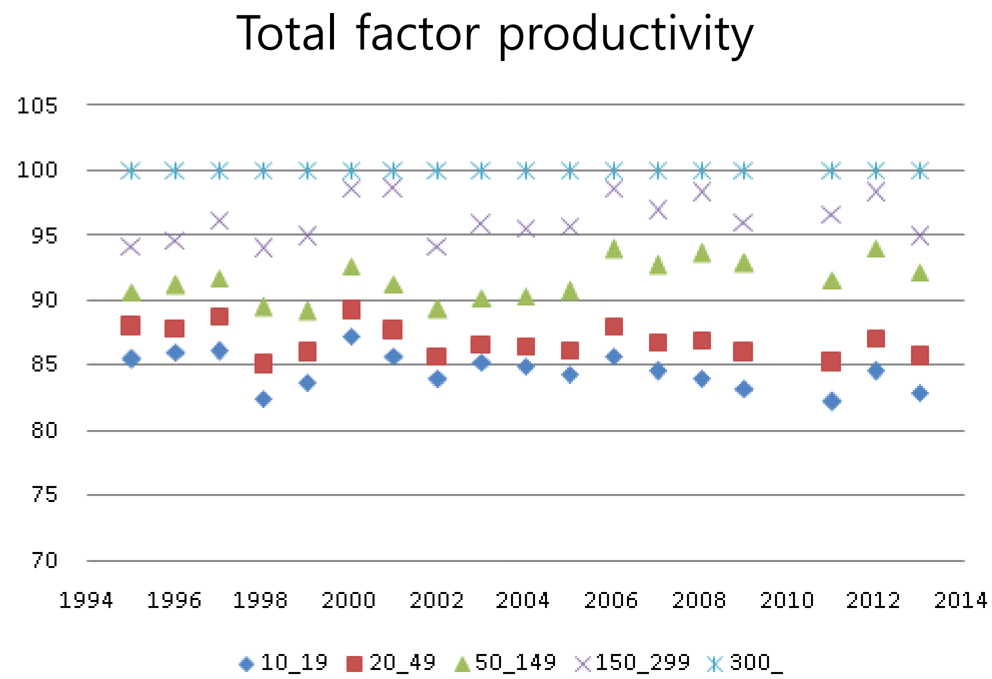


Aggregate productivity growth
Small (up to 300 employees) VS Big



Productivity by plant's size (number of employee)

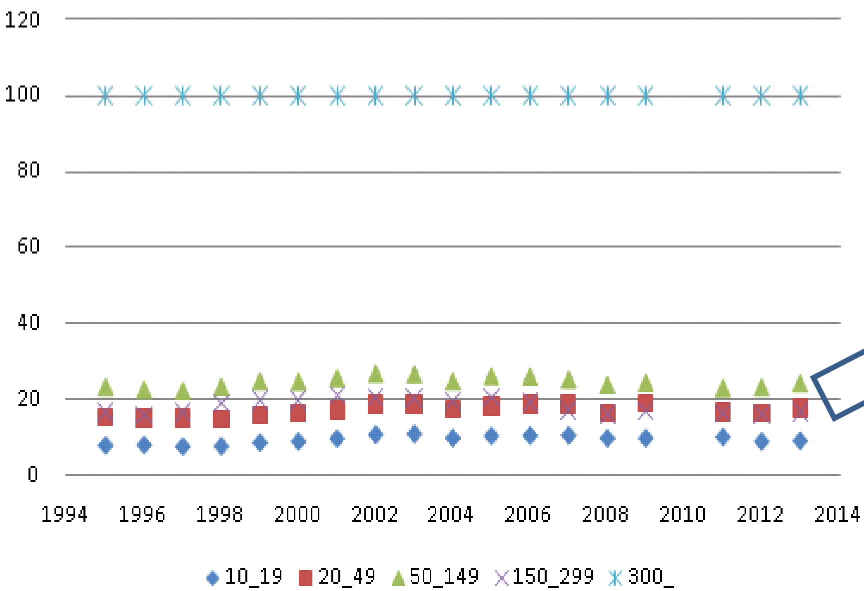


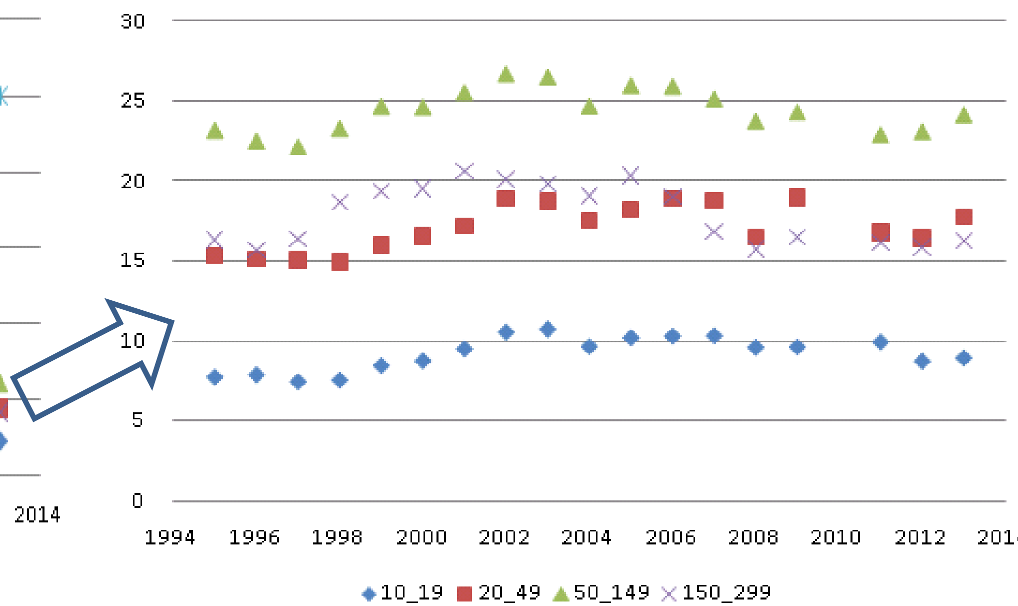


Productivity by plant's size

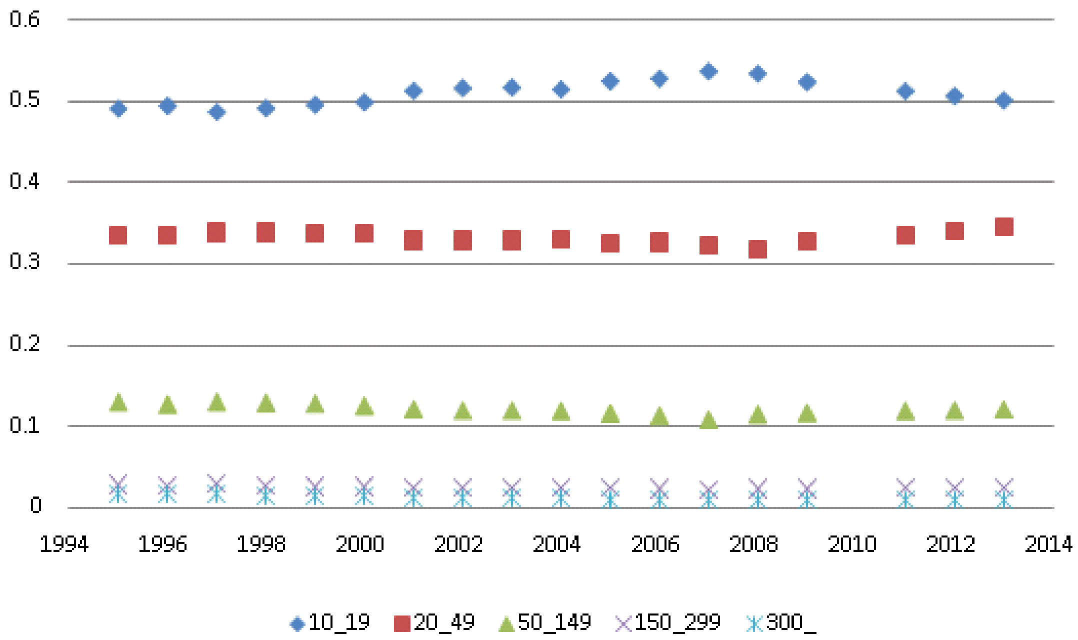
Domar weighted sum

Total factor productivity

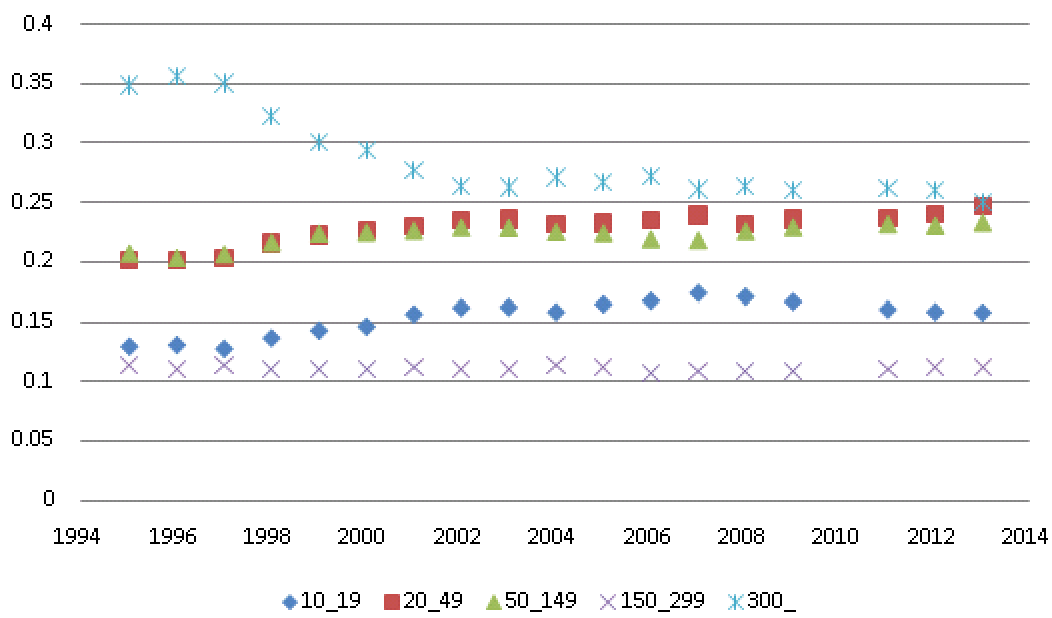




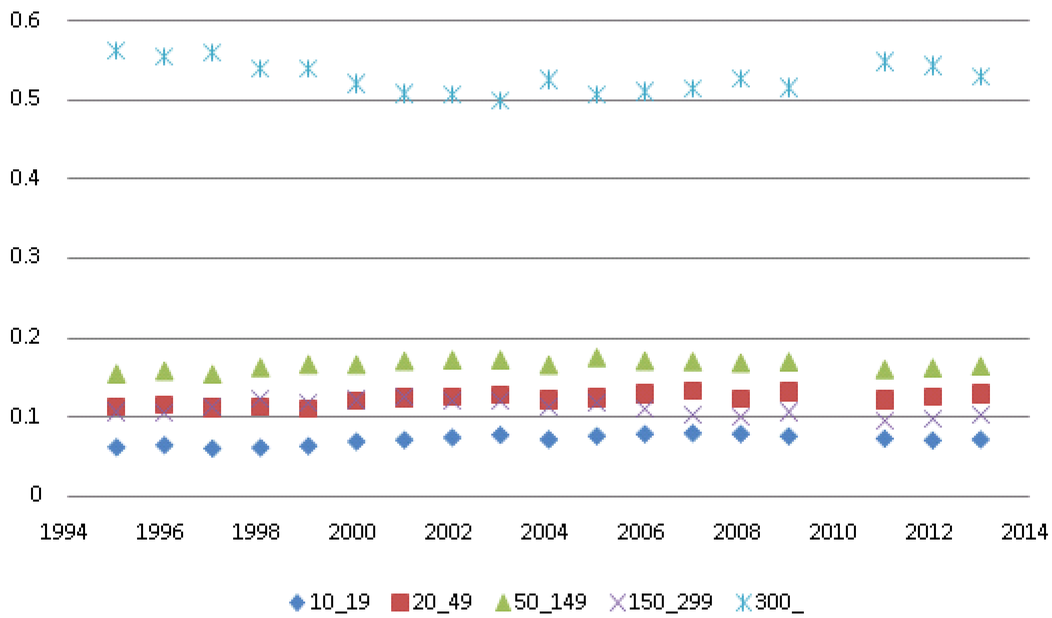
Proportion of number of plants by plant's size



Proportion of number of employees by plant's size

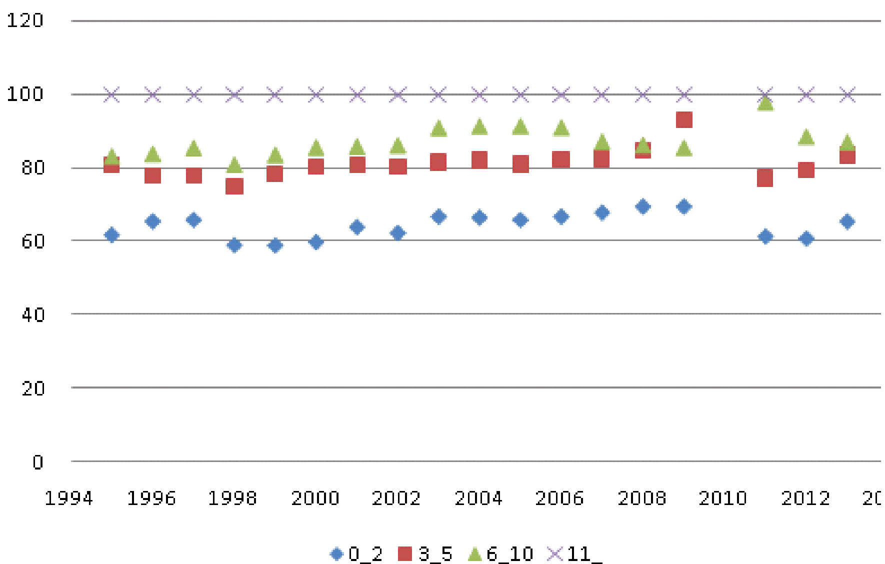


Proportion of value added by plant's size

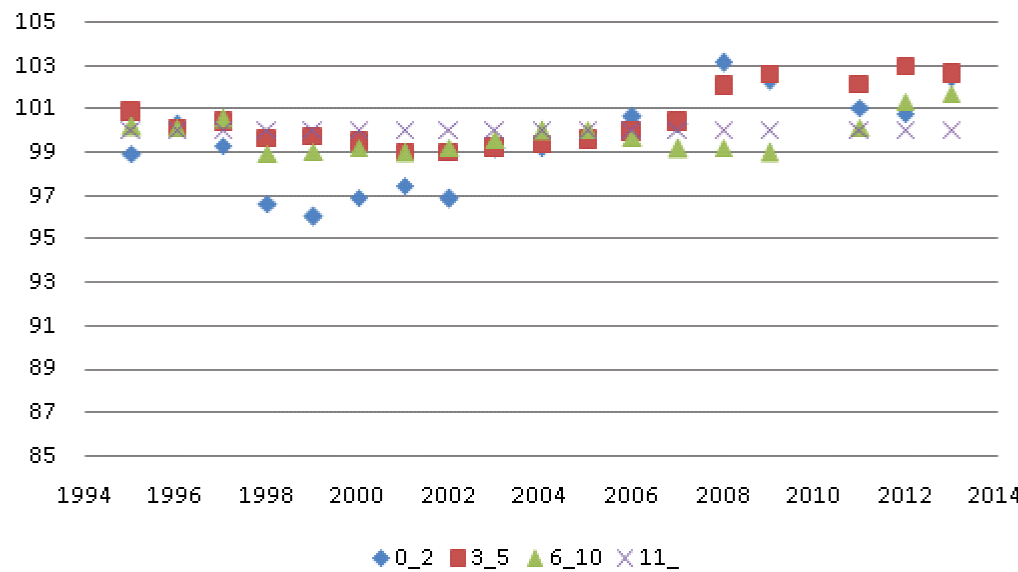


Productivity by plant's age

Labor productivity



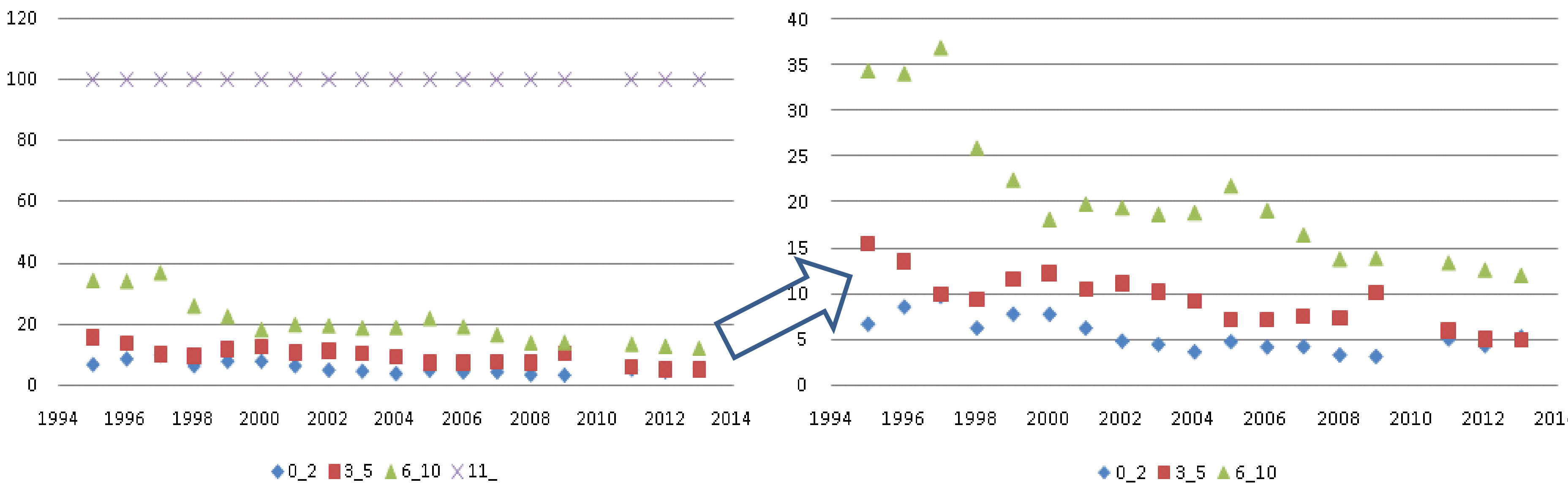
Total factor productivity



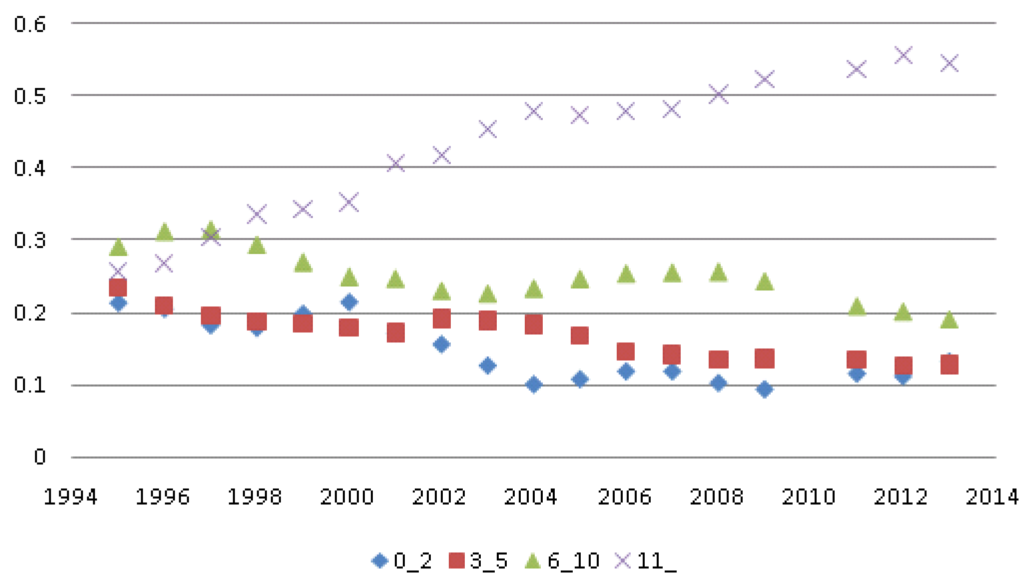
Productivity by plant's age

Domar weighted sum

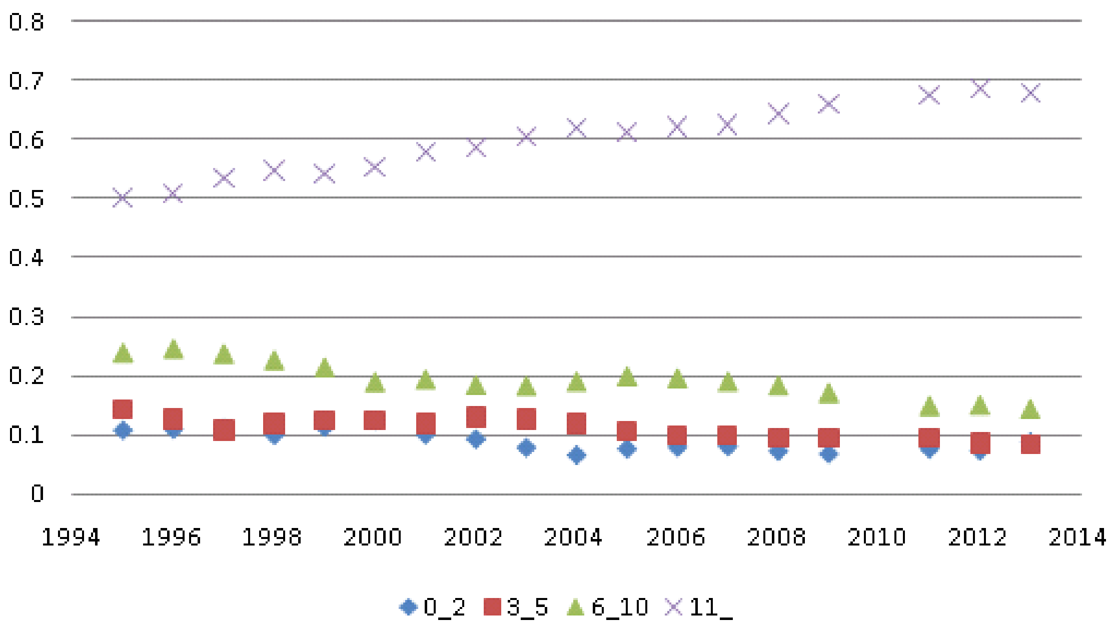
Total factor productivity



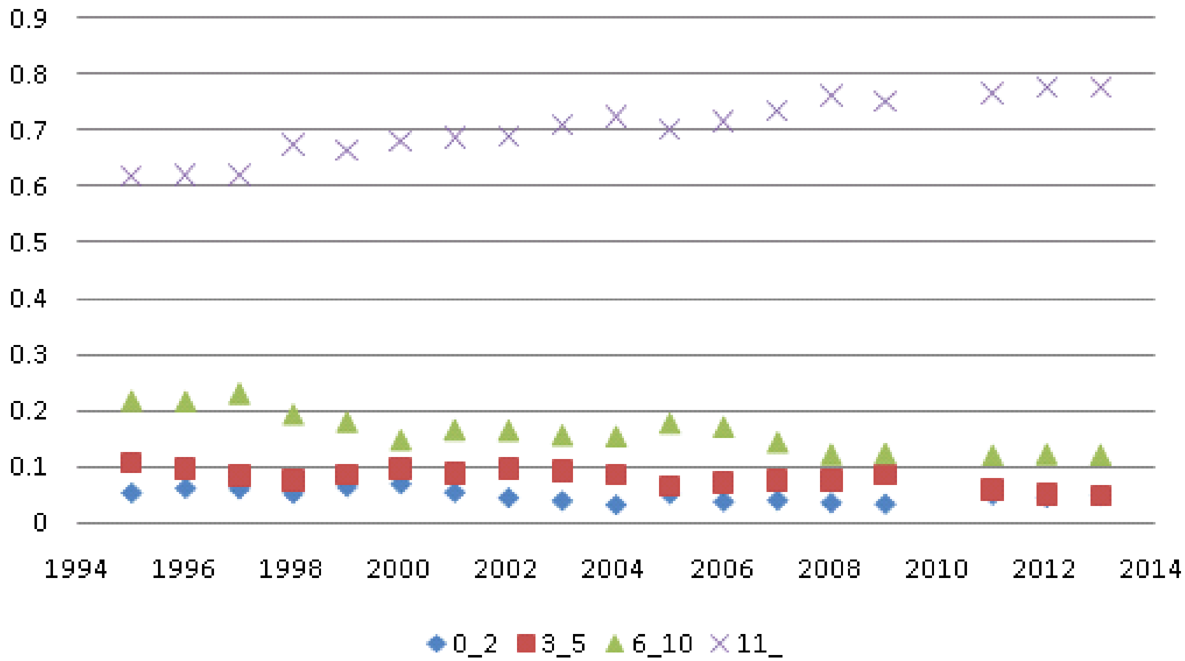
Proportion of number of plants by plant's age



Proportion of number of employees by plant's age



Proportion of value added by plant's age



Misallocation and Manufacturing TFP in Korea 1982-2007

by Kim, Oh, Shin (2017)

- Apply Hsieh and Klenow (2009) to assess degree of resource misallocation in the Korean manufacturing between 1982 and 2007
- We find an improvement in allocative efficiency during the first decade and a reversal after 1992.

Misallocation and Manufacturing TFP in Korea 1982-2007

- Firm faces firm specific wedges that affect marginal product of inputs

$$max_{L_{si},K_{si}} = (1-\tau_{Ysi})P_{si}Y_{si} - \omega L_{si} - (1+\tau_{Ksi})RK_{si}$$

- Revenue productivity (TFPR) is proportional to the geometric average of marginal products of capital and labor.

$$TFPR_{si} \equiv P_{si}A_{si}\frac{\sigma}{1-\sigma}\left(\frac{R}{\alpha_s}\right)^{\alpha}\left(\frac{\omega}{1-\alpha_s}\right)^{1-\alpha_s}\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}$$

$$TFP_s = \frac{Y_s}{K_s^{\alpha_s}L_s^{1-\alpha_s}}\left(\sum_{i=1}^{M_s}\left(A_{si}\ \frac{\overline{TFPR_s}}{\overline{TFPR_{si}}}\right)^{\sigma-1}\right)^{\frac{1}{\sigma-1}}$$

Misallocation and Manufacturing TFP in Korea 1982-2007

- Industry-level TFP is

$$TFP_s = \frac{Y_s}{K_s^{\alpha_s} L_s^{1-\alpha_s}} \left(\sum_{i=1}^{M_s} \left(A_{si} \frac{\overline{TFPR_s}}{TFPR_{si}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$$

- Without distortions, $\overline{TFPR_s} = TFPR_{si} \quad \forall\, i$

$$TFP_s = \overline{A_s} \equiv \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$$

- Ratio between the final goods produced with and without distortions

$$\frac{Y}{Y_{eff}} = \prod_{s=1}^{S} \left(\frac{TFP_s}{\bar{A}_s} \right)^{\theta_s} = \prod_{s=1}^{S} \left(\sum_{i=1}^{M_s} \left(\frac{A_{si}}{\bar{A}_s} \frac{\overline{TFPR_s}}{TFRP_{si}} \right)^{\sigma-1} \right)^{\frac{\theta_s}{\sigma-1}}$$

Year	1982	1987	1992	1997	2002	2007
Y/Y_{eff}	0.55	0.61	0.62	0.59	0.57	0.54
Implied TFP gains (%)	81.8	63.9	61.3	69.5	75.4	85.2
Std. dev. log TFPR	0.68	0.63	0.61	0.66	0.67	0.71

Table 1: Evolution of Allocative Efficiency, 1982—2007

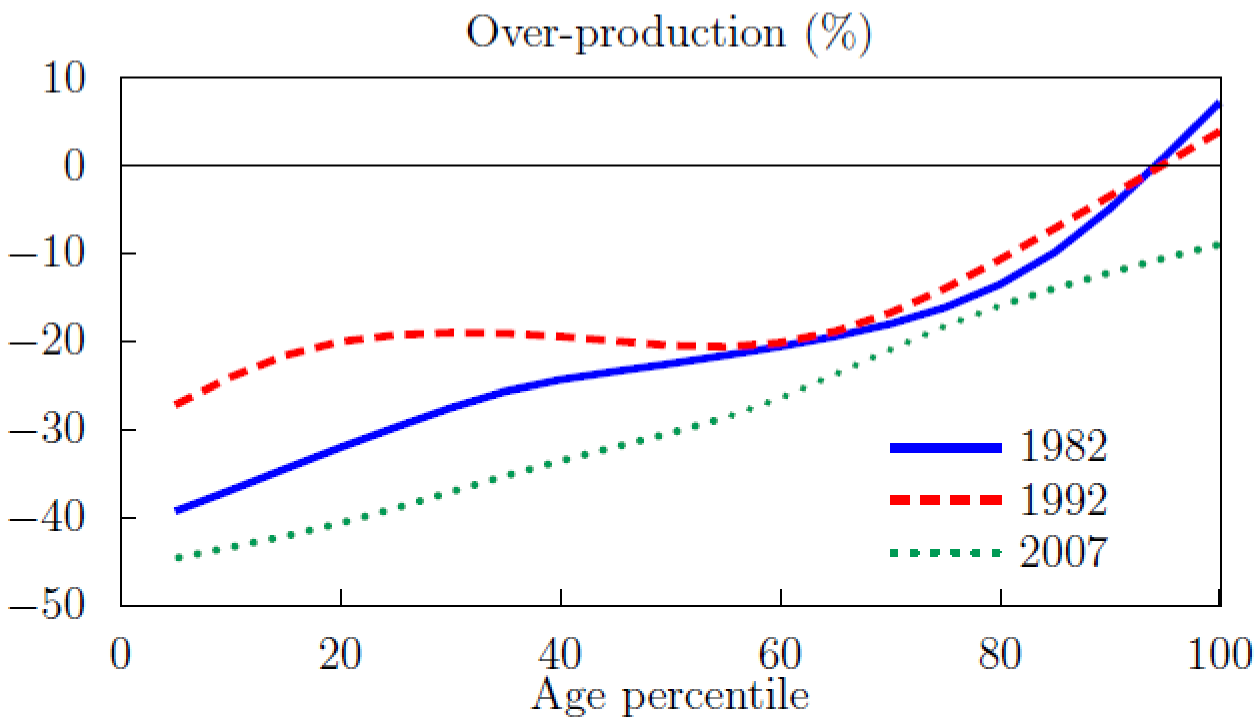


Fig. 1: Excess Production by Establishment Age: 1982, 1992 and 2007

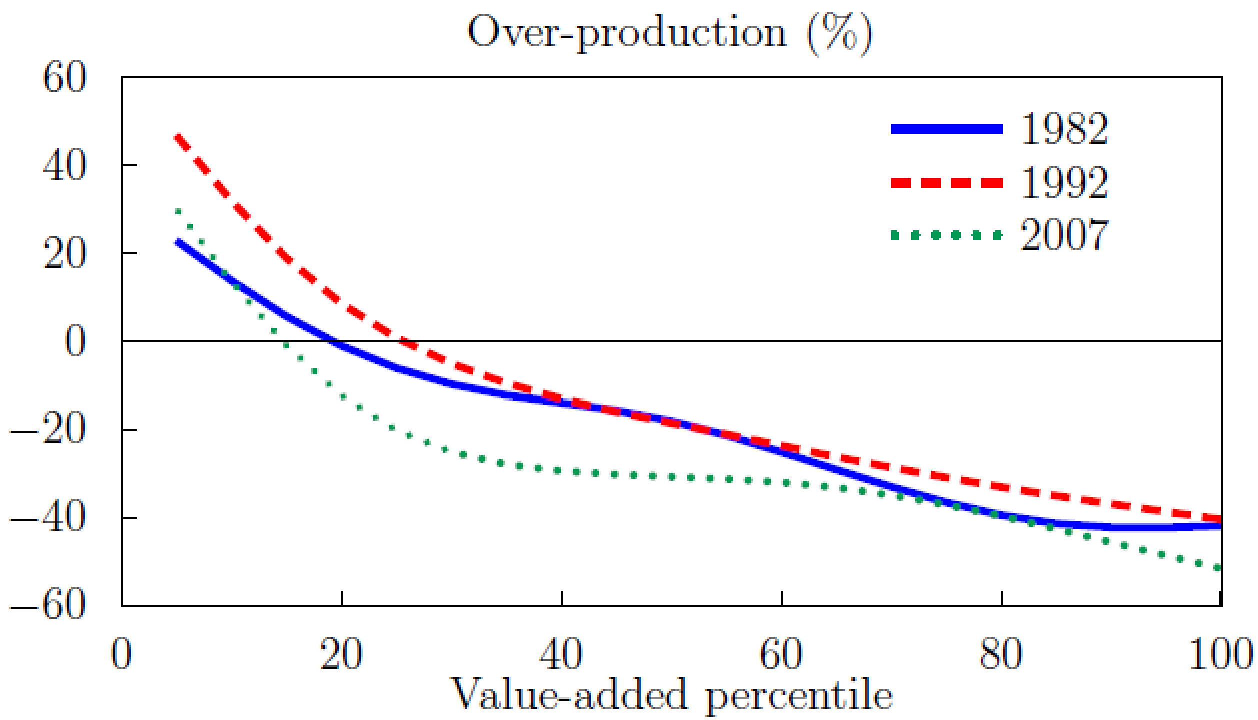


Fig. 2: Excess Production by Establishment Size: 1982, 1992 and 2007