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The Role of Competition in the Weak Finnish Productivity Growth after the Global Financial Crisis

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In Finland, the slowdown in labour productivity growth after the global financial crisis has been more severe than in other countries. In economic literature, weak market competition has been linked to lower productivity, as competition encourages firms to innovate and intensifies 'creative destruction', which in turn are the primary sources of productivity growth according to Schumpeterian endogenous growth theory.

This master's thesis aims to examine whether there has been any change in the state of competition in the private sector which could have contributed to the slowdown in productivity growth in Finland after the global financial crisis. In the empirical part of this thesis, this is done by investigating several indicators of competition, both static and dynamic, analysing them in absolute terms and in relation to the benchmark group, and finally by comparing the changes in the state of competition to the changes in labour productivity growth at the time and after the global financial crisis. The analysis was carried out utilizing micro-level data from OECD MultiProd and DynEmp databases, and the observation period is from 2004 to 2018.

In the light of the indicators analysed and presented in this thesis, the changes in the state of competition do not appear to be the answer to the sluggish productivity growth in Finland after the global financial crisis. In general, there are no noticeable changes in the state of the competition after the global financial crisis. In the observation period, Finland has had a lower productivity dispersion and lower firm mark-ups than in the benchmark, which would actually indicate a fairly good state of competition. There appear not to be any significant problems with business dynamics either. On the contrary, the survival and growth of micro-entrants are higher than in the benchmark. On the other hand, many industries are more concentrated in Finland than in the benchmark, and the allocative efficiency is lower than in the benchmark. However, even these indicators do not show significant changes for worse after the financial crisis, and both indicators have remained stable throughout the observation period.

Keywords: productivity, competition, indicators of competition, micro-level data

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Työn tuottavuuden kasvu on ollut Suomessa heikompaa kuin muissa maissa globaalin finanssikriisin jälkeen. Heikko kilpailu markkinoilla on taloustieteellisessä kirjallisuudessa yhdistetty matalampaan tuottavuuteen, sillä kilpailu kannustaa yrityksiä innovoimaan ja kiihdyttää 'luovaa tuhoa', jotka puolestaan ovat Schumpeterin endogeenisen kasvuteorian mukaan ensisijaisia tuottavuuskasvun lähteitä.

Tämän pro gradu -tutkielman tavoitteena on tutkia, onko yksityisellä sektorilla tapahtunut muutoksia kilpailutilanteessa, jotka olisivat vaikuttaneet Suomen hidastuneeseen tuottavuuskasvuun finanssikriisin jälkeen. Tutkielman empiirisessä osiossa tätä kysymystä tarkastellaan analysoimalla useita staattisia ja dynaamisia kilpailun mittareita. Mittareita tarkastellaan niin absoluuttisesti kuin myös vertailemalla Suomen arvoja vertailumaajoukon keskimääräisiin arvoihin. Lopulta mittareiden osoittamia mahdollisia kilpailun tilassa tapahtuneita muutoksia verrataan finanssikriisin aikana ja sen jälkeen tapahtuneisiin työn tuottavuuden muutoksiin. Tutkielmassa käytettävä mikrotason data on peräisin OECD:n MultiProd ja DynEmp tietokannoista, ja havaintojaksona on vuodet 2004–2018.

Tutkielmassa tarkasteltujen kilpailun mittareiden perusteella kilpailutilanteessa tapahtuneet muutokset eivät vaikuta olleen syynä Suomen heikompaan tuottavuuskasvuun finanssikriisin jälkeen. Yleisesti ottaen, markkinoiden kilpailutilanteessa ei ole tapahtunut huomattavaa muutosta finanssikriisin jälkeen. Suomessa on havaintojaksolla ollut vertailumaajoukkoa matalampi tuottavuuden hajonta ja matalammat yritysten katteet, mikä viittaisi oikeastaan melko hyvään kilpailutilanteeseen. Myöskään yritysdynamiikassa ei vaikuta olevan merkittäviä ongelmia, vaan päinvastoin, markkinoille tulevien mikroyritysten selviytyminen ja kasvu ovat vertailumaajoukkoa korkeammalla tasolla. Toisaalta markkinat ovat Suomessa monella alalla keskittyneemmät, ja allokaatio tehokkuus on matalampi kuin vertailumaajoukossa. Näissäkään mittareissa ei kuitenkaan huomata tapahtuneen merkittävää muutosta huonompaan suuntaan finanssikriisin jälkeen, vaan kumpikin mittari on pysynyt tasaisena koko havaintojakson ajan.

Avainsanat: tuottavuus, kilpailu, kilpailun mittarit, mikrotason aineisto

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ACRONYMS

EU	European Union
GFC	global financial crisis
HHI	Herfindahl-Hirschman index
ICT	information and communication technology
LP	labour productivity
MFP	multifactor productivity
OECD	The Organisation for Economic Co-operation and Development
R&D	research and development
SGP	the Schumpeterian growth paradigm
TFP	total factor productivity

1 Introduction

The current well-being of humankind is based on its economic growth. In turn, as Adam Smith acknowledged already in 1776:

> “The annual produce of the land and labour of any nation can be increased in its value by no other means, but by increasing either the number of its productive labourers, or the productive powers of those labourers who had before been employed… The productive powers of the same number of labourers cannot be increased, but in consequence either of some addition and improvement to those machines and instruments which facilitate and abridge labour, or of more proper division and distribution of employment.”

… the long-term economic growth is mainly based on labour productivity (henceforth LP) growth because the amount of labour or capital cannot be increased indefinitely. (Maliranta & Ylä-Anttila, 2007; Smith, 2002.) In addition, the role of LP growth will be stressed as we engage in sustainable growth. We cannot base our economic growth indefinitely on the over-consumption of tangible capital, so eventually on natural resources, if our goal is to keep the earth inhabitable.

LP indicates the efficiency of the production, and it is generally measured as output or value added or GDP per unit of labour input. One way to divide LP growth is to split it based on contributions of growth to capital intensities, labour force structure change, and multifactor productivity (henceforth MFP), which is also called total factor productivity, i.e. TFP. The MFP, which is computed as a residual term of other growth components, is often considered to represent technological development and to be the most essential factor of LP growth. (Dieppe, 2021, p. 57; Finnish Productivity Board, 2020; Timmer et al., 2007.) When not specified otherwise, 'productivity' refers to LP in this thesis.

The problem is, regarding both the economy and the environment, that LP growth has slowed down in many countries after the global financial crisis (henceforth GFC) (e.g. Dieppe, 2021). The exact causes for the slowdown are yet to be identified, but there are multiple possible explanations. To name only a few of these: the investment in R&D in advanced economies has decreased, sectoral labour reallocation from less productive sectors to more productive ones has slowed down, and the development of innovations that significantly improve productivity has become increasingly difficult. Optimists also believe that digitalisation has brought with it measurement errors, and LP growth would not have fallen as much as it appears. (Bank of Finland, 2017; Dieppe, 2021, pp. 70–73.)

Nevertheless, in Finland, the LP growth slowdown has been more severe than in other countries (Finnish Productivity Board, 2021b). In this regard, despite the active research on the topic, for example, by Finnish Productivity Board, the precise reasons for the difference are yet to be discovered. The reasons found so far are discussed in chapter 2.1.

The object of this thesis is to contribute to this field of study by investigating the state of competition and its effects on LP in Finland. In the United States, a lack of competition has been linked to the slowdown in productivity growth since the early 2000s (Philippon, 2019). As will later be discussed, healthy competition has a vital role in both encouraging firms to innovate and in intensifying creative destruction. In turn, innovating and creative destruction are the main drivers of LP growth. (Aghion & Howitt, 1992.) Could a lack of competition or changes in competition for the worse be one of the explanations for the slowdown in Finnish productivity growth? This thesis aims to examine this question by exploiting cross-country micro-level data.

To put it more precisely, the basic research questions of this thesis are the following:

- What was the state of competition in Finland in 2004-2018?
- Has a lack of competition been a reason for the sluggish productivity growth in Finland after the GFC?

The first of these questions will be examined with several indicators of competition, and the state of competition in Finland will be compared to the state of competition in benchmark countries. The idea is also to find out whether some industries are more problematic competition-wise than others. The second question will be analysed simply by looking at the changes in the state of competition when productivity growth slowed down.

The thesis begins with an institutional background chapter, chapter 2, which aims to briefly describe the special characteristics of Finland: the first subchapter in terms of LP growth, and the second, in terms of competition policy. The idea is to give the reader a context before diving into details. In chapter 3, the theoretical literature is discussed. The chapter starts by introducing the Schumpeterian growth paradigm and moves on to the theories regarding the relationship between competition and productivity. The aim is to answer the question: How does competition affect productivity growth? In chapter 4, the same question is debated in the light of previous empirical literature. Chapter 4 also presents the empirical literature on measuring competition, and answers the questions: How is competition generally measured? What does the earlier empirical research say about the state of competition in Finland? Chapter 5 describes the data and the methods utilized in the empirical part of the thesis. In chapter 6, the empirical results are presented, separately for static and dynamic indicators, one indicator at a time.

This thesis has got its subject from a collaborative project of three Finnish government bodies (Productivity Board, Economic Policy Council, and Research Division on Business Subsidies) and OECD. The project intended to produce an in-depth analysis of Finnish productivity. The writer wants to emphasize that the results of the empirical part of this thesis have been conducted together with the OECD colleagues: Sara Calligaris, Alexander Himbert, Outi Jurvanen, Francesco Manaresi and Rudy Verlhac. The writer would also like to thank Ville Korpela, Mika Maliranta and Markku Stenborg, whose expertise was invaluable in formulating the research questions and the structure of the thesis.

2 Institutional background

2.1 Labour productivity in Finland

The Finnish economy has encountered great difficulties after the GFC. This has mostly been due to poor LP growth (Pohjola, 2020). LP growth has slowed down in many developed countries after the GFC, but in Finland, the slowdown has been more severe (Economic Policy Council, 2022, p. 102; Finnish Productivity Board, 2020, p. 33). In Figure 1, the development of LP in Finland and a few other countries in the past twenty years is displayed. The figure shows that the development of LP in Finland has been two-folded: before the year 2007, LP growth was brisk, whereas, after 2007, it practically came to a standstill for almost ten years. Consequently, the factors affecting the development of LP will be next examined separately before and after 2007.

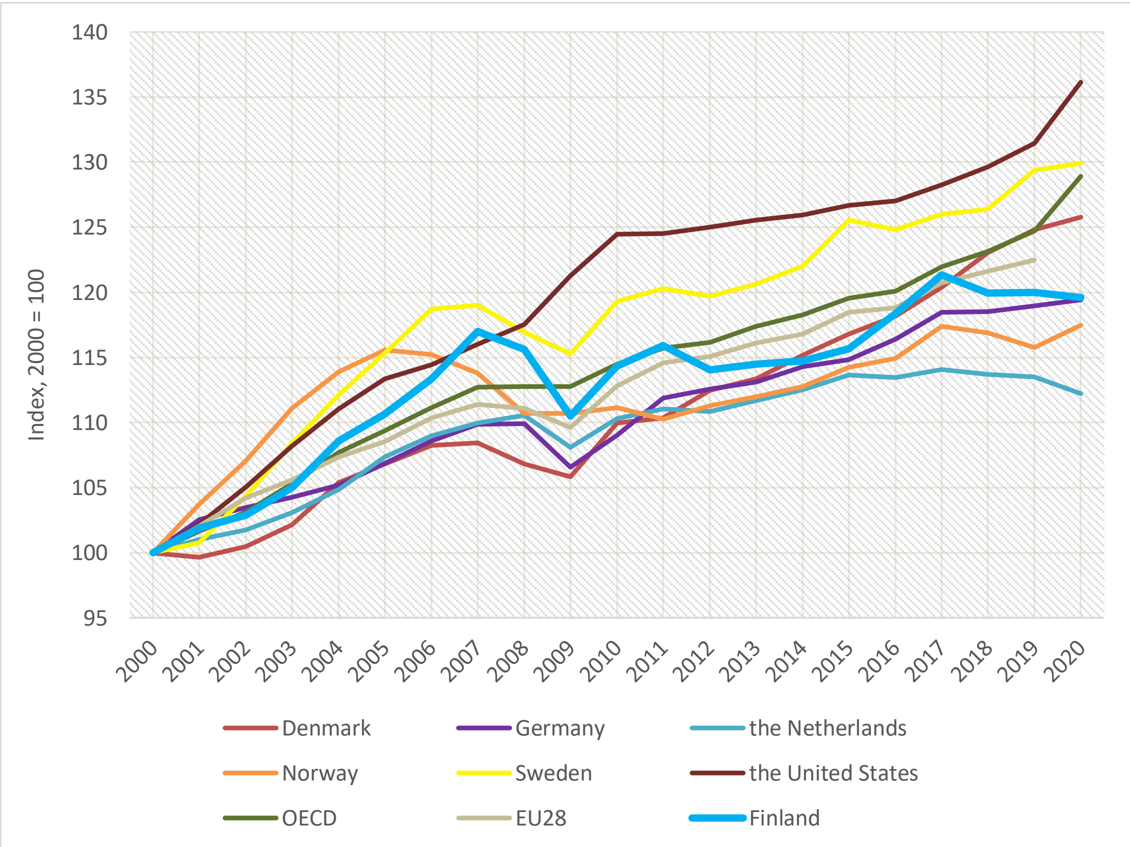

Figure 1 GDP per hour worked, the year 2000 = 100 (OECD, 2021b)[1]

[1] This indicator is measured in US dollars (constant prices 2010 and PPPs) and indices.

2.1.1 Pre-crisis high growth

LP growth in Finland was exceptionally strong from the mid-1980s until the GFC. The growth was particularly driven by the manufacturing sector, and especially by the computer and electronics industry since the beginning of the 1990s. At the same time, LP in the service sector was also growing, but the growth was fairly weak in many industries when compared, for instance, to the US and Sweden. (Finnish Productivity Board, 2021b; Maliranta et al., 2010.) As also seen in Figure 1, the aggregate LP growth remained extremely strong in the 2000s, until the decline after 2007.

According to Maliranta et al. (2010), the strong LP growth from the mid-1980s until the GFC can be explained mostly by intensified creative destruction: entries, exits and resource reallocation increased. The coincided economy-wide deregulation, liberalization, and Finland's opening to international trade also had a vital role in strong LP growth.

If the LP growth in Finland is examined without the computer and electronics industry, the growth before the GFC is much less steep. However, the same result holds also the other way around: if the computer and electronics industry is excluded, Finland has not lagged behind other countries as much since 2007 either. (Finnish Productivity Board, 2020.)

2.1.2 Post-crisis stagnation

The high LP growth was followed by a drastic collapse over 2008-2009, as seen in Figure 1. According to Finnish Productivity Board (2020, p. 33), in the years 2008 and 2009 the LP in Finland's private sector fell altogether by about 10%, which was far more severe than in the benchmark countries[2]. During the period 2007-2016, Finland's LP growth in the private sector was sluggish and clearly the slowest among the benchmark countries. The LP growth recovered only in 2016 when GDP per hour worked exceeded the level of 2007. (Finnish Productivity Board, 2020, p. 33; Pohjola, 2020, p. 22.) However, it appears the growth stagnated and even started to decrease again in 2017 (see again Figure 1). The

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[2] Here benchmark countries are referring to Denmark, France, Germany, Great Britain, Italy, the Netherlands, Norway, Sweden, the United States and EU15.

sluggish LP growth after the GFC can also be seen in Figure 2, where the average annual growth (in percentage) of GDP per hour worked from 2009 to 2019 is graphed.

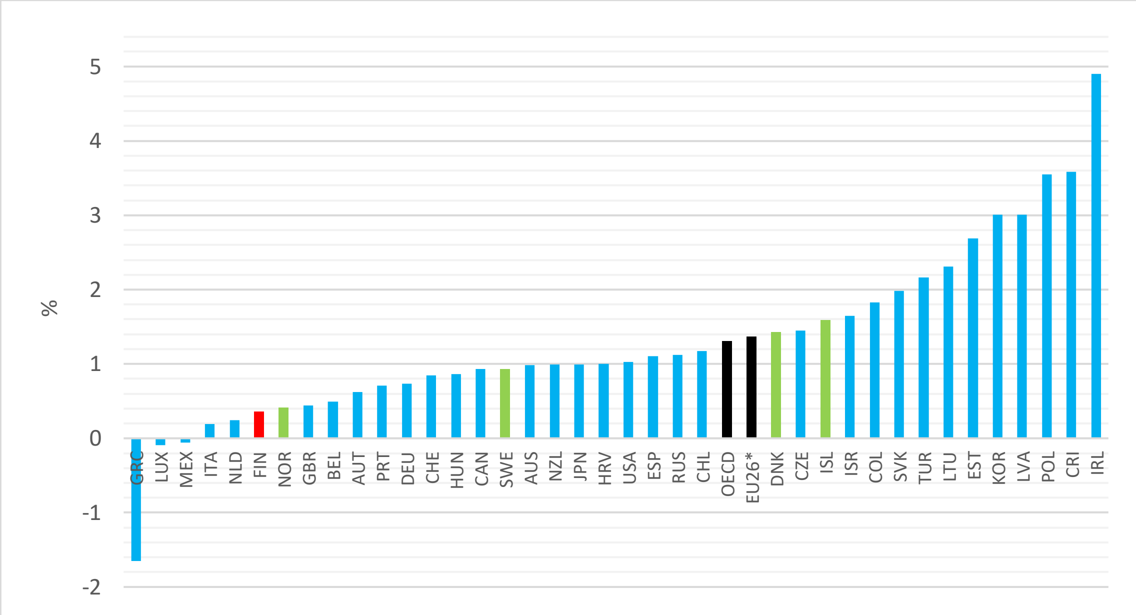

Figure 2 Average annual growth (%) of GDP per hour worked, 2009-2019 (writer's calculations based on OECD, 2021c)[3]

In Figure 2, we see that in 2009-2019, the average annual LP growth in Finland (marked in red) was considerably behind both the OECD and EU26 average (marked in black) as well as behind all the other Nordic countries (marked in green).

The reasons for the slowdown in LP growth are still debated. According to Finnish Productivity Board (2020), the main reasons for the fall in productivity over the period 2008-2009, and for the slowdown after the crisis, were the shock faced by the computer and electronics industry and the fall in the global cost competitiveness of the Finnish national economy. According to Pohjola (2020), the slowdown in LP growth after the GFC was primarily due to a slowdown in MFP growth but also due to a slowdown in the contribution of the growth of ICT capital intensity.

Finland's LP growth was mainly based on productivity growth in manufacturing and especially in the computer and electronics industry until the GFC. After Nokia fell from the spot of being the top manufacturer of mobile phones in the global market, which

[3] EU26 does not include Malta and Cyprus.

coincides with the GFC, the LP growth has become increasingly dependent on market services. This is, of course, the direction of the ongoing structural change, too. Nonetheless, the LP growth in services, especially in knowledge-intensive and digital-intensive services, has been poor. The contribution of market services to growth has been below Sweden, the UK, the Netherlands, Denmark, and Norway. There was a decline in LP in services in 2012, which may be explained by the weakening demand for services rather than by supply factors, especially in wholesale and retail, and in the hotels and restaurants industries. In these industries, the majority of the demand is coming from households and the purchasing power of households was at an exceptionally low level in these years. (Finnish Productivity Board, 2020; Kaitila et al., 2018; Mäki-Fränti, 2020; Pohjola, 2020.)

As already briefly mentioned above, weakening competitiveness was one of the main causes of the fall in LP over the period 2008-2009, and it also played a role in LP slowdown in the early 2010s (Finnish Productivity Board, 2020; Kaitila et al., 2018). The majority of job losses happened in higher-than-average productivity industries, and this way weakened competitiveness reduced capacity utilization (Kaitila et al., 2018, p. 64). On the other hand, the volume of Finnish exports decreased after the GFC, preceded by a long period of growth. The exports of the computer and electronics industry have not recovered, and the wood and paper industry has suffered from the weakening of global paper demand. (Finnish Productivity Board, 2021a, p. 17.) Moreover, the share of Finnish exports on world imports dropped during the crisis. The decrease in exports was partly due to the weakened competitiveness. For this reason, it was not easy for exporters to increase their value added after the crisis. (Finnish Productivity Board, 2020, p. 25.)

However, the causal relationship between productivity and competitiveness goes both ways. The wage and LP growth have not matched after the GFC like earlier. As a result, unit labour costs increased and led to poor cost competitiveness when compared to main trading partners[4]. (André & Chalaux, 2016; Finnish Productivity Board, 2021a.) However, according to Finnish Productivity Board (2021b), the competitiveness has improved since 2012 due to the slower rise in compensation of employees than in the benchmark countries[5], and Finland's competitiveness appeared to be historically

[4] Here the main trading partners are referring to Sweden, Germany and EU15.
[5] Here the benchmark consists of Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United States.

relatively good again in 2020. However, they do point out that the statistical data from 2020 and early 2021 do not provide a reliable basis due to the impact of the Covid-19 pandemic and the ongoing political measures related to that.

In addition to weak MFP, another factor behind the decline in LP might also be the low level of investments, especially in manufacturing (Pohjola, 2020). The decline in R&D investments, which is mainly explained by the fall of Nokia, and the slowdown in the growth of ICT investments have weakened LP growth in Finland. Compared to peer countries, especially Sweden, Finland is doing particularly poorly in terms of its ICT capital intensity. Moreover, the contribution of the R&D investments to growth has been negative in recent years. (Kangasharju et al., 2021; Mäki-Fränti et al., 2019; Pohjola, 2020.)

Possible larger scale explanations, at least in services, could also include the weakness of the global economy and the related slowdown in the diffusion of innovations, or difficulties in innovations (André & Chalaux, 2016; Mäki-Fränti et al., 2019). However, Finland has long been, and still is, among the innovation leaders in the EU, and performs especially well in digitalization, use of information technologies, intellectual assets and linkages (European Commission, 2021). However, it appears that this does not fully convert into economic prosperity. For example, the performance of Finland in medium and high-tech goods exports is only 74% of the EU average. In addition, it is also worth noting that the direct and indirect government support for business R&D is only 36% of the EU average.

As seen above, there are several reasons for the slowdown in LP growth after the GFC, and they are still debated. However, the role of competition in LP growth slowdown has not yet been studied profoundly.

2.2 Competition policies in Finland

In economy, there are numerous barriers to healthy competition, some of which are resulting from competition policies. Competition policy implies to a set of policies, regulations and laws which aim to protect markets from the abuse of market power and both build and uphold a healthy state of competition in the market. (Griffith & Van Reenen, 2021, p. 14; Maliranta & Ylä-Anttila, 2007, p. 17.) In Finland, the implementation of the competition policy is based on the national Competition Act (*Kilpailulaki 948/2011*), which contains similar substantive provisions to articles 101 and 102 of the Treaty on the Functioning of the EU. The responsibility for the practical implementation of competition policy and for the handling of individual antitrust cases is on the Finnish Competition and Consumer Authority. (Ministry of Economic Affairs and Employment of Finland, 2022b.) In this chapter, I will briefly discuss the developments of the Finnish competition policies.

From 1958 to 1992, Finnish competition policy was primarily based on the principle of control and the rule of reason, rather than totally banning cartels. For this purpose, there was a public register for antitrust and cartel cases. The goal was to keep track of and control the conditions of competition and its restraints and make an intervention only in the most radical and harmful cases. The policy was found ineffective, and it could only prevent a fraction of harmful competition restraints. (Fellman, 2010; Hyytinen & Toivanen, 2010.) For example, Hyytinen et al. (2018) studied how common the cartels were in the Finnish manufacturing industries in 1951-1990, and their analysis shows that there were a lot more cartels by the end of the 1980s than the register captured. At that time, however, this kind of competition policy was not unusual in small European countries (Fellman, 2010). Moreover, elsewhere in Europe the deregulation of the markets had started in the 1970s, whereas in Finland the reducing and streamlining of regulation in the markets began only in the late-1980s. One explanation for the late start is that competition was long considered to be harmful. Another explanation is that the economy was growing fast, so the incentives to change a working system were small. (Valkonen, 2006.)

In 1992, the competition policy was fundamentally changed. The register for cartels was abandoned, and antitrust and cartel cases were completely banned. In other words, the principle of control was abandoned, and the prohibition principle took place beside the rule of reason. This tightening of the policy was in line with other OECD countries and moved the Finnish competition policy towards the competition policies of other European countries, which was convenient for the near future EU membership and the accompanying obligation to comply with the EU's competition law. (Lindberg, 2018; Määttä & Reimavuo, 2015.) Moreover, the removal of restrictions on foreign ownership in 1993 and joining the EU in 1995 opened the national market for international competition like never before: unrestricted imports were permitted, and more foreign firms established offices and business premises in Finland. Furthermore, the deregulation of markets accelerated rapidly in Finland in the 1990s. (Valkonen, 2006.)

The next notable change in competition policy took place in 1998 when the merger control was incorporated into the competition law for the first time. The aim was to safeguard the competitive structure of the market by intervening in advance, where necessary, in anti-competitive acquisitions. Acquisitions exceeding a certain turnover limit had to be notified to the Finnish Competition Authority (henceforth FCA), and the merger could not be implemented before a decision of the FCA in the matter (Lindberg, 2018; Määttä & Reimavuo, 2015.)

In 2004, Finland's competition policy became even more European when national competition authorities and courts were given full jurisdiction and obligation to apply the antitrust articles of the EC Treaty. At the same time, the national system for exemption permits was abandoned. This system had been in the competition law since 1992 and allowed certain anti-competitive cooperation between firms in case their collaboration had been found to be profitable, for example, for consumers. The intention was to divert the resources of competition authorities from handling exemption permits to allow them to better address the most serious restraints of competition, such as cartels. Regarding merge control policies, the thresholds for the obligation to notify acquisitions were significantly raised. In addition, a leniency system was brought into use. This implied that a firm that had been involved in a cartel or other antitrust activity but had acknowledged its infringement to the competition authority was fully exempted from a penalty. (Lindberg, 2018; Määttä & Reimavuo, 2015.)

The current competition law came into effect in 2011. However, the competition policy was not drastically changed in 2011, since the restrictions of competitions (i.e. prohibition principle) remained the same. Instead, the most notable reforms related to merger control, to the system of sanctions and to the FCA's procedures for dealing with competition cases. In merger control, a new method of valuing acquisitions, based on the SIEC test (significant impediment to effective competition) and in line with EU law, was introduced. The antitrust penalty code was specified in various ways. For instance, the deadline for the FCA to submit a penalty payment proposal was harmonized with EU law. Regarding the FCA's procedures, the new conditions allowed the FCA to prioritize on identifying serious competition restrictions. (Lindberg, 2018; Määttä & Reimavuo, 2015, pp. 35–36.)

The 2011 competition law has been amended several times. For example, in 2013, competition neutrality provisions were added aiming to ensure equal competitive conditions for both public and private sector business activities (Finnish Competition and Consumer Authority, 2022). In 2014, a section on a dominant position in the grocery trade market was included in the law. The aim was to ensure the functioning of the grocery market, which has traditionally been highly concentrated in Finland. In 2018, the Nordic Agreement on Cooperation in Competition Cases and a few related amendments to the competition law entered into force. The amendments in 2021 were mainly the national implementation of the ECN+ Directive. Once again, the amendments strengthened and harmonized the powers of member states' competition authorities to enforce EU competition rules. (Ministry of Economic Affairs and Employment of Finland, 2022a.) In other respects, the changes in the law have been somewhat more technical (Lindberg, 2018, p. 941). One of these technical changes was that FCA was merged with Consumer Agency in 2013.

On the other hand, the public debate on antitrust and competition policy has highlighted, in particular, the asphalt and wood market cartels, which took place in the 1990s and at the beginning of the 2000s, and still existing state monopolies. (Määttä & Reimavuo, 2015, pp. 69–71.) Currently, there are state monopolies in passenger rail traffic, alcoholic beverage retailing and gambling. Especially the last is rare in the international framework (Raijas & Pirilä, 2019). As in many other countries, several state monopolies have been dismantled and many highly regulated industries have been opened for competition as part of regulatory reforms over the years. Just to name a few in addition to those already mentioned: the opening of the telecommunication services market in 1994, deregulation of electricity production and distribution in 1995, the opening of national rail freight to competition in 2007, deregulation of the long-distance bus market in 2009, and the opening of taxi markets in 2018. (Määttä & Reimavuo, 2015, p. 135.)

All in all, competition policy has shifted from a public register for antitrust and cartel cases to a system that relies heavily on the self-assessment of firms, maybe with the exception of a leniency system that encourages to inform authorities if they are involved in the abuse of market power. The policy has shifted from the principle of control to the principle of prohibition of cartels and other antitrust cases. (Lindberg, 2018.) Together with the deregulation of the markets and opening up to international trade, it can be reasoned that these changes have increased competition in Finland in the past decades.

3 Theoretical background

Generally, when it comes to any study on economic growth, the neoclassical growth model is a common starting point (Aghion & Howitt, 2009, p. 21). The most famous version of the neoclassical growth model was presented by Robert Solow (1956) and Trevor Swan (1956). The model predicts that in the long run, capital accumulation and labour cannot increase economic growth indefinitely. Eventually, the country's growth rate will instead depend on the rate of technological progress, which is exogenous in the model. This indicates that innovations that foster technological progress are coming from outside the model and are independent of economic decisions, such as thrift. (see Aghion & Howitt, 2009, p. 21.)

However, when the idea is to examine the role of competition in productivity growth via innovation and competition using micro-level data, the neoclassical growth model does not provide a too encouraging framework. First, because in the model the technological progress is assumed to be exogenous. Second, because the model assumes the competition is perfect. And third, because it also assumes the firms are identical. (Finnish Productivity Board, 2021b, p. 28.)

For these reasons, endogenous growth models appear more suitable for this purpose. Contrary to the neoclassical growth model, endogenous growth models consider technological progress endogenous: innovations are coming from inside the economy, are a result of economic decisions and are therefore defined within the model. In addition, the endogenous models allow business-to-business interaction, in other words, competition is not perfect. (Aghion & Howitt, 2009, pp. 39, 47.) The first and the most straightforward endogenous model is the AK model. It is a useful model in those cases where the distinction between innovation and accumulation is not the primary interest. (Aghion & Howitt, 2009, pp. 47–68.) The second wave of endogenous growth models can be divided into two branches: Romer's product-variety model and the Schumpeterian growth paradigm. Both branches have a stronger focus on understanding the mechanisms behind technological progress, especially innovation. Because of this, these models are called innovation-based growth models. In Romer's model, innovation creates new, but not necessarily improved, products that generate productivity growth, whereas, in the Schumpeterian growth paradigm, innovation creates new, quality improved products. Another, although very much related, difference and limitation in Romer's product-variety model is that it does not take into account the fact that some firms exit the market. In other words, the new, more productive, innovations do not obsolete the old ones. (Aghion & Howitt, 2009, pp. 69–104.) As a result, this thesis relies on the Schumpeterian growth paradigm, which instead does capture the role of creative destruction in the growth process.

3.1 Schumpeterian growth paradigm

The Schumpeterian growth paradigm (henceforth SGP) is an innovation-based endogenous growth theory. The SGP was named after an Austrian economist Joseph Schumpeter. In the 1940s and 1950s, he presented three fundamental ideas, which later inspired Philippe Aghion and Peter Howitt (1992) to formalize the actual SGP in an article called "A Model of Growth Through Creative Destruction".

Schumpeter's first idea was that long-term economic growth is based on innovation and the diffusion of knowledge. This comes from the concept of cumulative innovation: We can take advantage of existing innovations and build on them instead of having to reinvent the wheel over and over again. This, of course, requires a diffusion of knowledge, so that we know the wheel has already been invented, and more importantly, how it has been done. His second idea was that in order for innovation to emerge, a protection of property rights is needed. Entrepreneurs innovate to achieve potential profits, so-called 'innovation rents'. Anything that secures (endangers) these innovation rents will give an incentive to entrepreneurs to invest more (less) in innovation. The final idea was the concept of 'creative destruction'. Creative destruction is a process in which new innovations supersede outdated, less productive, old innovations. This occurs, for example, when a new, more innovative and productive, firm enters the market, and as a result, a less productive firm is forced to exit. In other words, this implies that business dynamism is high. (Aghion et al., 2021, pp. 4–5; Aghion & Howitt, 2009, p. 85.) Schumpeter describes creative destruction as a "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one", and he considers it "the essential fact about capitalism" (Schumpeter, 2010, p. 73).

However, Schumpeter did not formalize or test his ideas (Aghion et al., 2021, p. 4). As mentioned above, these ideas inspired Aghion and Howitt (1992) to formalize the SGP for analysing long-run economic growth. This basic SGP is too simple for empirical use, but it covers Schumpeter's most essential ideas. Next, we will take a closer, more formal, look at this basic SGP exploiting the initial paper (Aghion & Howitt, 1992) and later publications (Aghion et al., 2014, 2015).

In the basic model, time is continuous, and the population in the economy consists of a mass L of individuals. Each individual is risk-neutral and capable of doing one unit of labour per one unit of time. This one unit of labour can be dedicated either to manufacturing, to produce an intermediate good, or to R&D, to innovate a higher quality intermediate good. One unit of intermediate goods is produced by one unit of labour. Thus y implies both the amount of an intermediate good and the amount of labour working in manufacturing. Each new innovation increases the productivity (quality) of the intermediate good from A to βA where $\beta > 1$. R&D produces innovation, which 'arrives' at Poisson rate λz, where λ is a constant parameter that implies the probability of innovation and z is the amount of labour working in R&D. A production function is

$$Y = Ay^{\alpha} \tag{1}$$

where Y is a final output, i.e. a consumption good, y refers to the amount of an intermediate good, α is a coefficient between zero and one, and A is a parameter indicating the productivity (quality) of the intermediate good.

The first of the two basic equations in the model is the labour market clearing equation. The equation is

$$L = y + z \tag{2}$$

where L is the total labour mass, y denotes the amount of labour working in manufacturing and z is again the amount of labour working in R&D.

The second basic equation is a research arbitrage equation according to which, in the steady-state equilibrium, an individual does not have preferences between working in manufacturing and working in R&D. The left side of the equation is simply the marginal cost of the intermediate good, whereas the right side is the expected marginal benefit of the new innovation. The equation is

$$w_k = \lambda V_{k+1} \tag{3}$$

where w_k denotes the wage rate in manufacturing after the k-th innovation, λ is again the probability parameter of the innovation, and V_{k+1} implies the value of the next innovation. However, we do not know yet what V_{k+1} is exactly. Let's start figuring this out from the profits of a firm.

The next innovation gives profits π_{k+1} to a firm. If there is no creative destruction, the value of the next innovation V_{k+1} would be π_{k+1}/r, where r is a discount rate. However, because of the creative destruction, i.e. another innovating firm displaces the current firm, and the resulting Poisson rate λz, the V_{k+1} is instead $\pi_{k+1}/r + \lambda z$, where $r + \lambda z$ is the risk of the arrival of a superior firm.

To solve equilibrium profits π_{k+1}, the equilibrium profit of the current innovator π_k needs to be solved first. Utilizing the inverse demand curve of the firm and the assumption that the final good sector is competitive the profits are

$$\pi_k = \frac{1-\alpha}{\alpha} w_k y \tag{4}$$

where the profit π_k is simply wage costs $w_k y$ multiplied by $\frac{1-\alpha}{\alpha}$.

With the information on V_{k+1} and π_k, the research arbitrage equation (3) can now be rewritten as

$$w_k = \lambda \frac{\frac{1-\alpha}{\alpha} w_{k+1} y}{r + \lambda z} \tag{5}$$

where w_{k+1} denotes the wage rate in manufacturing at the time the next innovation happens, and the other variables and parameters are the same as earlier.

Combining the revised research arbitrage equation (5) and the labour market clearing equation (2) with the fact that at the steady-state equilibrium each variable is multiplied by β every time a new innovation takes place, we can determine the amount of labour working in R&D, z, i.e. equilibrium of R&D:

$$z = \frac{\frac{1-\alpha}{\alpha}\beta L - \frac{r}{\lambda}}{1 + \frac{1-\alpha}{\alpha}\beta} \qquad (6)$$

From this equation, we can deduce a few important comparative statics. First of all, the higher the λ, β or L, the higher is also the z. In contrast, the higher the α and r, the lower is the z.

With the information on z, it is possible to calculate the expected growth rate:

$$\mathbb{E}(g_t) = \lambda z ln(\beta) \qquad (7)$$

where $\mathbb{E}(g_t)$ is the expected growth rate, λz is the probability of the innovation, and $ln(\beta)$ is the size of the innovation. In other words, the growth derives entirely from innovation that raises the productivity parameter A.

This basic SGP was further developed to be more empirically applicable. The model was expanded with a multisectoral approach, in which innovation improves many different products each year (see Aghion & Howitt, 2009, pp. 92–96). Later, the model was elaborated to include capital accumulation. This model, also known as a hybrid model, combines both capital accumulation, as in the neoclassical growth model, and endogenous productivity growth, as in the previous SGP (Aghion & Howitt, 2007).

Despite the extensions, the SGP has its weaknesses too. First, the SGP has been criticised for not considering scale effects. As we noticed in comparative statics of the basic SGP, the equilibrium of R&D, z, depends partly on the size of the mass L of individuals. This way larger economies are able to generate more economic growth. However, the problem of scale effects can be eliminated by including both horizontal and vertical innovations in the model (Aghion & Howitt, 2009, pp. 96–99).[6] Second, the SGP has been criticised for assuming the financial markets to be perfect. Nevertheless, this issue has also been dealt

[6] The basic SGP allows only vertical innovations, which implies that innovations are quality improved versions of the existing innovations. On the contrary, completely new innovations are called horizontal innovations.

with later by introducing financial constraints into the model (Aghion & Howitt, 2009, pp. 129–150).

3.2 Competition and productivity

The impact of competition on innovation, and thereby on productivity growth, has long been of interest to economic researchers. For a long time, theoretical models and empirical evidence have been partly inconsistent on this matter (see Aghion et al., 2005, pp. 710–711; Bloom et al., 2019, p. 177). Most empirical results show the impact of competition on innovation to be positive, while some theories predict that it would be negative. Let's take a closer look at what the theories say about the relationship between competition and productivity growth.

Intuitively, it might sound reasonable that intensified competition would have a negative impact on innovation. This is exactly what Schumpeter himself argued. According to him, and numerous other economists and their papers[7], there is a trade-off between growth and competition. If competition becomes fiercer, the profits of the firm from innovating, i.e. innovation rents, will be lower. This implies that the incentive to innovate decreases. This is also the prediction of the earliest Schumpeterian models, including the basic SGP introduced in chapter 3.1. In the model, a leapfrogging assumption holds. This implies that incumbents are systematically surpassed by new entrants who innovate, while the incumbents do not innovate after their entry. In other words, this means that intensified competition, i.e. the entrance of new firms, threatens the innovation rents of incumbents. (Aghion et al., 2005, 2021, pp. 57–58; Aghion & Howitt, 2009, p. 7; Bloom et al., 2019, p. 177.)

A famous paper, with the opposite results, examining the relationship between competition and innovation is written by Arrow (1962). He shows, by comparing the potential profits from innovation with the costs, that the incentive to innovate will always be higher under competitive than under monopolistic conditions[8]. Yet, he also argues that the incentive would be still lower than is socially desirable. This is the reason why it

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[7] For instance, Aghion et al. (2005) mention Dixit and Stiglitz (1977), Salop (1977) and Romer (1990).
[8] Other papers that also predict the relationship to be positive are written e.g by Reinganum (1983) and Gilbert & Newbery (1982).

would be necessary for the government or some other zero-profit agency to finance R&D (Arrow, 1962).

Nevertheless, in his model Arrow (1962) ignored the difficulty of appropriating information and the property of information. When innovating, a firm encounters various risks, one of which is the risk of innovating an idea or product, which ultimately turns out to be redundant for the firm. This issue allows me to discuss a very much related question briefly; the question of the market of ideas, in other words, the market of patents. According to Akcigit et al. (2016), the fact that a firm could sell its ideas provides an incentive to invest in R&D. On the other hand, if a firm fails to innovate, it can buy the ideas from other firms that have successfully innovated but are selling their ideas since they are not beneficial for them anymore. The opportunity to buy ideas will also reduce the incentive to invest in R&D if the same outcome can be achieved by buying the idea. For these reasons, also the efficiency of the patent market affects productivity growth. An efficient patent market enables the exchange of ideas. Akcigit et al. (2016) argue that an efficient patent market "may play an important role in correcting the misallocation of ideas across firms". This way, for instance, the issue of asymmetric information is reduced: not every firm needs to invest in R&D separately and invent parallel ideas or ends up investing first in R&D and then discovering an idea that they do not actually need in the first place. (Akcigit et al., 2016.)

On the other hand, there is discussion in general on the importance of the patent system as an incentive for innovation. Intellectual property rights on innovation are important because they protect innovation rents, but they also limit competition. That is why it is important to practice both types of policies: to protect the intellectual property rights on innovation and to also safeguard competition. (Aghion et al., 2021, pp. 62–63; Maliranta & Ylä-Anttila, 2007.)

Back to the main question of interest: the relationship between competition and innovation. Nowadays, perhaps the most referenced paper regarding the question is written by Aghion et al. (2005), which builds upon the results of SGD. Aghion et al. (2005) find that the relationship between competition and innovation shapes an inverted-U curve. This inverted-U relationship is shown in Figure 3, where the x-axis represents the intensity of competition, and the y-axis shows the level of innovation measured by the number of patents.

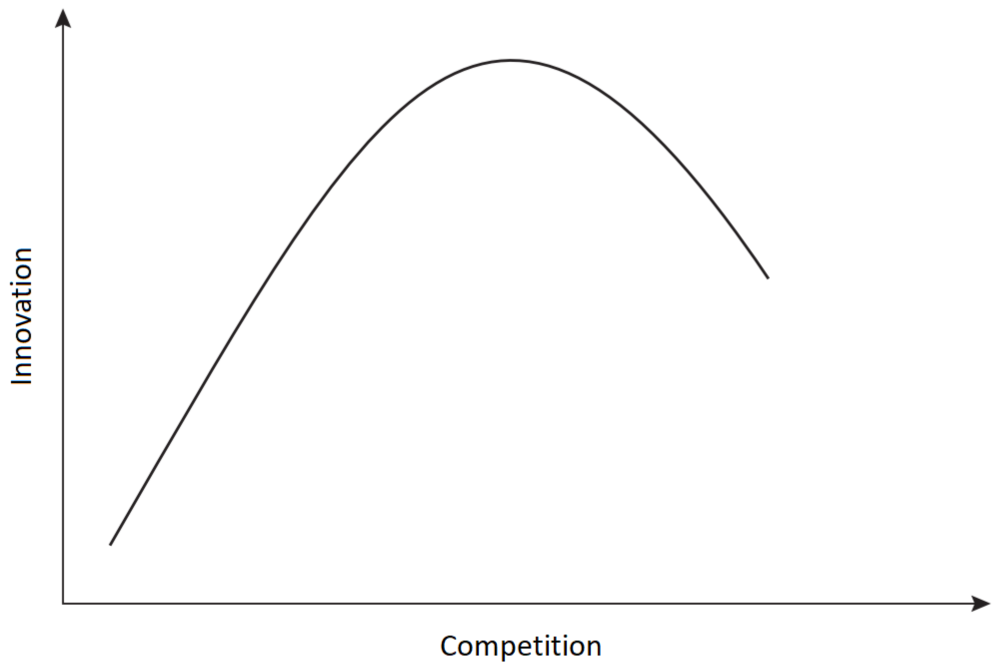

Figure 3 An inverted-U relationship between competition and innovation (based on Aghion et al., 2005)

In its simplicity, the inverted-U shape implies the following: when initial competition is low, the impact of increasing competition on innovation is positive, but when the competition is initially high, the increased competition affects innovation negatively. But what is driving this plot?

As pointed out above, the prediction of the inverted-U curve builds upon the results of SGP. However, in order to investigate the relationship between competition and innovation further, the leapfrogging assumption needs to be replaced with a more realistic and less drastic step-by-step assumption. To put it another way, unlike in the basic SGP, also the incumbents are now allowed to innovate. In economy, there are now two types of firms: those that are currently close to the technological frontier[9], henceforth ‘leaders’, and those that are behind the frontier firms, henceforth ‘laggards’. The laggards try their best to catch up with the leaders. Leaders and laggards react differently to competition, but how do their reactions differ? Aghion et al. (2021, pp. 58–59) give a simple illustrative example, where a class of students represents a market, and students represent firms. In

[9] Technological frontier refers here to the firms whose productivity is close to the top level of productivity in the industry.

the class, some students are performing better ('leaders') than others ('laggards') in terms of grades ('productivity'). What if a new excellent student arrives in the class (i.e. competition intensifies)? The well-performing students are likely to be willing to stay on top of the class, and therefore will work even harder than earlier. On the contrary, the students with lower grades have now an even longer way to catch up with the best-performing students, so the arrival of the excellent student discourages them. (Aghion et al., 2005, 2021, pp. 57–62.)

In the model, the reaction that the arrival of a new excellent student elicits in the top students is called the 'escape-competition effect'. In the case of firms, this implies that the increasing competition encourages leaders who are initially neck-and-neck to innovate more, and to escape this way competition and the lower innovation rents it causes to incumbents. On the other hand, in the model the reaction of students with lower grades to the new excellent student is called the 'Schumpeterian effect'. In the case of firms, this indicates that increasing competition discourages laggards to innovate because the intensified competition causes them to be even further away from the leaders, and this way catching up is more unlikely. The name of the effect refers also to the previously found negative effect of competition on innovation in the basic SGP. (Aghion et al., 2005, 2021, pp. 57–62.)

The balance between 'escape-competition' and 'Schumpeterian' effects changes according to the intensity of competition, resulting in an inverted-U curve. This is known as the 'composition effect'. The 'escape-competition effect' dominates, corresponding to the upward side of the inverted-U curve, if competition is initially low because laggards have a stronger incentive to innovate and catch up with the leaders than the leaders to leave the neck-and-neck state. This leads to a situation where most firms are neck-and-neck. As seen in the example, the intensified competition encourages neck-and-neck firms to innovate more, and this is the reason why the 'escape-competition effect' dominates. On the other hand, the 'Schumpeterian effect' dominates, corresponding to the descending side of the curve, if competition is initially high because the evermore increasing competition encourages neck-and-neck leaders to innovate further and the frontier moves rapidly forward. This leads to a situation where most firms are behind the frontier, in an unlevelled state, i.e. not neck-and-neck. As seen in the example, we know that intensified competition discourages these unlevelled, i.e. laggards, to innovate, so for this reason the 'Schumpeterian effect' dominates. (Aghion et al., 2005, 2021, pp. 57–62.)

The model also provides two additional predictions. First, the inverted-U curve is steeper when industries are more neck-and-neck. Second, competition increases the average technological distance between leaders and followers. (Aghion et al., 2005.) All in all, the bottom line is that intensified competition typically increases innovation. Innovation is most likely to increase if the firm is a leader. Instead, if the firm is a laggard, intensified competition can discourage it and reduce its innovation (Bloom et al., 2019; Finnish Productivity Board, 2021b, p. 32).

Competition affects productivity also through creative destruction. According to the new SGP, competition, and particularly increased international competition, drives creative destruction, which increases productivity growth in the economy. As a result of competition, labour and other inputs shift from low-productive firms to high-productive firms. These changes in corporate structures lead to faster productivity growth in the industry. (Aghion & Schankerman, 2004; Finnish Productivity Board, 2021b, pp. 33–34; Maliranta & Ylä-Anttila, 2007, pp. 15–18.)

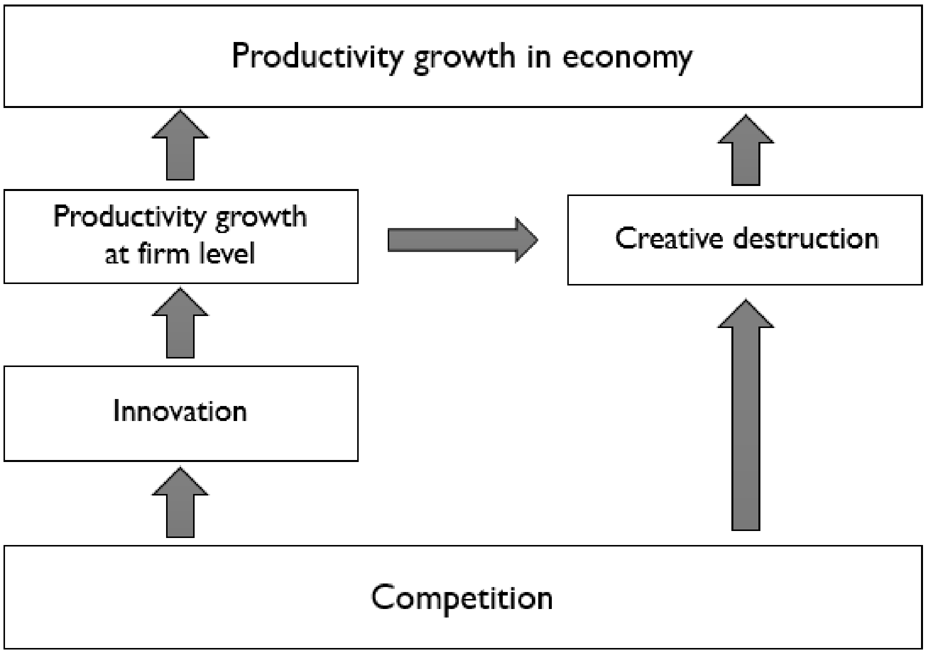

Figure 4 Theoretical framework: linkage between competition and productivity growth (Finnish Productivity Board, 2021b, p. 33)

To conclude this chapter, the relationship between competition and productivity growth based on the new SGP is shown in a simple framework in Figure 4. As discussed in the theoretical literature, healthy competition is considered to provide an incentive to innovate, while it is also considered to be one of the driving forces behind creative destruction. In this thesis, I rely on this theoretical framework when examining the state of competition and its impact on productivity.

4 Empirical literature

4.1 Competition and innovation

As previously mentioned, empirical studies have long predicted that competition has a positive effect on innovation. However, the results have also been mixed. Next, I'll go through some of the most notable empirical papers related to this matter with a special interest in the results regarding Finland.

The earliest attempts to explore the relationship between competition and innovation empirically were inspired by Schumpeter, and they suggested a negative impact of competition on innovation (see Aghion et al., 2005). Scherer, who Griffith and Van Reenen (2021) say to be the pioneer in studying the empirical link in question, developed the earlier research by allowing further nonlinearities. First, he found the relationship between industry concentration and patenting activity to be positive (see Griffith & Van Reenen, 2021). Later, extending his analysis, and utilizing a new and more comprehensive sample, he found strong evidence of the relationship being inverted-U shaped (Scherer, 1967).

One of the most well-known papers suggesting a positive relationship is written by Blundell, Griffith, and Van Reenen (1999). According to their own words, they were one of the first to apply firm-level panel data on innovations on this question (see Griffith & Van Reenen, 2021). Unlike Scherer, they returned to examining linear conditions. First, they find the relationship between competition and innovation to be strongly positive. Second, they find that firms with initially higher market shares have more incentives to innovate since their increase in stock market value resulting from innovating is higher. (Blundell et al., 1999; Griffith & Van Reenen, 2021.) Another article published about the same time with similar results is written by Nickell (1996). In addition, there is vast research that studies the question considered from the perspective of import shocks that increase competition, and how they eventually affect the innovation and the productivity of the firms. An article by Shu and Steinwender (2018) summarizes 40 articles on this matter and argues that in general, for firms in developing economies and in Europe, (import) competition drives innovation.

However, in the US, the empirical findings are more mixed (Bloom et al., 2019). Hashmi (2013) studies the relationship in publicly traded manufacturing firms in the US and finds that competition has a slightly negative effect on innovation. Autor et al. (2020) claim that competition resulting from Chinese imports has decreased innovation in the US manufacturing sector. Instead, Xu and Gong (2017) argue that the effect of Chinese imports on innovation in the US is ambiguous since the R&D employees shifted from manufacturing to the service sector. They also test the inverted-U curve hypothesis with US industry-level data, and their results confirm the theory.

Speaking of the inverted-U relationship, the theory has widely been tested in different countries and with different data, and the theory has held in a number of papers (see Griffith & Van Reenen, 2021, p. 14). For example, Aghion et al (2005) themselves tested the theory by exploiting UK panel data. However, Correa (2012) finds a structural break in the data in the early 1980s used by Aghion et al. (2005). He argues that the relationship between competition and innovation was positive from 1973 to 1982 and that there is no relationship from 1983 to 1994.

The inverted-U relationship between competition and innovation has also been tested with Finnish data. Kilponen and Santavirta (2004) examine the question with Finnish firm-level data from 1988 to 2001. Applying several different measures for innovation, they find relatively convincing evidence in favour of the inverted-U relationship in the manufacturing sector. In addition, their results suggest that industries with higher technology dispersion tend to innovate less than industries with lower dispersion, which again is in line with the theory of Aghion et al. (2005). In turn, Berghäll (2016) finds results pointing in the opposite direction when focusing only on the Finnish computer and electronics industry in the years 1990-2003. Her results suggest that the correlation between competition and innovation is somewhat ambiguous. The results vary when changing the innovation measure. The inverted-U relationship is only found when using technological change as an innovation measure. In the case of other innovation measures (R&D intensity and elasticity), the relationship is found to be more of a U-shape.

A more recent paper, although not solely concentrating on the inverted-U curve, but actually with a fairly similar research question to the aim of this thesis, is written by Koski (2021). She analyses the role of competition in the poor development of R&D investments in the Finnish private sector in the 2010s. She finds out that the industries with declining

R&D intensity concurrently experienced a decrease in the degree of competition, and the industries were mainly concentrated. In more competitive industries, R&D intensity did not decrease, or the competition even increased. These findings reflect a positive relationship between the degree of competition and firms' R&D intensity. That is to say, these results indicate the relationship between competition and innovation to be positive in Finland’s private sector in the 2010s. In general, the analysis suggests that the state of industry competition has been related to differences in the industry’s R&D intensity developments in Finland in the 2010s.

Overall, although the empirical literature regarding the relationship between competition and innovation is partially mixed, it could be said that competition usually encourages innovation, rather than discourages it, particularly in markets with a low initial level of competition (e.g. Bloom et al., 2019; Griffith & Van Reenen, 2021).

4.2 Measuring competition

Competition can be measured with both static and dynamic indicators, and it is important to combine them to gain an in-depth understanding of the competition in the market (Baldwin et al., 1995, pp. 1–7; OECD, 2021d, p. 16). Market concentration, productivity dispersion, allocative efficiency and firm mark-ups are some examples of static indicators. Firm entry rates, job reallocation rate, age structure, survival share and post-entry growth are some examples of dynamic indicators. In general, static measures are more commonly used, but dynamic measures have gotten more attention in recent years when data availability has improved. Dynamic measures capture the process of creative destruction and the competition between incumbents and new entrants. (Baldwin et al., 1995, pp. 1–7; OECD, 2021d.) Next, I will discuss these indicators and the related empirical results both in Finland and globally.

Market concentration, i.e. the weight of the largest firms in the industry, is an important structural characteristic of a market and a traditional way to examine the state of competition. The bigger the weight of the largest firms in the industry, the higher the industry share, and the more concentrated the industry. Increasing concentration can point to a decline in competition. The most widely used concentration indicators are the

Herfindahl-Hirschman index (henceforth HHI) and concentration ratios. (OECD, 2021d, pp. 11–13.)

However, sometimes the concentration indicators may be misleading. For example, in the case of ‘contestable markets’, the concentration measures do not tell the whole truth as the competitive pressure is coming from ‘outside’ the market (e.g. from other industries or abroad), from potential entrants. This is a situation where there is only a single or few firms operating in a market, so the market concentration is high, but according to other competition measures, the market is not highly competitive. (see Aghion et al., 2021, pp. 56–57; Bonfiglioli et al., 2021.) In addition, in official data, the market boundaries (e.g. product or geographic) are occasionally inappropriate for identifying a market where competition occurs. (see Ahn, 2002; Rossi-Hansberg et al., 2021).

According to Finnish Productivity Board (2021b), who use data from the older version of MultiProd, market concentration in Finland is stronger than in the benchmark countries[10], except in digital services. The concentration is particularly high in digital manufacturing, possibly due to high productivity firms in that sector. On the contrary, the low concentration together with low productivity dispersion in digital services could indicate that there might be a lack of high productivity firms on which the market could concentrate in this sector. (Finnish Productivity Board, 2021b, p. 42.)

However, the trend in market concentration has been decreasing, and markets are becoming less concentrated. Vanhala and Virén (2019) examine the market concentration using the HHI. They find that the HHI has declined from 2001 to 2016 in terms of net sales and value added, whereas with regard to employment rate, the HHI has been relatively stable. These trends are the opposite of what the trends in market concentration have been in Europe and North America where the concentration has increased over the years. (Autor et al., 2017; Bajgar, Berlingieri, Calligaris, Criscuolo, et al., 2019.) The reason for this divergence is yet to be examined, but Vanhala and Virén (2019) ponder the idea that the markets in Finland might be too small for superstar firms to arise.

High **productivity dispersion**, indicating large differences in productivity between firms, may imply that competition is so scarce that also relatively inefficient firms are able to stay in the market. Therefore, productivity dispersion is used when measuring the

[10] Benchmark countries are here referring to Belgium, France, Norway, Portugal, and Sweden.

competitiveness of the market. On the other hand, high productivity dispersion is typically only a consequence of intensive innovation activities in frontier firms, therefore it might as well be a misleading indicator when measuring competition. (Leibenstein, 1966; Martin, 2008.)

Overall, productivity dispersion in Finland has not been as extreme as in other countries. According to Finnish Productivity Board (2021b), who as previously mentioned use data from the older version of MultiProd, the productivity dispersion in Finland is much lower than in the benchmark[11]. They also note that the difference is particularly prominent in the digital services sector, and this might result from the lack of high-productivity firms rather than having too many low-productivity firms in the market. Moreover, the dispersion is also lower than the benchmark in digital manufacturing. In this case, the lower dispersion cannot be explained by a lack of high-productive firms since Nokia was undoubtedly in the international productivity frontier until 2007. Consequently, the low dispersion is then due to a lack of low-productivity firms. (Finnish Productivity Board, 2021b, pp. 40–41.) Likewise, Vanhala and Virén (2019) argue that internationally observed divergence of the frontier firms from other firms does not appear to apply fully to Finland. They suggest that this stems from the fact that not even the best firms have had fast productivity growth.

Moreover, **allocative efficiency**, i.e. reallocation of resources, can indicate the state of competition. If there is a lack of competition, firms may not use their full production potential (i.e. resources are not used as efficiently as possible). Therefore, an increase in competition may lead to higher allocative efficiency. Reallocation of resources can be measured with a number of different decompositions, of which one of the most commonly used is the Olley and Pakes (henceforth OP) decomposition. The decompositions increase when more productive firms obtain a higher resource share of the industry, and this way the allocative efficiency is higher. (Berlingieri et al., 2017, p. 36; Finnish Productivity Board, 2021b, pp. 48–52; OECD, 2021d, p. 36.)

In Finland, according to Fornaro et al. (2021), resource reallocation has room for improvement, even though it was improved in the last years of the analysis (2013-2018). Partially similar results, using different decompositions, were found by Finnish

[11] Benchmark is here referring to Belgium, France, Norway, Portugal, and Sweden.

Productivity Board (2021b). According to them, in 2011, Finland had a weaker reallocation than Sweden, Norway and Denmark. However, unlike Fornaro et al. (2021), Finnish Productivity Board (2021b, pp. 52–54) argues, based on Olley and Pakes (1996) decomposition implemented with data from the older version of MultiProd, that the reallocation has also weakened further in the 2010s. On the contrary, when they use Baqaee and Farhi (2020) decomposition, the results are more aligned with the findings of Fornaro et al. (Finnish Productivity Board, 2021b, pp. 55–59).

The state of competition can be assessed also by analysing the profitability of firms. A good profitability could be an indication of weak competition if the reason behind is that firms use abnormally high margins when selling their goods, in other words, **mark-ups** are high too. Increases in mark-ups indicate that the **Lerner index** has increased. The Lerner index, formalized by Abba P. Lerner (1934), is a frequently used measure of market power and is preferred by empiricists. (Aghion et al., 2021, pp. 55–56.) The index measures the price-cost margin (PCM) and is computed as

$$Lerner\ index = \frac{P - MC}{P} \tag{8}$$

where P responds to the price of the good set by the firm, and MC is the firm's marginal cost. The index equals 0 when prices equal marginal costs, while a close to 1 indicates that one or a few firms have a strong market power and because of that prices are above marginal costs. (Lerner, 1934; OECD, 2021d, p. 46.)

Data on marginal costs are difficult to access, so firm mark-ups cannot be observed directly. A widely used alternative approach is proposed by De Loecker and Warzynski (2012). In the De Loecker and Warzynski method, mark-ups are estimated as a ratio between the output elasticity of the firm, and the input costs of the firm as a share of its revenue. However, it is good to keep in mind that mark-ups are not an unambiguous indicator of competition. For instance, it is also theoretically possible that the increase in price-cost margins coincides with stronger competition. (De Loecker & Warzynski, 2012; OECD, 2021d, p. 21.)

In Finland, research on mark-ups has not been very extensive, but there are a few results available. Christopoulou and Vermoulen (2012) examine the mark-ups in the Euro area and the US and find the country level estimate for Finland to be 1.28. Moreover, Laine (2018) comes to an almost similar conclusion when calculating the weighted average for the country level mark-up ratio to be 1.25 in Finland. He also argues that the results provide some indication of mark-ups staying relatively stable in Finland over time. This is interesting since mark-ups appear to be increasing globally (Calligaris et al., 2018; Diez et al., 2018). Likewise, Vanhala and Virén (2019) show that there has not been a radical change in profits (apart from an increase in computer and electronics). If anything, there has been a slight decline.

Entry rate is a commonly used dynamic indicator of competition, and more generally an indicator of firm dynamism. The rate of entry of new firms is computed by dividing the amount of entering firms by all the active firms in the market. From a Schumpeterian perspective, high entry (and exit) rates are keys to innovative and competitive markets. Entry rates illustrate the phenomenon of creative destruction, as these new innovative entrants challenge the less productive incumbents. The entry of new innovative firms gives innovation incentives for incumbents, which could improve their productivity, or conversely, force incumbents out if they fail to compete with entrants. Low entry rates may be a result of barriers to entry (e.g. regulatory barriers or sunk costs) since they block the process of creative destruction. (Aghion et al., 2006, 2021, p. 87; OECD, 2021d, pp. 13–18.)

However, if the competition is already strong among incumbents, the entry rates do not tell the whole story about the state of competition. Neither are high entry (and exit) rates always a good indicator of high market dynamism. For example, the new entrants can also be exitors in the same observed time period if they fail to obsolete the incumbents. Moreover, high entry rates in the data might be a result of mergers and acquisitions, due to which the firm codes also change, and the firms appear as entrants in the data. These kinds of entrants are called ‘de alio’ or ‘artificial’ entrants, whereas we are interested in ‘de novo’ entrants, who are genuinely new firms. (Markman & Waldron, 2014; OECD, 2021d, p. 16.)

Another indicator of competition and business dynamism is **job reallocation rate.** The rate combines job creation, i.e. new employment, and job destruction, i.e. disappeared employment, in one metric. It measures the sum of job creation and destruction in the market relative to the total employment. Therefore, as the other dynamic indicators, a high job reallocation rate is linked with higher dynamism and higher competition in the market. (OECD, 2021d, p. 18.)

The next two indicators, survival share and post-entry growth, signal the renewal of the business structure and they are commonly referred to as the indicators of up-or-out dynamics. **Survival share** implies the survival of new firms n years after entering the market. This way survival share indicates the efficiency of the market selection mechanism. A high survival share suggests that the market selection mechanism is not working: low-productive and non-successful firms are able to stay in the market. This could be due to weak competition. In contrast, a low survival share might be an indication of intense competition, where only the ‘fittest’ firms survive. (OECD, 2021d, p. 18.)

Furthermore, **post-entry growth** indicates the employment growth of those new firms that are still in the market n years after entering. From the viewpoint of creative destruction, it is vital that new firms are able to grow and challenge the less productive incumbents. Because of this, post-entry growth could also be considered an indicator of competition. A high post-entry growth increases the competitive pressure on incumbent firms. Moreover, according to extensive research literature (e.g. Haltiwanger et al., 2013, 2017), young firms create a considerable amount of new employment and production in the market.

Globally, business dynamism has declined during the last decades, which has also been linked to the slowdown in productivity growth (e.g. Akcigit & Ates, 2019; Calvino et al., 2020). In Finland, recent literature on dynamic indicators appears not to be as broad as on static indicators. However, a few publications related to business dynamism in Finland can be found.

Finnish Productivity Board (2021b) finds some signs of declining business dynamism when exploiting the data from the older version of MultiProd: entry and exit rates appear to be lower than in the benchmark and post-entry growth has not been as high as in the benchmark[12]. On the other hand, a higher employment share in young firms compared to the benchmark would indicate higher business dynamism. Moreover, Vanhala and Virén (2018) discover that the share of zombie firms, i.e. weakly performing but resilient firms, has increased since the beginning of the 2000s. This would be an indication of a not

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[12] The benchmark here refers to Belgium, France, Norway, Portugal, and Sweden.

dynamic and competitive market. At the same time, the share of gazelle firms, young and fast-growing firms, has decreased after the GFC. This again could be a sign of decreasing business dynamism.

5 Data and methods

5.1 Data

Data for this thesis is obtained from the OECD. Databases utilized are called MultiProd version 2 and DynEmp version 3.2, which contain annual firm-level data from Finland and several other countries. The OECD collects MultiProd and DynEmp data through a network of national statistical offices and researchers. (OECD, 2021a, 2021e.) These databases have been proven invaluable in several studies conducted in the OECD, see for example OECD (2021a, 2021e). The OECD has also already provided a set of tables and graphs for the last productivity report of the Finnish Productivity Board (2021a), and these simple indicators were found useful.

MultiProd version 2 data include, for example, measures on both LP and MFP (e.g. decompositions of growth distinguishing between entrants vs. incumbents and frontier vs. laggard firms, within-industry dispersions etc.), on wages and labour share, on allocative efficiency, on concentration and mark-ups, and transition matrices that enable tracking the changes in productivity growth over time. Statistics are accumulated by age, size and ownership group. (Berlingieri et al., 2017; OECD, 2021e.) MultiProd microdata has been proven to capture macro trends relatively well. Across industries and countries, median correlations of gross output, value added, employment, LP and wages over time were all between 0.75 and 1. (Bajgar, Berlingieri, Calligaris, & Criscuolo, 2019.)

DynEmp version 3.2 data include dynamic measures computed at the industry level. The database provides measures on employment dynamics, such as job reallocation rates, entry and exit rates, the share of employment in young firms, and transition matrices that enable, for example, to follow how fast new firms grow in terms of employment. The data is aggregated by industries, size and age classes, and by employment growth distribution. (Criscuolo et al., 2014; OECD, 2021a.)

When conducting the indicators of competition in chapter 6, the time coverage of the data in both databases is 2004-2018. For Finland, the year 2013 was suppressed from the data due to a break in the time series caused by Statistics Finland’s business statistics renewal. The benchmark group consists of European countries and was selected based on data availability and quality. In consequence, the benchmark group is different[13] in MultiProd and DynEmp. In MultiProd, the benchmark group includes Belgium, France, Italy, the Netherlands, Portugal, and Sweden. In DynEmp, the benchmark group includes Austria, Belgium, France, Hungary, Italy, Norway, Portugal, Spain, and Sweden. All countries are given equal weight when calculating averages across countries in the benchmark. On top of these limitations, the data coverage varies also by indicator, year, and country. A more detailed description of the data coverage can be found in Appendix 2 Data coverage.

5.2 Methodology

There are several indicators of competition in both MultiProd and DynEmp. During the project, multiple indicators were analysed and eventually ten of them were selected after extensive robustness checks. The selected indicators are common indicators of competition and the methods used to compute them are closely following the theory. The methods of all the indicators are presented in detail in Appendix 1 Methodology of the indicators in detail. The first five indicators are from MultiProd, and they are static measures of competition. The static indicators subject to analysis are gross output share of the top decile, HHI, MFP dispersion, OP decomposition and mark-ups. MFP is used when calculating the productivity dispersion and OP decomposition, and it is calculated using the Wooldridge (2009) approach. The other five selected indicators are from DynEmp and are dynamic measures of competition. The dynamic indicators subject to analysis are entry rates, job reallocation rate of incumbents, survival share of micro-entrants, share of growing firms among all surviving micro-entrants and post-entry growth of micro-entrants. The role of de alio entries, entries due to mergers and acquisitions, appears to be significant in the Finnish data since the size of entrants is especially high. These problems are considered throughout the analysis, and instead of using all entrants in the transition matrices (survival shares and post-entry growth) only micro-entrants are used.

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[13] However, for consistency the results were also run with the same, more restricted, benchmark, and the results held. The common benchmark was Belgium, France, Italy, Portugal, and Sweden.

The analysis focuses on the private sector, and more specifically on SNA A38[14] industries in manufacturing and non-financial market services (services, hereafter). These sectors correspond to the largest share of value added and employment in most countries, and for this reason this focus is often used when exploiting the MultiProd and DynEmp databases. The following A38 industries are excluded from the analysis: coke and refined petroleum, real estate, and pharmaceuticals. The A38 industries in manufacturing and services are further classified into digital and non-digital sectors (Calvino et al., 2018). An industry is digital if it is in the top half of the industry distribution in terms of digital intensity. Alternative further classification is based on Eurostat indicators, which divide manufacturing and services based on their technological and knowledge intensity (Eurostat, 2016). The indicators of competition were run with this sectoral classification as well, but in this case, the results were very similar when compared to the digital/non-digital classification, so they are not presented separately in this thesis. Detailed industry and sector classifications are presented in Appendix 2 Data coverage and industry classification.

When aggregating the variables to these separate macro sectors (e.g. digital vs. non-digital and manufacturing and services), sector-level weights are used. These weights are computed as the sector shares of the weighting variable. The weighting variables are presented below in Table 1.

Table 1 Indicators and their weighting variables

Indicator	**Sector-level weighting variable**
Gross output share of the top decile	Gross output at time t
HHI	Gross output at time t
MFP dispersion	Value added at time t
OP decomposition	Value added at time t
Mark-ups	Gross output at time t
Entry rates	Number of all active units at time t
Job reallocation rate of incumbents	Average of total employment of incumbents at time t and $t-1$
Survival shares of micro-entrants	Number of micro-entrants (excluding size class 0-1) units at time t
Share of growing firms among all surviving micro-entrants	Number of micro-entrants (excl. 0-1) units at time t and still in business at time $t+j$
Post-entry growth of micro-entrants	Total initial (time t) employment of micro-entrants (excl. 0-1) surviving after `j' years

[14] In transition matrices (i.e survival share of micro-entrants, share of growing firms among all surviving micro-entrants and post-entry growth of micro-entrants) the analysis can only be done in manufacturing and services since the data is available only at SNA A7 aggregation level.

Both in MultiProd and DynEmp, the sector shares were initially calculated in three different ways: in the initial period, as average over the years, and separately for each year. The results were very similar to each other, but calculating sector shares separately for each year appeared to be the most accurate for this purpose, so we decided to run the indicators with it.

6 Results

The results presented in this chapter are the results of a collaborative project carried out with Calligaris, Himbert, Jurvanen, Manaresi and Verlhac (2021), and part of the results have also been published in the annual report of the Economic Policy Council (2022).

6.1 Static indicators of competition

The first indicator examined is the market concentration, which is measured by the gross output share of the top decile and HHI. However, the HHI figures have been omitted from this chapter since the results were consistent with the results of the gross output share of the top decile. However, the corresponding figure to Figure 5 for the HHI is available in Appendix 3 Additional results.

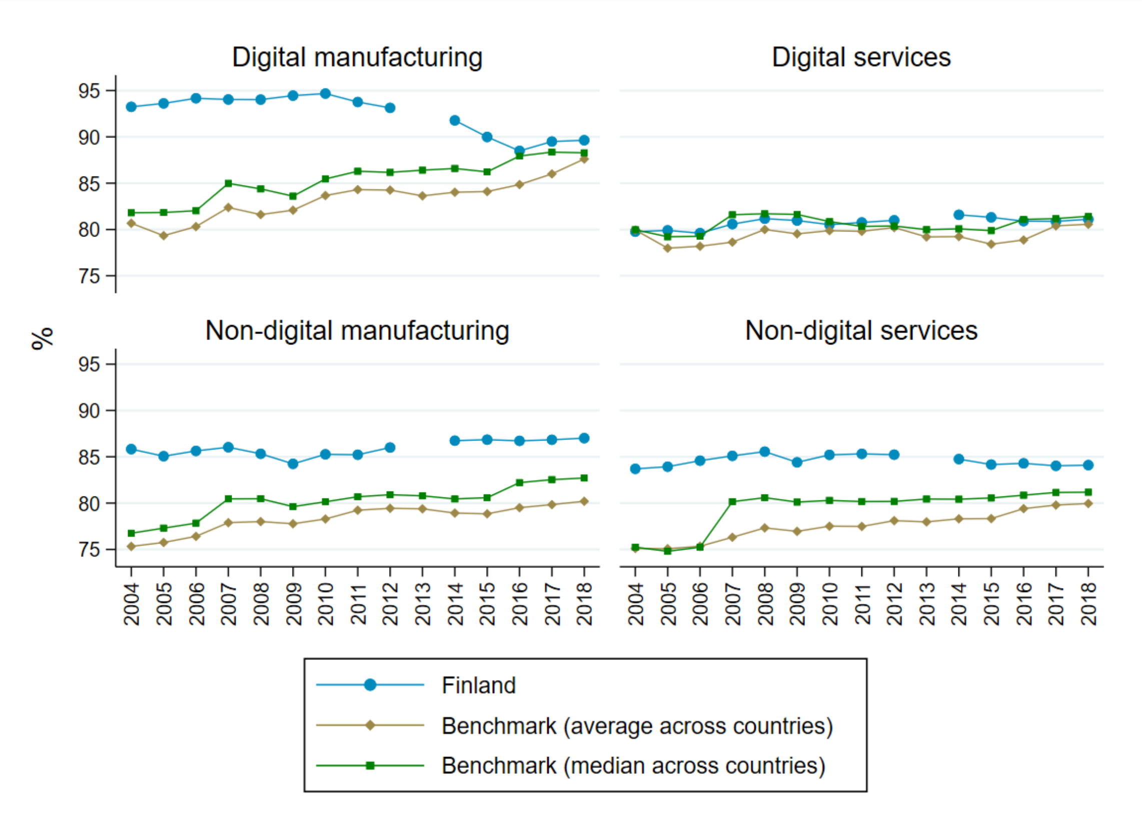

Figure 5 Gross output share of the top decile

Figure 5 presents the levels of market concentration in Finland and the benchmark by digital intensity within manufacturing and services. Concentration is clearly above the benchmark in every sector except in digital services, where the level of concentration has been in line with the benchmark over the observation period. In Finland, the trend in concentration has been rather stable over the period, except in digital manufacturing. In other sectors, there are no major differences between the time before and after the GFC. The decline in digital manufacturing is caused by a drop in the computer and electronics industry and is particularly linked to the fall of Nokia[15]. However, digital manufacturing remains the most concentrated sector in Finland, as it is as well in the benchmark. In the last years of the analysis, in 2016-2018, digital manufacturing was relatively in line with the benchmark median. In the benchmark, the concentration has increased apart from digital services where it has been stable.

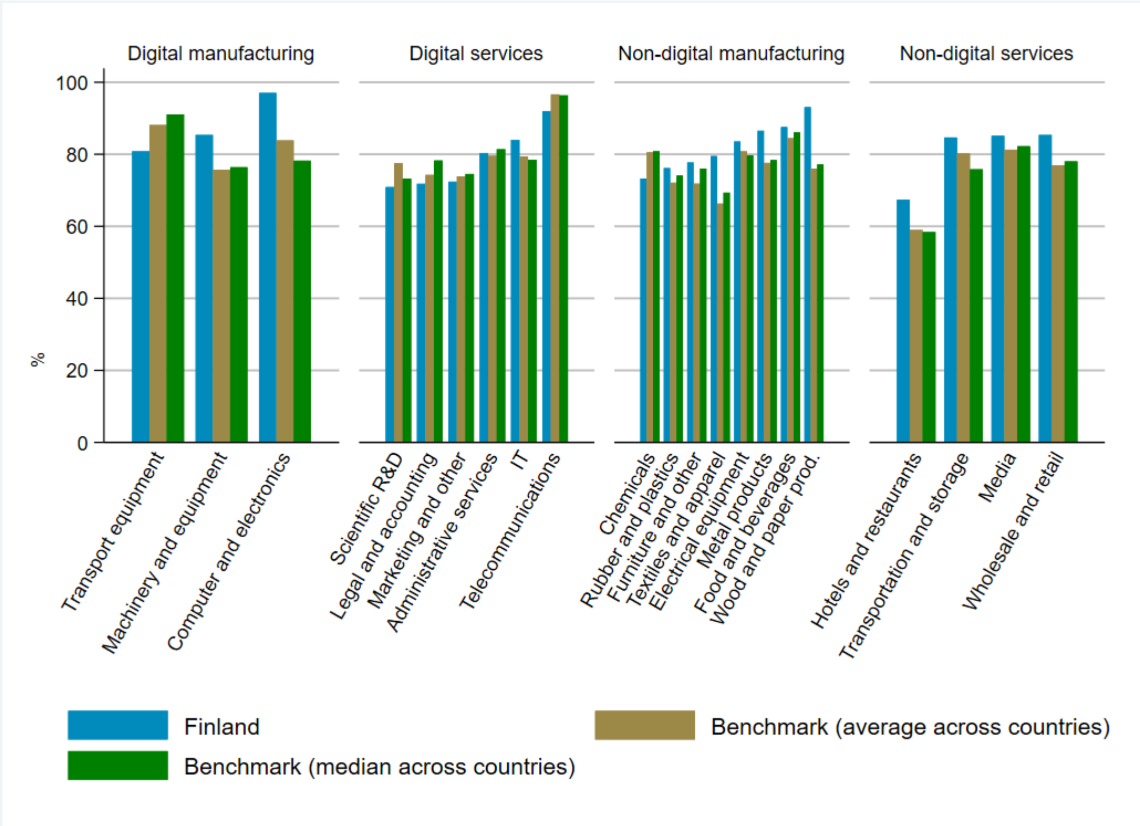

Figure 6 Gross output share of the top decile, an average of the years 2004-2018

Figure 6 reveals more detailed information by presenting the average concentration of each A38-level industry in Finland and the benchmark over the years 2004-2018. The figure shows that in Finland services are two-folded when it comes to concentration and compared to the benchmark: concentration is higher in all non-digital service industries, while in digital services the concentration is lower in all industries, with the IT industry

[15] Additional checks were carried out to confirm this claim by looking at the levels and trends of concentration separately for all industries in digital manufacturing.

as an exception. In manufacturing, the concentration is lower in Finland only in transport equipment and chemicals industries. In Finland, the most concentrated industries are computer and electronics, wood and paper production, and telecommunications. In the benchmark, the most concentrated industries are telecommunications, transport equipment, and food and beverages. The industries with the greatest difference in concentration between Finland and the benchmark are wood and paper, computer and electronics, and textiles and apparel, in all of which the industry was more concentrated in Finland.

High market concentration may indicate a lack of competition, but as discussed in chapter 4.2, it is not always the case. To further examine the matter, let's move on to productivity dispersion.

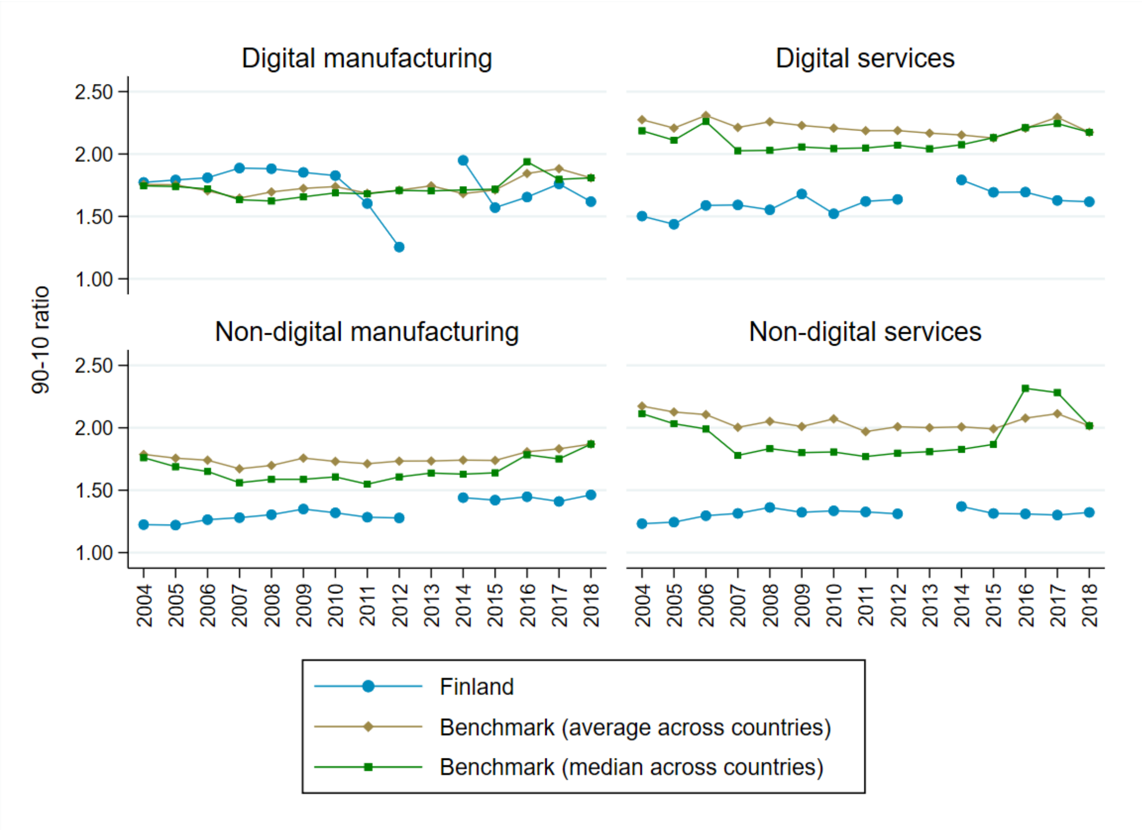

Figure 7 90-10 MFP ratio

Figure 7 shows the levels of MFP dispersion in Finland and the benchmark by digital intensity within manufacturing and services. Apart from digital manufacturing, productivity dispersion is distinctly lower in Finland in comparison with the benchmark. The trends in dispersion are relatively stable both in Finland and in the benchmark, with the potential exception of digital manufacturing in Finland, where the dispersion has slightly decreased. If examined closely, the productivity dispersion in sectors other than digital manufacturing has slightly increased from 2004 to 2018, of which the non-digital manufacturing sector the most, but still there are no radical changes at the time of the GFC or the time after it.

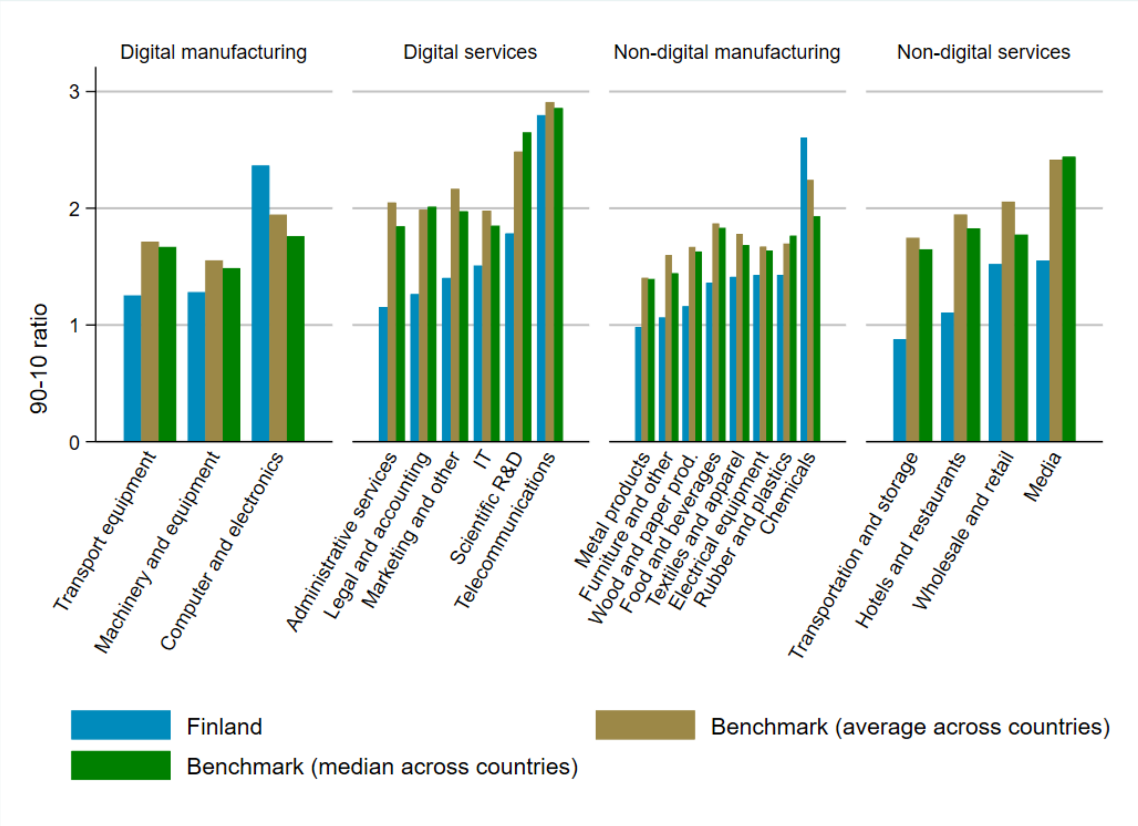

Figure 8 90-10 MFP ratio, an average of the years 2004-2018

Figure 8 gives a more detailed picture of the MFP dispersion by presenting the average 90-10 ratio of each A38-level industry in Finland and the benchmark over the years 2004-2018. The only industries in Finland with higher productivity dispersion when compared to the benchmark, are computer and electronics, and chemicals. All the other industries have a lower dispersion than in the benchmark. In consequence, it can be concluded that the higher level of productivity dispersion in digital manufacturing, seen in Figure 7, was precisely due to the computer and electronics industry. In Finland, the industries with the highest productivity dispersion are telecommunications, chemicals, and computer and electronics. In the benchmark, the industries with the highest productivity dispersion are telecommunications, scientific R&D, and media. The industries with the greatest difference in dispersion between Finland and the benchmark are media, transportation and storage, and scientific R&D, in all of which the industry was more dispersed in the benchmark.

In terms of competition, the low productivity dispersion is a positive thing as previously discussed. The low dispersion indicates that Finland does not have a problem with technology diffusion from the frontier to the laggard firms. In terms of productivity, the results are of course similar to the findings of Finnish Productivity Board (2021b), since they used MultiProd data as well. Together with the high concentration, the low-productivity dispersion could indicate two opposite things: there is either a lack of high-productivity firms in the market, or there are too many low-productivity firms in the market.

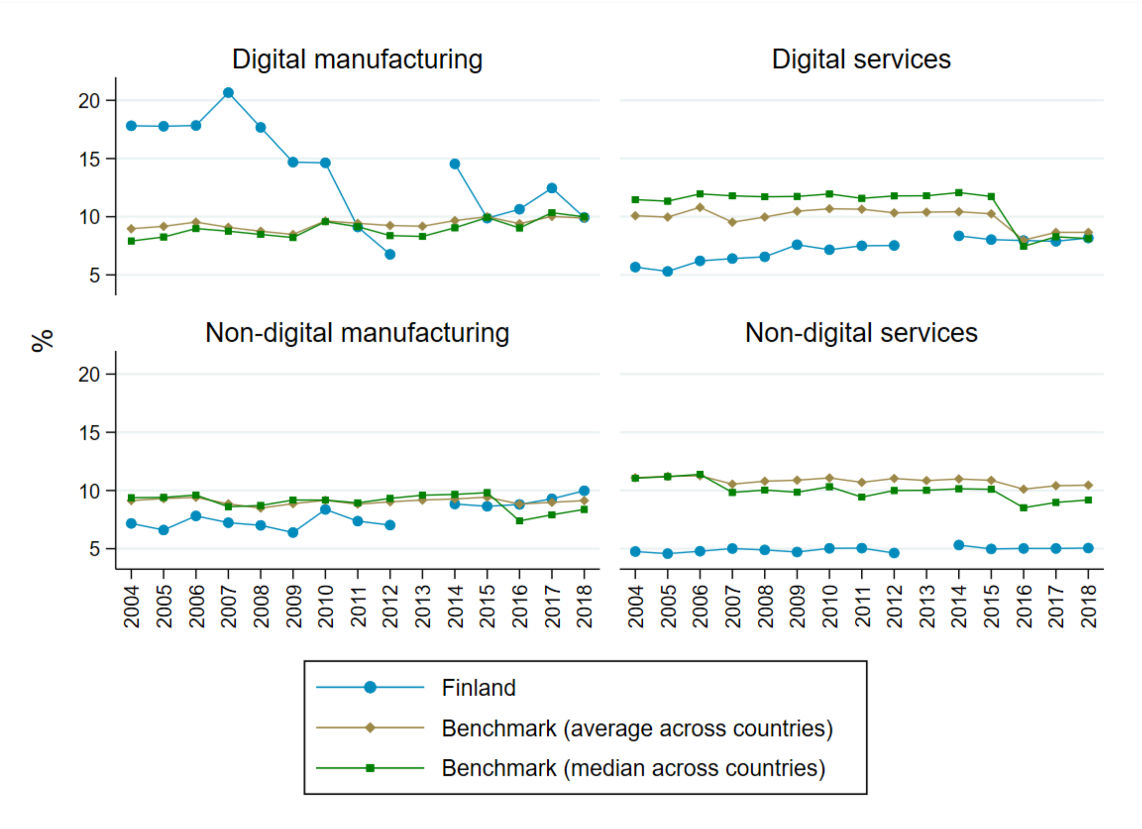

Figure 9 Share of OP covariance term into logarithmic MFP

Figure 9 describes the levels of allocative efficiency in Finland and the benchmark by digital intensity within manufacturing and services. The allocative efficiency is lower in Finland, especially in non-digital services, but also in digital services and non-digital manufacturing if the last years are not taken into account. In Finland, the allocative efficiency in digital manufacturing was particularly high in the 2000s, which again, is linked to the success of Nokia, as is also the decline from 2007 onwards. In digital services and non-digital manufacturing, the trend has been slightly increasing while in non-digital services the level has remained almost unchanged. As in the case of concentration and productivity dispersion, the only sector that has seen a clear change around or after the GFC is digital manufacturing. In the benchmark, the trend has been stable, with the exception of the drop in 2016.

The low allocative efficiency is, of course, worrying both competition and productivity-wise as discussed in chapter 4.2. Indeed, the drop in digital manufacturing is a worrying sign in terms of productivity, but in this case, associated with the fall of only one firm, Nokia, the indicator does not tell about a decrease in the state of competition. On the contrary, when a frontier firm falls, the competition is likely to increase. In addition, the allocative efficiency is very competitive with the benchmark in the last years of the observation period. Moreover, in other sectors, poor allocative efficiency, and the possibly weaker state of competition that it may indicate, do not appear to explain the slow productivity growth after the crisis either because it was low already earlier.

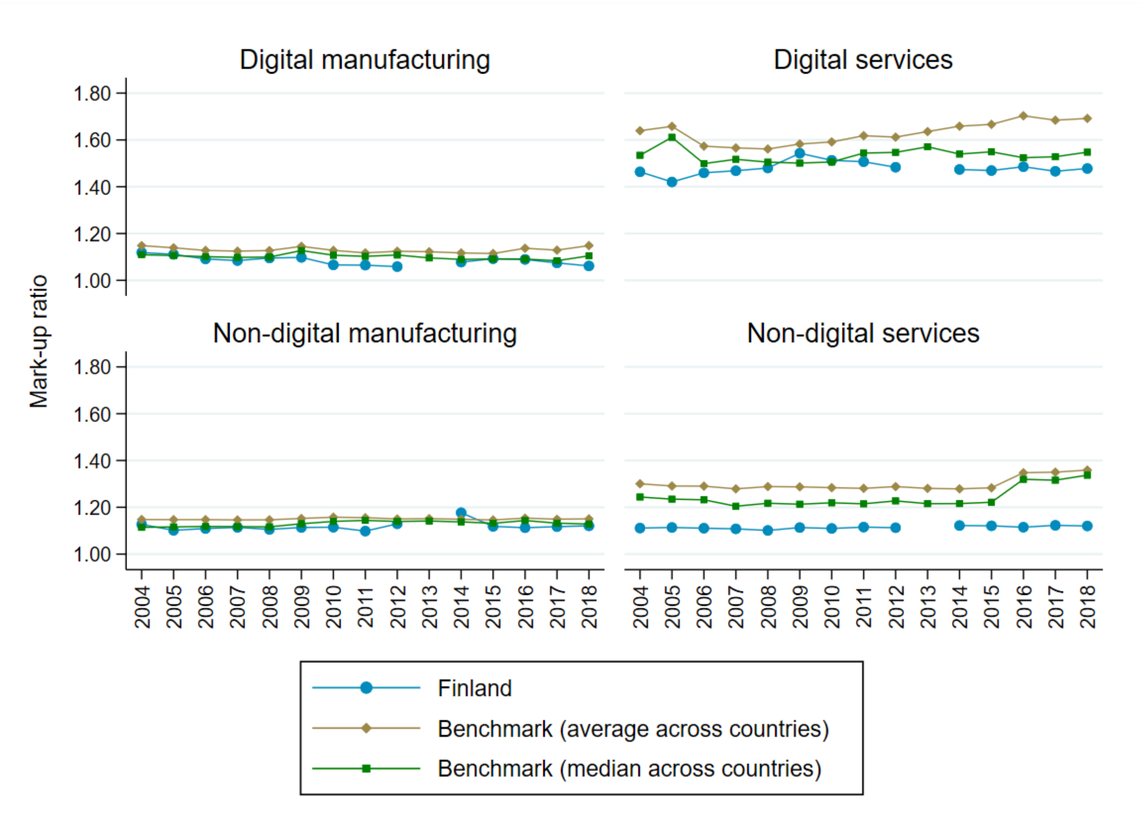

Figure 10 Mark-up ratio

Figure 10 illustrates the levels of mark-ups in Finland and the benchmark by digital intensity within manufacturing and services. Overall, the mark-ups have been very stable over the observation period both in Finland and in the benchmark. In manufacturing, the mark-ups are very much in line with the benchmark. Curiously, the fall of Nokia does not seem to have affected mark-ups. In services, and particularly in non-digital services, the mark-ups have been below the benchmark. Again, there are no changes at the time or after the GFC, not even in digital manufacturing.

All in all, these static indicators do not provide evidence of significant change in the state of competition that would have had a negative impact on competition, and through it to LP after the GFC. In fact, the low productivity dispersion and low mark-ups would indicate a reasonably healthy state of competition. Although the high concentration and low allocative efficiency might suggest there is room for improvement in the state of competition, neither of them explains the sluggish productivity growth after the GFC since their trends have remained rather stable throughout the observation period. The only radical change in static indicators after 2007 has occurred in digital manufacturing. However, not even this change has affected the mark-ups. In fact, in the light of declined concentration and productivity dispersion, the changes in digital manufacturing have indicated an increased level of competition rather than a decreased level of competition after the crisis.

6.2 Dynamic indicators of competition

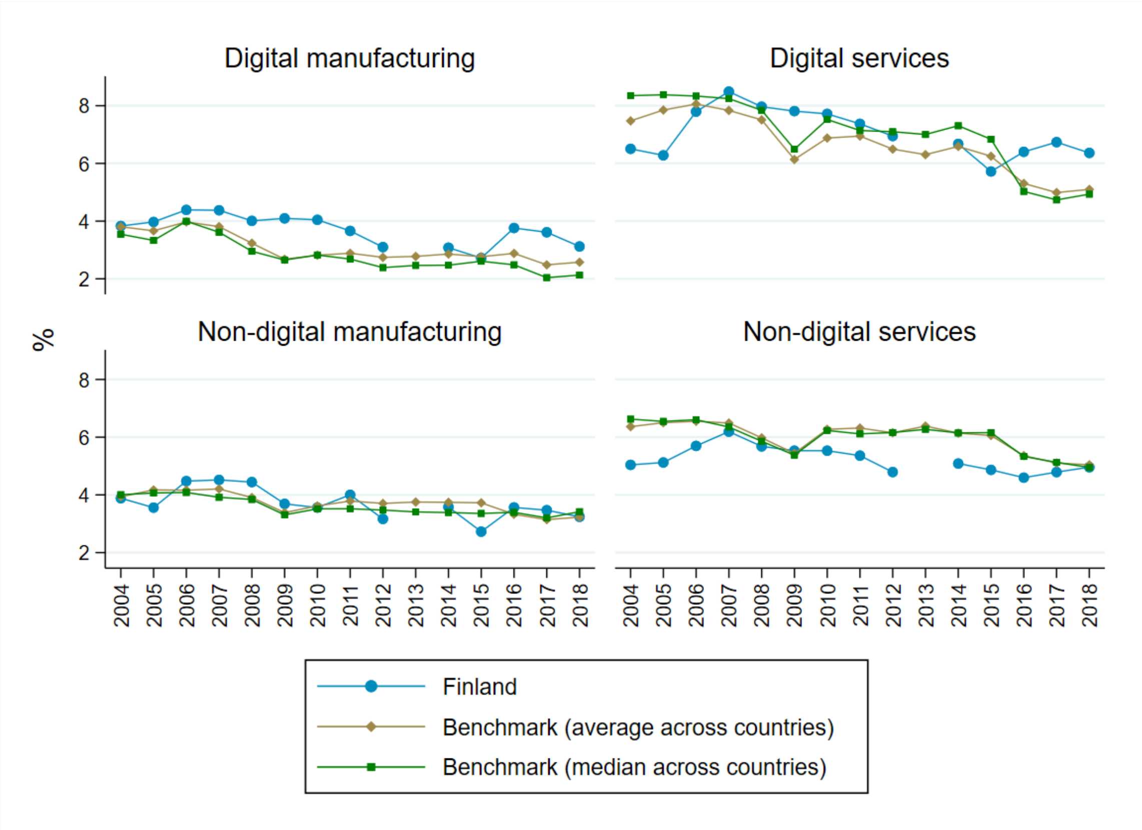

Figure 11 Entry rates

Figure 11 presents the levels of entry rates in Finland and the benchmark by digital intensity within manufacturing and services. Firm entry rates in Finland are somewhat aligned with the benchmark in terms of both levels and trends. In digital manufacturing, the rates are slightly above the benchmark while in non-digital services they are slightly below the benchmark. In Finland, the trend has been decreasing in every sector since 2007. This development is aligned with the benchmark and the global decline of business dynamism, so it does not provide an answer to the fact that the Finnish LP growth has been lower than elsewhere after the GFC. In general, entry rates are the highest in services, especially in digital services, and the lowest in manufacturing sectors.

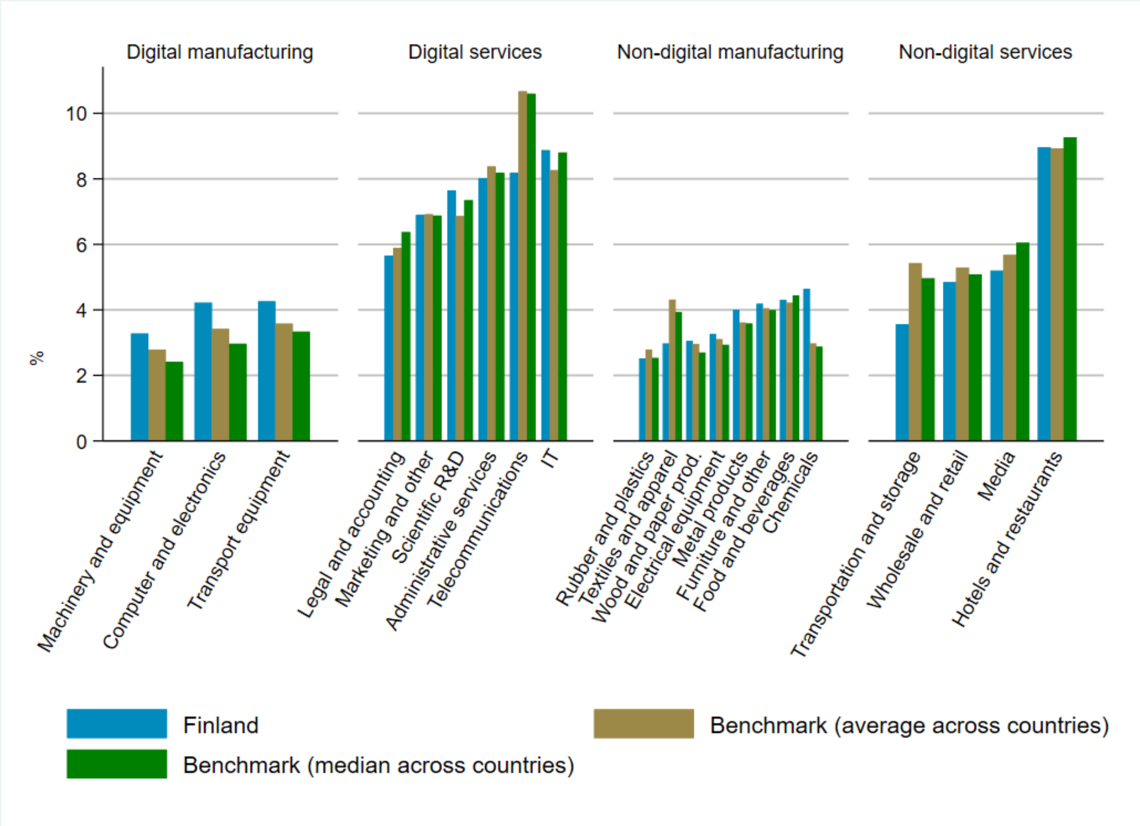

Figure 12 Entry rates, an average of the years 2004-2018

Figure 12 provides a more specific illustration of entry rates by presenting the average entry rates of each A38-level industry in Finland and the benchmark over the years 2004-2018. The lower level of entry rates in non-digital services in Finland over the years is largely explained by the transportation and storage industry. One possible explanation for this could be the fact that Finland is geographically relatively isolated from the rest of Europe, so it does not attract foreign firms into the market. Other explanations include: the current state monopoly in passenger rail traffic, there was a state monopoly in the postal and courier activities at the beginning of the observation period, and the fact that Finnair has strong market power in passenger air traffic. The higher level of entry rates in digital manufacturing in Finland over the years is not explained by any specific industry, instead, all the industries in the sector are above the benchmark. The industries with the greatest difference in entries between Finland and the benchmark are telecommunications, transportation and storage, and chemicals. Regarding telecommunications, one explanation for the low entries could be that there are three strong incumbents in the industry, so entering the market can be challenging. On the other hand, reasons for higher entries in chemicals are trickier to find and explain.

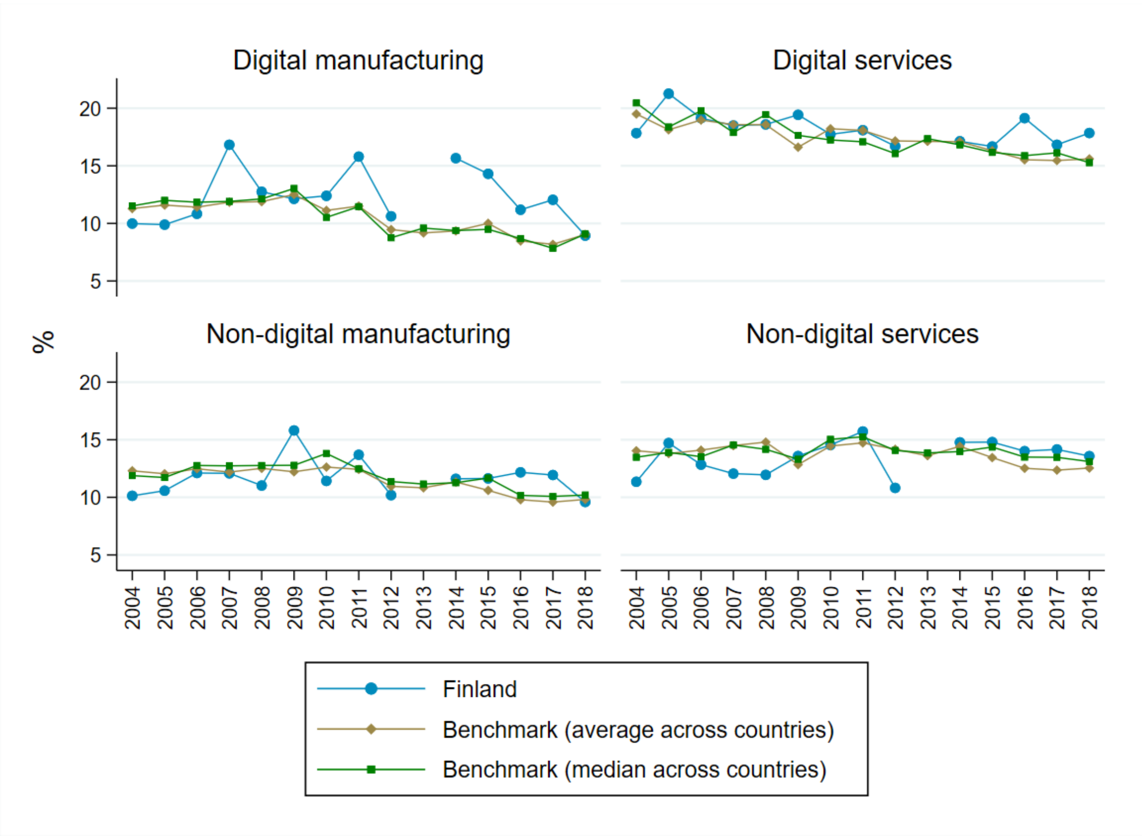

Figure 13 Job reallocation rates of incumbents

Figure 13 presents the job reallocation rates of incumbents in Finland and the benchmark by digital intensity within manufacturing and services. Overall, the levels and trends of job reallocation rates in Finland appear to be relatively in line with the benchmark. However, the level is higher than in the benchmark in digital manufacturing. As previously seen in the case of entry rates, the declining trend is also observable in job reallocation rates both in Finland and the benchmark since 2007, apart from non-digital services, but not as strongly as in entry rates. In digital manufacturing, the job reallocation rates appear to have been above the benchmark after the crisis, except in 2018. In general, the job reallocation rates are higher in services as was the case in entry rates too.

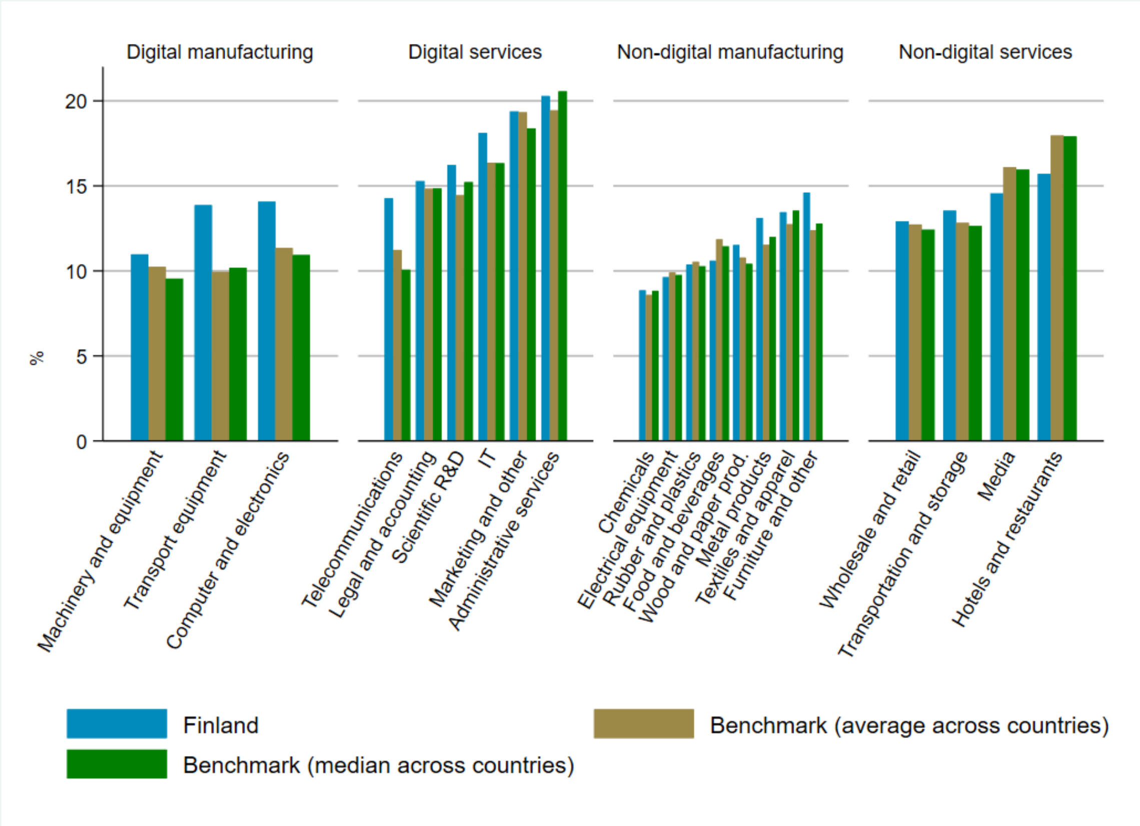

Figure 14 Job reallocation rates of incumbents, an average of the years 2004-2018

Figure 14 shows the average job reallocation rates of incumbents of each A38-level industry in Finland and the benchmark over the years 2004-2018. Based on this figure, the job reallocation rates would appear to be higher in Finland than on the basis of Figure 13, especially in digital sectors. The only industries with lower job reallocation rates of incumbents than in the benchmark are media, food and beverage, and hotels and restaurants. However, the averages might be distorted by the volatility of the Finnish data seen in Figure 13.

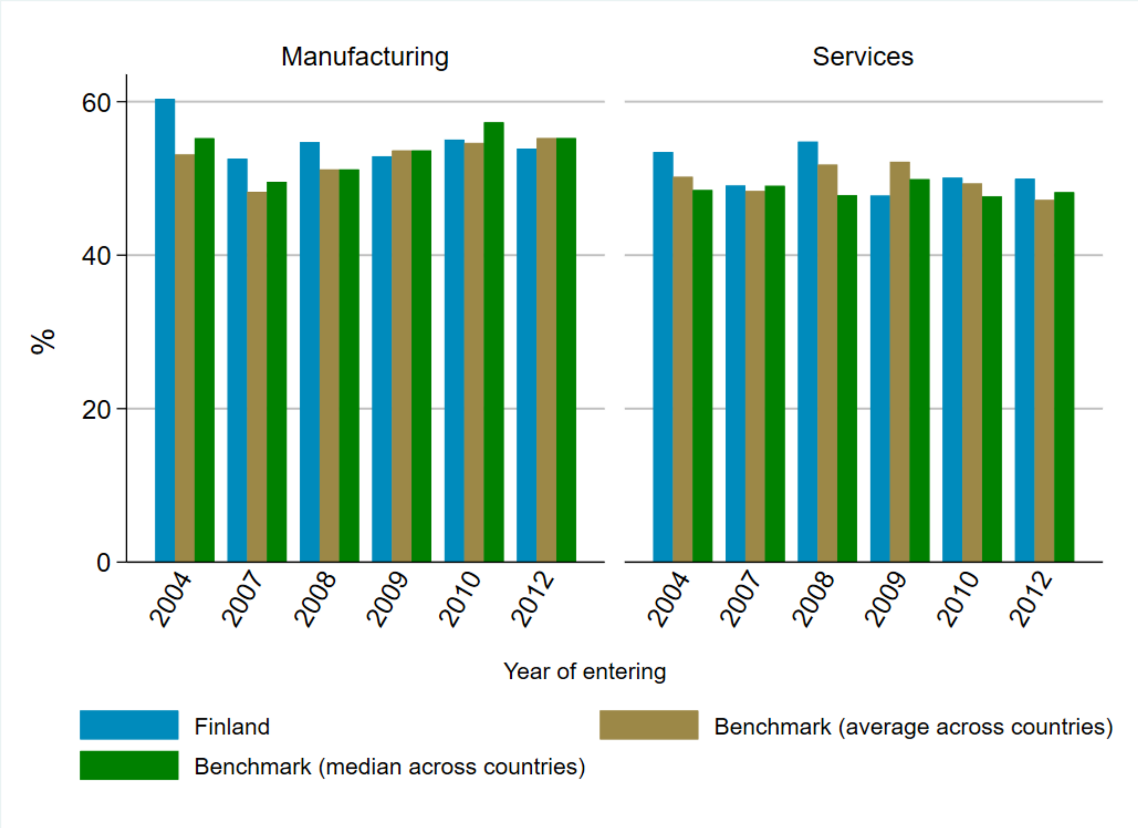

Figure 15 Survival share of micro-entrants five years after entering

Figure 15 presents the first up-or-out indicator, which is the survival share of micro-entrants five years after entering the market in Finland and the benchmark in manufacturing and services. In manufacturing, the survival share was higher in Finland than in the benchmark in the earlier cohorts and comparable also in other cohorts. In services, the survival share is similarly very comparable with the benchmark, with the exception of the 2009 cohort. Both in Finland and the benchmark, the impact of GFC is more clearly seen in manufacturing, where 2007 and 2008 are lower than the 2004 cohort, in which the firms had already solidified their position during the upturn before the crisis hit. Apart from that, the trend of survival share has been stable in both sectors and both in Finland and in the benchmark. In general, the survival share in services has been a little lower than in manufacturing.

As discussed in chapter 4.2, a higher survival share could indicate that low-productivity and poor performance firms are able to stay in the market, for example, with the help of state aid. However, the next two indicators, the share of growing among surviving micro-entrants and post-entry growth of micro-entrants, show that in this case surviving in the market is related to stronger growth.

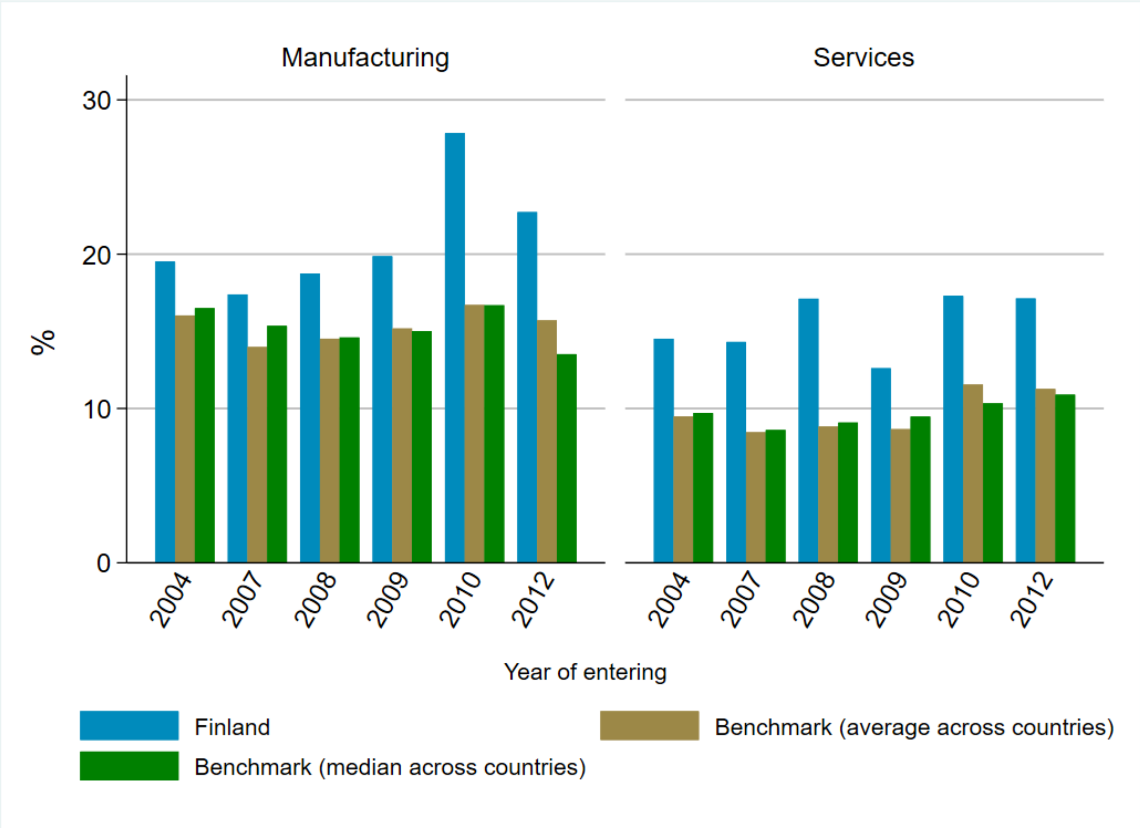

Figure 16 Share of growing among surviving micro-entrants five years after entering

Figure 16 presents the second up-or-out indicator, the share of growing firms among surviving micro-entrants five years after entering the market in Finland and the benchmark in manufacturing and services. The share of growing firms is drastically higher in Finland in relation to the benchmark across all cohorts and both in manufacturing and services. In manufacturing, the share of growing firms is especially high in the last two cohorts.

In the benchmark, the trend across cohorts has been rather stable, except for the slight bend in both sectors in the cohorts that entered the market right before or during the crisis. In Finland, the pattern is mainly similar to the benchmark in manufacturing, but Finland is more volatile. For instance, the increase in middle-cohorts, 2008, 2009 and especially 2010, compared to the earlier ones is larger than in the benchmark, and so is the drop in cohort 2012. In general, the drop in the 2012 cohort is interesting both in Finland and in the benchmark. On the contrary, the trend in services differs from the benchmark. The bend caused by the GFC is not observed, and the benchmark 2009 cohort is not significantly lower compared to other cohorts like in Finland. In general, the share of growing among surviving micro-entrants is lower in services than in manufacturing.

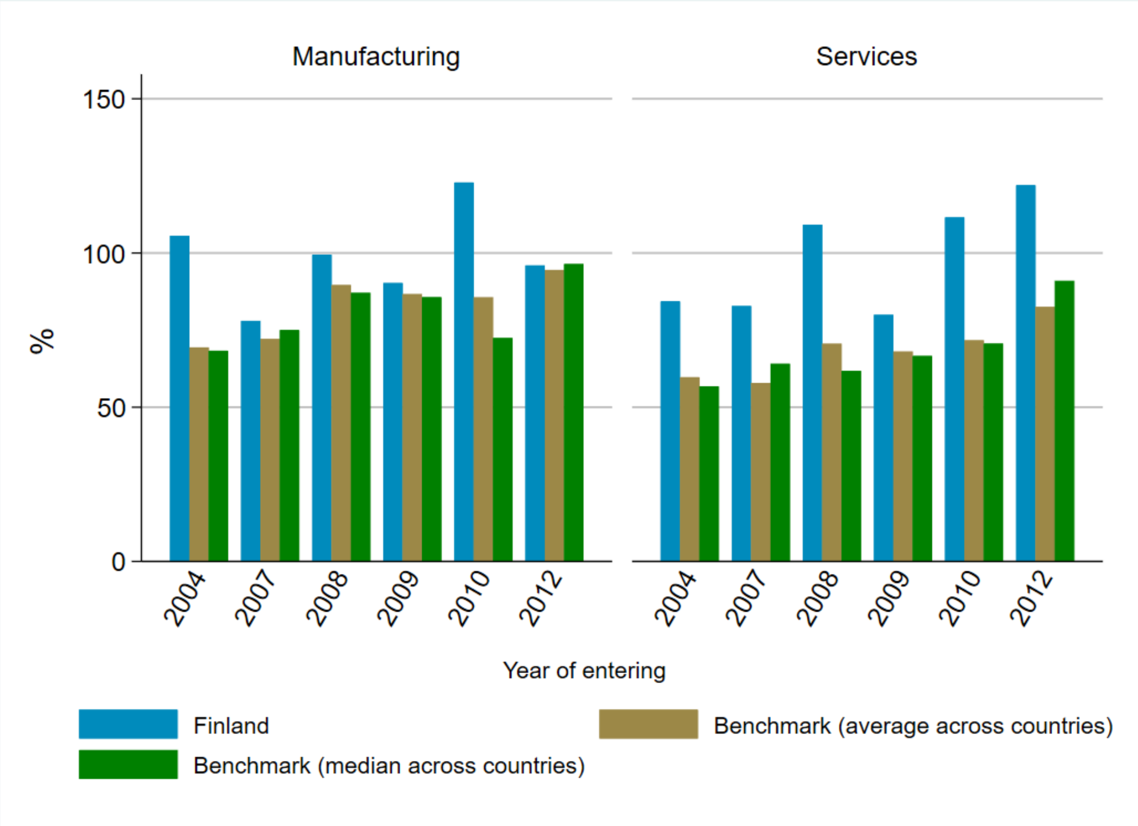

Figure 17 Post-entry growth of micro-entrants five years after entering

Figure 17 presents the third up-or-out indicator and the last indicator to be considered in the context of competition in this thesis, which is the post-entry growth of micro-entrants five years after entering the market in Finland and the benchmark in manufacturing and services. This indicator speaks the same story as the previous indicator: the growth of micro-entrants is higher in comparison with the benchmark in all cohorts and both sectors. In services, the trend appears to be increasing both in Finland and in the benchmark. Still, the 2009 cohort is again lower than the rest of the cohorts in Finland. In manufacturing, the upward trend is seen mainly in the benchmark whereas in Finland the post-entry growth has been more volatile. The greatest differences between Finland and the benchmark in manufacturing are in cohorts 2004 and 2010. The other cohorts are relatively aligned with the benchmark.

If the static indicators did not indicate a weakened state of competition, the dynamic indicators would suggest it even less. In fact, the dynamic indicators, and especially up-or-out indicators, suggest that Finland performs very well in terms of business dynamism when compared to the benchmark. From a competition perspective, the interpretation could be ambiguous. On the one hand, the high growth of micro-entrants could be an indication of competitive pressure if new firms innovate and supersede the incumbent firms. On the other hand, the high survival together with high post-entry growth might point to a higher selection process in entry, which could be related to barriers to entry. Nevertheless, typically barriers to entry also mean lower entry rates, which is not supported by the data in the case of Finland.

7 Conclusions

In Finland, the slowdown in LP growth after the GFC has been more severe than in other countries. This thesis aimed to examine whether there has been any change in the state of competition that could have contributed to the slowdown in productivity growth. This was done by investigating several indicators of competition, both static and dynamic, analysing them both in absolute and relative terms, and finally by comparing the changes in the state of competition at the time productivity growth slowed down. The analysis was carried out utilizing MultiProd and DynEmp cross-country industry-level data.

In the light of the indicators analysed and presented in this thesis, the changes in the state of competition do not appear to be the answer to the sluggish productivity growth in Finland after the GFC. In general, there are no apparent changes in the state of competition after the GFC. Neither do the results indicate that competition would be any lower in digital services, in which Finnish Productivity Board (2021b) found the productivity to be the lowest.

Regarding the static indicators, the low productivity dispersion, as well as low mark-ups would suggest a rather healthy state of competition in Finland. Even though the high concentration and low allocative efficiency are not ideal, and policy action may be needed to improve them in the future, neither of them explain the sluggish productivity growth after the GFC since their trends have stayed rather stable throughout the observation period. The only radical change has taken place in digital manufacturing, where the fall of Nokia altered allocative efficiency, concentration, and productivity dispersion. However, not even this change has impacted mark-ups, and in fact the weakening of the largest player in the industry usually tends to increase competition in the market rather than decrease it.

When it comes to business dynamism and particularly up-or-out indicators, Finland appears to perform very well in comparison with the benchmark. From a competition perspective, the interpretation could be ambiguous. On the one hand, the high growth of micro-entrants could be an indication of competitive pressure if new firms innovate and supersede the incumbent firms. On the other hand, the high survival together with high post-entry growth might point to a higher selection process in entry, which could be related to barriers to entry. Nevertheless, typically barriers to entry also mean lower entry rates, which is not supported by the data in this case. The entry rates are in line with the benchmark. As in static indicators, there are no clear changes in the indicators at the time of GFC or after it.

Regarding the limitations of the empirical analysis, it was unfortunately not possible to test the actual relationship between competition and innovation empirically within the framework of this thesis, or directly between competition and productivity due to data availability and the scope of this thesis. Industry-level data on innovation, more specifically on patents, are neither easily nor freely accessible. For further research, it would be interesting to examine the actual relationship if these limits are overcome. Another limitation of the analysis was the relatively restricted benchmark group. Finland is usually compared to its main trading partners, but the data availability limited implementing this in this instance.

The results of this thesis give several motives to continue studying the explanations for the sluggish LP growth in Finland. As expected, the fall of Nokia has clearly affected the indicators in digital manufacturing. It would be interesting to examine whether the collapse of Nokia also triggered the productivity of other industries in digital manufacturing, or even more precisely in the computer and electronics industry. Another further research topic arising from the results could be to look more closely at the factors behind the poor allocative efficiency.

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Appendices

Appendix 1 Methodology of the indicators in detail

All the indicators rely on certain dimensions of analysis (Calvino et al., 2020, p. 53): First, the unit of analysis in the DynEmp and MultiProd data collection is the firm. The letter i points to the firm in the indicators' formulas. Second, the indicators are computed at different thresholds. In DynEmp, these thresholds include, size class, age class, industry, country, and in MultiProd, thresholds are the same plus productivity quantiles. These scopes allow for defining cells at different levels of aggregation. In the indicators, the cells are marked as c. Each cell c is computed at different points in time and the time reference unit is a year. The time is marked as t in the indicators. Within each cell c, the DynEmp database separates units of different statuses, which are entering-, incumbent and exiting units. A unit is an entering unit (i.e. entrant) in t if it is not present in the data in year $t-1$ but is present in t with positive employment. A unit is an exiting unit (i.e. exitor) in t if it is not present in t and is there in $t-1$ with positive employment. A unit is an incumbent unit if it is present both in $t-1$ and in t with positive employment. Third, a number of units, *I,* in the indicators' formulas, indicates the total number of units i in a cell c at time t. And lastly, total employment, marked as *E* in the indicators' formulas, indicates the sum of employment across all units i in a cell c, so as

$$E_{c,t} = \sum_{i \in c} E_{i,t} \tag{9}$$

Gross output share of the top decile

The first indicator used to measure concentration is the gross output share of the top decile. It measures the industry share by the share of gross output of the top 10 per cent of firms. The indicator equals 100 per cent if there is only one firm in the industry and draw near zero if there is an infinite number of equal firms in terms of output in the industry. (Berlingieri et al., 2017; OECD, 2021d, p. 11.) The gross output share of the top decile is computed as

$$\frac{GO_{c,t}^{Q_5}}{\sum_{i=1}^{5} GO_{c,t}^{Q_i}} \times 100 \tag{10}$$

where variable GO is gross output and Q_i denotes quantile[16]. In consequence, $GO_{c,t}^{Q_5}$ defines the gross output of the top decile of firms and $\sum_{i=1}^{5} GO_{c,t}^{Q_i}$ is the total gross output of all deciles.

Herfindahl-Hirschman index

The second indicator of concentration used is the HHI, which is the most used concentration measure in the competition literature. A HHI close to 0 indicates that there are many firms with a low industry share, while a HHI 10,000 indicates that there is only one single firm in the industry. Alternatively, and as done in this analysis, if per cents are not used as whole numbers, e.g. 0.5 instead of 50, the index ranges from 0 to 1. Since the maximum value HHI theoretically can get is 1, the cells with values over 1 are dropped. By summing squares, larger firms get higher weight than the smaller ones, so the HHI emphasizes the significance of larger firms. (OECD, 2021d, p. 12.) The HHI for an industry can generally be expressed as

$$\sum_i \left(\frac{GO_{ir}}{GO_r}\right)^2 \tag{11}$$

where $\frac{GO_{ir}}{GO_r}$ denotes the industry r share by the share of gross output of firm i. In this case, because MultiProd does not have all the data for all the firms in the country, we have to use a sum of inverse probability weights to get the total number of firms in the country-industry-year population. HHI is therefore in this case:

$$\frac{P2GO\_av_{c,t} \times P2GO\_sum\_w_{c,t}}{(GO\_av_{c,t} \times GO\_sum\_w_{c,t})^2} \tag{12}$$

Where $P2GO\_av_{c,t}$ denotes the country-industry-year average of gross output of the number n firms i in the cell c, i.e. $P2GO\_av_{c,t} = \frac{1}{n}\sum_{i=1}^{n} GO_i^2$, $P2GO\_sum\_w_{c,t}$ is the sum of the inverse probability weights for $P2GO\_av_{c,t}$ and it should approximately equal

[16] In MultiProd, the industry is divided into five quantiles, ranked based on their gross output. The quantiles are 0-10th, 10th-40th, 40th-60th, 60th-90th and 90th-100th, in which the top decile 90th-100th is marked as Q_5.

the total number of firms in the country-industry-year population. GO_av is the country-industry-year average of the gross output and GO_sum_w is the sum of the inverse probability weights for GO.

Productivity dispersion

Productivity dispersion is measured with 90-10 productivity ratio, which is defined as the ratio between the 90th and the 10th percentile of the productivity distribution (Berlingieri et al., 2017, p. 26). The 90-10 ratio is computed in this analysis as

$$(LogMFP)_{c,t}^{P_{10}} - (LogMFP)_{c,t}^{P_1} \qquad (13)$$

where $(LogMFP)_{c,t}^{P_{10}}$ denotes the logarithmic MFP[17] at the 90th percentile and $(LogMFP)_{c,t}^{P_1}$ is the logarithmic MFP at the 10th percentile. The result coming out of the ratio is quite intuitive: the firms at the top of the productivity distribution produce X times as much as firms at the bottom of the productivity distribution given the same input, in other words, their productivity is X times higher (Berlingieri et al., 2017, p. 26).

Olley and Pakes decomposition

The Olley and Pakes (1996) decomposition is used as a measure of allocative efficiency. According to Olley and Pakes, the industry MFP can be decomposed into an (unweighted) average of firm-level MFP and a covariance term that represents reallocation (see Berlingieri et al., 2017, p. 36). The OP covariance term is defined as follows:

$$\frac{cov\left(VA_{i,t}, \log\left(MFP_{i,t}\right)\right)}{\frac{1}{n}\sum_{i=1}^{n} VA} \qquad (14)$$

Where $cov\left(VA_{i,t}, \log\left(MFP_{i,t}\right)\right)$ is the covariance of the value added of firm i and the logarithmic MFP of the firm i, and $\frac{1}{n}\sum_{i=1}^{n} VA$ refers to the average of value added of the number n firms i. The OP covariance term relative to logarithmic MFP is calculated by

[17] To calculate MFP, the Wooldridge (2009) control function approach is utilized, and value added is used as a measure of output. Firm production function is assumed to be a Cobb-Douglas: $Y_{i,t} = A_{i,t}K_{i,t}^{\sigma_K}L_{i,t}^{\sigma_L}$, where $A_{i,t}$ is firm i's MFP, which will be estimated. Wooldridge method is a regression-based method, that corrects for bias in estimates. (Berlingieri et al., 2017, p. 26)

dividing the equation 14 by $Log\_MFP\_W\_w\_VA\_av_{c,t}$, where $Log\_MFP\_W\_w\_VA\_av_{c,t}$ is the value added weighted average of logarithmic MFP of the firms in the cell c. Formally the same is

$$Log\_MFP\_W\_w\_VA\_av_{c,t} = \frac{1}{n}\sum_{i=1}^{n} Log(MFP_{i,t}) \times VA_{i,t} \tag{15}$$

The OP covariance term relative to logarithmic MFP shows the share of reallocation into MFP in percentages.

Mark-ups

MultiProd version 2 includes firms' mark-ups for the first time and they are computed using De Loecker and Warzynski (2012) methodology. In this method, mark-ups are computed as

$$\frac{Output\ elasticity_{i,t}}{Input\ costs\ revenue\ share_{i,t}} \tag{16}$$

The firm's input costs revenue share is observed in the data and is computed as $\frac{II_i}{GO_i}$, where II_i is the input costs of the firm i and GO_i refers to gross output of the firm i. The output elasticity of the firm i is estimated using the Ackerberg et al. (2015) production function[18]. Mark-ups equal 1 if output elasticity equals input costs revenue share, in other words, competition is perfect. Practically, output elasticity is always higher, and thus mark-ups are greater than 1.

Entry rate

Entry rate is measured as a share of entering units in all active units. The entry rate is computed as

$$\frac{I_{c,t}^{ent}}{I_{c,t}^{ent} + I_{c,t}^{incb}} \times 100 \tag{17}$$

[18] Further details and a corresponding application can be found for example in Calligaris et al. (2018, pp. 8–9).

where $I_{c,t}^{ent}$ denotes the number of entering units in cell c (i.e. a country-industry) at time t, and $I_{c,t}^{incb}$ denotes the number of incumbent firms. Entry rate equals 100 per cent if all the units are new, i.e. entrants, and 0 per cent if there are no entrants at time t .

Job reallocation rate of incumbents

Job reallocation rate of incumbents is computed as

$$\frac{JC_{c,t}^{incb} + JD_{c,t}^{incb}}{\frac{1}{2}\left(E_{c,t}^{incb} + E_{c,t-1}^{incb}\right)} \times 100 \qquad (18)$$

where job creation $JC_{c,t}^{incb}$ is defined as a sum of all positive unit-level job variations between $t-1$ and t in cell c, thus $JC_{c,t}^{incb} = \sum_{i \in c} \Delta^{+} E_{i,t}^{incb}$, and job destruction $JD_{c,t}^{incb}$ is defined as an absolute value of the sum of all negative unit-level job variations between $t-1$ and t in cell c, thus $JD_{c,t}^{incb} = \sum_{i \in c} \Delta^{-} E_{i,t}^{incb}$. The job reallocation rate shows the share of reallocated employment of incumbents in the average of employment of incumbents in percentages.

Survival share of micro-entrants

The survival share of micro-entrants is computed as

$$\frac{I_{c,t+j}^{surv\_microent}}{I_{c,t}^{microent}} \times 100 \qquad (19)$$

where $I_{c,t+j}^{surv\_microent}$ denotes the number of micro-entering units in cell c at time $t+j$, i.e. surviving micro-entrants, and $I_{c,t}^{microent}$ denotes the number of micro-entering units in cell c at time t, i.e. all micro-entrants in the previous period. Micro-entering unit refers here to an entrant at time t with 2-9 persons engaged. In transition matrices, at time t, only entering units of size class 2-9 are kept. At time $t+j$, firms are considered as surviving firms if they i) do not exit between t and $t+j$, ii) are not in size class 0-1 and iii) do not have missing employment. The share equals 100 per cent if all micro-entrants survive to the next period $t+j$.

Share of growing firms among all surviving micro-entrants

Share of growing firms among all surviving micro-entrants indicates the number of surviving and growing entrants over the number of all surviving micro-entrants. The share is computed as

$$\frac{I_{c,t+j}^{surv\_microent\_g}}{I_{c,t+j}^{surv\_microent\_g} + I_{c,t+j}^{surv\_microent\_s}} \times 100 \qquad (20)$$

where $I_{c,t+j}^{surv\_microent\_g}$ denotes the number of surviving and growing micro-entering units in cell c at time $t + j$, and $I_{c,t+j}^{surv\_microent\_s}$ is the number of stable, i.e. surviving but not growing, micro-entering units in cell c at time $t + j$. As in the previous indicator, at time t, only entering units of size class 2-9 are kept. At time $t + j$, firms are considered as surviving if they i) do not exit between t and $t + j$, ii) are not in size class 0-1 and iii) do not have missing employment. Firms are considered as growing micro-entrants if they are in size class 2-9 at time t and in larger size classes (≥10 persons engaged) at time $t + j$, and as stable micro-entrants, those whose size class is still 2-9. The share equals 100 per cent if all surviving micro-entrants grow.

Post-entry growth of micro-entrants

Post-entry growth of micro-entrants is calculated as

$$\frac{E_{c,t+j}^{surv\_microent}}{E_{c,t}^{surv\_microent}} \qquad (21)$$

where $E_{c,t+j}^{surv\_microent}$ denotes the total employment in surviving micro-entrants in cell c at time $t + j$, and $E_{c,t}^{surv\_microent}$ is the total employment in these same units in cell c at time t. More specifically, at time t, the total employment in entering units in size class 2-9 is kept. At time $t + j$, the analysis focuses on the total employment of those same micro-entering units from time t that i) do not exit between t and $t + j$, ii) are not in any other size class than 2-9 and iii) do not have missing employment. The share equals 100 per cent if the total employment has doubled from the previous period

Appendix 2 Data coverage and industry classification

Table 2 Data coverage in MultiProd in chapter 6.1

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BEL	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
FIN	■	■	■	■	■	■	■	■	■		■	■	■	■	■
FRA[19]	■	■	■	■	■	■	■	■	■	■	■	■			
ITA	■	■	■	■	■	■	■	■	■	■	■	■			
NLD[20]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PRT[21]	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SWE[22]				■	■	■	■	■	■	■	■	■	■	■	■

Table 3 Data coverage in DynEmp in chapter 6.2

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AUT	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
BEL	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
ESP	■	■	■	■	■	■	■	■	■	■	■	■			
FIN	■	■	■	■	■	■	■	■	■		■	■	■	■	■
FRA[23]	■	■	■	■		■	■	■	■	■	■	■			
HUN		■	■	■	■	■	■	■	■	■	■	■	■	■	■
ITA	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
NOR	■	■	■	■	■	■	■	■			■				
PRT	■	■	■	■	■	■		■	■	■	■	■			
SWE							■	■	■	■	■	■	■	■	■

[19] France is excluded from the top decile gross output share.
[20] The Netherlands has a threshold of 10 firms, so the 90-10 ratio is not covered.
[21] Portugal is excluded from Olley and Pakes indicator, and the 90-10 ratio is not covered in 2018
[22] The Swedish data do not cover mark-ups.
[23] The French data do not cover transition matrices; therefore, France is included in the benchmark group only in entry rates and job reallocation rates of incumbents.

Table 4 SNA A38 and A7 aggregations

SNA A38 aggregation based on ISIC Rev.4 classification	SNA A7 aggregation
01 to 03 AGRICULTURE, FORESTRY AND FISHING	**Agriculture**
05 to 09 Mining and quarrying	**Mining**
10 to 12 Food products, beverages and tobacco	**Manufacturing**
13 to 15 Textiles, wearing apparel, leather and related products	
16 to 18 Wood and paper products, and printing	
19 Coke and refined petroleum products	*Excluded*
20 Chemicals and chemical products	**Manufacturing (continued)**
21 Basic pharmaceutical products and pharmaceutical preparations	*Excluded*
22 to 23 Rubber and plastics products, and other non-metallic mineral products	**Manufacturing (continued)**
24 to 25 Basic metals and fabricated metal products, except machinery and equipment	
26 Computer, electronic and optical products	
27 Electrical equipment	
28 Machinery and equipment n.e.c.	
29 to 30 Transport equipment	
31 to 33 Furniture; other manufacturing; repair and installation of machinery and	
35 Electricity, gas, steam and air conditioning supply	**Utilities**
36 to 39 Water supply; sewerage, waste management and remediation activities	
41 to 43 CONSTRUCTION	**Construction**
45 to 47 Wholesale and retail trade, repair of motor vehicles and motorcycles	**Market services**
49 to 53 Transportation and storage	
55 to 56 Accommodation and food service activities	
58 to 60 Publishing, audiovisual and broadcasting activities	
61 Telecommunications	
62 to 63 IT and other information services	
64 to 66 FINANCIAL AND INSURANCE ACTIVITIES	*Excluded*
68 REAL ESTATE ACTIVITIES	*Excluded*
69 to 71 Legal and accounting activities; activities of head offices; management consultancy activities; architecture and engineering activities; technical testing and analysis	**Market services (continued)**
72 Scientific research and development	
73 to 75 Advertising and market research; other professional, scientific and technical activities; veterinary activities	
77 to 82 Administrative and support service activities	
84 Public administration and defence	*Excluded*
85 Education	**Non-Market services**
86 to 88 Human health and social work activities	
90 to 93 Arts, entertainment and recreation	
94 to 96 Other service activities	

Table 5 Digital and non-digital classification by STAN A7 aggregation

Manufacturing	**Digital**	26 Computer, electronic and optical products
		28 Machinery and equipment n.e.c.
		29 to 30 Transport equipment
	Non-digital	10 to 12 Food products, beverages and tobacco
		13 to 15 Textiles, wearing apparel, leather and related products
		16 to 18 Wood and paper products, and printing
		20 Chemicals and chemical products
		22 to 23 Rubber and plastics products, and other non-metallic mineral products
		22 to 23 Rubber and plastics products, and other non-metallic mineral products
		24 to 25 Basic metals and fabricated metal products, except machinery and equipment
		27 Electrical equipment
		31 to 33 Furniture; other manufacturing; repair and installation of machinery and equipment
Services	**Digital**	61 Telecommunications
		62 to 63 IT and other information services
		69 to 71 Legal and accounting activities; activities of head offices; management
		72 Scientific research and development
		73 to 75 Advertising and market research; other professional, scientific and technical activities; veterinary activities
		77 to 82 Administrative and support service activities
	Non-digital	45 to 47 Wholesale and retail trade, repair of motor vehicles and motorcycles
		49 to 53 Transportation and storage
		55 to 56 Accommodation and food service activities
		58 to 60 Publishing, audiovisual and broadcasting activities

Table 6 Technology and knowledge-intensive classification by STAN A7 aggregation

Manufacturing	**Low/medium-low technology-intensive**	10 to 12 Food products, beverages and tobacco
		13 to 15 Textiles, wearing apparel, leather and related products
		16 to 18 Wood and paper products, and printing
		22 to 23 Rubber and plastics products, and other non-metallic mineral products
		24 to 25 Basic metals and fabricated metal products, except machinery and equipment
		31 to 33 Furniture; other manufacturing; repair and installation of machinery and equipment
	Medium-high/high technology-intensive	20 Chemicals and chemical products
		26 Computer, electronic and optical products
		27 Electrical equipment
		28 Machinery and equipment n.e.c.
		29 to 30 Transport equipment
Services	**Less knowledge-intensive**	45 to 47 Wholesale and retail trade, repair of motor vehicles and motorcycles
		49 to 53 Transportation and storage
		55 to 56 Accommodation and food service activities
		77 to 82 Administrative and support service activities
	Knowledge-intensive	58 to 60 Publishing, audiovisual and broadcasting activities
		61 Telecommunications
		62 to 63 IT and other information services
		69 to 71 Legal and accounting activities; activities of head offices; management consultancy activities; architecture and engineering activities; technical testing and analysis
		72 Scientific research and development
		73 to 75 Advertising and market research; other professional, scientific and technical activities; veterinary activities

Appendix 3 Additional results

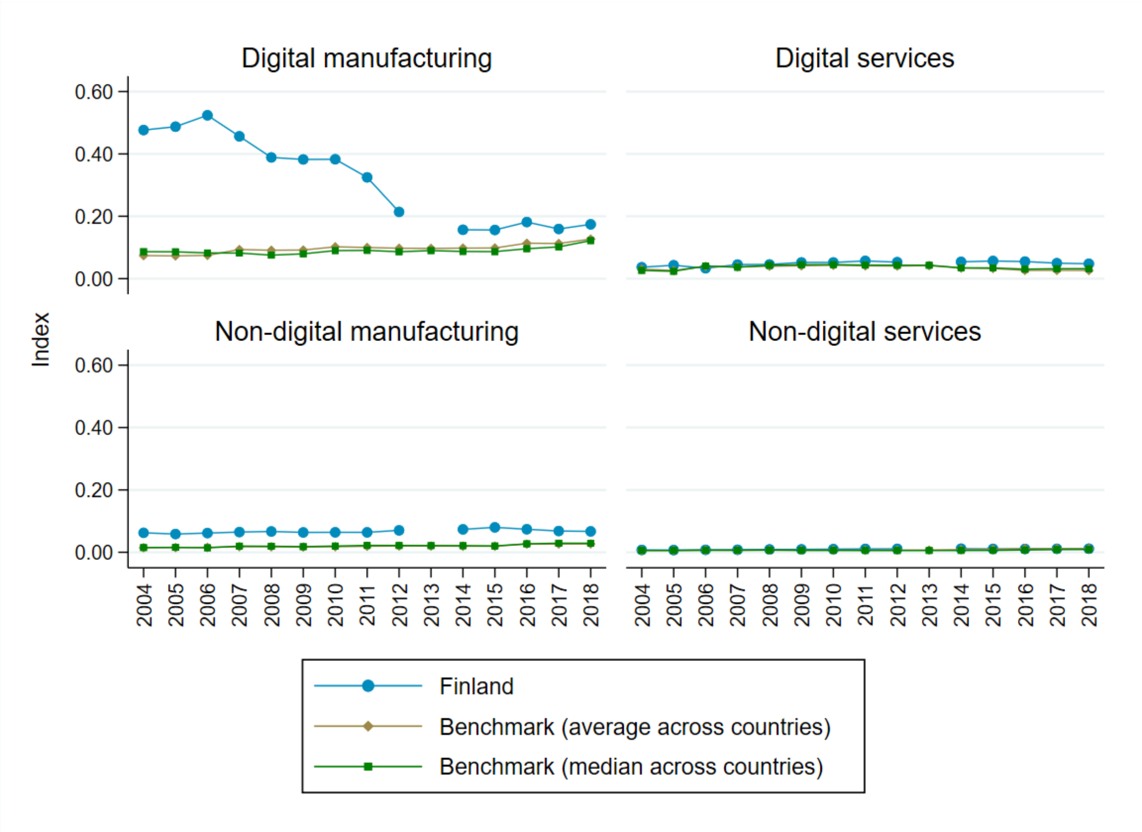

Figure 18 HHI