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FACTOR INCOME SHARES AND MICRO-LEVEL RESTRUCTURING

An analysis of Finnish manufacturing

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ABSTRACT: This paper examines the relationship between productivity-enhancing restructuring at the micro level and changes in aggregate factor income shares in Finnish manufacturing. As a framework we make use of a simple model where long-run aggregate productivity growth is determined by successive technology steps that are taken in the new plants by seizing new technological opportunities. This requires investments into tangible and intangible capital that involve sunk costs. Wages are determined through centralised bargaining. In the equilibrium wages are set so that the present value of profits of the plants are squeezed to zero. Identical workers share the same wage level and the wages are increased at the rate of previous aggregate productivity growth, so that in the steady state factor income shares are unchanged.

According to the model, the larger the new technological opportunities, the higher is the R&D intensity and the higher is the restructuring component of aggregate productivity growth and the larger is the income share of capital. We find evidence that the decline in the aggregate labour share can be very much explained by the transfer of payroll shares from high labour income share (poorly profit-making) plants to low labour income share (profitable) plants. Empirical findings about the micro-level sources of aggregate productivity growth and the micro-level features of the changes in aggregate income shares are consistent with the interpretation that Finnish manufacturing experienced a positive technology shock in the latter part of the 80s. Some signs of the chilling of restructuring can be found in the late 90s.

KEY WORDS: Labour income share, productivity, micro-level restructuring, technology shock

JEL-Code: J3, O12

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TIIVISTELMÄ: Tutkimuksessa selvitetään tuottavuutta vahvistavan mikrotason rakennemuutoksen ja aggregaattitason tulo-osuusmuutosten välistä yhteyttä Suomen tehdasteollisuudessa. Tarkastelun kehikkona on yksinkertainen malli, jossa pitkän aikavälin aggregaattitason tuottavuuskasvu määräytyy peräkkäisissä teknologia-askeleissa, jotka tehdään uusissa toimipaikoissa tarttumalla uusiin teknologisiin mahdollisuuksiin. Tämä vaatii investointeja aineelliseen sekä aineettomaan pääomaan, josta aiheutuu upotettuja kustannuksia. Palkoista sovitaan keskitetysti. Tasapainossa palkat ovat asettuneet siten, että toimipaikkojen voittojen nykyarvo on nolla. Identtisillä työntekijöille on samat palkat ja palkkoja nostetaan samalla vauhdilla kuin aggregaattituottavuus on parantunut aikaisemmin, jolloin normaalioloissa tulo-osuudet pysyvät muuttumattomana.

Mallin mukaan mitä enemmän on uusia teknologisia mahdollisuuksia, sitä korkeampi on T&K intensiteetti, sitä korkeampi on aggregaattitason tuottavuuskasvun rakennekomponentti ja sitä suurempi on pääoman tulo-osuus. Tutkimuksessa saadaan näyttöä siitä, että työn tulo-osuuden pieneneminen aggregaattitasolla voidaan paljolti selittää palkkaosuuksien siirtymällä korkean työn tulo-osuuden (huonosti kannattavista) toimipaikoista matalan työosuuden (hyvin kannattaviin) toimipaikkoihin. Empiiriset havainnot aggregaattitason tuottavuuskasvun mikrotason lähteistä sekä aggregaattitason tulo-osuusmuutosten mikrotason piirteistä puhuvat sen puolesta, että Suomen teollisuus koki positiivisen teknologiashokin 1980-luvun jälkimmäisellä puoliskolla. Joitakin merkkejä saadaan siitä, että rakennemuutos on rauhoittunut 1990-luvun lopulla.

Yhteenveto

Tutkimuksessa tarkastellaan funktionaalisen tulonjaon määräytymistä aggregaattitasolla ja mikrotasolla (toimipaikkatasolla). Teknologiashokin ilmentymistä mikrotasolla sekä aggregaattitasolla luonnehditaan yksinkertaisen mallin avulla. Mallissa oletetaan, että uusi tekniikka voidaan ottaa käyttöön vain uusissa toimipaikoissa. Palkat määrätään keskitetysti niin, kaikkien palkat nousevat sen verran kuin aggregaattitason tuottavuus on parantunut aiemmin ja että samasta työstä saadaan sama palkka toimipaikasta riippumatta. Tällöin normaalioloissa työn ja pääoman jako-osuudet pysyvät muuttumattomana eikä toimipaikat saavuta elinkaarensa aikana ylimääräisiä voittoja.

Ennakoimaton positiivinen teknologiashokki saa aikaan sen, että tuolloin perustettavat toimipaikat ovat poikkeuksellisen kannattavia, eli työn tulo-osuus on poikkeuksellisen alhainen. Ne maksavat saman hinnan työstä kuin vanhat toimipaikat, mutta saavat aikaan suuren tuotoksen ylivertaisella teknologiallaan. Aggregaattitasolla työn tulo-osuus laskee. Tämä johtuu niin sanotuista mikrotason rakennetekijöistä. Mallissa ne koostuvat sisääntulo- sekä poistumisvaikutuksesta. Ensiksi työn tulo-osuutta pienentää sisääntulovaikutus ja seuraavaksi poistumisvaikutus. Sen sijaan toimipaikkatasolla työn tulo-osuus pysyy ensin muuttumattomana ja myöhemmin nousee. Mikrotason rakennesopeutuksen jälkeen aggregaattitason työn tulo-osuus palautuu entiselleen.

Tutkimuksen loppuosassa tarkastellaan, kuinka hyvin malli luonnehtii Suomen teollisuuden tulo-osuuksien kehitystä aggregaattitasolla ja toimipaikkatasolla. Selvitämme, missä määrin mikrotason rakennekomponentit selittävät tulo-osuuksien muutoksia. Empiirisessä osassa mikrorakennetekijöinä tarkastellaan ilmestymis- ja poistumisvaikutuskomponentin ohella myös niin sanottua osuussiirtymäkomponenttia. Se on työn tulo-osuutta pienentävä silloin, kun kannattavat tuotantoyksiköt, joissa on alhainen työn tulo-osuus, lisäävät palkkasummaa (työllisyyttä) enemmän kuin heikosti kannattavat tuotantoyksiköt. Tulokset paljastavat, että rakennekomponentit, erityisesti poistumis- ja osuussiirtymäkomponentti, ovat vaikuttaneet työn tulo-osuutta pienentävästi 1980-luvun jälkipuoliskolta alkaen.

Toimipaikkatason vaikutus dominoi lyhyen aikavälin heilahteluja. Laman iskettyä tämä tekijä vaikutti voimakkaasti työn tulo-osuutta kasvattavaan suuntaan. Muutamana ensimmäisenä elpymisvuotena se puolestaan vaikutti työn tulo-osuutta pienentävästi. Pitkällä aikavälillä (1974-1999) sen vaikutus on ollut kuitenkin keskimäärin nolla.

Toimialatason tarkastelut paljastavat kaksi kiinnostavaa seikkaa. Ensiksi, pääosa rakennevaikutuksista on toimialojen sisäistä ja vain osa teollisuustoimialojen välistä. Toiseksi, kehityskulku on ollut erilaista toimialojen välillä. Paperiteollisuutta ja metallin perusteollisuutta koskevat tulokset kertovat, että näillä aloilla työn tulo-osuutta pienentävää mikrotason rakennemuutosta on tapahtunut monia muita aloja aiemmin ja rakennevaikutus on ollut niissä viime vuosina aiempaa vähäisempää. Sen sijaan TeVaNaKe-alalla sekä sähköteknisessä teollisuudessa aggregaattitason tulo-osuuksia heilutellut rakennemuutos on painottunut selvemmin 1990-luvulle.

Tässä saadut tulokset antavat lisätukea sille aiemmissa toimipaikkatason rakennemuutosta koskevissa tutkimuksissa tehdylle johtopäätökselle, että teollisuuden tuottavuuden ja kilpailukyvyn kehitys kiihtyi 1980-luvun jälkipuoliskolla paljolti syvälle toimipaikkatasolle käyneen rakennemuutoksen ansiosta. Kiristynyt kilpailu ja 1990-luvun lama putsasi alhaisen tuottavuuden ja kannattavuuden työpaikkoja. Tulo-osuudet normalisoitunevat ajan kuluessa rakennesopeutuminen rauhoittumisen myötä. Palautuminen tapahtunee toimipaikkatason vaikutuksen kautta.

Contents

1. Introduction

The downward tendency in the labour income share in the Finnish economy since the 80s has attracted attention (see for example Pohjola 1998, Sauramo 2000 and Ripatti and Vilmunen 2001). This type of drift in income shares can be found in manufacturing and in many other sectors. Not surprisingly this has raised discussion whether this is something that should be responded to in the Finnish wage determination, which takes place at the total economy level or industry level bargaining between trade unions, confederations of employers and government.

The increase in the capital income share is the direct consequence of the rapid aggregate labour productivity growth that has exceeded the real wage growth. Maliranta (1997 and 2001) has shown that a substantial proportion of the unusually high labour and total factor productivity growth rate can be attributed to the plant-level restructuring. Restructuring has taken place through plant shutdowns and openings as well as through divergent employment (and capital growth) among incumbents that are heterogenous in terms of productivity levels.

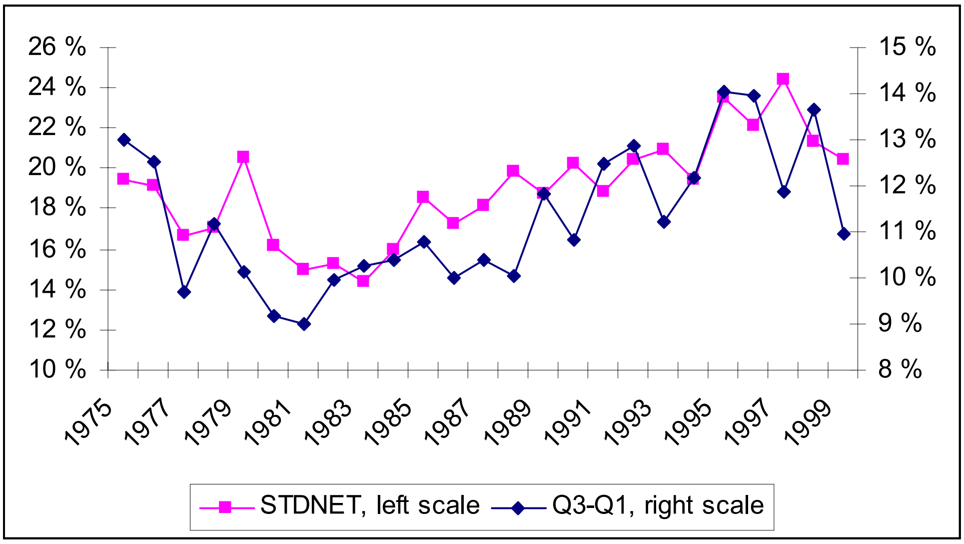
The plants that will disappear in the following year have accounted for an ever-increasing share of employment in Finnish manufacturing. At the same time, new plants have had continuously increasing stake in the manufacturing employment (see Maliranta 1997). In other words, there has been more and more turnover in labour shares due to plant turnover. Usually entries and exits are only particular steps in the course of events during the life-cycle of a typical plant. In the short-run the march of renewal may be better portrayed by analysing changing stakes among incumbents that are in different stages of their life-cycles.

To provide an illustration of the intensity of restructuring in Finnish manufacturing, we measure the growth of employment in plant i in year t by $NET_{it} = (L_{it}-L_{i,t-1})/(L_{it}/2+L_{i,t-1}/2)$, where L is the number of employees. The divergence in this indicator of growth among incumbent plants can be measured by the labour input weighted standard deviation (*STDNET*) or by the difference of labour weighted 3rd and 1st quartile of the distribution, for example. Figure 1 demonstrates that plant-level restructuring has markedly intensified since the mid-80s up to the latter part of the 1990s.

So the intensity of the restructuring has clearly increased over time. Moreover, according to the earlier findings (Maliranta 1997 and 2001) the intensified reshuffling of the stakes has contributed substantially to the catching up the aggregate productivity level of the US manufacturing, which is a long-established international benchmark. In addition, Maliranta (2001) provides evidence that increased R&D intensity and exposure to Western global competition have had an important role to play in the restructuring process of the Finnish manufacturing. Though noticeable acceleration in labour productivity growth can be found since the mid-80s, the productivity growth within plants has stayed relatively stable over the period 1975-1999 (this will be seen clearly in Figure 9 below).

These considerations invite us to ask, whether the steady decline in the labour income share in the Finnish manufacturing and the increased productivity-enhancing restructuring experienced especially since the mid-80s (and possibly the increased R&D intensity) have something to do with each other.

Figure 1 . Divergence in employment growth among incumbent plants



The rest of this paper is organised as follows. A simple model of life-cycles of plants and determination of the aggregate labour income share is presented and some of its implications are discussed in Section 2. Section 3 introduces a method for the decomposing growth of some aggregate ratio, e.g. productivity, hourly wage or labour income share. The empirical analysis of income shares is provided in Section 4 and Section 5 concludes the paper.

2. The life-cycle of a plant

2.1. A simple model of the life-cycles of the plants

We illustrate the restructuring process by means of a simple overlapping-generations model. At each point of time there are two plants, each belonging to a different sequential technology generation.[1] We denote the new plant of decade t by 2 and the old one by 1.

Firm 2's profits in its first and second decade are π_{2t} and $\pi_{2,t+1}$, respectively. Analogously firm 1's profits were $\pi_{1,t-1}$ in decade t-1 and are π_{1t} in decade t. To generate value added y each firm uses in each decade one unit of labour, whose unit cost is w. In the first decade each firm generates tangible and intangible assets by means of investments i that are needed for the implementation of the technology choice. Production is sold in competitive market with price = 1.

In the first decade the profits of firm 2 are

(1) $$\pi_{2t} = y_{2t} - w_{2t} - i_{2t}$$

and in the second decade

[1] As it was mentioned in the introductory section, the firm demographics of this type involving only entries and exits overlook the time-consuming nature of appearance and disappearance. Usually in the first part of the life-cycle a plant improves its relative productivity level and it expands. The shadow-of-death of a plant (see Griliches and Regev 1995) is characteristic of a long-lasting decline in relative productivity as well as size (see, for example, Maliranta 1997, pages 16-17, and Jensen and McGuckin 1997).

(2) $\pi_{2,t+1} = y_{2,t+1} - w_{2,t+1} \geq 0$

We require that production must be profitable in the second decade (operating margin is positive). In this model a plant stops operation after two decades. Later we will mostly consider such situations, where the operating margin would be negative in the third decade due to the increase of wages in the labour markets. Alternatively we may assume that plants' capital becomes unusable after two decades.

Firm 2 decides to make an entry if

(3) $\pi_{2t} + \beta \cdot \pi_{2,t+1} \geq 0$,

where discount factor $\beta < 1$.

2.2. Labour markets

Wages and employment are determined in the centralised bargaining. The efficient outcome that is reached involves identical wages for identical workers, that is to say $w_{1t} = w_{2t}$, and full employment, i.e. both of them are employed. We presume that each plant takes the wages as given. Wages are increased at the rate of aggregate productivity growth in the previous period, so that in the steady state labour and capital income shares stay constant. Given the full employment this can be expressed formally as follows

(5) $w_{1,t+1}/w_{1,t} = (y_{1t}+y_{2t})/(y_{0,t-1}+y_{1,t-1})$,

where y_0 is the value added of a firm plant in decade t-1

The level of wages is set so that in the steady state firms do not earn excess profits over their life cycles. As we have full employment, labour and capital income shares are determined in the wage determination as well. In other words, labour share a in the economy is as follows:

(6) $a_t = (w_{1t}+w_{2t})/(y_{1t}+y_{2t})$

2.3. Productivity of plants

Here technology parameter A includes intangible and tangible capital needed to produce value added y by using one unit labour, i.e.

(7) $y_{2t} = A_{2t}$

We assume that technological development takes place in cumulative steps that can be characterised by a quality ladder model (see, for example, Klette and Griliches 2000). Next generation plant benefits from the new technological opportunities created by previous technology. We presume that each implemented technology A encloses potential new production possibilities $b \cdot A$ $(0 < b < 1)$ for the next generation. However, seizing the opportunity requires investments into the knowledge formation. To discover and implement new production potentials a plant needs to make R&D investments as well as investments into the tangible assets.[2]

2 The models by Pakes and Schankerman (1984) and Klette and Griliches (2000), for example, predict that the increased innovative opportunities lead to the higher aggregate R&D intensity.

To keep things simple, let us assume that to take the next technology step, $A_{2t}/A_{1,t-1}$=(1+b), requires R&D expenditures to the amount of $b \cdot y_{1,t-1}$ and other investments $d \cdot y_{1,t-1}$, where d is a constant.[3]

When a technology step is taken, a new entry is made with investments to the amount of $i_{2t} = b \cdot y_{1,t-1} + d \cdot y_{i,t-1}$.

A plant may also experience productivity growth in the second decade due to learning-by-doing,

(8) $$y_{2,t+1}=(1+c) \cdot y_{2t}.$$

If $c > 0$ productivity increases due to more efficient use of initial technology A_{2t}. If production potentials deteriorate over time, c may be negative.

Two points are worth of noting. Firstly, in this model technological opportunities are determined exogenously but they are materialised through R&D investments of new generation firms. In this respect our model bears some resembles with those of Caballero and Hammour (1994) and Campbell (1997) that emphasise the potential role of entry and exit in technological development. Aggregate productivity growth rate and R&D efforts are high when the amount of new technological opportunities is high.

There is a strict positive relationship between aggregate R&D intensity and aggregate productivity growth by construction. This is keeping with usual empirical findings that suggest social return to R&D to exceed private return.[4] Secondly, productivity growth rate within firms is independent of R&D intensity rate. This accords with empirical evidence by Maliranta (2001), who found no difference in productivity growth rates within plants between high R&D and low R&D intensity plants.[5] R&D helps to build new high technology and high productivity firms (or plants) but is worthless in retooling the current technology in hand.

2.4. Some properties of the model

Aggregate productivity growth

In equilibrium the aggregate productivity growth rate p is

[3] So in this case productivity growth rate equals R&D intensity, measured by R&D expenditures per value added. Investment ratio and tangible capital productivity is constant over time.

[4] A recent paper by Bassanini, Scarpetta, and Hemmings (2001) provides evidence on the effect of R&D intensity and a comprehensive review of growth-regression studies.

[5] It is worth of noting that returns on R&D investments are so high that profit maximising firm will make any R&D efforts that is needed to catch fully the opportunities available. Of course, any extra investments beyond that point would be waste of money according to this model.

$$p=\frac{\left(y_{1t}+y_{2t}\right)}{\left(y_{0,t-1}+y_{1,t-1}\right)}-1$$

$$\Leftrightarrow p=\frac{y_{1t}+(1+b)\cdot y_{1t}\cdot(1+c)^{-1}}{y_{1t}\cdot(1+b)^{-1}+y_{1t}\cdot(1+c)^{-1}}-1$$

(9)
$$\Leftrightarrow p=\frac{y_{1t}\cdot(1+c)^{-1}\left[(1+c)+(1+b)\right]}{y_{1t}\cdot(1+c)^{-1}\left[(1+c)\cdot(1+b)^{-1}+1\right]}-1$$

$$\Leftrightarrow p=\frac{(1+c)+(1+b)}{(1+c)\cdot(1+b)^{-1}+1}-1$$

$$\Leftrightarrow p=\frac{(1+b)\left[(1+c)\cdot(1+b)^{-1}+1\right]}{(1+c)\cdot(1+b)^{-1}+1}-1$$

$$\Leftrightarrow p=b$$

So, the long-run aggregate productivity growth is independent of productivity growth rate within plants. This is because we have assumed that the new plant does not benefit from productivity gains obtained in incumbent plants through learning by doing.

Labour share

Labour share is

(10) $$a_t=\frac{w_{1t}+w_{2t}}{y_{1t}+y_{2_t}}.$$

At each point of time all workers are assumed to share the same wage.

$$\Rightarrow a=\frac{2\cdot w_{1t}}{y_{1t}+(1+b)\cdot y_{1t}\cdot(1+c)^{-1}}$$

(11)
$$\Leftrightarrow a=\frac{2\cdot w_{1t}}{y_{1t}\cdot\left[1+(1+b)\cdot(1+c)^{-1}\right]}$$

In the equilibrium wages are set so that the expected present value of profits of the plants are squeezed to zero, i.e.

(12) $$y_{1,t-1}-w_{1,t-1}-i_{1,t-1}+\beta\left(y_{1t}-w_{1t}\right)=0$$

Labour share is stable, when wages increase at the same rate with aggregate productivity. Using this property and (12) we obtain

$$y_{1,t}\cdot(1+c)^{-1}-w_{1t}\cdot(1+b)^{-1}-i_{1t}\cdot(1+b)^{-1}+\beta\cdot y_{1t}-\beta\cdot w_{1t}=0$$

$$\Leftrightarrow y_{1t}\cdot\left[(1+c)^{-1}+\beta\right]-w_{1t}\cdot\left[(1+b)^{-1}+\beta\right]-i_{1t}\cdot(1+b)^{-1}=0$$

(13)
$$\Leftrightarrow w_{1t}=\frac{y_{1t}\cdot\left[(1+c)^{-1}+\beta\right]-i_{1t}\cdot(1+b)^{-1}}{\left[(1+b)^{-1}+\beta\right]}$$

$$\Leftrightarrow w_{1t}=\frac{y_{1t}\cdot\left[(1+c)^{-1}+\beta\right]-(b+d)\cdot y_{1t}\cdot(1+c)^{-1}(1+b)^{-1}}{\left[(1+b)^{-1}+\beta\right]}$$

$$\Leftrightarrow w_{1t}=\frac{y_{1t}\cdot\left[(1+c)^{-1}+\beta-(b+d)(1+c)^{-1}(1+b)^{-1}\right]}{(1+b)^{-1}+\beta}$$

Inserting (13) into (11) we obtain the following formulation

(14) $$\Leftrightarrow a = \frac{2 \cdot \left[(1+c)^{-1} + \beta - (b+d)(1+c)^{-1}(1+b)^{-1}\right]}{\left[1 + (1+b)\cdot(1+c)^{-1}\right]\left[(1+b)^{-1} + \beta\right]}$$

2.5. Numerical illustration of the equilibrium

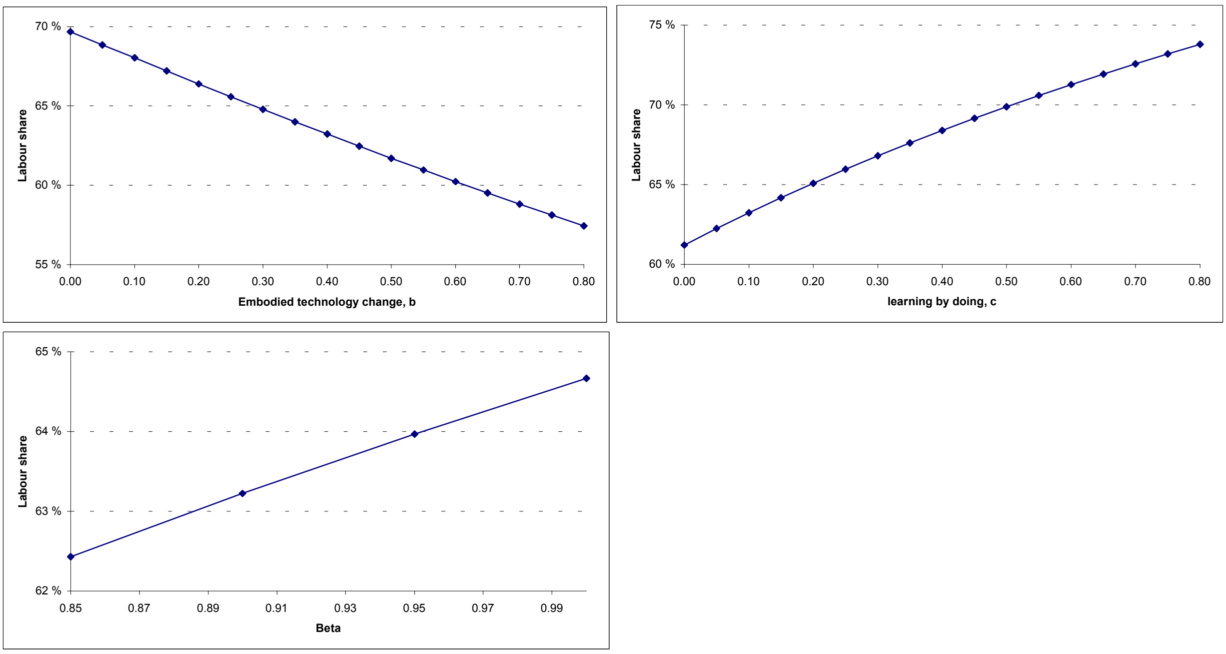
We define a standard state by the following parameter values:

the technological step rate $b = 0.4$, the rate of learning by doing $c = 0.1$, the investment ratio $d = 0.6$, and discount factor $\beta = 0.9$.

Under these circumstances labour share a = 63.2 % and total investment ratio $i_t/(y_{1t}+y_{2t})$ = 24.0 %. Firms would have negative operating margin in their third decade so they will be closed down before that. A slight decrease in b (<0.39) or increase in c (>0.13) would make it profitable to operate in the third decade, as value added still exceeds the labour costs. So, it is obvious that the survival (and entry) rates can be expected to be dependent on the variables of our interest, e.g. b and c, as well.[6]

Figure 2 illustrates how the labour share changes, ceteris paribus, when we vary parameters b, c or β. We see that the labour share is negatively dependent on b and positively on c and β. A doubling of the growth rate of technological opportunities (and R&D intensity and productivity growth) from 0.4 to 0.8 would mean a drop in labour income share from 63 % to 57 %. This is, of course, due to the fact that we have assumed in (12) that sunk costs needed to capture the higher technology opportunities by R&D and other investments must be met. On the other hand, the higher the productivity growth over a plant's life-cycle trough learning-by-doing, the smaller is the proportion of value added needed to cover the given expenses.

Figure 2. Labour share and productivity growth due to embodied technological change and learning-by-doing



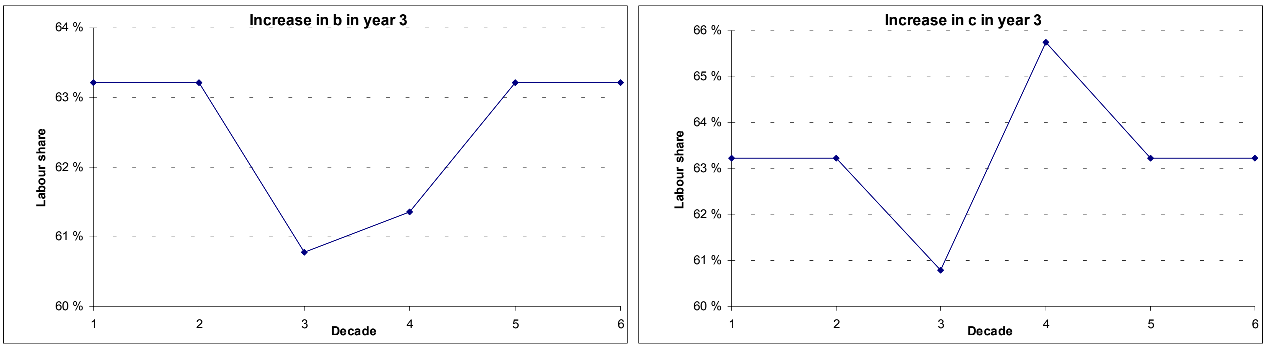
6 If we allow flexibility in wage levels between firms that have varying labour productivity, i.e. $w_{1t}=e\cdot w_{2t}$ (e>1), old firms would, of course, have better prerequisites for survival.

Temporary increase in *b* or *c*

Next we consider the situation where in some decade, say in decade 3, an abnormal amount of technological opportunities emerge unexpectedly so that $b_{decaded\ 3}$ = 0.4+0.1 = 0.5 ($b_{decaded\ 4}$=0.4). It should be noted that in the disequilibrium aggregate productivity growth rate does not need to be equal to technology step rate *b*. The plant that makes an entry in that particular period benefits from an unexpected technology stride potential that it will realise when making its investment decision. It manages to reap positive present value of profits during its life-cycle. In decade 3 aggregate productivity growth rate is 0.456 but the wage increase is due to a lag we have assumed still 0.4 in decade 3. Therefore the labour income share falls. In the next two decades wage increase exceeds aggregate productivity so that the labour share begins to recover (see Figure 3). Because wages of both plants are determined according to aggregate productivity growth in the past also the second generation plant after the shock gains some positive profits.

Consequences of an unexpected temporary increase in learning-by-doing (*c*) from 0.1 to 0.2 are somewhat different. Contrary to what was the case with *b*, in this particular model a temporary increase in *c* does not have permanent consequences for the later technology and output levels (see equation (9)). The plant experiencing abnormal growth in productivity in its latter part of life-cycle gains positive present value of profits, but next new plant suffers a loss due to increased aggregate productivity growth stimulated by the gainer.[7] Of course, mirror-image is obtained when *c* unexpectedly falls due to recession, for example. Then the incumbent of the recession period suffers a loss with its low productivity growth rate, and labour share increases. Next generation plant, however, gains extra profits thanks to previously lowered aggregate productivity growth rate. Thus, there is an income transfer taking place between plants belonging to different generations.

Figure 3. Unexpected increase in b and c



Note: In the first case (left diagram) shock involve an increase in *b* from 0.4 to 0.5 and in the second case (right diagram) an increase in c from 0.1 to 0.2. In both case a shock takes place in decade 3.

7 Of course, in this case next generation firm would not have made an entry, had it known that the rise in learning-by-doing rates was temporary.

3. Decomposition of aggregate growth

3.1. Decomposition formula

We are interested in an aggregate ratio F in year (or decade) t:

(15) $$F_t = \frac{Y_t}{X_t} = \frac{\sum_i y_{it}}{\sum_i x_{it}},$$

where y and x are some variables and i denotes plant.

A corresponding indicator is defined for each plant i as follows

(16) $$f_t = \frac{y_{it}}{x_{it}}.$$

At the first stage we are interested in the micro-level components of the change rate of the aggregate ratio among incumbents (or stayers, denoted henceforth by S), i.e. ignoring entries and exits for a moment. Maliranta (2001) proposes the following formula to identify the micro-level components of aggregate change rate among stayers (incumbents):

(17) $$\frac{F_t^S - F_{t-1}^S}{\overline{F}_t^S} = \sum_i \overline{w}_{it} \cdot \frac{f_{it} - f_{i,t-1}}{\overline{f}_{it}} + \sum_i \left(w_{it} - w_{i,t-1}\right) \cdot \frac{\overline{f}_{it}}{\overline{F}_t^S} + \sum_i \overline{w}_{it} \cdot \frac{f_{it} - f_{i,t-1}}{\overline{f}_{it}} \cdot \left(\frac{\overline{f}_{it}}{\overline{F}_t^S} - 1\right),$$

where $\overline{F}_t^S = \frac{F_t^S + F_{t-1}^S}{2}$, $\overline{f}_{it} = \frac{f_{it} + f_{i,t-1}}{2}$, $w_{it} = \frac{x_{it}}{\sum_i x_{it}}$, and $\overline{w}_{it} = \frac{w_{it} + w_{i,t-1}}{2}$.

It is worth of noting that

(18) $$(F_t - F_{t-1}) / \overline{F}_t \cong \ln(F_t) - \ln(F_{t-1})$$

for the relatively small change rates.

The first term on the right-hand side of the equation (17) is the within component (denoted by *WH)* that is a weighted average of growth rates of the plants. The second term is the between component (BW) that indicates the contribution of restructuring between incumbents to aggregate change rate. This term is positive, when plants having high f tend to increase relative size in terms of x, i.e. if there is restructuring towards high f plants. The third term may be called as catching up term (*CH*). If the size of plant is uncorrelated with the level and the change rate of ratio f, negative value of this component indicates that those plants that have low f have high growth rate of f. In other words, under these particular conditions this term can be used as an indicator of β-convergence (see Barro and Sala-i-Martin 1995).

The combined effect of entries and exits, *ENTEX*, can be defined as follows:

(19) $$ENTEX = \frac{\Delta F_t^T}{\overline{F}_t^T} - \frac{\Delta F_t^S}{\overline{F}_t^S},$$

where T (total) indicates that all plants are included in both years t and t-1.

So the aggregate change rate among all plants is a sum of the combined effect of entries and exits, *ENTEX*, and micro-level components among stayers. Inserting (17) into (19) and rearranging terms we obtain

$$(20)\qquad \frac{F_t^A - F_{t-1}^A}{\overline{F}_t^A} = ENTEX + \sum_{i\in S}\overline{w}_{it}\cdot\frac{f_{it}-f_{i,t-1}}{\overline{f}_{it}} + \sum_{i\in S}\left(w_{it}-w_{i,t-1}\right)\cdot\frac{\overline{f}_{it}}{\overline{F}_t^S} + \sum_{i\in S}\overline{w}_{it}\cdot\frac{f_{it}-f_{i,t-1}}{\overline{f}_{it}}\cdot\left(\frac{\overline{f}_{it}}{\overline{F}_t^S}-1\right)$$

This formula is a modified version of the method proposed by Bernard and Jones (1996) and thus we call it as MBJ-method.

The term *ENTEX* can be split further into separate entry and exit effects. By making use of property expressed in (18), we may write (19) as

$$(21)\qquad ENTEX \cong entex = \Delta\ln F_t^A - \Delta\ln F_t^S$$

With slight manipulation we obtain the following formula

$$(22)\qquad entex = \ln\left(1-w_t^E\left(1-\frac{F_t^E}{F_t^S}\right)\right) + -\ln\left(1-w_{t-1}^D\left(1-\frac{F_{t-1}^D}{F_{t-1}^S}\right)\right),$$

where $w_t^E = 1-\frac{X_t^S}{X_t^A} = 1-\frac{\sum_{i\in S}x_{it}}{\sum_{j\in A}x_{jt}}$, is the employment share of the plants made entry in year *t* and F_t^E is an aggregate indicator calculated for them. Analogously, $w_t^D = 1-\frac{X_{t-1}^S}{X_{t-1}^A} = 1-\frac{\sum_{i\in S}x_{i,t-1}}{\sum_{j\in A}x_{j,t-1}}$ is the employment share of those plants that will disappear after year *t*-1 and F_{t-1}^D is an aggregate indicator calculated for them in the last year of their existence (year *t*-1). The first term on the right-hand side of equation (22) is the entry effect, *ent*, and second term is the exit effect, *ex*. For example, exit effect has a positive contribution to aggregate change rate, when $F_{t-1}^D/F_{t-1}^S < 1$ and entry effect is positive, when $F_{t-1}^E/F_{t-1}^S > 1$.[8]

3.2. Use of the decomposition formula

We proceed in the following way. Next we look how the components obtained from the decompositions behave in the numerical illustrations of our simple model introduced above. In Section 4 we examine what sort of patterns of the development can be identified when the decomposition method is applied to a real plant-level data on Finnish manufacturing. This is done in order to assess whether the empirics concerning the development of factor income shares is consistent with the hypothesis that Finnish manufacturing sector had experienced a technology shock that required plant-level structural adjustment.

Productivity growth

By setting *Y* as output and *X* as input, this formula can be used for decomposing aggregate productivity growth. In the standard state of our model defined in the previous section, the aggregate productivity growth rate is 33.3 %. The within component is 9.5 % that in this case indicates the rate of learning-by-doing.[9] In our model there is no restructuring among stayers so that the between component is zero. The catching up term is zero as well.

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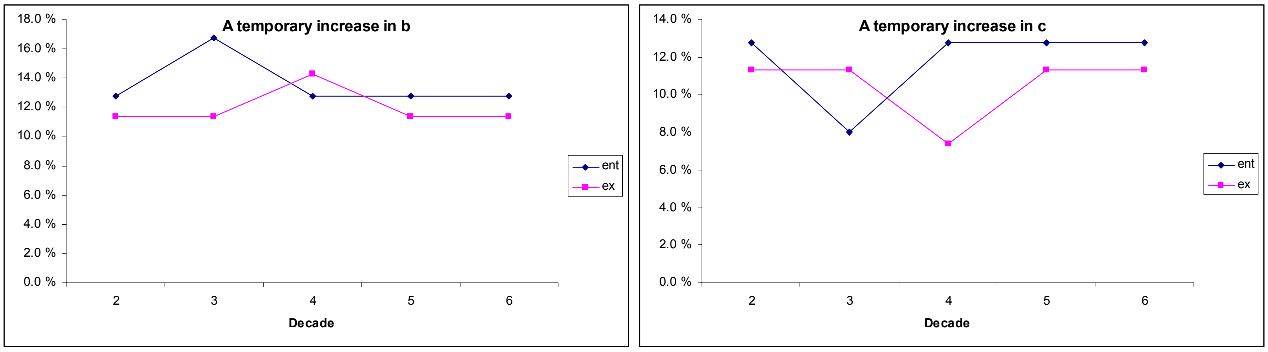
8 It should be noted that in this particular decomposition method entry effect is zero if the continuing firms are similar in the year of entry. Similarly, exit effect is zero when the exiting firms are similar with the surviving ones.

9 It is worth noting that the rate of growth is measured here by $\Delta Y/\overline{Y}$ instead of $\Delta Y/Y_{t-1}$. For example, when $\Delta Y/Y_{t-1} = 0.1$ then $\Delta Y/\overline{Y} \approx 0.095$.

The combined effect on entry and exit, *ENTEX*, is 23.8 % (the log version of it, *entex,* is 24.1 %). Entry effect is 12.8 % and exit effect 11.3 %. Of course, entry and exit effects are positively dependent on the value of *b*. When *b* = 0.6, *ENTEX* = 36.6 %, *entex* = 37.5 %, *ent* = 20.5, and *ex* = 17.0 %. We find that the higher *c*, the lower are *ent* and *ex*.

The effects of a temporary increase in *b* and *c* on entry and exit components are depicted in Figure 4. In both cases entry effect reacts first and exit effect later. In the case of a shock in *b* the within component stays stable over the whole period, but an increase in *c* is immediately reflected in an upsurge of the within component (not reported here).

Figure 4. Dynamics of productivity growth components



Note: see the note of Figure 3.

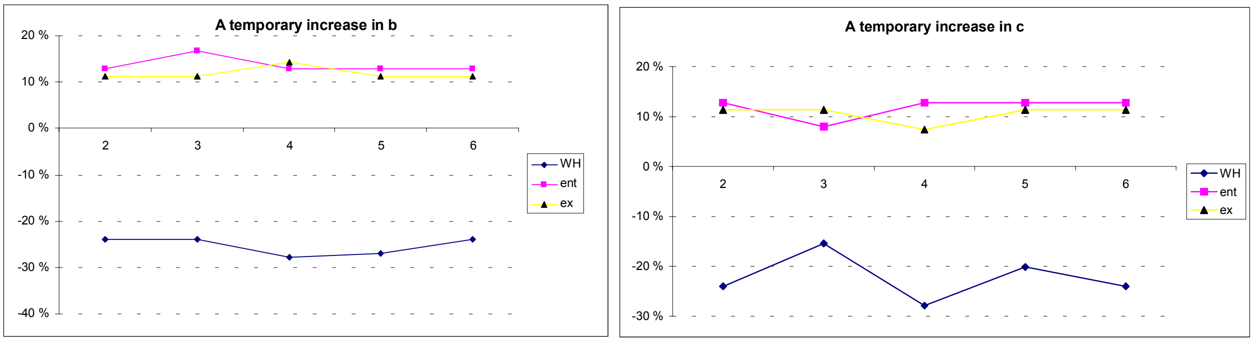
Changes in income shares

The decomposition can be applied in the analysis of the change of the aggregate income shares as well. When we are interested in the role of reallocation in the determination of aggregate income shares, it is useful to set labour compensation as denominator *X* and value added as *Y*. So *F* is the inverse of the labour income share.

Again, as in our model there is only one incumbent at each point of time, the between and catching up components are zeros. In the standard state of our model the within component is -24.0 % indicating that labour share increases within plants. The combined effect of entry and exit eliminates the within effect with the value of 24.0 % (*entex* = 24.1 %). Entry effect is 12.8 % and exit effect 11.3 %. When *b* is higher (*b* = 0.6), the entry and exit effects are higher (*ent* = 20.5 % and *ex* = 17.0 %) and the within component lower (-37.0 %).

A temporary increase in *b* from 0.4 to 0.5 is reflected in the components in a manner illustrated in Figure 5. An increase in *b* first lifts entry effect and later exit effect. Within component reacts with a delay by first declining and then recovering gradually to the initial level. So, a technology revolution first increase capita share through the entry and later trough the exit effect. The return to the initial standard state of income shares takes place through the within component with a lag (the within component lowers).

Figure 5. The effect of change in *b* and *c* on the components of aggregate income share change



Note: see the note of Figure 3.

A temporary increase in c from 0.1 to 0.2 within the incumbent plant of the period 3 first decreases the labour income share through the within component (the within component increases) but this is partly eliminated by the entry effect. In the subsequent periods the within component oscillates towards the initial standard state that is reached by period 6.

Change in wages

By setting Y as labour compensation and X as hours worked the decomposition method can be used for the analysis of wage increases. One pivotal feature of our model is that identical workers share identical wages. As a consequence both entry and exit components are zeros and wage increase takes place within plants. As we have assumed that wage increases are set according to aggregate productivity growth rate of the previous period, wages respond to a technology shock with a one period delay.

4. An empirical analysis

4.1. Data

We use longitudinal data on Finnish manufacturing plants that are constructed especially for research purposes. This data source is rich in variable variety and it covers quite thoroughly the production activities of the Finnish manufacturing sector. The data set is compiled from the annual production censuses. Inquiries have consisted of reasonably detailed questions about the characteristics of the plant, production, employment, costs etc. In particular, this data source includes measures for output, inputs and wages that are needed in this analysis.

The data cover the years from 1974 to 1999.[10] Up to the year 1994 they basically include all manufacturing plants employing at least 5 persons. There is a break in the series in 1995. The major change is that since 1995 our data include basically all plants owned by a firm that has at least 20 persons on payroll. So, on the one hand the data may nowadays include very small plants of multi-unit firms, but on the other hand, plants of small firms are left outside. This break in the series needs to be taken into account especially when analysing entries and exits.

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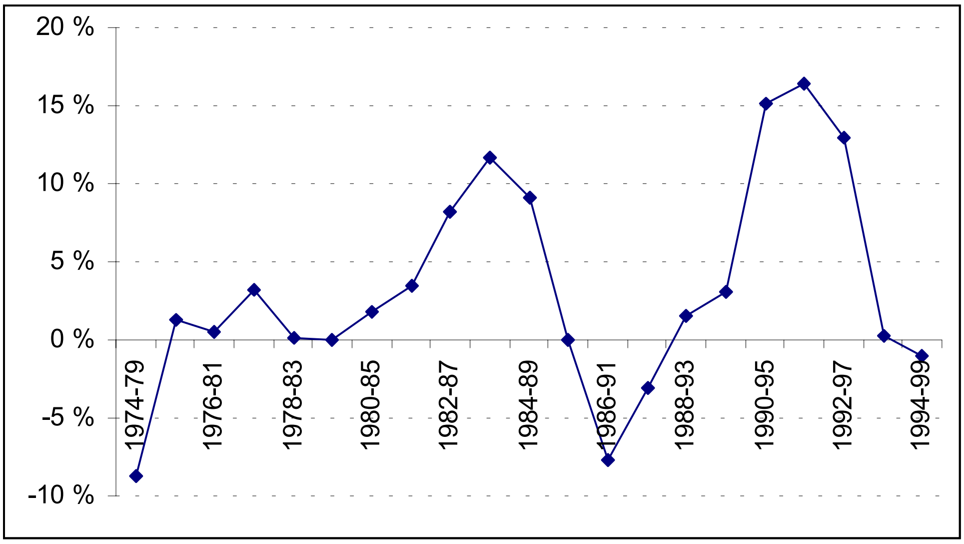
[10] Year 1974 is dropped in productivity and wage computations due to the lack of price deflator for that year.

4.2. Micro-level components of changes in income shares

Figure 6 demonstrates the decline in aggregate labour share in Finnish manufacturing since the latter part of 1980s (that appears in an increase of F). The computations are made for 5-year moving windows. The tendency of declining labour share was interrupted by a demand shock experienced during the recession in the early 1990s. However, the cumulative effect of changes in income share for capital's good has been considerable. Very recently the income shares seem to have stabilised. For how long, is to be seen.

Figure 6. Change of aggregate value added per labour compensation, 5-year moving windows



Notes: Change rate of aggregate value added per labour compensation (wages plus supplements) is calculated as in the equation (20). Up to the period 1989-94 we have included all Finnish manufacturing plants employing at least 5 persons. To calculate changes since the period 1990-95 we have included only plants employing at least 20 persons. This needs to be done in order to avoid artificial entries and especially artificial exits since 1995. However, computations for periods up to 1989-94 using 20 as cut-off limits indicate that the values of components, not to mention patterns over time are not sensitive at all to differences in the cut-off limit.

Next we identify different micro-level components of the change in aggregate value added per labour compensation, *F*, by using formula (20). The developments of the components are depicted in Figure 7. The use of 5-year moving windows helps us to capture better the long-run effects of restructuring.

The increase in the combined entry and exit effect, i.e. the sum of entry and exit effects, and in the between component since the latter part of the 80s is consistent with the interpretation that Finnish manufacturing confronted a technology shock in the latter part of the 80s that required plant level restructuring. Moreover, the negative values of the within component in the periods from 1985-90 to 1989-94 are similarly in accordance with our model of embodied technology shock (see also Figure 5). Although the recovery from the demand shock in the periods from 1990-95 to 1992-97 was characterised by high positive within components, the cumulative effect of the within component on aggregate labour income share growth has been negative or zero from the mid-80s to date.[11] This is to say that productivity growth within plants has not exceeded wage growth, consistently with our model (see also Figure 9 below).

[11] The analysis of annual components by Maliranta (2001) suggest that the cumulative within effect seems to have been negative since the late 1980s.

We note that entry effect (*ent*) was barely positive up to the late-80s and subsequently declined into negative side. On the basis of the model that was presented in Section 2, we would expect entry effect to be positive.

Two remarks, however, are worth of making at this point. First, our model ignores the fact that there is likely to be a substantial amount of uncertainty about technological opportunities. Some firms make mistaken technology choices and entry decisions, whereas some are successful. So there may be a lot of heterogeneity in labour shares between newcomers (see Jovanovic 1982). If there is a lot of selection among newcomers, extending the period under consideration may pick up those entries that are essential for long-run aggregate growth. Therefore we have also made these calculations for 10-year periods (results are not reported here). Entry effect is positive in the first half of the period under consideration, but the effect is still quite small compared to that of the between (*BW*) or exit (*ex*) components.

Secondly, it is possible that new successful plants are able to increase productivity and value added to labour compensation in the early part of life-cycle thanks to learning-by-doing, for example (see Ericson and Pakes 1995). Moreover, new plants are usually rather small. It is possible that it is those entries having found leading edge technology (and achieved high profitability) that are able to expand in the early stages of the life-cycle and thus in a sense make a full-blown entry. Thus, the between component may capture entry effect when entry is interpreted more broadly comprising both the initial appearance and the subsequent expansion of the scale of the production.

The exit effect was strikingly negligible up to the mid-80s, but has contributed positively to the decline of the labour share ever since. Hence exit effect has behaved according to our model in the latter part of the period under consideration. The increase in the impact of the exit component has been a result of two concurrent developments. There has been a decline in the relative value added to labour compensation, which is an aspect that is included in our model. In addition, there has been an increase in the employment share of exiting plants. So in a sense the life cycle of a typical plant has become shorter. This is something one could expect when the rate of such new technological opportunities that can be implemented in the new plants rises.

We find a good deal of similarities in the patterns of the exit and between components over time. Both increased in the latter part of the 1980s and remained clearly positive up to the late-90s. We note that especially in the period 1988-93 the churn in labour compensation shares among incumbent plants has lowered the aggregate labour income share. So the hit of the recession, that was timed within this period, entailed such reshuffling among plants that explains much of the decline in the aggregate labour share. Those plants that had high value added per labour compensation gained shares in terms of labour compensation. Broadly speaking high values of the between component can be argued to be consistent with our model, although strictly speaking between component should be, of course, zero.

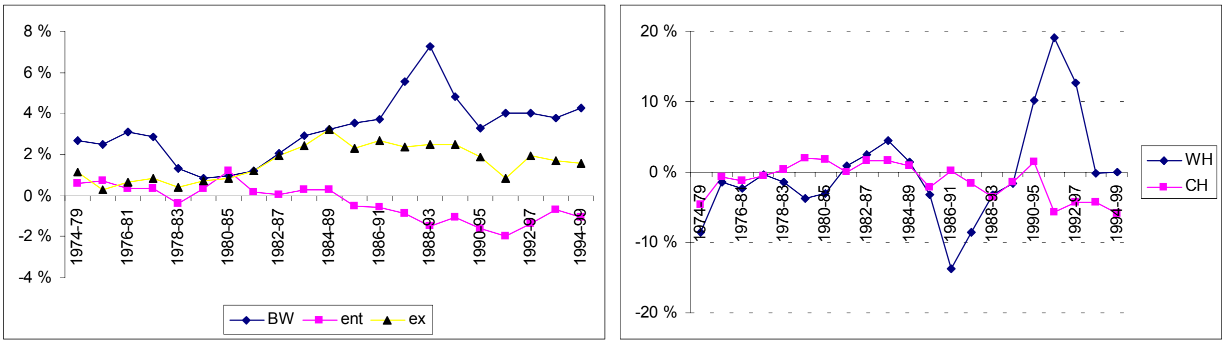
The entry, exit and between components together may expose outcomes of a deeper micro-level process needed to renovate production of a sector. It is then no surprise that these components of aggregate productivity change seem to be mutually correlated in Finnish manufacturing (see Maliranta 2001, 35-36). In particular, it is shown that the positive contribution of the between component of aggregate productivity can be attributed almost entirely to the relatively new plants (see page 38-39).

New technological opportunities can be expected to be seized not only by new plants, but also by those incumbents capable of retooling at moderate cost. It seem plausible to expect that retooling can be performed more successfully by those plants having relatively new technology and organisation. Subsequent expansion of plants having made a successful retooling should be reflected in the subsequent positive values of the between component of aggregate growth of value added to labour compensation ratio, as seems to be the case.

Catching up term has gone down during the 1990s and has now negative values. This may reflect the tendency that capital shares decline more (or increase less) rapidly within those plants that have high capital shares compared to low capital share plants. In other words, a low catching up term may indicate that there is a negative correlation between the level of labour share and growth of labour share at the plant level. So low catching up term may be a symptom of narrowing capital share dispersion between plants. Unreported computations show that the dispersion of the labour shares between plants was high in the recession years 1991-94 and low in the latter part of the 1990s.[12]

Our austere model does not encompass those features of development that are reflected in the catching up component. Maliranta (2001) reports low and negative values of catching up component of aggregate productivity growth especially for the 1990s (and especially for total factor productivity). One possible interpretation of these findings is that a part of plants having low productivity and high labour share has been able to avoid exit (or decline) by extra productivity growth and this is reflected in an increase of operating margin within some plants.

Figure 7. Components of aggregate income share change



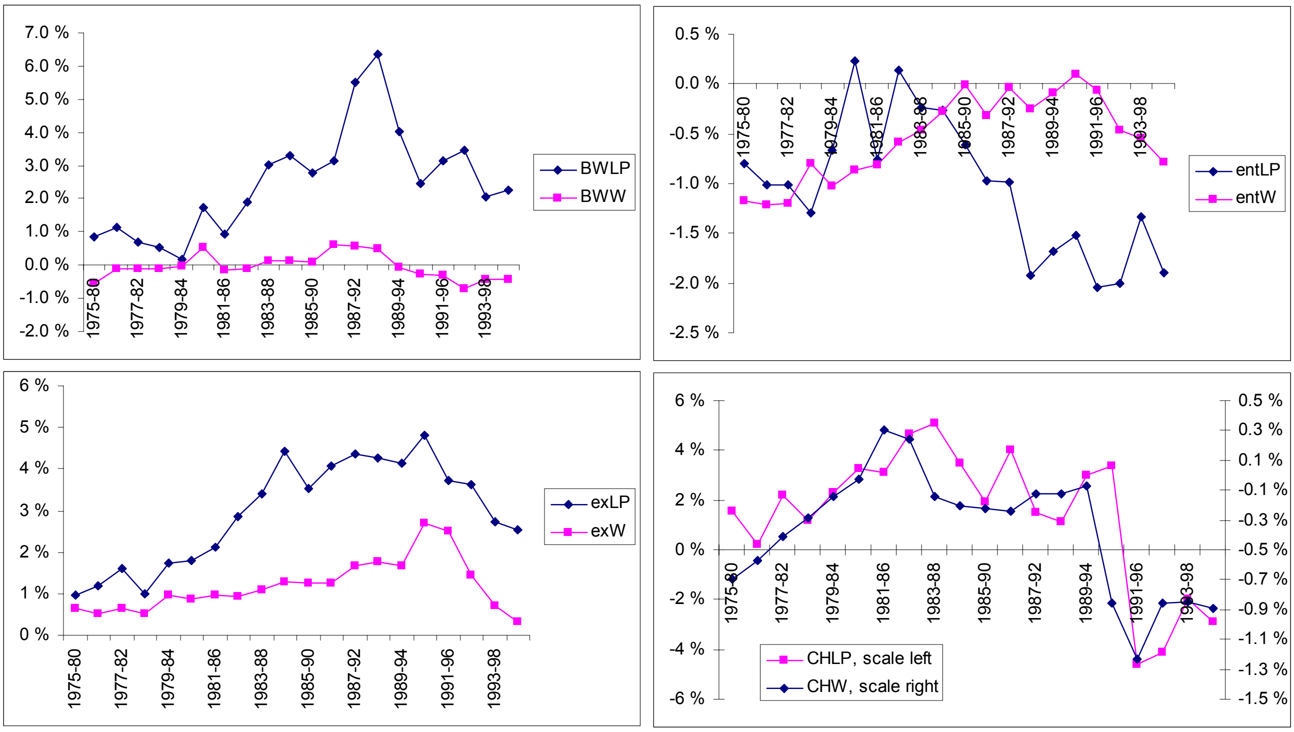
Note: see the note of Figure 6.

4.3. Components of aggregate wage and productivity changes

Upper-left diagram in Figure 8 repeats the earlier findings by Maliranta (2001) that the between component has been an important source of aggregate labour productivity (*LP)* increase in Finnish manufacturing in the recession years, but also before and after that.

[12] As it was pointed out in Section 3, this term is somewhat complex so that a sceptical reader may consider this term as a residual element. However, when annual components were analysed, the catching up term predicts very accurately the log change of coefficient variation of value added per labour compensation (results are not reported here). When the catching up term is low (negative), the dispersion of income shares between plants is low.

Figure 8 . Components of labour productivity and wage growth



Note: see the note of Figure 6

One might be inclined to believe that aggregate productivity has increased as low productivity plants using low skilled workers have grown smaller in relative terms. In that case the aggregate productivity growth may have been achieved at the cost of unemployment of low skilled workers. Put differently, a positive between component of aggregate productivity growth could reflect skill biased technological steps taken in (relatively) new plants. This is to say that new technology can be put on the use successfully only with skilled workers. Plants with high productivity and highly skilled workers may be the ones that are able to implement new technology and these plants expand by hiring high skilled workers. Low productivity plants with low skilled workers fail to maintain their jobs, so low skilled workers are laid off from low productivity plants. This description of the course of events seems logical also from the standpoint that Finnish wage dispersion is lower than in some other countries. Moreover, there have also been some efforts to compress further the wage difference between skilled and unskilled workers.

This story, however, does not pass very successfully an empirical test performed with a decomposition of aggregate wage growth (components of the wage-variable are indicated by letter *W*).[13] As high skill workers usually earn high wages, the skill biased technological revolution should show up in the form of a positive between component of aggregate wage growth (*BWW*). The upper-left diagram in Figure 8 indicates that the between component of aggregate wage growth indeed varies together with that of aggregate productivity growth, but, it is important to note that the contribution of it is practically very close to nothing.

Of course, this is not to say that the education or age of the workers does not have an important role to play in the technological development or restructuring. Findings concerning the level of educa-

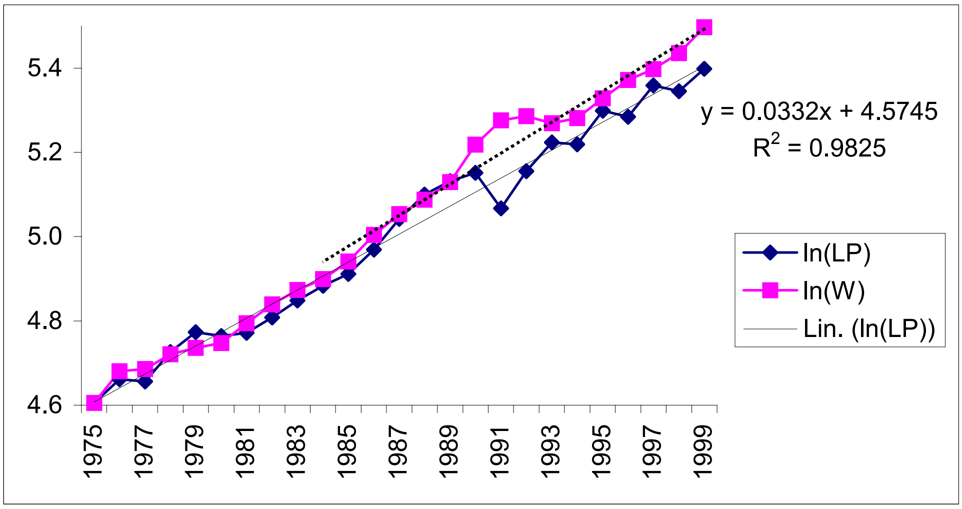
13 We have used the same deflator for wages and productivity, that is the producer price index obtained from 2- or 3-digit industry level.

tion of workers and employment growth of the plant are somewhat mixed according to Ilmakunnas and Maliranta (2000). However, the relationship between plant's growth and the age of labour force is evident; those plants with young labour force have relatively high employment growth. It may be the case that skills obtained through learning-by-doing may be valuable in terms of efficient use of the old technology in hand, but may be less important from the standpoint of adapting and implementing new technological steps.

Due to institutional features of the Finnish wage determination or due to incentive considerations of firms, a la Lazear, it is possible that the relative wage of young workers does not agree with their contemporary relative productivity. Wages of young workers may increase more rapidly than plant productivity when they manage to increase their insider power or pick up their postponed compensation. So we would expect that an increase of age of workers by one year increases wages more than productivity in percentage terms. In that case we would find decreasing labour income share within plants, when there is no churning of labour within plants, i.e. plants age with their labour.[14]

We note from the upper-right diagram of Figure 8 that the entry effect of aggregate wage increase has been relatively moderate especially from the end of the 1980s to the mid-1990s, whereas the entry effect of labour productivity has been clearly negative. This can be explained by the fact that initially the capital intensity of the plant is relatively low. Entry effect of total factor productivity instead seems to have been clearly positive (see Maliranta, 2001, page 36). Slightly inconsistently with our model, the exit effect of aggregate wage growth has been positive though not as much as is the case with the productivity growth. So those employees that have lost their jobs due to plant closure have had below-average hourly wage. Finally, the catching up term of aggregate productivity and aggregate wage growth share quite similar patterns, but absolute values of wage growth component is inessential.

Figure 9. Labour productivity (LP) and real wage (*W*) growth within plants, 1975 = ln(100)



Note: the cumulative effect of within component is measured by log of index $IND_t = IND_{t-1} \cdot (1+0.5 \cdot a_t) \cdot (1-0.5 \cdot a_t)^{-1}$, where is a_t is the within component in year *t*.

14 Ilmakunnas, Maliranta and Vainiomäki (2000) show that seniority-productivity and seniority-wage profiles are quite different. While the average seniority years of workers have an independent positive effect on wage at least over the range from the beginning to 25 years, the seniority-productivity profile is downwards sloping after the peak reached by a few years of seniority.

Figure 9 depicts the trends of annual wage and labour productivity growth within plants. The figure indicates that labour productivity has followed very closely a log-linear trend in the period from 1975 to 1999. The trend of wage growth has diverged after the mid-1980s (sketched by a dashed line obtained by a regression model estimated separately for the period from 1984 to 1999). These findings are fully consistent with our earlier observations. Labour shares have increased **within plants** since the mid-1980s. It is the restructuring between plants that has caused the decline of aggregate labour share.

4.4. Industry-level analysis

A part of the plant level restructuring takes the form of industry level restructuring. Next we examine whether there has been restructuring within industries that can be expected when new technologies used in producing certain types of products are substituted for old technologies. We have performed decompositions separately for different industries and aggregated the industry-level results to the manufacturing level. Aggregation from the 3-digit industry level results (87 industries), which is done by using industry shares of labour compensation as weights, is indicated by letter *M* (see Figure 10). For the sake of comparison we have also replicated computations made at the total manufacturing level (components without letter *M*).

Figure 10. Micro level components of income shares in total manufacturing and within 3-digit industries

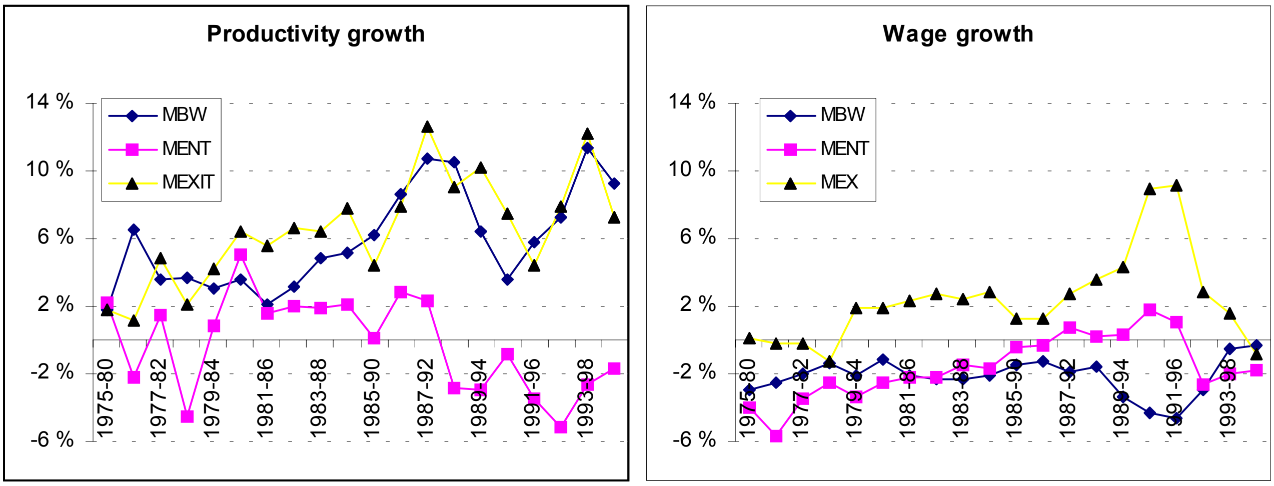
Note: *M*-letter denotes that the component is aggregated from industry level components by using labour compensation shares as weights

A couple of conclusions can be drawn from the figure. First, it turns out that a significant proportion of the increase in the aggregate capital share of total manufacturing can be attributed to changes in industry structures (i.e. there is a gap between BW- and MBW-components). But, however, restructuring among incumbents within 3-digit industries has been at least equally important. We note also that the entry component rises when the industry effect is taken into account. The entry effect is usually positive or at least not very much negative. Quite drastic change can be found for exit effect. The labour share of exiting plants does not differ so much from the industry-average as from the manufacturing-average.[15]

Quite consistently with the previous findings, unreported results of a similar type of computations and comparisons performed for productivity indicate that roughly one half of productivity enhancing restructuring among incumbent plants has taken place within 3-digit industries.[16] Entry effect is clearly higher in the detailed industry-level (usually positive) than in the total manufacturing level. Exit effect in turn is lower when the productivity of disappearing plants is proportioned to the industry-average instead of the manufacturing-average.[17]

In Figure 11 the effects of restructuring on aggregate productivity and wage growth at the 3-digit industry level are compared. Now we express the effects of the components as the shares of the aggregate change rate. We see that while the between component (MBW) has an important positive impact on productivity, the effect of this component has been even negative on aggregate wage growth. These findings tell us that while high productivity plants have gained labour input shares at a detailed industry-level, high wage plants have lost shares. Broadly consistent with our model, entry and exit components of wage growth are usually relatively small in absolute values. However, high exit effect on aggregate wage growth in the recovery periods 1990-95 and 1991-96 seems to be the exception that proves the rule here.

Figure 11. The share of between, entry and exit component



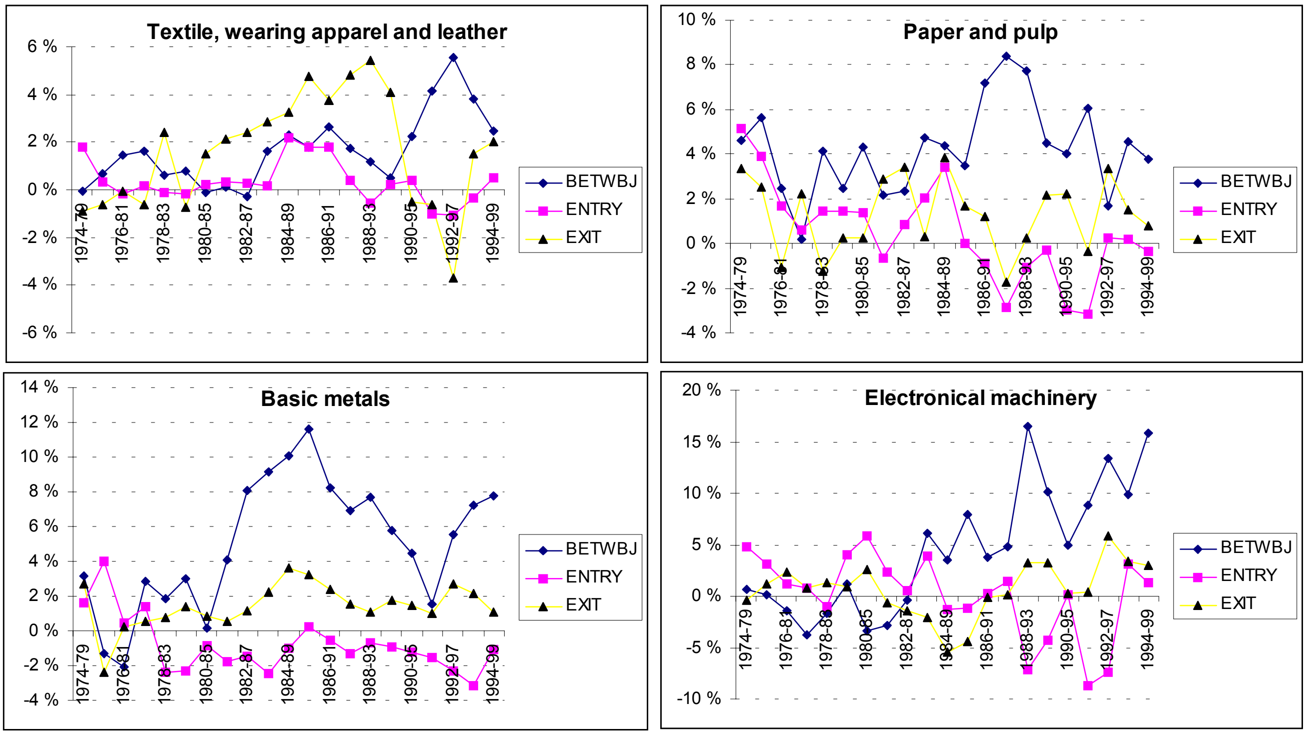
Note: M-letter indicates that these manufacturing level results are obtained by aggregating industry-level results (3-digit level, 87 industries) by using worked hours (average of initial and end year) as weights.

These findings shown above may hide a lot of differences across different industries. The restructuring components of aggregate income share change in four different industries are shown in Figure 12. We find that the timing of the components may vary across industries. This suggests that

[15] The within component is the same, by construction, when it is calculated directly for the total manufacturing or aggregated from the industry-level computations (i.e. WH=MWH).
[16] Bernard and Jones (1996) investigate the impact of sector-level restructuring on aggregate productivity growth.
[17] For example Gösta Rehn and Rudolf Meidner argued that one of the positive outcomes of solidarity wage policy is that it stimulates output and productivity growth by speeding up the transfer of resources from low-productivity sectors to high-productivity sectors (see Erixon 2000, and Hibbs Jr. and Locking 2000).

technology and other shocks that may have stimulated turbulence at the plant level are at least partly industry-specific.

Figure 12. Restructuring components of aggregate income share change in four different industries



The between component was at its highest during the recession in paper industry, whereas in basic metals the most intensive restructuring phase was experienced before that. The development in the manufacture of textiles and wearing apparel, a typical sunset industry, in turn is characterised by a high exit component during and before recession and a high between component during the recovery period. In electrical machinery industry, which is the most typical sunrise industry in Finland, the between component has risen since the late 1980s and has been very sizeable in recent years.

5. Conclusions and discussion

We have shown that the main part of the increase in the capital income share in Finnish manufacturing in the 1990s can be attributed to plant level restructuring. Profitable plants that have high capital income shares have increased payroll shares at the cost of low profit plants. The restructuring contributed very little the aggregate changes in the income shares up to the mid-1980s, but has been an important component since then. An important part of the restructuring has taken place within industries if for changes in industry structures have played a role as well. There are interesting differences in the magnitudes and time patterns of the restructuring component of income share change between industries. Plant level restructuring has been aggregate productivity enhancing but has had little effect on aggregate wage growth. Wage growth within plants has exceeded that of labour productivity growth in the 1990s, which means that labour income share have increased within plants, as a contrast to what has happened at the aggregate level. On the other hand, the differences in the wage and productivity growth rates within plants are substantial in the short run. Labour share increase during downturn and declines during boom. One of the purposes of this paper is to explain why plant level restructuring may affect positively aggregate capital income share and productivity change but is irrelevant for aggregate wage growth.

The turbulent episode starting in the latter part of the 80s in Finnish manufacturing has involved a considerable increase in R&D intensity, an outstanding acceleration of aggregate productivity growth that has taken place mainly through plant level restructuring and declining aggregate labour income share. The plant level restructuring process culminated in the recession and some signs of cooling down can be found in the late 90s.

As a framework of this study we use a simple model of plant's life cycle that turns out to provide a coherent interpretation of the course of events. A central feature of the model is that a productivity leap requires implementation of technological discoveries generated with R&D efforts at the new plants.

This model implies that a technological advance needs to be embodied into new plants and it becomes materialised at the aggregate level through restructuring components of aggregate productivity while the within plants component remains unaltered. Earlier findings by Maliranta (2001) about the components of aggregate productivity in Finnish manufacturing are in keeping with the model in these respects. R&D intensive and (relatively) new plants have had an important role to play in productivity-enhancing restructuring process. It is worth noting that it was found that the within component was roughly the same in low and high R&D intensity plants as well as in relatively new and in old plants, again consistently with our model.

Technological opportunities are determined exogenously, absorbed for example from Western markets, but the implementation requires investments involving sunk costs. When the rate of the increase in technological opportunities is high, as it may have been the case during the integration with Western markets, R&D intensity needs to be high as well as operating margin, since sunk costs need to be covered by the end of the plant's life-cycle. Thus high aggregate productivity growth can be expected to be associated with high R&D intensity and low labour income share.

We assume that under the normal conditions an efficient outcome is reached in the centralised wage bargaining. It involves equal pay for equal work, full employment and such wage increases that investment costs of firms are expected to be met. So our model bears features of Rehn-Meidner model (see Erixon 2000). The policy rule according to which the wages are increased at the rate of the past aggregate productivity growth is consistent with these goals. This guarantees non-negative profits and stable income shares between labour and capital as long as aggregate productivity rate is unaltered.

Because wages are increased on the basis of aggregate productivity growth and because there is a lag in wage increases, the firm that makes entry when a positive technology shock occurs derives largest profits. Not all fruits of a positive technology shock are reaped until the old plant established before shock has disappeared. This is why aggregate productivity growth rate is abnormally high even after the shock. Also the second generation plant after the shock is able to capture some pure profits, but since the third period workers are able to avail fully the outgrowth of the cake due to the positive technology shock.

Of course, consequences of diminished growth of technological opportunities may be serious, when the simple policy rule of increasing wages at the rate of the past aggregate productivity growth is applied. The entry would not happen since the later wage growth would exceed the rate that would guarantee non-negative profits.

We have not found much evidence that plant level restructuring has led to disproportionate job destruction in low wage plants and disproportionate job creation in high wage plants. To put it differently, wage growth within plants has agreed with the aggregate wage growth with a reasonable accuracy, as it is assumed in our model. So, assuming that wage differences reflect skill differences we do not find support for the view that productivity-enhancing restructuring has been essentially an outcome of skill biased technology shock.

While giving a description of the events compatible with many empirical features of Finnish manufacturing development, our simple model fails, however, to capture all the elements. The renewal process seems to have been in operation during the latter part of the 1980s that is characterised by high and stable employment, which is in accordance with our model. The recession in the beginning of the 1990s entailed a 20 percent collapse in manufacturing employment in a couple of years and huge flows of workers from manufacturing plants to unemployment (see Ilmakunnas and Maliranta 2000). One interpretation is that the recession was a separate episode that was given rise to by a huge demand shock. Within component of the growth of value added-labour compensation ratio made a deep plunge (labour income share within plants arose) and then quickly surged during the recovery. According to an alternative interpretation the recession was a kind of culmination of the restructuring process that has emerged gradually since the mid-1980s.

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