How to maintain a technologically progressive economy while preventing unemployment?

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Research question:

Could Baumol's (1993, 2012) solution to the cost disease – i.e. the transfer of productivity gains from the technologically progressive to the technologically stagnant sector – help to maintain a technologically progressive economy, while preventing unemployment? If so, under what conditions would this be the feasible?

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List of Abbreviations

AI	....	Artificial intelligence
CbC	....	Country-by-country
CBS	....	Centraal Bureau voor de Statistiek
CPP	....	Consumer purchasing power
E	....	Number of people employed
ECB	....	European Central Bank
GDP	....	Gross domestic product
GPT	....	General purpose technology
GAV	....	Gross added value
H	....	Amount of hours workked
ICT	....	Information communication technology
ILO	....	International Labour Organization
IT	....	Information technology
OECD	....	Organisation for Economic Co-operation and development
p	....	Progressive sector
R-M	....	Rehn-Meidner
RE	....	Relative employment
RULC	....	Relative unit labour cost
s	....	Stagnant sector
t	....	Calendar year
U.K.	....	United Kingdown
ULC	....	Unit labour cost
U.S.A.	....	United States of America
w	....	Hourly wage
Y	....	Output per year
λ	....	Labour productivity

Executive Summary

Summary

The jobs of the world population are increasingly threatened in a world filled with constant technological improvements, and automation of tasks by machinery and artificial intelligence. Substitution of labour by machines is not only occurring in blue-collar jobs (usually uniformed workers working in eg. manufacturing) but increasingly also in white-collar jobs (usually 'suit-and-tie' workers working in offices). The more labour-saving technology is created and deployed, the more jobs are made obsolete, possibly leading to technological unemployment.

This problem is likely to be aggravated by research and policies that are concerned with the so-called 'productivity paradox' or 'Solow-paradox', as well as the 'cost disease', and that seek to avoid or remedy both by increasing labour productivity across-the-board, that is, in 'personal services' such as education, health care, research, and the arts as well as in the goods-producing economy. If this were feasible, how could technological unemployment be avoided? Another option, explored in this thesis, is to take a fresh look at these phenomena, by asking whether they really are a 'disease' or 'paradox', or simply a consequence of a (harmless) natural structural change that is taking place in society, namely, the growth of 'personal services' relative to the physical (goods-producing) economy.

Inspired by the writings of William Baumol (1993, 2012), this thesis explains that it will be possible to avoid dramatic increases in unemployment, if the productivity gains that are achieved in the technologically progressive sector (that implements labour-saving technologies) are used to fund the creation of new work in the technologically stagnant sector, the sector that tends to have a lower labour productivity growth compared to the technologically progressive sector. According to Baumol (1993, 2012), it is not possible or not desirable to increase labour productivity in the stagnant sector in the same way as this happens in the progressive sector by for example replacing human beings with software, machines, and AI. It may not be possible because of the nature of work in the stagnant sector compared to the progressive sector and it may not be desirable because the quality of services may decrease (Baumol & Wolff 1998).

A case study involving the Netherlands and Germany, both of which are shown to suffer from the 'cost disease', was carried out to investigate whether the transfers of funds from the progressive to the stagnant sector is a realistic possibility. If resources are to be transferred from the progressive to the stagnant sector, the question arises how this could be realised. One possibility is investigated, namely, that governments implement profit taxation in the technologically progressive sector to collect the productivity gains in this sector and then use it to fund new work

in the technologically stagnant sector, including a public educational system. The conditions under which this solution is feasible was then investigated for the Netherlands and Germany, and concludes that Baumol's (1993, 2012) solution to the cost disease could be realised if 50-70% of productivity gains in the progressive sector are used to fund work in the stagnant sector, and as long as the average wage rate in the stagnant sector is not consistently higher than the average wage rate in the progressive sector.

Message to the executives

The information provided in this thesis is important for executives with the role of policy makers and governmental entities. The message for such executives is that a solution for technological unemployment in an economy could be to tax companies in the progressive sector and use this transfer to fund new work in the stagnant sector. This would be relevant for executives in all countries because even though only two countries were considered in the case study, these countries have different economic structures. It is relevant for such executives because not only does it address the problem of technological employment, which is an important factor that policy makers and political entities have to address to ensure its society is satisfied with their government, but also provides a solution and the conditions for which this solution is feasible.

An additional, but just as important executive for whom this thesis is relevant to, are the board of directors of companies in the progressive sector. The structural economic change discussed in this thesis may open the eyes of board of directors to the disadvantage that society faces when large multinational corporations avoid taxes. Governments acquire most of their financial budget from taxation of entities, let it be personal or a corporation. Large multinational corporations have a much larger amount of yearly income than a person as an entity, and so their tax payments to the government is crucial in ensuring financial means for the government to invest in society. In this way, large corporations hold a lot of the power when it comes to providing for society, and so, they should reflect and realize their role in society and work towards being more socially responsible.

The scope of this thesis, however, highlights great changes within the labour market structure due to technologies which affects society as a whole, and so, this thesis may also be of interest for the general society to read. By gaining more insights into the structural change in the labour market, society as a whole, could become more aware how innovations affect the labour market, not just by possibly making some jobs obsolete, but also by creating new jobs which require new skills and funding.

Introduction

Throughout the existence of humankind, people have been trying to save labour by inventing and using new technologies such as the steam engine, the electric motor, and computers, which are named 'general purpose technologies' or GPTs (T. Bresnahan, 2010). Companies purchase these technologies or capital in order to increase labour productivity. Labour productivity growth not only makes goods cheaper, but it also reduces the need for people to do boring-draining work, which now automated machines may perform. Brynjolfsson and McAfee even claimed: "In the long run, productivity growth is almost the only thing that matters for ensuring rising living standards", as automated machines free people from repetitive-dull work, particularly in the manufacturing industry (Mazzucato & Perez, 2016).

One would think that the more investment is put into technology R&D, the more technology is invented and thus higher labour productivity growth. However, economist Robert Solow noted in 1987 that there has been a slowdown in productivity growth in the U.S. despite the growing investment in information technology (IT), a phenomenon that became known as the 'productivity paradox' (Dewan & Kraemer, 1998). The productivity paradox is, however, not only a paradox from the time frame of IT from 1960 to 1990s. There has also been a slowdown in the measured labour productivity growth from 2005 to 2015 in the U.S. (Syverson, 2016). The productivity paradox is therefore not limited to IT, and is present within other GPTs, such as automation technologies. The paradox means that even if more money is invested into researching and producing innovative technologies, this does not result in an equally quantified labour productivity growth from the newly invented technologies. The productivity paradox was claimed to be a problem in Europe by Jean-Claude Trichet in 2006, the president of the European Central Bank (ECB) while giving a speech in Paris in 2006 (Trichet, 2006). He claimed that Europe needs reform in order to overcome this problem.

In order to fix a problem, the root or the cause of the problem needs to be studied. The origin of the paradox has been studied by several academics in the past years, and various possible causes of the paradox have been brought forward. There are a few of the explanations of the existence of the productivity paradox. These explanations and origins for the productivity paradox will be discussed in this thesis, and the possible solutions to the productivity paradox will be analysed.

The paradox is considered a problem because technology is seen as a great invention that can only make peoples' lives better off. However, this might not be the complete story. Machines, computers, and various other technologies have made many jobs obsolete, particularly in the manufacturing industry. (Hornstein, Krusell, & Violante, 2005; Mazzucato & Perez, 2016)

Therefore, if it were possible to solve the productivity paradox by restoring productivity growth, this may have a downside, namely technological unemployment. (Brynjolfsson & McAfee, 2011; Di Pietro, 2002; Harari, 2018; Naastepad & Mulder, 2018). The reasoning for this is because if the productivity paradox is fixed, more investment into innovation will lead to more innovative technologies, which will perform work that was previously done by a person, leading to technological unemployment.

Even though possible downsides of technological advancements (such as unemployment) have been researched in-depth, the dominant approach to the productivity paradox is that productivity growth should be restored by major investments in technology. The risk that this will increase technological unemployment is often ignored in the solutions. There is, therefore, a knowledge-gap that has plenty of room to be investigated:

Is there a solution to the productivity paradox that prevents technological unemployment?

The dominant view that overall labour productivity growth needs to be restored is not shared by the economist William Baumol. Baumol (2012) presents an unconventional view that suggests that it is possible to maintain a technologically progressive economy while preventing unemployment. This work could be used in order to find an answer to the knowledge-gap of how the productivity paradox could be solved while preventing unemployment.

Baumol splits the economy into two sectors: technologically stagnant (where productivity is constant or growing at a slow rate, e.g. services such as health care) and technologically progressive (productivity is rising, e. g. manufacturing). He claims that there is a macroeconomic unbalanced growth due to differences in technological advancement between the progressive and the stagnant sector. There are technological advancements in the progressive sector due to the adoption of innovations that make labour more productive, while productivity in the stagnant sector is slowly increasing or not at all. He claims that it will be hard to remove the imbalance in productivity growth rates by increasing labour productivity in the stagnant sector while maintaining a good quality of service (Baumol, 1967).

In 2012, Baumol writes about the cost disease: one of the outcomes of this macroeconomic unbalanced growth. This disease is the tendency for the cost of stagnant sectors such as health care and education to grow relative to the costs of the progressive sector (Baumol, 2012). The reason for the increase in cost is because of the realistic assumption that as productivity increases in the progressive sector, higher wages are demanded, and are given to the whole economy, meaning that the stagnant sector also sees an increase in wages even though it does not have a relative increase in productivity.

Based on Baumol's analysis of the structural growth of the stagnant relative to the progressive sector, this thesis suggests that it will be possible to prevent technological unemployment if people who perform jobs for the progressive sector that become obsolete due to new innovations can shift to new jobs in the stagnant sector. This would imply a major macroeconomic shift in terms of workforce, so that the larger share of the population would work in the stagnant sector, offering services, while machines take over most of the progressive sector's work. If the stagnant sector is permitted to grow, technological unemployment could be prevented, because all those whose labour is no longer needed in the technologically progressive sector could find new work in 'personal services'.[1] Such a structural change (the growth of personal services relative to the technologically progressive economy) would allow the maintenance of a technologically progressive economy while preventing unemployment. It could also prevent possible declines in the quality of personal services caused by attempts to artificially increase labour productivity in the stagnant sector (Baumol, 2012).

Baumol's more recent writings (1993, 2012) allow the productivity paradox (as well as the cost disease) to be seen through a different lens. The productivity paradox may disappear once we realize that automation technologies may be possible in the progressive sector of the economy, but not to the same degree in the stagnant sector. In the stagnant sector, it could even be the case that the opposite happens: that automation technologies decreases productivity. The cost disease also appears in a different light: is the rise in stagnant sector's costs a disease, or just a consequence of an underlying structural change that, from a societal point of view, desirable?

This has led to the main research question for this thesis:

"*Could Baumol's (1993, 2012) solution to the cost disease – i.e. the transfer of productivity gains from the technologically progressive to the technologically stagnant sector – help to maintain a technologically progressive economy, while preventing unemployment? If so, under what conditions would this be feasible?*"

[1] See also Naastepad & Mulder (2018).

Thesis structure

The thesis is divided into three parts, the first part consists of a qualitative literature study, the second part of an econometric test of Baumol's model of unbalanced growth, and lastly, the third part consists of the conclusion, recommendations and relevance.

Part 1.

The thesis starts off by introducing the relationships between general purpose technologies, the productivity paradox and technological unemployment. Robert Solow's paradox that, according to many, needs to be solved to further increase labour productivity. However, solutions proposed to 'fix' the productivity paradox may aggravate technological unemployment and so a different solution is proposed based on a particular interpretation of the work of Baumol (1993, 2012).

The second chapter first defines the important term of labour productivity, and explain why we, as human beings innovate to make labour more productive. Thereafter, Baumol's 1967 article is introduced to shine a new light on why labour productivity has not been increasing as much as one may expect: this may be due to what Baumol (1967) called "unbalanced growth". Finally, the causes of this unbalanced growth will be discussed.

The third chapter introduces the consequence of unbalanced productivity growth, known as the cost disease and explains that neither unbalanced growth (and its consequence), nor the 'productivity paradox' are a problem if these phenomena are looked at from the perspective of structural economic change. Then, three different approaches will be explored to 'alleviate' the symptoms that come from unbalanced productivity growth. Baumol's solution is chosen for further analysis because his solution does not result in hindrance of technology progression, and the transfer of funds from one sector to the other ensures that workers from the progressive sector can acquire a job in the stagnant sector.

Part 2.

The fourth chapter investigates, via a case study, whether the Netherlands and Germany have the cost disease based on the four hypotheses formulated in this chapter (see Section 4.1).

The fifth chapter investigates econometrically under what conditions would Baumol's solution to the cost disease be feasible and discuss the method of profit taxation, its downsides, and solutions as a possibility to implement Baumol's solution.

Part 3.

The last closing chapter will highlight the conclusions within this thesis, recommendations for further research and end with closing remarks.

Research methodology

The research methodology for part one of this thesis consists of a literature study based on secondary qualitative data. The majority of the literature is published academic papers acquired from different sources, such as ScienceDirect and ResearchGate, and recommended articles by the primary supervisor. The other literature pieces used include books and dictionaries.

The second part of this thesis consists of an econometric test of Baumol's model of unbalanced growth via a case study method which uses information from a particular case with the purpose to generalize its finding. The case studied had a geographical focus in the Netherlands and Germany, and focused on health-care social work and education as the stagnant sector, and manufacturing as the progressive sector. For this case study, secondary quantitative data, mostly acquired from OECD was used. The data was selected on a date criterion from 1991-2018 (or 1996-2018 where data are lacking from the OECD). Some of the desired variables for analysis were found within the data base, but others had to be calculated from the data available. Excel was used to compute any necessary calculations, the creation of graphs, analysis of graphs and the statistical test. The graph was analysed by a linear regression trendline, and the regression analysis function was used for the statistical test to gain insight into the R-square, F-value, significance F, coefficient, t-stat and p-value.

Part 1

Chapter 1. General Purpose Technologies', the 'Productivity Paradox', and Technological Unemployment

In this chapter, relationships between general purpose technologies, the productivity paradox and technological unemployment are introduced. An increase in investment in general purpose technologies does not always lead to a proportional increase in productivity growth. Robert Solow describes this as a paradox that, according to many, needs to be solved to further increase labour productivity. However, solutions proposed to 'fix' the productivity paradox may aggravate technological unemployment. This chapter is closed-off by proposing a different solution, based on a particular interpretation of the work of Baumol (1993, 2012). Baumol was primarily concerned with the quality of services provided by the stagnant sector, and paid little attention to problems of technological unemployment. However, if Baumol's (1993, 2012) suggestions were followed, this could help to prevent technological unemployment while maintaining a technologically progressive economy.

1.1 Automation as a General Purpose Technology (GPT)

Since the early days of humankind, we, human beings have invented several tools to make our lives easier. We started off with inventions such as bows and arrows, boats, wheels to later inventions seen today such as electricity, airplanes, computers, and artificial intelligence (AI). Many inventions have been invented with the purpose of decreasing the amount of labour or work performed by a person, thus increasing labour productivity. Increasing labour productivity by the means of inventions has allowed human beings to produce food, clothing, housing, and vehicles faster than ever.

In the past century, humans got more creative with their inventions, moving on from typewriters to computers. Scientific research allows for new concepts to be understood and reflected in a new piece of innovative technology. But what is technology? The most current definition of 'technology' by Collins English Dictionary states: "Technology refers to methods, systems, and devices which are the result of scientific knowledge being used for practical purposes." (Collins English Dictionary, n.d.-b). Nowadays, there are many different types of technologies being used around the world, but the focus of this paper lies on 'general purpose technologies', a self-explanatory category in which the technologies serve for general purposes, meaning they are not aimed to perform only one task.

General purpose technologies, referred to as GPTs, have four distinctive characteristics. First, it needs to be an enabling technology, meaning that it enables other technologies to exist. Second, it should be improved over time. Third, it induces further (complementary) innovations. Last but not least, it is adopted in a wide scope of sectors of an economy (T. Bresnahan, 2010; Liao, Wang, Li, & Weyman-Jones, 2016). Some examples of GPTs are steam engines, electricity, electric motors, computers and automation technologies (David & Wright, 1999; Oulton, 2012). Additionally, different general purpose technologies may exist at the same time, and complement each other, like electricity enabled computers (Schaefer, Schiess, & Wehrli, 2014).

Automation technologies are an example of GPT (Acemoglu & Restrepo, 2017) which will be focused on throughout the entirety of this paper. Webster's dictionary has two definitions for 'automation'. The first one refers to manufacturing and defines it as "a system or method in which many or all of the processes of production, movement, and inspection of parts and materials are automatically performed or controlled by self-operating machinery, electronic devices, etc." Second, "any system or method resembling this in using self-operating equipment, electronic devices, etc. to replace human beings in doing routine or repetitive work." (Collins English Dictionary, n.d.-a) An example of automation technologies is industrial robots for factory optimization (Acemoglu & Restrepo, 2017).

The following paragraph lists examples of how automation technologies comply with the previously named characteristics of GPTs. First of all, automation technologies are an enabling technology because it requires additional technologies to be deployed, such as control systems. Furthermore, automation technologies is improved over-time, such as factory equipment, to make the process more time efficient. It also induces complementary innovations, such as self-scanner for the self-check-out lane at the supermarket. At last, it is adopted in a wide range of sectors in the economy, such as in the manufacturing industry as well as the service industry. Two examples of automation technologies facilitating work will now be highlighted. The first example are blue-collar workers, such as workers in manufacturing who experienced automation of their jobs due to the steam engines in the 18th century (T. Bresnahan, 2010). A second and more recent example are white-collar jobs being automated by the means of computers. Computers dedicated to work-processing systems have automated certain white-collar office tasks, such as reproducing repetitive documents, for example contracts and insurance forms, which could easily and quickly be modified and customized (David & Wright, 1999). Additionally, automation technologies are a technology that is enabled by and enables other GPTs. Industrial robots, artificial intelligence (AI), computers, and steam engines are just some examples of GPTs that have enabled automation (Acemoglu & Restrepo, 2017; David & Wright, 1999).

Automation technologies have been around for a long time and will probably continue to be around for the rest of the capitalist years. The first half of the 20th century had the peak of the industrial revolution, where mechanization led to the automation of much of blue-collar work and hard manual labour, such as in manufacturing. In the late 20th century, the productivity gains to automating blue-collar work were slowing down and the productivity gains to automating white-collar work were rapidly increasing (T. Bresnahan, 2010). A lot of white-collar work, normally done in suit-and-tie by people who often work in the service industry and avoid physical labour, became automated too via computerization and ICT (Parietti, 2019). Nowadays, artificial intelligence (IA) is automating more and more white-collar work.

1.2 Automation and the 'Productivity paradox'

Revisiting the definition of technology given in the previous chapter, technology is a result of scientific knowledge used for a practical purpose. Scientific knowledge, however, does not come cheap. For human beings to gain more scientific knowledge to produce innovative technologies, there needs to be research and development (R&D), which requires intelligent researchers, sophisticated apparatuses and other resources. Therefore, innovative technologies, such as GPTs, including automation technologies, require a great amount of investment in terms of research and development. By this logic, for our world to keep generating vast amounts of great innovative technologies, one would think it is needed to keep investing a vast amount of funds in R&D. However, economist Robert Solow noted in 1987 that there had been a slowdown in productivity growth despite the growing investment in information technology (IT), a phenomenon that became known as the 'productivity paradox', also known as the 'Solow paradox' (Dewan & Kraemer, 1998).

Solow observed the 'productivity paradox' with a geographical focus on the U.S.A. and information technology (IT) as the GPT. The annual growth rate in labour productivity had decreased from 3% in the 1960s to around 1% in the 1990s, even though IT investment had been growing at much larger rates for most of this time period (Dewan & Kraemer, 1998).

The productivity paradox is, however, not only a paradox from the time frame of 1960 to 1990s. There has also been a slowdown in the measured labour productivity growth from 2005 to 2015 in the U.S., averaging around 1.3% per year (Syverson, 2016). The productivity paradox is therefore not limited to IT, and is present within other GPTs, such as automation technologies.

Research has been done by academics on whether the productivity paradox exists in other countries, such as the research done by Dewan & Kraemer in 1998. In the study, five countries were looked at: U.S., Japan, France, Germany and the U.K. The conclusion driven from the study is that Solow's observation about the U.S. applied equally well to the other four countries. The trends for the five countries are similar, showing that the labour productivity growth decreased from a rough average of 5% in 1965 to only around 1-2% in the 1990s (Dewan & Kraemer, 1998). Since the study resulted that these four countries have the productivity paradox, it is a realistic possibility that the productivity paradox exists in many other countries. In 2006, the productivity paradox was claimed to be a problem in Europe by Jean-Claude Trichet, the president of the European Central Bank (ECB) while giving a speech in Paris in 2006. He claimed that Europe needs a reform to overcome this problem (Trichet, 2006). This paradox, which is encountered in the U.S.A., Europe, Japan and very possibly other countries, needs to be addressed. To fix the paradox, the root of the problem needs to be investigated. Six main existing explanations are described in the following section.

1.3 Which explanations have been given for the Productivity paradox?

The productivity paradox has intrigued many academics worldwide into finding a reason behind why the increase in investment is not consequently increasing labour productivity growth. A few of the explanations of the existence of the productivity paradox include financialization[2], a mismeasurement hypothesis[3], an adoption delay or implementation lag of the technology[4], labour hoarding[5], false hopes[6], and, lastly, concentrated distribution & rent dissipation[7]. I focus on financialization and the mismeasurement hypothesis because these are structural explanations, while the others are incidental explanations.

Financialization

The financialization hypothesis claims that there is too much speculative investment and not enough productive investment. The first explanation of the cause of financialization is due to the financial sector mainly lending to itself rather than to other sectors of the economy (Mazzucato & Perez, 2016; Mazzucato & Wray, 2015). This is counter-productive because the risks of the financial sector lending to itself are a lot higher and severely under-priced. The second

[2] Mazzucato & Perez, 2016; Mazzucato & Wray, 2015.

[3] Brynjolfsson, 1993; Korinek & Stiglitz, 2017; Syverson, 2016.

[4] Amendola, Gaffard, & Saraceno, 2005; Brynjolfsson, Rock, & Syverson, 2017; Ceccobelli, Gitto, & Mancuso, 2012; Korinek & Stiglitz, 2017; Liao, Wang, Li, & Weyman-Jones, 2016; Schaefer, Schiess, & Wehrli, 2014.

[5] Martin & Rowthorn, 2012.

[6] Schrage, 1997.

[7] Brynjolfsson, 1993; Brynjolfsson et al., 2017.

explanation, which explains the productivity paradox, is that the corporate sector focuses on short-term boosts of profit, such as 'mergers & acquisitions', and stays away from long-run investments such as R&D. Even if R&D were invested in, the preference would be for short-term R&D with the least committed capital as possible. This is because corporations do not see clear profit opportunities and are not willing to make long-term capital commitments (Mazzucato & Perez, 2016).

Mismeasurement hypothesis

Labour productivity growth is measured by the amount of output and input, and the mismeasurement hypothesis claims that labour productivity growth is undermeasured because output and input are not measured correctly.

There are three explanations of why output and input are not measured correctly. The first is that labour productivity growth is undermeasured, meaning that it although it may seem low, it is in fact higher. This is because of non-traditional sources of value (eg. quality, variety and customer service) that are not taken into account when measuring labour productivity growth because they are hard to quantify (Brynjolfsson, 1993).

The second explanation according to Brynjolfsson (1993), arises from the difficulty of developing accurate deflators. The prices need to be deflated accurately by removing the effects of inflation and adjusting for quality changes so that the comparison is reliable.

Lastly, Brynjolfsson (1993) states that input mismeasurement occurs because inputs may have long-lasting effects, such as spending on new software or robot and trainings for staff, but its costs is marked only the purchasing year. This could lead to an overestimated of these technologies on cost. However, these technologies with long-lasting effects may also have maintenance that are not fully accounted for, controversially, leading to an underestimate of these technologies on the costs. The current methods for measuring input and output is therefore adequate for some economic activities, where as highly inadequate for others. Brynjolfsson (1993) claimed that the measurement problems are worst in the service sector or with white collar workers than the manufacturing sector or with the blue collar workers, where measures are better.

Adoption delay (implementation lag of the technology)

Adoption delays can occur in three areas. First of all, the existence or utility of the GPT may be unnoticed to firms at the beginning of its launch, leading to a delay in adopting this GPT. Second, there can be a delay in the creation of complementary assets of the GPT that are necessary for certain tasks. Last, learning new skills needed for the usage of a GPT can be slow, especially in the beginning (Amendola, Gaffard, & Saraceno, 2005; T. F. Bresnahan & Trajtenberg, 1995; Liao et al., 2016).

Labour hoarding

Labour hoarding hypothesis claims that low productivity growth is because labour is underutilized. The output is lower than what it could be, because workers are not working to their full potential. The name of the hypothesis originates from companies that 'hoard' more employees than necessary, because their productivity is not to full potential (Martin & Rowthorn, 2012).

False hopes

Firms that invest in technology hope that this investment will improve their profitability and competitive position. According to (Schrage, 1997), the 'false hopes' hypothesis claims that it is irresponsible to rely on technology to solve fundamental problems because its solutions are over-rated. On the micro-level or industry level, companies could even get great returns on their digital investment, but the macro-level view is more pessimistic as it claims that more money has been put in investment than has been returned

Concentrated distribution & rent dissipation

There has been an increasing productivity and profit difference between frontier firms and average firms within the same industry. According to (Brynjolfsson, Rock, & Syverson, 2017), the explanation given for this is that the benefits of new innovative technologies are concentrated on a 'higher class' firm, which therefore continue to invest in technologies, and thus gain even more benefits. The 'lower class' firms, however, do not benefit from the technology due to insufficient funds and therefore cannot increase the productivity through the means of these innovative technologies. The distribution of technology gain is thus concentrated to the 'higher class' firms and therefore it is not guaranteed that these resources will be dissipated.

1.3 Which solutions, if any, have been suggested?

Some solutions that have been suggested for the structural causes of the productivity paradox, (financialization and mismeasurement) are described below.

De-Financialization

For the amount of investment in technology to be reflected in the productivity, Mazzucato and Perez (2016) gave a few solutions, of which some will be highlighted. First, productivity growth as well as economic growth depend on innovation, and since private sectors may be reluctant to make long-term investments, the research required for innovation should be publicly funded. An example is the internet, which received huge investments from the U.S. government for development and setting up. Second, investment should move away from short-term goals such as immediate private financial gain towards long-term investment in growth-driving innovation. Third, the real economy should grow relative to the financial sector by means of de-financialisation. Definancialization would ensure that financial sectors do not only lend to themselves, for example, in the form of share buybacks, but to other sectors in the economy that create value such as R&D, human capital, equipment and software. Ultimately, Mazzucato & Perez (2016) have suggested a few policies in order to address this issue; one of them is that the government could reform tax structures in a way that long-term investments are rewarded in R&D.

Correction of Mismeasurement

The mismeasurement hypothesis states that there is an illusion of a productivity paradox due to measurement errors. The productivity growth has therefore not slowed down (or slowed down less than what was measured) (Syverson, 2016). Therefore, no solutions to the paradox, but only to correct the measurements of labour productivity growth are proposed.

1.4 Possible consequences of proposed solutions for technological unemployment

According to Mazzucato & Perez (2016), general purpose technologies (GPTs) result in technological change and if technological change occurs in clusters (e.g. electricity followed by computers), it results in successive technological revolutions. Because this leads to higher labour productivity, it may also cause major job losses or displacements. A country that improves its technology and hence makes labour more productive, not only affects the jobs within this country, but due to the current globalization, affects jobs in other countries. An example was during the seven years of easy credit bubble, around the 2000s, when there was a massive shift of production to Asia due to its innovative capabilities. In the U.S.A. alone there were 4 million manufacturing jobs dropped within that period. In Europe, even though the drop was not as high, it is still greatly significant. In order to put things into perspective, in the U.K., for example, a loss of a million jobs in the manufacturing sector occurred during the NASDAQ boom of the 2000s; by comparison, the current recession resulted in only half a million job losses. It is therefore important to take two important notes. First, due to globalization, for a country's production capabilities to remain significant compared to another country, it will need constant innovation to keep up with changes and to avoid job losses. Secondly, the country's own innovative capabilities may make some of its jobs obsolete, meaning that it is time to think about re-specialization.

Conventional solutions to the productivity paradox that aim at increasing productivity growth are unlikely to prevent such loss of jobs. This applies even to the de-financialisation solution, which proposes to increase long-term investments in GPTs, because the resulting faster technological progress will increasingly lead to jobless economic growth.

In the literature, there exist broadly two different views on the outcome of technological progress on unemployment. The first view is from Keynes who claimed back in 1930: "*The increase of technical efficiency has been taking place faster than we can deal with the problem of labour absorption*" (Keynes, 1930, p358). His view is that technological unemployment is a result of overall reduction of work due to technological progress. Keynes claimed it to be a disease in 1930: "*We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come—namely, technological unemployment. This means unemployment due to our discovery of means of economizing the use of labour outrunning the pace at which we can find new uses for labour*." (Keynes, 1930, p364). If a trade-off between innovation and technological unemployment exists, fixing the productivity paradox for labour productivity to grow even higher may have the consequence of an ever-increasing technological unemployment rate. This is where humankind may be destined to go with the already existing amount of successful GPTs, and more to come. It is estimated that the up-coming GPT, artificial intelligence (AI) will enable automation technologies further, and result in the automation of 45% of the activities, which people are currently employed to perform (Brynjolfsson et al., 2017). This is an outcome humankind cannot afford as Trajtenberg (2018) stated: "*we cannot afford to have many more, and longer lived unemployed or underemployed people.".* Low-skilled workers who are likely to not have obtained a secondary or tertiary education are the ones most prone to technological unemployment, because they perform tasks that are the easiest to automate (Prettner & Strulik, 2019). This means that the inequality gap would increase with technological unemployment.

On the other hand, Brynjolfsson & McAfee (2012), have a different view regarding technological unemployment. "*So we agree with the end-of-work crowd that computerization is bringing deep changes, but we're not as pessimistic as they are* (stagnationists*). We don't believe in the coming obsolescence of all human workers. In fact, some human skills are more valuable than ever, even in an age of incredibly powerful and capable digital technologies. But other skills have become worthless, and people who hold the wrong ones now find that they have little to offer employers.*

They're losing the race against the machine, a fact reflected in today's employment statistics." (Brynjolfsson & McAfee, 2011, p8) According to this view, it is incorrect to say that technological revolutions only bring about unemployment. The problem is not the decreased number of jobs, because technologies that make the jobs obsolete also create new ones. The problem is that the recently unemployed people have skills that are no longer in demand and do not have the skills necessary for the newly existent job, therefore there is a skills mismatch. The ICT revolution, for example, did result in some jobs disappearing and skills being devalued, but other skills did gain more value and activities that did not previously exist, now do (Mazzucato & Perez, 2016).

Taking the second view into account, technological unemployment need not necessarily occur. It will only remain a threat if there is no investment in funding the new jobs, along with the new skills it will require. The results of technological unemployment if left alone would not only be financial struggle, such as loss of a secure source of income, but also mental struggles, such as a sense of loss of dignity, purpose of life, and fulfilment (Korinek & Stiglitz, 2017). It is therefore extremely urgent to address the creation of new jobs and training of new skills.

The aim of this thesis is to analyse a solution proposed by Baumol (2012) to a problem that he described (in 1967) as the "Macroeconomics of Unbalanced Growth", and to show how it could help to prevent technological unemployment. Baumol (1993, 2012) suggests that major transfers of funds from the technologically progressive sector to the technologically stagnant sector will be required in order to support an expanding so-called 'stagnant sector' (education, health care, and other 'personal services'). If his advice were followed, these transferred funds would create new work in the stagnant sector. A technologically progressive sector could then coexist with a technologically stagnant sector, and technologically unemployment would be avoided if productivity gains achieved in the technologically progressive economy were transferred to the stagnant sector.

Chapter 2. Labour productivity growth and Baumol's (1967) 'Macroeconomics of Unbalanced Growth'

The goal of this chapter is to first define the important term of labour productivity, and to explain why we, as human beings innovate to make labour more productive. Thereafter, Baumol's 1967 article is introduced to shine a new light on why labour productivity has not been increasing as much as one may expect: this may be due to what Baumol (1967) called "unbalanced growth". Finally, the causes of this unbalanced growth will be discussed.

2.1 What is labour productivity growth? How does productivity grow?

The previous chapter mentioned the two terms 'labour productivity' and 'labour productivity growth'. The aim of this section is to give a more in-depth definition of the terms, what determines how productive workers are, and how labour productivity grows.

Labour productivity is generally measured as output per labour hour. It can be computed as total output divided by the hours of labour used to produce that output, which gives the output per hour worked, as shown in the formula below:

$$\lambda = \frac{y}{h}$$

Equation 1

where λ is labour productivity, that is, output per hour,
y is total output (real),
h is the number of hours worked to produce total output.

Therefore, the higher the labour productivity, the more output there is per hour worked. But what determines how productive a worker is? The main factor that increases labour productivity is capital, for example a machine or computer, which, when utilized by a worker, enables them to produce a higher output per hour. A supporting factor to labour productivity increase is 'mental capital', that is, as new capital is added, workers need the knowledge and skills to use increasingly high-tech machines.

The labour productivity growth rate can be defined as the rate of output growth minus the rate of growth of hours:

$$\dot{\lambda} = \dot{y} - \dot{h}$$

Equation 2

where the dot on top of the variables denotes the growth rate of that variable.

Why do we, human beings, strive for more efficient and productive work? Is it solely to have a higher output, or is there another reason?

2.2 Why do human beings strive for labour productivity growth?

Innovations have been creating more efficient and creative ways of working, going back to the invention of the steam engine, and the current invention and development of artificial intelligence. But why have human beings strived for labour productivity growth?

Raising standards of living through productivity growth

Living standards have increased dramatically in the past centuries: we no longer have to cook for hours on end to eat a meal and we can install a heater in our houses to protect us from the cold. Our inventions and progress, including GPTs, have made possible overall economic growth tailored to meet people's need for goods, ranging from essential needs to luxury needs. The output one person can produce (labour productivity), is higher than ever before. Economic growth and living standards are very much intertwined: higher standards of living enable us to spend more time on education and research, which leads to higher productivity, and subsequently even higher living standards (Amighini, Blanchard, & Francesco, 2010). There is, however, a downside to our devotion to increasing productivity.

Freeing people from repetitive, boring work; but what about interesting work?

Labour productivity has not only increased the amount of output per hour worked, but also reduced the need for people to do boring-draining work, which now automated machines may perform. Brynjolfsson and McAfee (2011) even claimed: "*In the long run, productivity growth is almost the only thing that matters for ensuring rising living standards*", as automated machines free people from repetitive-dull work, particularly in the manufacturing industry (Mazzucato & Perez, 2016). However, GPTs are now also used to replace interesting work done by, for example, doctors, nurses, therapists, school teachers, and so on. We have become so infatuated with the idea of reducing the number of workers, and automating tasks, that we are in danger of destroying not just boring-draining work, but also very meaningful and essential work.

2.3 The 'Productivity paradox' reconsidered: Baumol (1967) on 'unbalanced growth'

So far, labour productivity has been defined, the reason why labour productivity growth is an important objective for humanity has been discussed, and the productivity paradox has been analysed. The main highlights so far are that labour productivity growth is desired to increase the standard of living and to reduce the need for people to do boring and repetitive work. Does this mean that we have reason to worry about the observed slowdown of labour productivity growth? In the previous chapter, we concluded that there is a 'productivity paradox' that needs to be explained and solved. However, what if there is no paradox and the reason for the decrease in labour productivity growth, despite increases in investment, is of another origin?

Baumol wrote a piece of literature in 1967 called 'Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis', that could be used to shine a different light on the fall in labour productivity growth relative to the increase in investment. Baumol describes a structural change in society that has been occurring since new innovations that increase labour productivity growth have been created. New innovations have greatly affected the economic structure, but not uniformly. Baumol separates economic activity in two types: technologically progressive activities and technologically stagnant activities. These two will from now on be abbreviated to 'progressive sector' and 'stagnant sector'. The progressive activities have a cumulative rise in labour productivity. The stagnant activities, however, only have occasional and infrequent increases in labour productivity. An industry does not necessarily have to be classified as one type of economic activity or the other, but it is a degree of one of them or the other. To give an example, the manufacturing sector is on one extreme end, the progressive end of the scale, because when new machines are invented to optimize the process, the production is much more efficient. On the other hand, a theatre is on the other extreme end, the stagnant end, because new inventions will not increase labour productivity growth. It should be noted that, even though it is highly technologically stagnant, it can be indirectly made more productive by, for example, a theatre group doing more shows per month due to them travelling by car instead of with a horse carriage.

Going back to Baumol's categorization of economic activity, he makes two important assumptions. The first assumption is that even though one type of activity becomes more productive than the other, the wages tend to go up and down together in both sectors. The second assumption is that money wages will rise as rapidly as output per man hour in the sector where productivity is increasing more rapidly. Therefore, if there is a 2% increase in labour productivity in the manufacturing sector, according to the second assumption, there will soon be a 2% increase in wage as people are aware of how their productivity should affect their wages. However, according to the first assumption, this means that the stagnant sector will also have a 2% increase in wage, but without the 2% increase in labour productivity. Hence, there will be a rise in the cost of the stagnant sector, which is not present in the manufacturing sector which has a relatively constant unit cost. Due to these circumstances, there is an unbalanced growth within the economy, in which the progressive sector is constantly growing due to its increase in labour productivity, and the stagnant sector is lagging behind and having to deal with the increased costs.

The results are of a large scale. Stagnant activities in the economy that have elastic demands, such as fine pottery, fine restaurants, and hand-worked furniture, will suffer the most, and may be forced to leave the free market. Meanwhile demand-inelastic activities such as health care and education are still viable in a free market, although they will be available at a much higher price than years before (Baumol, 1967), and therefore unaffordable to many.

Baumol's insight into unbalanced growth gives a different perspective on labour productivity growth. Rather than a problem of 'unproductive investment', we may have to do with a phenomenon of structural change in society and economic activity. The productivity paradox is then no longer a paradox, but a reflection of this structural change: the growth of technologically stagnant relative to technologically progressive sectors.

2.4 Causes of unbalanced productivity growth

The unbalanced productivity growth described by Baumol (1967) has two underlying causes that will be discussed. Firstly, the unbalanced productivity growth is due to the nature of the stagnant activities. Unlike the progressive activities, the stagnant sector does not have a cumulative rise of labour productivity due to innovations, capital accumulation and economies of large scale. The relatively constant productivity in this sector is not due to incapacity or mismanagement, but due to its nature (Baumol, 1967). An example is a doctor treating a patient or a mechanic repairing a damaged car. The treatment of the patient and of the car must be tailored to the individual case, it cannot be standardized and automated as each case is unique (Baumol, 1993).

The second cause is the preservation of quality. Increasing productivity in stagnant sectors of the economy, such as education, could lead to great decrease in quality. For example, a teacher with double the amount of students will teach more students, but surely the teacher will struggle to give the same needed attention to each student, resulting in a dramatic decrease of the teaching quality (Baumol, 1993).

Chapter 3. Why the 'Productivity paradox' and the 'Cost disease' are not a problem

The purpose of this chapter is to introduce the consequence of unbalanced productivity growth, known as the cost disease and to explain that neither unbalanced growth (and its consequence), nor the 'productivity paradox' are a problem if these phenomena are looked at from the perspective of structural economic change. Then, three different approaches will be explored to 'alleviate' the symptoms that come from unbalanced productivity growth.

3.1 Consequences of unbalanced productivity growth: Baumol's (1967) 'Cost disease'

Baumol's 1967 article on unbalanced growth was discussed in the previous chapter, and this chapter will focus on Baumol's 2012 book about the consequence of this unbalanced growth: the cost disease. The cost disease is a name given to a phenomenon – the rising costs of a growing technologically stagnant sector alongside a technologically progressive sector – and the name suggests that there is a problem with this phenomenon. Baumol has focused most of his research on the U.S.A. which has shown the 'symptom' of this disease: cumulative and persistent cost increase in a certain sector, the technologically stagnant sector. In this chapter, the possibility is investigated that neither the productivity paradox, nor the cost disease are necessarily a problem.

Technologically stagnant sector and the cost disease

According to Baumol (2012), two main examples of the cost disease in the U.S.A. are the immense growth of college tuition fees and the continuously rising costs of hospital services. As discussed in the previous chapter, this is due to the low-productivity growth (if a productivity growth at all) in the stagnant sector. This sector, which includes activities such as health care, education, legal services, postal service, police protection, repair services, performing arts, restaurant services and many others, has the characteristic that human input cannot always be replaced by machines (Baumol, 2012). However, it is still important to note that machines can still aid the work, even if it is not making it obsolete, such as MRI machines aiding the doctor to give a diagnosis to a patient or a computer aiding a mailman to take the best route to deliver letters and packages.

Why was this cost disease not seen earlier if it has been showing symptoms since the industrial revolution? There has often been a misunderstanding of where this increase in costs has come from, such as in health care. Particularly the increase in costs of health care has often been blamed on greedy hospital directors, aging population, pricing of pharmaceutical products, pricing of medical technology products, and several others, which are not unreasonable blames at all.

However, Baumol (2012) explains that the increase in costs has been so dramatic in the past years, that it is not realistic to blame the increase in costs only on the greedy hospital director, aging population and other factors mentioned above. (Baumol, 2012).

Technologically progressive sector and the cost disease

The technologically progressive sector (referred to as the 'progressive sector') has different features than the stagnant sector. Its distinguishing feature is its constant or decreasing unit labour costs. The need for human labour, in this sector, decreased due to the abundant opportunities for labour-saving machines. The amount spent on wages therefore decreased over time, but the amount of investment in new machines, capital, and maintenance increased. The amount of money that is saved on wages that are no longer needed, and the investment spent on technology, such as new machines, would lead to two different cost scenarios according to Baumol (2012). Firstly, if the amount of money saved on wages is equal to the amount spent on invested technologies, the total costs for a company in the progressive sector would be constant (while labour costs per unit of output decline). Lastly, if the amount of money saved on wages is more than the amount invested on new technologies, total costs decrease.

The future of the disease

In the technologically progressive sector, we can expect a continuously growing labour productivity due to competition between firms, which cannot survive in the 'free market' without constant upgrade and innovation for higher productivity. In Baumol's words, "*…large, competitive high-tech firms cannot avoid – indeed, cannot survive without- constant and substantial reinvestment in R&D, whether conducted in-house or outsourced…Thus, there seems to be little reason to worry that productivity growth will slow down in the near future."* (Baumol, 2012, p. 58).

The disease's symptoms for the stagnant sector got worse throughout the years as Baumol's 2012 analysis of the U.S.A. showed, with prices increasing more and more for the stagnant sector. The estimate is that this will continue for the future years if nothing is changed.

Consequences of the cost disease

The cost disease, cumulative and persistent cost increase in the technologically stagnant sector has a wide range of consequences for the economy. These are now discussed.

- Affordability struggle

There is no doubt that there will be continuous creation of new innovations throughout the upcoming years in the progressive sector. If productivity growth in the progressive sector translates into higher wages, and if wage growth in the stagnant sector follows wage growth in the progressive sector, this will continue to increase the prices of stagnant products *relative to* prices in the progressive sector. This raises the question of whether we will be able to afford even the most crucial services in the future in the stagnant sector, such as health care. Baumol (2012) analysed this in depth and proposed solutions for the U.S.A., which will be discussed in section 3.2.

- Technological unemployment

The issue of technological employment has already been discussed in chapter 1 (section 1.4). Technological unemployment may result also from the cost disease, because the rising costs of human work in the stagnant sector may induce labour-capital substitution also in this sector. Technological unemployment affects mostly workers in the progressive sector of the economy, as this sector would (and can) adopt automated technologies that replace human labour. However, today this is increasingly happening also in the stagnant sector.

- Craftmanship industries and culture

The cost disease has consequences not only for the economy, but also for society. Industries on the very end of technologically stagnant sector with an elastic demand may soon be non-existent in the market, if not so already. An example is fine pottery and hand-worked furniture (Baumol, 1967). These industries require high levels of expertise and high levels of manual labour time in order to produce a single unit of output. The cost for such unit, according to the thesis of the cost disease, has abundantly increased throughout the years since there has been no labour productivity growth. The loss of these industries would result in a loss of craftmanship and culture due to an increase in consumption of mass-produced pottery and furniture.

- Dark side of technological innovations

Technological innovations have already been discussed to lead to an increase in the standards of living, but they can also threaten life itself. Baumol (2012) stated that it is important to be aware that unhindered technological progress does have its dark sides involving innovation in the military and negative externalities on the environment. Military innovation has led to the invention of extremely powerful and deadly automated weapons, which has led to the extensive debates regarding the ethics of such machines (de Sio & van den Hoven, 2018). Humanity has made new weaponry innovations with the power to destroy itself, and with its great productivity gains and lower costs, it has been made more affordable than ever. Additionally, GPTs such as automobiles, computers, 5G and the Internet of Things, with their unbridled energy consumption, contribute significantly to climate change, which can have deadly consequences such as droughts, floods and hurricanes

The rest of this chapter will consist of an analysis of different solutions that have been proposed to the cost disease, including Baumol's solution, the Rehn-Meidner solidaristic wage policy, and Salter's productivity growth to lower prices (Baumol, 2012; European Central Bank, 2021). Each section will focus on a different solution by first defining the solution, and then reflect on how it could be implemented, as well as how it affects technological unemployment, and, at last, analyse its ability to cure the cost disease. This analysis of the solutions will lead to an answer (in Section 3.5) to the first part of the research question, *"Could Baumol's solution to the cost disease -i.e. the transfer of productivity gains from the technologically progressive to the technologically stagnant sector- help to maintain a technologically progressive economy, while preventing unemployment?".* The remaining chapters will then investigate under what conditions this would hold true.

3.2 Baumol's (1993, 2012) solution: a "startling" transfer of income from the progressive to the stagnant sector in order to keep up essential "personal services"

Description

Baumol claims that as long as productivity is growing in almost every sector (even small growths) and declining in none, consumption of every good and service can still grow, provided that transfers of labour and funds take place from the technologically progressive to the technologically stagnant sectors (Baumol, 1993, 2012). Baumol's 2012 book focused on a quantitative analysis of whether we will be able to afford the same products and services in the future, which he then concludes by stating that it is possible. His early-stage analysis of the U.S.A. revealed the average American's purchasing power in 2010 is about seven times as great as its ancestor's a century earlier. His analysis went on to reveal that the price of products from the progressive sector, which we may now consider as essential goods (e.g. washing machines, cars and computers), became less costly throughout the years and will continue to decrease (Baumol, 2012). The consumer purchasing power (CPP) of the progressive sectors' products has therefore increased throughout the years and will continue to do so with the current continuous innovations. The increase in prices for services, such as health care and education, due to the cost disease, will therefore not increase our overall spending since the spending on goods produced in the progressive sector will decrease. Therefore, the lower prices of the products from the progressive sector will balance out the higher prices of products from the stagnant sectors.

Accordingly, the cost disease will change the way we spend our money, and not decrease the amount that we buy with it. A higher percentage of our income will go towards the stagnant sector, and a smaller into the progressive sector. That being so, there is no need to worry about whether or not we can afford products in the future (Baumol, 1993, 2012).

Baumol's solution goes beyond the statement that the affordability of products and services in the future will not be a problem. His solution is to balance the two unbalanced economic sectors through the means of transfer of funds. The productivity gains in the progressive sector, which arise from adopting new automated technologies or other innovations that can replace work, could be collected and redistributed to the stagnant sector in order to fund the new work that is needed in the stagnant sector. Baumol reflected on his solution: "*the very nature of the cost disease ensures that we can cover these cost increases, though if government intervention is lacking, this remains an urgent problem for the impoverished members of society*." (Baumol, 2012, p. 28). In his point of view, the cost disease is not a problem as long as capital is transferred from the progressive to the stagnant sector, which could possibly be done through taxation.

Redistribution of funds via profit taxation

The implementation of this solution, the transfer of funds, would mean a loss of capital for companies in the progressive sector and so they are very likely to be strongly reluctant about this. This capital is now used in various ways, for example to pay off dividends to its shareholders or to invest in research and development (Pettinger, 2019) or it is even hidden in tax havens (Shaxson, 2020). Consequently, it would be extremely likely for companies, or their shareholders, to see no incentive to willingly give up their gains to the stagnant sector, especially since they would not directly benefit from such an action. In order for this transfer to occur, it would then have to be non-optional. Additionally, in order for the distribution of the funds to be done securely, the government could take over and ensure the collection and distribution of the funds. This could take the form of taxation on the profits of the progressive sector.

Technological unemployment

Regarding the consequence of technological unemployment, Baumol (2012, p137) states that in order to diminish technological unemployment, the labour that is shed by the progressive sector would need to find new work in the stagnant sector. This transfer of labour from the progressive to the stagnant sector would allow both sectors to maintain their share of overall output, the former with a shrinking labour force and the latter with a growing labour force, and still lead to an increase in the economy's overall productivity growth. However, such a transfer of labour would be possible only if the requisite funds are provided, that is, if the progressive sector's productivity gains would be redistributed to the stagnant sector, as explained in the previous paragraph (Baumol, 2012).

Ability to solve the cost disease or its symptoms

Concluding the analysis on Baumol's solution, implementing this solution would not directly cure the cost disease, as the prices of products from the stagnant sector would continue to increase dramatically. It would, however, take care of the negative consequences of the disease. The use of the productivity gains in the progressive sector, as the source of funding of the stagnant sector, would ensure enough monetary resources to fund new work in the stagnant sector. The stagnant sector would now have more funding to acquire new workers from the progressive sector and train them. Additionally, Baumol's solution to fund work in the stagnant sector and his analysis that we will be able to afford products with increasing prices from the stagnant sector, may make it a possibility for craftmanship industries, and especially schools, hospitals, universities, nursing homes etc., as well as the fine arts, to stay alive in this high-technology era.

This solution could be implemented via the imposition of taxes but its possible consequence is lessening economic growth as the productivity gains would be taxed and not further invested. Nevertheless, the extent to lessening the economic growth is debatable, because with lower unemployment, more people have incomes, therefore increasing overall demand hence stimulating economic growth.

Overall, Baumol's solution shows that 'unbalanced growth' need not be a problem. It is, however, also worth exploring other economic models that could provide another solution to the same problem. If these economic models are just as successful as Baumol's proposed solution, they could be used as an alternative or as an addition to Baumol's solution. The models that will be investigated in the following sections are Rehn-Meider's solidaristic wage policy and Salter's model of using productivity growth to lower prices. (European Central Bank, 2021)

3.3 Rehn-Meidner's 'solidaristic wage policy' reconsidered

Rehn-Meidner's model is a relevant model to be considered as a solution to the cost disease because it suggests a wage model that differs from Baumol's. According to Baumol (1967), the unbalanced growth in labour productivity between the sectors and the current wage setting model (where wages go up and down together in both sectors and money wages rise as rapidly as output per man hour in the sector where productivity is increasing more rapidly) lead to the cost disease. Exploring Rehn-Meidner's different wage-setting model may therefore give new insight into how to prevent or mitigate the cost disease.

Description

According to Erixon, 2010, Rehn-Meidner's (R-M) model of solidaristic wage policy is a structural economic model that was designed to stimulate full employment (through fiscal policy and active intervention in the job market) and to control inflation (for price stability). In the R-M model, employees with similar jobs are paid the same wage regardless of the profit situation of the firm or industry. Therefore, all engineers would be paid the same, all cleaners would be paid the same and all lawyers would be paid the same. Wages would be only dependent on the skills required to perform the job. In this model, firms with low profitability are likely to not be able to afford the set wages, giving them two options: to increase their profitability via productivity or to leave the market. If the firm leaves the market, its employees would move on to work the same job for the same wage in a firm with higher profitability that can afford the set wages. This is a model that would increase the overall productivity of the economy. Firms with high profitability, which would be able to afford a higher salary than the set salary, cannot do so because of the solidaristic wage policy, but they can use this extra profit for various purposes, such as price reduction or investment (promoting economic growth). When the R-M model faces increases in labour productivity growth in the progressive sector, it would not have an up-ward pressure on wages, like Baumol's model does. Consequently, the high-profit firms can lower their prices, creating more demand, generating economic growth and consequently lessening the affordability struggle of products from the stagnant sector, that is present in Baumol's (1967) model.

Implementation

According to Erixon (2010), the successful implementation of the solidaristic wage policy would require restrictive macroeconomic policy and active labour-market policy. Erixon (2010) analysed in depth the implementation of the R-M model in Sweden between the 1950s and the 1970s. The implementation of the model was somewhat successful during this period, being called the 'golden period', showing low inflation, high growth, and decrease in inequality. However, around the mid 1970s, the model applied was deviated from the original model by R-M. There were political-institutional changes, new exchange-rate system and less coordinated wage bargaining, all of which contributed to the deviation from the R-M model. External factors had an influence on the deviation from the model, such as increasing globalisation, which allowed for businesses that no longer wanted to pay high set wages to move to another country without solidaristic wages, which weakened position of Swedish trade union. The introduction of general purpose technologies, such as ICT, also contributed to widening the wage gaps in Sweden.

Applying this model successfully in the long-term would require for labour unions to have immense power in politics, and to carry out wage-setting policies without much interference from the government. There is a large room for possibility in which if applied correctly, the R-M model could lessen the wage-pressure and alleviate the cost disease. However, the external factors are hard to control, such as globalisation and GPTs, and they can hinder the application of the model, like it did in Sweden. To succeed, the country would need to adapt to the external factors, while remaining within the R-M model.

Implementing this in a country within the European Union is very complex. Workers from countries within the European Union are allowed to immigrate freely to work and applying a solidaristic wage policy in a certain country could motivate workers to immigrate to other countries to find more favourable wage conditions. The European Union as a whole could implement this, but the Union would have to study the consequences of this implementation with a great level of detail. There are therefore many complex factors to analyse before implementing such a model, especially considering the two focus countries which are in the European Union.

Additionally to Erixon's view, implementing such a model requires a complex study that could take a large amount of time into how much wage each job should be received based on its level of difficulty, responsibility and education. This would also be highly inefficient because of the situation nowadays in which new technologies are generating new jobs that previously did not exist.

Technological unemployment

According to Erixon (2010), the R-M model would pressure firms with low productivity to be more productive and gain more profits, and if the firm cannot do so, it would leave the market, leaving its workers unemployed. However, the firms with high-profit levels can afford to take on those employees, they hire more people, further increase their productivity, consequently their profitability, giving them enough funds to either hire more employees, invest it or lower its prices. Investing the profits would generate economic growth, hence creating more jobs and lowering its prices, would create higher demand, and consequently economic growth, leading again to job creation. Regarding work that is made obsolete by new technology, Rehn-Meidner had suggested active labour policy (training for workers whose jobs had become scarce) and high unemployment benefits, which remove the pressure for the unemployed people to get the first job opportunity, and give them an opportunity to receive education or training to improve their skills.

Rehn-Meidner's unemployment solution, however, addresses only frictional unemployment, unemployment that comes about due to a mismatch between skills and education required by the employer and the skills and education the employee has. It does not address technological unemployment, unemployment in the form of a decrease of the number of jobs existing, that comes about from structural change, and not skill mismatch. Rehn-Meinder's solution would then only fix the former by re-educating individuals, but not the latter, fixing the structural issue of employment.

Ability to solve the cost disease or its symptoms

Despite the implementation complexity of this model, it offers great potential to mitigate the cost disease and its symptoms. Implementing the solidaristic wage policy would remove the wage-pressure in the stagnant sector that arises from unbalanced labour productivity growth and consequently the wage growth. The removal of wage-pressure in the stagnant sector consequently reduces the price increase in the stagnant sector, and along with it, eases the affordability struggle. Friction unemployment would be taken care of by the active labour policy which would train the workers whose job had become scarce, while giving them unemployment benefits. Rehn-Meidner's policy does, however, not provide a solution for the long-run, which consists of structural unemployment (technological) that also needs to be tackled to provide enough jobs for society.

3.4 Salter: using productivity growth to lower prices (and raise real incomes)

When considering different solutions to the cost disease, it is worth looking into work that has been done that has the same assumptions as Baumol, such as Salter's. Salter has the same wage-setting assumptions as Baumol. His idea of using productivity growth to lower prices (rather than to increase wages) is a promising alternative solution to the symptom of the cost disease, rising prices in the stagnant sector, and this idea will now be discussed.

Description

According to Groot & Schettkat (1999), Salter emphasized technological change as the main source for productivity growth and hence changes in relative prices and demand. Salter uses the same wage assumption as Baumol - wages go up and down together for all sectors. However, he suggests that, instead of the progressive sector using its gains from the productivity growth to increase wages, which is what Baumol claims to happen, it should use them to lower their relative prices. Productivity gains are then distributed to consumers through lower prices of products with high labour productivity growth. This would result in lower output prices for the products and increase real incomes, meaning that all goods and services become more affordable even when the costs of personal services increase relative to costs in the progressive sector. This solution to the cost disease, resembling Baumol's solution, would also require a transfer, but, in this case, productivity gains in the progressive sector would be transferred, via lower progressive sector's prices, to consumers, whose real incomes would rise, permitting them to afford stagnant sector services.

Implementation

For it to be effective, a great majority of companies within an industry should adopt this approach. This is most likely to happen in a perfectly competitive market, because when for example, company A lowers its prices, its competitors are likely to copy it due to the need to compete on costs. In fact, this is particularly true for companies with products that have high price elasticity of demand. A high price elasticity of demand means that the consumers' choice to buy a product is strongly affected by the price of the product. Thus, higher prices would decrease the demand and lower prices would increase the demand. In a perfectly competitive market, companies necessarily use their gains in order to take some of the price 'burden' off the consumer, in order for demand to be higher. However, if the company is not perfectly competitive, it would very likely need incentives or regulation to make companies lower their prices when productivity increases, which is not the case for Salter's approach. If it is not possible for governments to oblige companies to redistribute their gains by lowering prices, Salter's approach is an option which only companies themselves may choose to take.

Technological unemployment

Regarding the additional consequence of technological unemployment that comes with labour productivity growth, Salter's approach does not address it. Nevertheless, Salter's approach could have an influence on technological unemployment. Salter's approach to transfer productivity gains on to consumers via lower output prices in the progressive sector would raise real income, meaning that consumers can spend more on stagnant services. As consumers can afford more products or services from the stagnant sector, there will be more demand, and due to the market forces, more supply of activities from the stagnant sector, consequently resulting in more jobs within the stagnant sector.

Ability to solve the cost disease or its symptoms

Salter's proposed approach eliminates some of the cost burden, because productivity growth translates into lower prices rather than higher wages. The wages in the stagnant sector as well as in the progressive sector would not increase as much as labour productivity growth in the progressive sector, because the progressive sector's productivity gains are redirected to the consumers instead of higher wages. This is not to say that there will not be any increase in wages throughout the years, but there is a significant decrease of pressure on the wages. This is of course only the case, if all companies from the progressive sector take Salter's approach. The sky-rocketing increase in costs in the stagnant sector would then be alleviated and so would its prices. The symptoms of the cost disease, increased prices of the stagnant sector, would then be alleviated, but there may still be technological unemployment if labour continues to be displaced by capital, especially when this happens in the stagnant as well as the progressive sectors. Additionally, the progressive sector making the prices lower with its gains coincides with Baumol's theory in the sense that due to the decreasing prices of products of the progressive sector, we will be able to afford all goods and services in the future.

3.5 Summary of proposed solutions for the cost disease

The different proposed solutions have been described and analysed in terms of their effectiveness in solving or mitigating the cost disease, and will now be summarized.

Baumol's 2012 proposed solution is the only one that takes a completely different stance than the other two proposed solution. Instead of trying to eliminate the cost disease, he (finally, in 1993 and 2012) accepts it, and then explains how we can live with it. The real solution comes from Baumol (1993, 2012), when he says that society can afford the rising costs, because we can pay for them out of the productivity gains reached in the progressive sectors. Paying for the rising costs can be done in various way, as Baumol explains. One possibility is to make sure that productivity gains are used to lower output prices, which is an idea similar to Salter's.

Salter's and Baumol's idea to use productivity gains to lower output prices would alleviate the wage growth pressure in the progressive sector, and consequently in the stagnant sector. This model could lessen the affordability struggle because removing the pressure on wage growth would means lower price growth in the stagnant sector, hence raising real incomes, and thereby raising the ability to pay for the services of the stagnant sector. The amount of money spent would stay relatively the same, but now a higher share of person's income will be used for products and services in the stagnant sector and a lower share in the progressive sector. Such a model would however only have successful implementation if the majority of companies from the progressive sector do this redistribution to the consumers. It is a promising approach, but unfortunately, it would be extremely likely not be implemented by companies due to the market power that many technologically progressive and especially high-tech companies have. High-tech markets are often an oligopolistic market, meaning that a few powerful large firms dominate the market. Such firms have the power to choose whether they use their productivity gains to lower their prices. Using their productivity gains to lower their prices would however decrease their profits which could be used for other purposes (e.g. investment) and therefore may consider this option unworthy of implementing. Additionally, the few firms may even unite and form a collusive oligopoly, allowing them to behave like a monopoly (only one firm in the market, holding price-setting power), and setting the price at the maximum amount as consumers have no other option.

The second possibility that Baumol suggested (deviating from Salter's idea) is to redistribute the productive gains from the progressive to the stagnant sector. If productivity gains are transferred from the progressive to the stagnant sector, these funds can be used for creating new work in the stagnant sector, which would tackle the problem of shortage of work opportunities. The corresponding growth of education (a part of the stagnant sector) would enable people to educate and (re-)train themselves, reducing chances that they become unemployed due to lack of skills or education.

The cost disease arises from two factors: unbalanced labour productivity growth and the wage-setting model. Rehn-Meidner's solution tackles the second factor by the proposal of a solidaristic wage policy in which wages are the same for employees with similar jobs, the wage rate depends on the difficulty, responsibility and education required to perform the job, and its rate is independent of the firm's profit (Erixon, 2010). Due to the wages being labour productivity independent, it is a model that could very well alleviate the upward pressure on wages and consequently alleviate the upward pressure on prices in stagnant sectors, tackling the affordability struggle. The cost disease would therefore be somewhat alleviated if a solidaristic wage is implemented, but it does not fully remove the problem. Even though this model does have potential to alleviate the cost disease, it is hard to implement in a non-solidary globalised economy, where many businesses do not accept either a cap or a lower limit on wages.

Answer to the first part of the research question

Although it would not take away the cost disease, Rehn-Meidner's model of the solidaristic wage could certainly alleviate it. This implementation would however have strict requirements to be successful, and even if implementation was successful, its wanted results could be hindered by globalisation. Salter and Baumol offer the possibility to pass on the productivity gains from the progressive sector to consumers via lower prices. This is perfectly possible and economically sensible, but it is, however, unlikely to work in today's oligopolistic markets. The collusion of oligopoly firms to form a monopoly could be reduced by legal measures if there is proof of colluding, however for this to be effective, an absurd number of firms would have to be brought to face legal measures. If markets remain oligopolistic, Baumol's idea of transferring productivity gains from the progressive to the stagnant sector through the recommended method of profit taxation could be put into practice. Concluding from the analysis in section 3.2, Baumol's 2012 solution to the cost disease of transfer of resources between sectors **does** help maintain a technologically progressive economy, while preventing unemployment. His solution does not result in hindrance of technology progression, and the transfer of funds from one sector to the other ensures that workers from the progressive sector can acquire a job in the stagnant sector.

Baumol's (2012) proposed solution is, however, only theoretical and has not yet been empirically tested. The aim of the second part of this thesis is to investigate with a small model and using data, under which economic conditions this solution would be possible. In particular, how high the profit tax rates would have to be and at what wage differential between the progressive and the stagnant sector would be feasible.

The second part of the thesis will then consist of two steps. The first step is to determine whether the countries focused on for the analysis have the cost disease in the following chapter. The next step will be to estimate what size the proposed transfer of funds would have to be, and its viability, consequently answering the second part of the question:

"*If Baumol's solution to the cost disease helps to maintain a technologically progressive economy while preventing-unemployment, under what conditions would this be feasible?*"

Part 2

Chapter 4. Do the Netherlands and Germany have the 'Cost disease'?

The purpose of this chapter is to investigate, via a case study, whether the Netherlands and Germany have the cost disease based on the four hypotheses formulated in this chapter (see Section 4.1).

4.1 Introduction to the case study and hypotheses

The case study method was chosen in order to narrow down the research scope. A case study is a research method that gets information from a particular case with the purpose of gaining a deeper understanding of a particular problem, such as relationships between certain variables (and possibly to generalize its findings). This chapter describes the two cases and focuses on two countries between 1991-2018, with a focus on four types of activity: education, health care and social work for the stagnant sector and manufacturing for the progressive sector. The reason for each choice will explained in the following text, along with the hypotheses to be tested in this case study.

Countries

The trend to replace labour with machines is universal and affects all countries in the world. In that respect there is no scientific reason to choose one country or the other for a case study. At the same time, since this trend is universal, all countries of the world will need to find a solution to this problem. The Netherlands is a country with a largely trade-based economy. At least since the 'Agreement of Wassenaar' in 1982, policy makers and business leaders in the Netherlands have opted for wage moderation as well as 'flexibilization of the labour market', because this was believed to stimulate exports (through price-competition) and thereby economic growth and employment (Langenberg & Zwan, 2007). The policy of wage moderation reminds of the Rehn-Meidner model, where wage growth is kept below the rate of labour productivity growth. However, since the growth of exports alone has not generated sufficient work, the main strategy to avoid technological unemployment has been to absorb increasing numbers of workers for who there is no work in manufacturing in flexible, low-skill, low-paid services (Kleinknecht, Oostendorp, Pradhan, & Naastepad, 2006). As a consequence, a relatively large share of the labour force works on flexible, relatively low-paid contracts (Kleinknecht et al., 2006).

In order to be able to judge to what extent results for The Netherlands could be generalised to other developed countries, I decided to do a second case study on Germany, a European country with (historically) very different economic characteristics The German economy is largely grounded in a high-tech domestic industry. Within Europe, Germany stands out for its strongly skill-based and highly productive industrial labour on permanent contracts. However, this picture is slowly changing. High productivity growth in industry has led to labour-shedding, and those whose labour is obviated are looking for work in other sectors, which is often found in so-called 'mini jobs' (marginal employment, mostly part-time and with a low wage) (Hamilton, 2014).

Thus, it seems that, as a result of unchecked technological progress, two countries with very dissimilar economic structures (Netherlands being trade-based vs. Germany being industry-based) are developing in very similar directions, and suffering from similar problems (the absorption of labour shed by highly productive sectors in flexible, low-skill, low-paid services). This is surprising, and of scientific as well as societal interest. However, in terms of solutions, the economic-scientific problem to be solved remains the same: how to transfer resources from the technologically progressive sectors toward technologically stagnant service sectors, so that those whose work in the progressive sectors is obviated can find meaningful and rewarding work in the latter? There is no reason to assume that this problem, or its solution, will necessarily be different for a small, trade-based as compared to a large, industry-based country.

Industry

The progressive sector will be represented by the manufacturing industry, while the stagnant sector will be represented by health care, education, and social work. This is due to three reasons. First and foremost, Baumol's (2012) analysis of the cost disease in the U.S.A. focuses on the manufacturing industry for the progressive sector, and education and health-care for the stagnant sector. These are chosen because these three activities are on the extreme end of low productivity growth. Manufacturing is on the extreme end of the progressive sector, meaning that their labour productivity is very strongly affected by new technologies, whereas, on the opposite extreme, in the stagnant sector, health care and education’s labour productivity is weakly affected by new technologies (Baumol, 2012). ‘Social work’ is additionally included because the data base that will be used, OECD, CBS and ILO groups together ‘health-care and social work’ as one category. In order to have consistent results, these three activities were chosen. This way, depending on the data being analysed, the three can be grouped together into the stagnant sector.

Time period

Automation technologies debuted in the early 18th century, since then enabling many different GPTs. Due to data constraints, the time period covered is from the late 20th century to the beginning of the 21st century. This time period includes automation technologies and its new enabling GPTs, such as computerization and IT for the 20th century, and artificial intelligence for the 21st century (T. Bresnahan, 2010). The OECD data used contain data for all the relevant variables (except hourly wages per economic activity) for the analysis between 1985-2018 for the Netherlands and between 1991-2018 for Germany. The time frame 1991-2018 would be considered for both countries to ensure compatibility in analysis. Data from the OECD will be used for collecting almost all data due to its larger time frame, allowing the analysis within a larger time frame. However, due to the absence of hourly wages data per industry in the OECD data base, the data will be retrieved from EU KLEMS, which has a shorter time frame of 1995-2017. To gain a more precise analysis for both countries over time, whenever possible, the analysis will have a time period of 1991-2018. However, when not possible, some analysis will have a time period of 1995-2017 This inconsistency is assumed to be negligible because each variable being tested (eg. labour productivity) will be tested consistently, with the same time period for both countries.

Hypotheses

To determine whether the Netherlands and Germany have the cost disease, it must fit Baumol's description and characteristics of the disease. Four hypotheses were formed based on Baumol's writings that defined the cost disease (Baumol, 1967, 1993, 2012). If the hypotheses cannot be falsified, then the analysed country has the cost disease.

H1. Labour productivity increases for both sectors, but more dramatically for the progressive sector over time.

It is important to test this hypothesis first, because this is the starting point of Baumol's analysis. It is expected that, due to the adoption of new technologies, both sectors will see an increase in labour productivity. Their growth rates will, however, vary, with the technologically progressive sector having a much steeper growth than the stagnant sector. If this is so, relative labour productivity (RLP), as defined in Equation 3, will decline over time:

$$RLP = \frac{\lambda_t^s}{\lambda_t^p}$$

Equation 3

Where:
the symbol λ refers to labour productivity,
the superscript s refers to the stagnant sector,
the superscript p refers to the progressive sector,
the subscript t refers to the variable at time t.

H2. Output and the wage rate increase in both sectors over time.

Output (here measured as gross value added in an economic sector) will increase over time for both sectors. Wage rates will increase in the progressive sector because of higher labour productivity rates, and consequently, on account of Baumol's assumption that wage rates in all sectors increase accordingly, so will the wage rates in the stagnant sector. It is important to note that even though it is stated that the wage rates will increase accordingly, it does not necessarily mean the increase will be proportional.

H3. Relative employment will increase over time.

If both sectors grow over time, while labour productivity grows more slowly in the stagnant sector, relative employment, which is defined in Equation 4, will increase over time.

$$\mathrm{RE}_t = \frac{\mathrm{E}_t^s}{\mathrm{E}_t^p}$$

Equation 4

Where:
RE stands for relative employment,
the variable E depicts employment
the subscript 't' refers to the calendar year
the superscripts 's' and 'p' refer to the stagnant and progressive sector respectively.

This third hypothesis tests indirectly whether the country under consideration has the cost disease. This hypothesis does not tell whether the country has the cause of the cost disease (differential productivity growth), or the symptom of the cost disease (rising Unit Labour Cost; see H4), but whether it has the consequence of a labour market structural change characterised by an increase in employment in the stagnant sector relative to employment in the progressive sector. The relative increase in employment in the stagnant sector may be (partly) due to GPTs, which obviate labour in the progressive sector, causing people to look for jobs in the stagnant sector.

H4. Unit labour cost (ULC) in the stagnant sector will rise relative to the progressive sector. $RULC_t$ will increase over time.

To keep the model simple and focused on the problem at hand, Baumol's 1967 analysis, neglected costs that are not labour costs. Increases in wages are translated into higher costs if labour productivity does not increase correspondingly. However, if wage costs and labour productivity increase proportionally, they could cancel each other out leading to no increase in costs. The stagnant sector which sees a low, if any increase in labour productivity growth, should therefore see increases in the ULC relative to the progressive sector. For the progressive sector, if wage costs and labour productivity cancel each other out perfectly, there could be a constant ULC, and, if labour productivity growth surpasses the wage costs growth, even a slight decrease in ULC could be seen (Baumol, 1967).

The relative unit labour cost (RULC) will also be analysed for easiness of comparison between the two sectors' costs. Its formula is the following:

$$\mathrm{RULC}_t = \frac{\mathrm{ULC}_t^s}{\mathrm{ULC}_t^p}$$

Equation 5

where:
the variable ULC refers to unit labour cost,
the subscript t refers to the variable at time t,
the superscript 's' and 'p' refer to the stagnant and progressive sector respectively.

Since UCL in the stagnant sector are expected to rise faster than UCL in the progressive sector, the ratio RULC is expected to increase over time.

4.2 Structural change: relevant economic trend analysis of the 'technologically progressive industry' relative to the 'technologically stagnant industry'

The trends analysed in this section will test the hypotheses listed in the previous section. The analysis will be done as follows: the raw data points of the chosen endogenous variable (i.e. the variable to be explained or analysed) are plotted over time (calendar years), which then have their trend analysed by a linear trend analysis. The trend will thus have the following (linear) equation format:

$$y = c + m * t$$

Equation 6

where y is the endogenous variable,
m is the gradient of the line,
t is the calendar year
and c is the y-axis intercept.

Analysing the data points with a polynomial trend of order 1 (i.e. a linear trend) gives the absolute average annual change of the variable throughout the years, denoted by *m*. When computing the growth rate (or average annual rate of change), the following formula is used:

$$100 * \left[\left(\frac{y_n}{y_b}\right)^{\frac{1}{n}} - 1\right]$$

Equation 7

where y_b is the value of variable y in the base year (the first year of the period under consideration,
y_n is its value in the last year of the period,
and n is the number of years considered.

Furthermore, a regression analysis will be performed to test whether the linear trend line is statistically significant, in other words, whether it has a high probability of being correct. For this analysis, five different statistical analysis tools will be used: R squared, F value, significance-F, t-statistics and the p-value. The first three determine the overall significance of the model, whereas the last two determine significance of the dependent variable. Sekaran & Bougie (2013) explain the four values as follows.

R-squared

The R-squared value or R^2 provides information about how well the regression line approximates the data points. The closer to 1 the R-squared value gets, the more the regression line fits well with the data points. The closer to 0 it gets, the more poorly the regression line fits the data points. As a point of reference, a R-squared value above 0.75 will be considered as a good-fit.

F value and significance-F

The F value determines whether the null hypothesis, which states that there is no relationship between the variables, can be rejected. The F value by itself does not say a lot. The significance F, however, gives the overall significance, meaning that it gives the probability that the model is wrong. The lower the significance F, the higher the probability of the model, the polynomial trend line, being correct. A threshold that is most commonly used is 5%, meaning that, if $significance\ F \leq 0.05$, then the model used is a good-enough representation of the data points.

T-statistics and the p-value

The t-statistic (referred to as t-stat) for the coefficient (or gradient, m) is a reference number to determine whether the null-hypothesis should be accepted or rejected. The number itself, like the F value, does not say a lot; it needs to be used with t-values table. Using the t-stat with the table, the p-value can be determined. The p-value for the coefficients determines whether the dependent variable is statistically significant. When the p-value is less than the chosen significance level, $p \leq 0.05$, the null hypothesis that the coefficient equals zero can be rejected.

<u>Hypothesis 1</u>

Labour productivity

Labour productivity is the first variable to have its trend analysed in order to check whether Baumol's observation that labour productivity growth in education, health care and social work lags behind productivity growth in manufacturing holds also for the countries under consideration. Figure 1 illustrates the data points for each sector (in each country), as well as their linear trend. The regression analysis (in Table 1a), as well as a table with the data points (Table 1b) can be found in the appendix.

Labour productivity was calculated using the following formula:

$$\lambda_t^i = \frac{y_t^i}{H_t^i}$$

Equation 8

Where:
the symbol λ refers to labour productivity
the symbol y refers to real output (at constant prices)
the symbol H refers to hours worked
the subscript t refers to the variable at time t
the superscript i refers to the progressive or stagnant sector.

By simply observing the data points in Figure 1, it can already be noted that both countries have a substantial increase in labour productivity growth over time in the progressive sector, but an almost negligible growth in the stagnant sector. The linear trend analysis confirms the findings. The coefficient for the variable 'time' for Germany's progressive sector is 1.070, meaning that the level of labour productivity increases by 1.070 on average per annum (starting from a value of 31.8 in 1991). The time coefficient for the Dutch progressive sector is 1.336 (starting from a value of 30.0 in 1991). The p-values for these coefficients are 0.00% meaning that they are both significant. It is also interesting to note that even though Germany has a more high-tech-industry based economy than the Netherlands (which is more trade- and service-based), the Dutch progressive sector has a higher labour productivity growth than Germany. The stagnant sectors' time coefficients are -0.007 for Germany and -0.093 for the Netherlands. The negative gradient represents an extremely small, decrease in labour productivity over time. For the Netherlands, the trend is statistically significant, but this is not the case for Germany, which has a p-value of 58.4%. The results for Germany's stagnant sector's progressive sector is thus inconclusive.

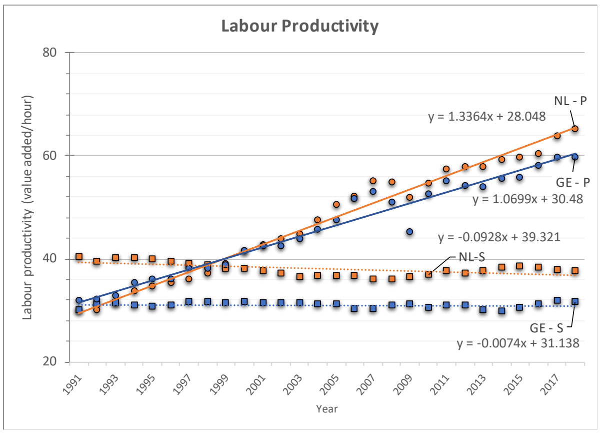


Figure 1

OECD (2020)

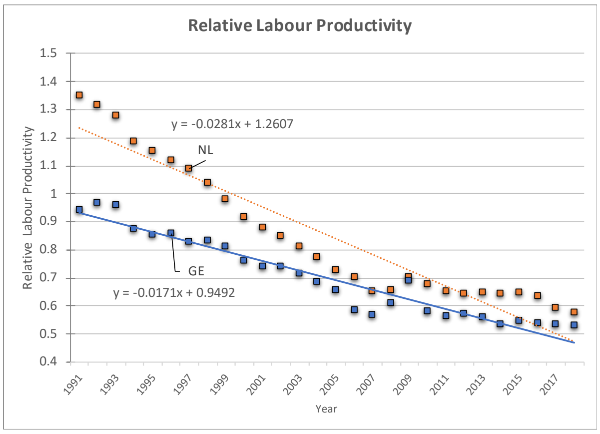


Figure 2

OECD (2020)

NL – P: The Netherlands's progressive sector consisting of manufacturing
NL – S: The Netherlands's stagnant sector consisting of health care, education and social work
GE – P: Germany's progressive sector consisting of manufacturing
GE – S: Germany's stagnant sector consisting of health care, education and social work

Apart from this one inconclusiveness, this analysis so far shows that hypothesis 1, which stated that labour productivity increases for both sectors, but more dramatically for the progressive sector, cannot be rejected. However, H1 was stated in terms of relative labour productivity, RLP. The RLP is reported in the next paragraph.

Relative Labour Productivity

The relative labour productivity (RLP) is shown in Figure 2. The regression analysis (in Table 1a), as well as a table with the data points (Table 1b) can be found in the appendix. As predicted by hypothesis 1, the RLP decreases for both countries over time via the trend analysis, which is statistically significant. The Netherlands has a decrease of 0.0281 per year while Germany has a slightly higher rate, with a decrease of 0.0017 per year, both of which have a statistically significant time coefficient. Hypothesis 1, therefore cannot be rejected.

<u>Hypothesis 2</u>

Output

Figure 3 shows the data points and trend line for output (here measured as gross value added in an economic sector) in millions of euros (at constant prices). The regression analysis (in Table 2a), as well as a table with the data points (Table 2b) can be found in the appendix.

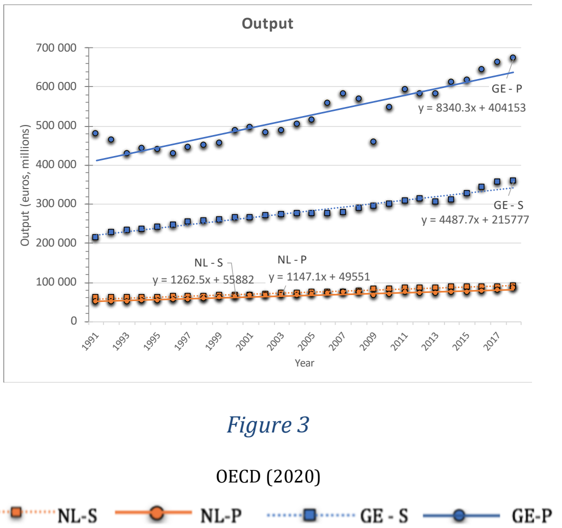


Figure 3

OECD (2020)

GE – P: Germany's progressive sector consisting of manufacturing
GE – S: Germany's stagnant sector consisting of health care, education and social work
NL – P: The Netherlands's progressive sector consisting of manufacturing
NL – S: The Netherlands's stagnant sector consisting of health care, education and social work

Output grows over time in both countries in both sectors, all of which have a statistically significant trend line. Germany sees a much steeper increase especially in the progressive sector, with an average increase of 8'340 million of euros per annum. The Netherlands' stagnant sector has an inferior average growth of 4'487 million of euros per annum, while the Dutch stagnant and progressive sector have an average growth of 1'263 and 1'147 million euros per annum, all of which are statistically significant. Germany's progressive sector sees a rather significant dip in 2009, which may have occurred due to the financial crisis.

The output growth for the Netherlands and Germany with the base year 1991 is illustrated respectively in Figure 4 and Figure 5 and its data points can be found in Table 2b in the appendix. The Netherland's output growth for the stagnant and progressive sector varies throughout the time period, but most of the years with the progressive having a higher growth than the stagnant sector. Germany's output growth case is the opposite, the growth in the stagnant sector it is at all times higher than the progressive sector's. Germany's progressive sector's growth is negative until 2000, from then onwards, remaining a positive growth except for 2009. Its stagnant sector's growth slows down from 1992 until 2005, where it's growth rate stabilizes for the rest of time observed. These findings of a positive growth of output over time cannot falsify the first part of hypothesis 2: output increases in both sectors over time.

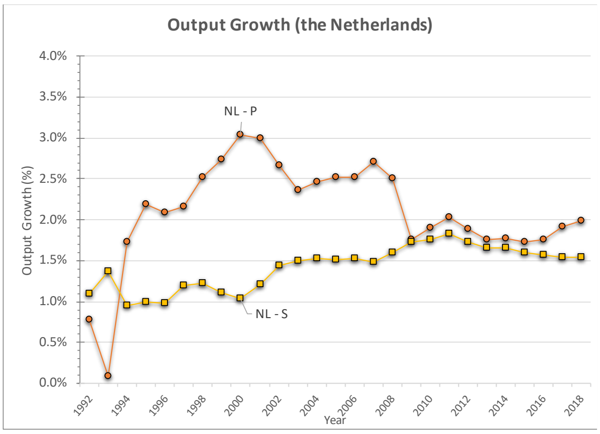


Figure 4

OECD (2020)

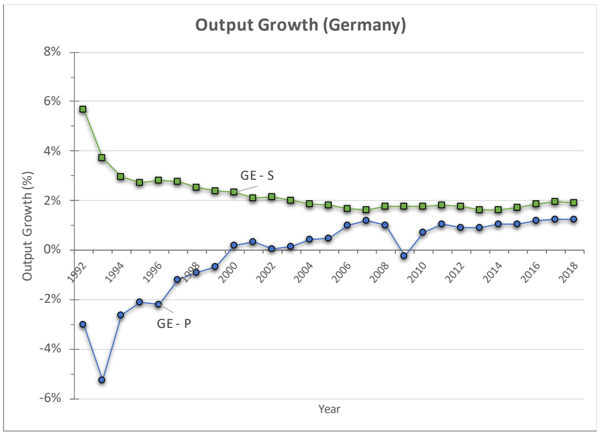


Figure 5

OECD (2020)

GE – P: Germany's progressive sector consisting of manufacturing
GE – S: Germany's stagnant sector consisting of health care, education and social work
NL – P: The Netherlands's progressive sector consisting of manufacturing
NL – S: The Netherlands's stagnant sector consisting of health care, education and social work

Hourly Wage

The hourly wage (at constant prices) is graphed in Figure 6 for each sector. The regression analysis (in Table 2c), as well as a table with the data points (Table 2d) can be found in the appendix.

The Netherlands' stagnant sector has a decrease in hourly wage over time of 0.0042 per annum, which is inconsistent with hypothesis 2. This trend is, however, statistically insignificant with a p-value of 87%, and so no conclusions can be drawn from this. On the other hand, the Netherlands' progressive sector and Germany's stagnant sector have an increase in the hourly wage of 0.809 per annum and 0.141 per annum respectively, both of which are statistically significant and coincide with the hypothesis. Germany's progressive sector has an increase in hourly wage of 0.171 per annum, but this is however statistically insignificant, with a p-value of 35%, and therefore no conclusions can be drawn. The results that are significant, coincide with the second part of hypothesis 2, which states that the wage rates increase in both sectors over time, and it can therefore not be falsified.

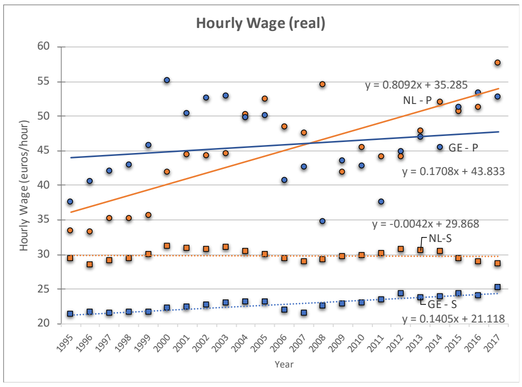


Figure 6

Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019)

NL-S NL-P GE - S GE-P

GE – P: Germany's progressive sector consisting of manufacturing
GE – S: Germany's stagnant sector consisting of health care, education and social work
NL – P: The Netherlands's progressive sector consisting of manufacturing
NL – S: The Netherlands's stagnant sector consisting of health care, education and social work

Focusing on the data points, rather than the trend lines, it can be noted graphically that for both countries, the progressive sector has had higher wages than the stagnant sector in the time period observed.

<u>Hypothesis 3</u>

Employment

The variable tested in this hypothesis is relative employment. We start by analysing employment levels. Employment is measured in hours worked, including full-time, part-time, corporate employees, and self-employed workers. Figure 7 shows the trends in employment. The regression analysis (in Table 3a), as well as a table with the data points (Table 3b) can be found in the appendix. The stagnant sector for both countries has an increase in employment over time, with an average increase of 37.3 million hours engaged per annum in the Netherlands and an even higher increase of 146.7 millions hours engaged per annum in Germany. The progressive sector for both countries, on the other hand, has a decrease in employment, with the Netherlands having an average decrease of 16.3 million hours engaged per annum and Germany with bigger decrease of 101 million hours engaged per annum. The time coefficients are statistically significant. The model for Germany's progressive sector has, however, a R-square value of 0.57, which is lower than the desired minimum of 0.75. This means that the trend line is not a good-fit. Nevertheless, because the F-significance and p-value are statistically significant, the regression line is a good model to describe trend, and so it is still concluded that Germany's progressive sector has an average decrease of 101 million hours engaged per annum.

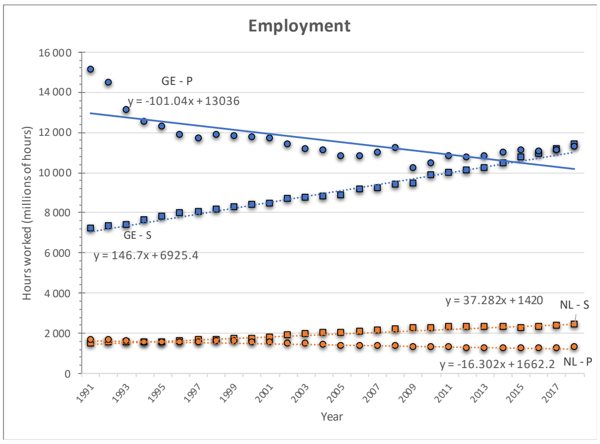


Figure 7

OECD (2020)

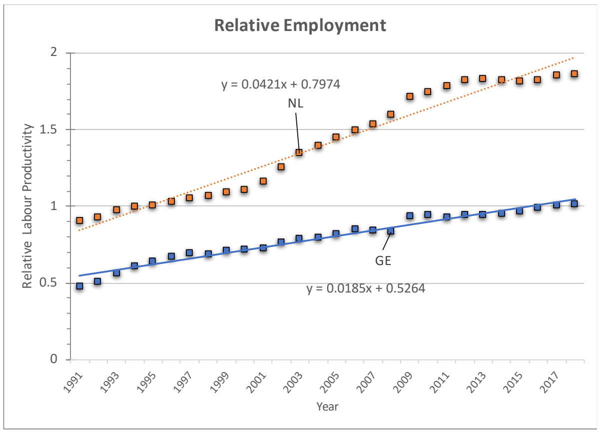


Figure 8

OECD (2020)

NL-S NL-P GE - S GE-P

NL GE

GE – P: Germany's progressive sector consisting of manufacturing
GE – S: Germany's stagnant sector consisting of health care, education and social work
NL – P: The Netherlands's progressive sector consisting of manufacturing
NL – S: The Netherlands's stagnant sector consisting of health care, education and social work

<u>*Relative employment*</u>

The relative employment which was calculated as $\mathrm{RE}_t = \frac{\mathrm{E}_t^S}{\mathrm{E}_t^P}$ is illustrated in Figure 8. The regression analysis (in Table 3a), as well as a table with the data points (Table 3b) can be found in the appendix. An increase in relative employment is seen in both countries, with the Netherlands having a larger average increase of relative employment of 0.0421 per annum, and Germany a lower increase of 0.0185 (both of which are statistically significant). This is an indirect proof of labour shedding by the progressive sector as the share of hours engaged in the stagnant sector is increasing relative to the progressive sector.

As was to be expected, employment in the progressive sectors of both countries declined. Over the same period, employment in the stagnant sectors increased (in both countries). This analysis coincides with the structural change described by Baumol, where increases in the stagnant sector relative to the progressive sector and gives no reason to reject H3: Relative employment will increase over time.

<u>Hypothesis 4</u>

Unit Labour Cost (ULC)

Figure 9 shows the trends of unit labour cost (ULC) over time. The regression analysis (in Table 4a), as well as a table with the data points (Table 4b) can be found in the appendix. The data for ULC were calculated with the following formula:

$$\mathrm{ULC}_t^i = \frac{w_t^i}{\lambda_t^i}$$

Equation 9

Where:
w = hourly wage,
λ = labour productivity,
ULC = unit labour cost,
the subscript t refers to the calendar year,
the superscript i refers to the sector (stagnant or progressive).

This is an important variable to be analysed because its results will show whether costs and, consequently, prices in the stagnant sector are rising compared to the progressive sector, the cost disease's symptom. According to the linear trendline analysis for the stagnant sector, the Netherlands has an increase in ULC of 0.0009 per annum, but this is, however, statistically insignificant with a p-value of 41%. Germany's stagnant sector, on the other hand, has a statistically significant ULC increase of 0.0052 per annum. The progressive sector for both countries has a negative trendlines, with the Netherland's progressive ULC having a decrease of 0.0082 per annum, and Germany a decrease of 0.0190 per annum, both of which are statistically significant.

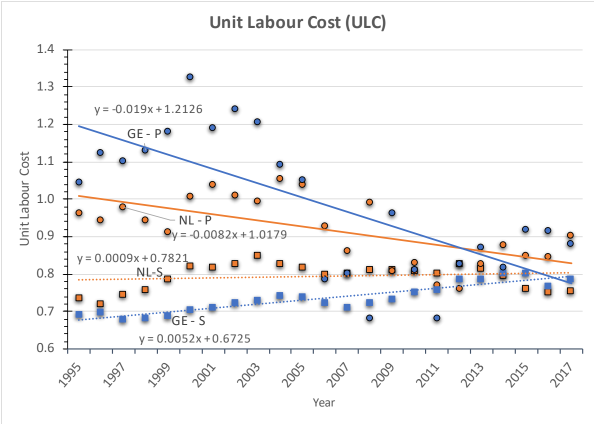


Figure 9

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

NL-S NL-P GE - S GE-P

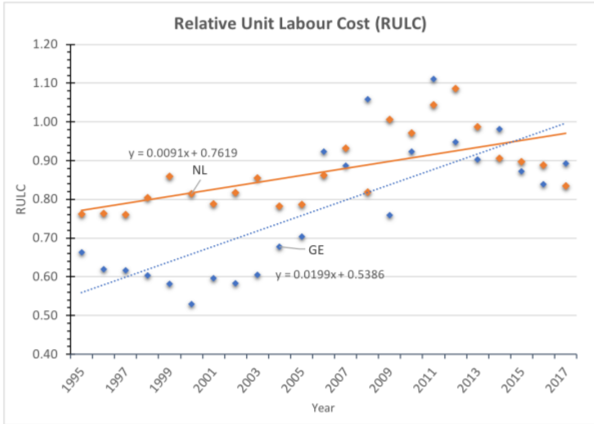


Figure 10

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

NL GE

GE- Germany
NL: the Netherlands
P: Progressive sector consisting of manufacturing industry
S: Stagnant sector consisting of health care, education and social work

According to the results which can be concluded due to their statistically significance, the progressive sector of the Netherlands and Germany has a decrease in ULC over time, and Germany's stagnant sector has an increase of ULC over time. The Netherlands' stagnant sector ULC trend is statistically insignificant and therefore not conclusions can be drawn. According to the results that can be concluded from this analysis, hypothesis 4 cannot be falsified.

Relative Unit Labour Cost (RULC)

Figure 10 shows the relative unit labour cost (RULC). The regression analysis (in Table 4a), as well as a table with the data points (Table 4c) can be found in the appendix. The RULC was calculated with the previously introduced Equation 5.

$$RULC_t = \frac{ULC_t^s}{ULC_t^p}$$

Equation 5

where:
the variable RULC refers to the relative unit cost,
the variable *ULC refers to unit labour cost,*
the subscript *t* refers to the calendar year,
the superscript *p* and s refers to the progressive and stagnant sector respectively.

Figure 10 illustrates that both countries have an increase in RULC over time, meaning that the ULC costs of the stagnant sector are rising compared to the progressive sector. The Netherlands has an increase of RULC of 0.009 per annum, and Germany an increase of 0.0199, both of which are statistically significant. Conclusively, these findings cannot falsify the second part of hypothesis 4: the RULC will increase for both countries.

These results are interesting because despite the stagnant sector for both countries having a lower wage than the progressive at all times, the unit labour costs in the stagnant sector has risen relative to the progressive sector (see Figure 6 . It is possible that the increase in the unit labour costs in the stagnant sector must have not come from the wages, but from another source, which will be discussed in the following paragraphs.

RULC growth

In the previous section we have analysed changes in the RULC graphically. It is also possible to analyse changes in RULC mathematically (by computing its growth rate). Figure 11 shows the relative unit labour growth (RULC growth) over time for both countries. The table with the data points (Table 4d) can be found in the appendix. The growth rate of relative unit labour costs $(R\dot{U}LC_t)$ was calculated with the following formula:

$$R\dot{U}LC_t = UL\dot{C}_t^s - UL\dot{C}_t^p$$

Equation 10

where $U\dot{L}C$ was calculated with the following formula:

$$U\dot{L}C_t^i = \frac{ULC_t^i - ULC_{t-1}^i}{ULC_{t-1}^i}$$

Equation 11

where:
the variable RULC refers to the relative unit cost,
the variable *ULC refers to unit labour cost,*
the subscript *t* refers to the calendar year,
the superscript *i* refers to the progressive and stagnant sector respectively,
the dot above the variable depicts a growth rate.

The Netherlands and Germany have shown great variation in RULC growth during the time period analysed but has had higher positive growths than negative. Both countries have had their most significant negative RULC growth in 2009, which could be due to the financial crisis which occurred around that time.

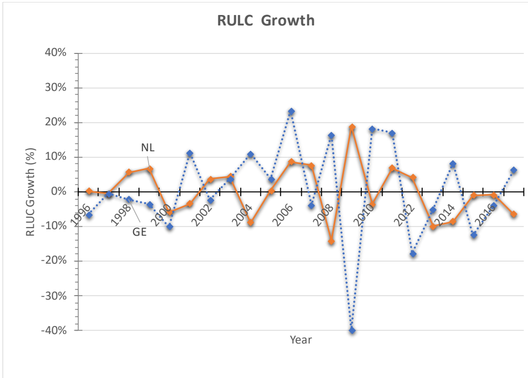


Figure 11

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

NL GE

The growth in the RULC can be analysed mathematically (rather than graphically, as above) if we study its two components: relative wage growth and relative labour productivity growth. The formula and graphical analysis done in Figure 11 does not specify whether the growth originates from the wage growth or the labour productivity growth. Re-writing the formula by splitting it into two components, the wage component and the labour productivity component as shown in Equation 12, will help to explain whether the changes in RULC_t are due to primarily a difference in wage growth rates or to a difference in productivity growth rates. The equation also reveals that the wage component has a positive impact on the $\dot{\text{RULC}}_t$ whereas the labour productivity component has a negative impact.

$$\dot{\text{RULC}}_t = (\dot{w}_s - \dot{w}_p) - (\dot{\lambda}_s - \dot{\lambda}_p)$$

Wage component Labour productivity component

Equation 12

where:
the variable RULC refers to the relative unit cost,
the subscript *t* refers to the calendar year,
the symbols *w and λ refer to the hourly wage and labour productivity respectively,*
the superscript *i* refers to the progressive and stagnant sector respectively,
a dot above a variable depicts a growth rate.

The wage growth and labour productivity growth were calculated with the following formula:

$$\dot{w}_t^i = \frac{w_t^i - w_{t-1}^i}{w_{t-1}^i} \text{ and } \dot{\lambda}_t^i = \frac{\lambda_t^i - \lambda_{t-1}^i}{\lambda_{t-1}^i}$$

Equation 13

The *relative* wage growth for Germany and the Netherlands, is calculated with the following formula:

$$Relative\ hourly\ wage\ growth = (\dot{w}_s - \dot{w}_p)$$

Equation 14

Average Hourly wages growth rates and average relative hourly wage growth rates in the two countries						
Variable	Average annual growth rates for wages ($\dot{w}_i$)				Average relative hourly wage growth ($\dot{w}_s - \dot{w}_p$)	
Country	Netherlands		Germany		Netherlands	Germany
Sector	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
Average (1996-2017)	-0.10%	2.88%	0.78%	2.15%	-2.99%	-1.00%

Table 1

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

The table with the data points for the hourly wage growth and relative hourly wage growth (Table 4e) can be found in the appendix. The relative hourly wage growth for the Netherlands per annum is on average -2.99% and Germany's is -1.0%.

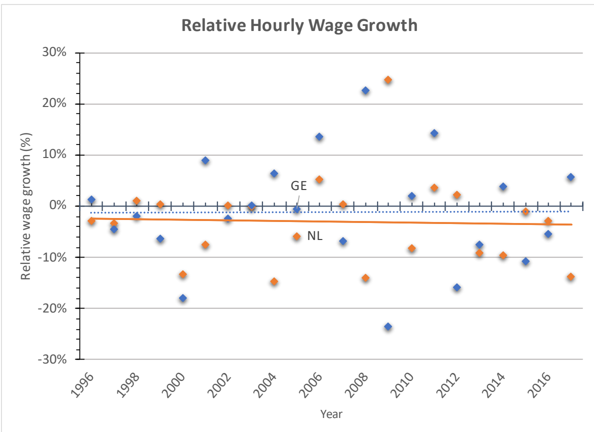


Figure 12

Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019)

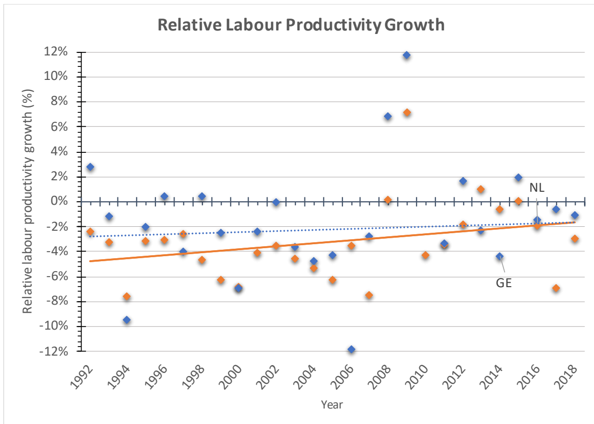


Figure 13

OECD (2020)

NL GE

The relative labour productivity growth was calculated with Equation 15 and the trend results are illustrated Figure 13 .

$$Relative\ labour\ productivity\ growth = (\dot{\lambda}_s - \dot{\lambda}_p)$$

Equation 15

Visually analysing, the trend line for the relative labour productivity growth is negative in both countries for most of the time. This means that labour productivity growth in the stagnant sector has consistently remained below labour productivity growth in the progressive sector.

The table with the data points for the labour productivity growth and relative labour productivity growth (Table 4f) can be found in the appendix. The average relative labour productivity growth rates were computed and illustrated in Table 2.

Labour productivity growth rates and relative labour productivity growth rates in the two countries						
Variable	Average annual growth rates labour productivity ($\dot{\lambda}_t$)				Average relative labour productivity growth ($\dot{\lambda}_s - \dot{\lambda}_p$)	
Country	Netherlands		Germany		Netherlands	Germany
Sector	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
Average (1992-2018)	-0.26%	2.96%	0.22%	2.47%	-3.22%	-2.26%

Table 2

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

The average annual growth rate of labour productivity is higher in the progressive sector than the stagnant sector for both countries. This leads to a negative average relative labour productivity growth for both countries, -3.22% for the Netherlands and -2.26% for Germany.

The table below shows the average RULC growth rate for the time period 1992-2018. On average, the RULC growth rate is positive for both countries, meaning that the stagnant's sector unit labour cost has been increasing relatively to the progressive sector as Baumol's (2012) work predicted. The table also shows that if it were not for the negative relative hourly wage growth offsetting the negative relative labour productivity growth, the $\dot{\text{RULC}}_t$ would be even higher.

Average RULC growth rate (1992-2018)			
	$\dot{\text{RULC}}_t$=	$(\dot{w}_s - \dot{w}_p)$	$-(\dot{\lambda}_s - \dot{\lambda}_p)$
The Netherlands	0.23%	-2.99%	3.22%
Germany	1.26%	-1.00%	2.26%

Table 3

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

These results reveal that any increase in the RULC growth rate over time has been caused predominantly by a lagging productivity growth in the stagnant sector, and that the relative hourly wage growth rate has prevented an even larger average RULC growth rate. This means that the cost disease symptom of increased costs in the stagnant sector arose mainly from differences in labour productivity growth between the sectors. This is consistent with Baumol's explanation of the symptom (increase in costs and consequently prices) in which the increase in costs in the stagnant sector arise from very low (or non-existent) labour productivity growth over time and not from the wage rate changes over time.

4.3 Is cost disease a problem that the Netherlands and Germany face?

The aim of this chapter was to determine whether the Netherlands and Germany have the cost disease. This was done by testing the hypotheses, and if those were proven to be true, these countries suffer the disease. The hypotheses were the following:

H1. Labour productivity increases for both sectors, but more dramatically for the progressive sector over time.

H2. Output and the wage rate increase in both sectors over time.

H3. Relative employment will increase over time.

H4. Unit labour cost (ULC) will remain constant (or maybe even have a small decrease) in the progressive sector and increase in the stagnant sector; $RULC_t$ *will increase over time.*

And the results were summarized for each country in the table below:

		The Netherlands		Germany	
Hypothesis tested	**Variable tested:**	**Progressive S.: Correct?**	**Stagnant S.: Correct?**	**Progressive S.: Correct?**	**Stagnant S.: Correct?**
H1.	Labour productivity	Yes	Yes	Yes	Inconclusive
H2.	Output	Yes	Yes	Yes	Yes
	Wage rate	Yes	Inconclusive	Inconclusive	Yes
H3.	Relative employment	Yes		Yes	
H4.	ULC	Yes	Inconclusive	Yes	Yes
	RULC	Yes		Yes	

Table 4

The conclusion based on this empirical part of the thesis based on the case study is that both countries do have the cost disease. Hypothesis 1, 2 and 4 do face inconclusive results, but they do not falsify their hypothesis.

This conclusion confirms a research done by Fase and Winder in which they tested whether the Netherlands has the cost disease (Fase & Winder, 1999). Their study focused on the time period from 1956 to 1992 and on the manufacturing industry for the progressive sector, like this study, and the general service industry for the stagnant sector, unlike this study, which focuses on education, health care and social work. The results of my study show that this is also the case (although for a slightly different definition of sectors) for the years after Fase and Winder concluded their study.

Chapter 5. Maintaining a technologically progressive economy while preventing unemployment: is it viable and how would it be done?

This chapter will explore whether it is viable for Germany and the Netherlands to maintain a technologically progressive economy while preventing unemployment, and how it would be done. The subject is approached in five sections. It will first be estimated how much labour is shed by the progressive sector, which gives us an estimate of how many hours of work will be sought in the stagnant sector. Then, it will be estimated whether there would be enough money to fund new work in the stagnant sector. The third task is to investigate how money could be transferred from the progressive sector to the stagnant sector. One possibility would be profit taxation, which will be analysed to find out how high the profit tax would need to be. Then, the difficulties of profit taxation will be discussed. In the final section of this chapter, I will answer the research question of how to maintain a technologically progressive economy while preventing unemployment, and on what conditions this would be possible.

5.1 The changing nature of work: the shift of work from the progressive to the stagnant sector

This section includes calculations to estimate how much labour is shed by the progressive sector due to increases in labour productivity growth. This estimate reveals how much work needs to be created in the stagnant sector if technological unemployment is to be avoided.

To estimate the labour shed by the progressive sector, the following simple model will be used:

$$Y_t^p = \lambda_t^p * H_t^p$$

Equation 16

where:
Y_t^p stands for the output of the progressive sector at time t
H_t^p for hours worked in the progressive sector at time t
λ_t^p for labour productivity in the progressive sector at time t.

Equation 14 says that total output in the progressive sector depends on total hours worked in this sector, multiplied by labour productivity. The hours of labour shed by the progressive sector are now computed as follows.

The model is adapted to the situation, resulting in Equation 17.

$$H_1^* = \frac{Y_1^p}{\lambda_0^p}$$

Equation 17

The idea is to compare, over a particular period of time, two points in time: a base year (0) and a final year (1). H* is the number of hours the progressive sector would have required to produce the higher output at time 1 (Y_1^p) if labour productivity had remained constant from year 0 to year 1.

The hours of work shed by the progressive sector will equal the difference between H* and H_1^p (i.e. the *actual* number of hours worked in the progressive sector at time 1), as shown in the following equation:

$$\Delta H_1^p = H_1^* - H_1^p$$

Equation 18

where ΔH is the hours of work that are no longer needed in the progressive sector,
H_1^p is the *actual* number of hours worked in the progressive sector at time 1,
H* is the number of hours the progressive sector would have required to produce the higher output (Y_1^p) if labour productivity had remained constant from year 0 to year 1.

The hours of work shed by the progressive sector were estimated in this way, for every year of the time range observed in the previous chapter (1992 – 2018). The full results (1992-2018) can be found in Table 5a in the appendix, and a preview of the results for the last five years of available data is illustrated in the table below.

Year	**ΔH_1 (millions of hours)**		**ΔH_1 / H_1^p (%)**	
	The Netherlands	Germany	The Netherlands	Germany
2014	30.79	361.3	2.46%	3.34%
2015	11.94	23.4	0.95%	0.21%
2016	14.86	478.8	1.19%	4.32%
2017	72.66	305.2	5.77%	2.76%
2018	27.20	-0.6	2.15%	-0.01%
Average (1992-2018)	-	-	2.94%	2.49%

Table 5

As the above 'preview' table shows, during the last five years of the period studied, millions of hours have been shed every year by the progressive sector. The percentage of the labour shed yearly by the progressive sector in terms of the labour force in the progressive sector is reflected by the ratio of ΔH_1 / H_1^p shown in the table above. The Netherlands and Germany have had a shed of its progressive sector's labour force of on average 2.94% and 2.49% from 1995-2018. To estimate the hours for which work is sought in the stagnant sector, it will be assumed that all those who have lost their work in the progressive sector will seek new work (for the same number of hours) in the stagnant sector.

5.2 Would productivity gains achieved in the progressive sector be sufficient to fund the required money transfers to the stagnant sector?

In this chapter I try to answer the question whether it is possible to maintain a technologically progressive economy, while preventing unemployment. In this section I will first estimate the magnitude of the transfer that would be required to fund new work in the stagnant sector for those whose labour is obviated in the progressive sector. As already mentioned, it is assumed that all those who lose work in the progressive sector will be looking for new work in the stagnant sector for the same number of hours.

Next, the size of the productivity gains in the progressive sector will be estimated for both countries. Finally, the estimated required transfer and the productivity gains will be compared to see whether they match.

5.2.1 What is the estimated magnitude of the transfer that will be required to fund new work in the stagnant sector for those whose labour is obviated in the progressive sector?

The magnitude of the required financial transfer from the progressive to the stagnant sector is estimated by multiplying the hours of work that will be sought in the stagnant sector at time t (and which in this model is assumed to equal the hours of work that have become redundant in the progressive sector, as computed in Section 5.1) by the wage rate of the stagnant sector at time t. The estimated required money transfer between the sectors then equals:

$$\text{required money transfer } (p \rightarrow s) = \Delta H_t^p * w_t^s$$

Equation 19

where ΔH_t^p is the hours of work that will be sought in the stagnant sector in year t
w is the wage rate
t refers to the calendar year
the superscript s and p refer to the stagnant and progressive sector respectively.

The required money transfer was calculated for the time range 1996-2018, which can be found in table 5b.1 and table 5.b.2 in the appendix. The data for the most recent five years of the time period analysed, are shown in the following table.

Year	Required money transfer (millions of Euros)		$Required\ money\ tranfer_t^s / Y_t^s$ (%)	
	The Netherlands	Germany	The Netherlands	Germany
2014	937	8627	1.08%	2.77%
2015	351	569	0.40%	0.17%
2016	429	11522	0.49%	3.37%
2017	2076	7687	2.33%	2.16%
2018	Unavailable data*	Unavailable data*	Unavailable data*	Unavailable data*
*There is only data for hourly wages until 2017				

Table 6

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

The two countries require a very large amount of money transfer in the order of magnitude of millions of Euros. These results correspond to the estimation of total employment in the previous chapter (Figure 7), which revealed decreasing numbers in employment in the progressive sector and increasing numbers in the stagnant sector for both countries. This shift in hours from the progressive to the stagnant sector implies that significant transfers of money from the progressive to the stagnant sector are needed every year. Not unexpectedly, Germany will require greater transfers compared to the Netherlands, as seen by Germany having a higher ratio of required money transfer to the output than the Netherlands, given its larger population.

5.2.2 What is the estimated size of productivity gains ('freed capital') in the progressive sectors?

Productivity gains are defined in this thesis as money that is saved due to productivity growth (resulting from labour-saving devices). In other words, the labour that was previously done by workers is now done by machines, and now there is money that no longer needs to be spent on the now obviated labour (Naastepad & Houghton Budd, 2019). Productivity gains for both countries are roughly estimated by multiplying the wage rage in the progressive sector at time *t* by ΔH_t^p, the hours of work obviated in the progressive sector at time *t*, which was calculated in section 5.1. This calculation will give an indication of how much money has been saved in the progressive sector due to the hours of labour that have been obviated and that are therefore no longer paid. The productivity gains thus achieved have been called 'freed capital' (Naastepad & Houghton Budd, 2019). Freed capital could be estimated through the following formula:

$$'\text{freed capital}' = w_t^p \Delta H_t^p$$

Equation 20

where ΔH_t^p is the hours of work shed in the progressive sector in year t
w is the wage rate
t refers to the calendar year
the superscript p refers to the progressive sector

This means that, for example, freed capital for the year 2018 would be estimated as

$$w_{2018}^{p}\left(H_{2018}^{*}-H_{2018}^{p}\right)=w_{2018}^{p}\left(\frac{Y_{2018}^{p}}{\lambda_{2017}^{p}}-\frac{Y_{2018}^{p}}{\lambda_{2018}^{p}}\right).$$

The estimated freed capital for the Netherlands and Germany with the full time range from 1996-2018 can be found in table 5b.1 and table 5.b.2 in the appendix, and a preview for the most recent five years of the time period analysed can be found in the table below:

Year	Freed capital F_t^p (millions of euros)		Ratio $FY = F_t^p/Y_t^p$ (%)	
	The Netherlands	Germany	The Netherlands	Germany
2014	1600	16411	2.16%	3.00%
2015	605	1196	0.81%	0.20%
2016	761	25519	1.00%	4.38%
2017	4189	16080	5.19%	2.76%
2018	Unavailable data*	Unavailable data*	Unavailable data*	Unavailable data*
*There is only data for hourly wages until 2017				

Table 7

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

The two countries have a significantly large amount of freed capital. Germany has a much larger freed capital than that of the Netherlands because Germany has a larger manufacturing sector. Throughout the entire time range, both countries' freed capital as a percentage of the progressive sector's output at time t, stay relatively low. This corresponds to labour productivity growth for the progressive sector, which was computed (found in table 4f in the appendix) to be an average of 2.96% for the Netherlands and 2.47% for Germany for the time period 1991-2018.

When labour productivity in the progressive sector increases, freed capital (defined as the hours that are freed times the progressive sector wage rate) will also increase. Taking the absolute value of the change in hours (to avoid complications with negative numbers), we can write:

$$\frac{F_t^p}{Y_t^p}=\frac{w_t^p\left|\Delta H_t^p\right|}{Y_t^p}=\frac{w_t^p\left|\Delta H_t^p\right|/H_t^p}{Y_t^p/H_t^p}=\frac{w_P\,\dot{H}_t^p}{\lambda_P}=ULC_P\times\dot{H}_t^p=ULC_P\times\dot{\lambda}_p.$$

This means that freed capital is a function of unit labour cost in the progressive sector (ULC^p) and the growth rate of labour productivity in the progressive sector. If labour productivity grows by around 3 per cent per annum ($\dot{\lambda}_p=0.03$), and ULC^p is around two-thirds, the ratio F_t^p/Y_t^p will be around 2 per cent. On average, the ratio F_t^p/Y_t^p to the labour productivity growth rate in the progressive sector in the Netherlands is around 92%, while around 104% for Germany, which is not impossible as order of magnitude. These averaged percentages are considerably higher than around the expected two-thirds. However, it should be taken into account that averages from annual results take into account the extreme values that arise from very large fluctuations from year to year.

5.2.3 Do the estimated required transfer and available productivity gains match?

The aim of this section is to gain a perspective of whether transfers of freed capital would be enough to fund the new work in the stagnant sector in the last five years with available data. In order to find out whether there is an abundance or lack of funds to be transferred, I calculated the difference between the two values, here denoted by M, for both countries. A positive M value would mean that the country

has more than enough funds (freed capital) to fund the required additional hours of work in the stagnant sector, whereas a negative M value would mean that it is missing funds.

$$M = '\text{freed capital}'_t - 'required\ money\ transfer'_t$$

Equation 21

The freed capital, required transfer, M values and required transfer/ freed capital can be found in table 5b.1 and table 5.b.2 in the appendix, and a preview of the results for the most recent five years of the time period analysed and the percentage difference between these values are shown in the table below:

	Year	Freed capital	Required transfer	M value	Enough funding ?	Percentage difference	Required Money Transfer/Freed capital
		€, millions	€, millions	€, millions		%	%
The Netherlands	2014	1600	937	662.9	Yes	55.96%	59%
	2015	605	351	254.4	Yes	70.76%	58%
	2016	761	429	331.7	Yes	72.47%	56%
	2017	4189	2076	2113.7	Yes	77.32%	50%
	2018	Unavailable data*					
Germany	2014	16411	8627	7784	Yes	90.2%	53%
	2015	1196	569	627	Yes	110.1%	48%
	2016	25519	11522	13997	Yes	121.5%	45%
	2017	16080	7687	8393	Yes	109.2%	48%
	2018	Unavailable data*					

*There is only data for hourly wages until 2017

Table 8

(Stehrer,. Bykova, Jäger, Reiter & Schwarzhappel, 2019; OECD, 2020)

These results indicate that the Netherlands and Germany would have more than enough freed capital to transfer to the stagnant sector, on average, 65% more than necessary for the Netherlands and 101% for Germany. Both countries would therefore be able to fund a growing stagnant sector if on average 68% of the Netherland's and 50% of Germany's newly generated freed capital is fully used to fund it. It is important to note that these values are based on an incremental analysis, meaning that it would take 50-70% of the progressive sector's freed capital at year *t* to fund new work for those who lost their job at year *t*. This analysis does therefore not include funding new work for those workers who lost their job prior to funding. If this were to be taken into account, it is very likely that *all* freed capital would need to be used to fund new work in the stagnant sector.

Based on the model used, the explanation of both countries having enough freed capital to fund new work in the stagnant sector can be found in the difference between the progressive and stagnant sector wage rates.[8] Both countries have had the stagnant sector's hourly wage lower than the progressive sector's hourly wage during the entire time period analysed. (See Figure 6) For the progressive sector's newly generated freed capital to fund the stagnant sector, both countries would need to keep the average wage rate in the stagnant sector not consistently higher than the average wage rate in the progressive sector.

So far, it has been shown that the Netherlands and Germany have the cost disease, and funding expansions of the stagnant sector (to absorb the labour shed by the progressive sector) is possible in principle. Consequently, the research question can now be answered: Yes, it is possible to prevent unemployment *if*:

1. *50-70%* of freed capital (money that is saved through labour productivity growth annually) in the progressive sector transferred to the stagnant sector to fund new work in that sector, and
2. the average wage rate in the stagnant sector is not consistently higher than the average wage rate in the progressive sector.

The next question is how freed capital could be transferred from the progressive sector to the stagnant sector. In accounting terms, freed capital appears as profit in the Income-Expense account (or Profit & Loss account) (Naastepad & Houghton Budd, 2019). Therefore, one possibility would be a profit tax.

[8] Note that, in the model used, the difference between the 'required money transfer' (in Equation 19) and 'freed capital' (Equation 20) is the wage rate.

5.3 Profit taxation

This section will discuss profit taxation as a method, giving an estimate for each country's profit taxation in the progressive sector, analysing its difficulties, and limitations.

5.3.1 Profit taxation as a method for maintaining a technologically progressive economy while preventing unemployment

Profit taxation was first brought up in section 3.2 when recommending methods to implement Baumol's solution of transfer of funds. A characteristic of this method is that it is mandatory: it forces companies in the progressive sector to contribute to essential activities such as health care, education, and social work. Freed capital initially shows up as profit in the Profit & Loss account (Naastepad & Houghton Budd, 2019). Imposing a profit taxation on companies in the progressive sector would therefore ensure that freed capital, which arises because labour is obviated, is used to fund new work in the stagnant sector for those who lose their work (due to productivity growth) in the progressive sector.

The rate of profit taxation will be calculated in a way so that it is enough to fund work in the stagnant sector.

The rate of profit taxation can be estimated by the following formula:

$$\text{profit taxation} = \frac{\text{required money transfer } (\mathrm{p} \rightarrow \mathrm{s})_{\mathrm{t}}}{\text{profit before tax}_{\mathrm{t}}^{\mathrm{p}}}$$

Equation 22

where p and s refer to the progressive and stagnant sector respectively
the subscript t refers to calendar year

where the profit before tax was retrieved as gross operating income from Eurostat. [9] The operating income is similar to profit in terms of it being equal to the total revenue minus costs and operating expenses. However, the gross operating income does not include taxes and therefore it is taken as 'profit before tax' (Hayes, 2020). The required money transfer was calculated in section 5.2.1, and its results can be seen in Table 5b.1 and Table 5.b.2 in the appendix.

The profit taxation was calculated from 2005-2018, and not the focused time range, due to unavailability of data of profit before tax before 2005. This full data results can be found in table

[9] Eurostat (2020) Annual detailed entreprise statistics for industry (NACE Rev.2, B-E) Retrieved from https://ec.europa.eu/eurostat/cache/scoreboards/BSP/#

5c in the appendix. The five most recent years of the time period analysed for both countries is illustrated in the table below.

Year	Profit taxation (%) needed to fund money transfer	
	The Netherlands	Germany
2014	4.12%	6.03%
2015	1.33%	0.40%
2016	1.43%	6.67%
2017	6.45%	4.32%
2018	Unavailable data*	Unavailable data*
Average (2005-2018)	3.50%	2.89%
		***There is only data for hourly wages until 2017**

Table 9

Eurostat (2020)

The Netherlands and Germany have a reasonable average profit taxation for the time period, with an average of 3.50% for the Netherlands and 2.89% in Germany.

Note that the above computation pertains only to the required *annual increases* in work in the stagnant sector. To finance the whole of the stagnant sector, the profit tax[10] will have to be around 50-70% per cent (depending on differences between the wage rates in the two sectors). This can be understood from Section 5.2.3, where it was shown that the required transfer would have to be 50-70% per cent of the productivity gains (i.e. of the amount of money saved through the obviation of labour) – see point 1 in Section 5.2.3. The difference between this transfer of 50-70% per cent of the productivity gains (profit), and a 3 per cent profit tax can be explained by distinguishing between *annual* increases and *cumulative* increases in productivity. This is further explained in Section 5.3.4.

5.3.2 Questions of profit taxation

As has been previously discussed, profit taxation, if implemented and redistributed well, could help fund work in the stagnant sector. However, firms often use their profit to fund capital replacements and new capital. Hence, if most or all profit is taxed away, how will businesses cover their capital costs? An image that is often used in economics may help to find an answer: the circular flow of income. When profit income is taxed, it does not disappear from the economy. Governments use tax revenues to fund work (incomes) in the stagnant sector. These incomes will

[10] Profit is here assumed to equal the productivity gains as computed in this thesis.

be spent, and when this happens, the money that was originally taxed away will return to businesses, restoring their profits. The money that is taxed away does not disappear; via government spending it returns to businesses, enabling them to cover their capital costs.

5.3.3 Difficulties of profit taxation

Profit taxation may seem like a straightforward solution, but in reality, it faces several difficulties, regarding firms finding legal loopholes to abstain from paying their profit taxes, which will now be discussed.

Stock buybacks and dividend payments

Companies have to invest deeply in the firms' productive capabilities to remain competitive in this fast-paced economy. Nevertheless, according to Lazonick, Sakinç, & Hopkins, (2020), firms that have the capability to invest in their productive capabilities with their acquired productivity gains do not often do so. They are often used for stock buybacks and dividend payments, both of which make no contribution to the productive capabilities of the firm. Senior corporate executives and even investment bankers can use stock buybacks to increase the share prices and benefit from this increase in value. An increase in a company's value via stock value increases the market value (value of a company according to its number of outstanding shares and their price) but not its book value (difference between the company's total assets and total liabilities) (Murphy, 2019). Some even leverage stock buybacks with debt which increases its financial fragility. A firm can also choose to use its productive gains for excessive dividend payouts to its shareholders to keep them happy. A solution proposed by Shaxson (2020) is to ban stock buybacks, which would remove the power of the executives to increase the firm's value and benefit from this action. There is however the risk of sharper market decline when stock prices decline because companies can no longer buy them to bring the prices back up and additionally, the downside that because the company cannot reduce the number of outstanding shares by stock buybacks, the growth in earnings per share would be slower (Kolakowski, 2019).

Tax Havens

An additional difficulty on imposing profit tax is tax havens. According to Shaxson (2020) multinational companies take advantage of tax havens by registering in other countries with 'cheaper' tax to escape 'expensive' taxes in their own country and keep their profit or productivity gains. This is the case where there is a territorial system in place, where the profit is taxed where it is booked and not where it is received. Such a tax system increases the use of offshore tax havens increases the rewards for corporate offshoring and puts small businesses into a disadvantage (ITEP, 2017). Shaxson (2020) has suggested solutions to tackle tax havens via country-by-country reporting and unitary taxation.

Country-by- Country report

A country-by-country (CbC) reporting require multinationals to report their income and costs for each country they operate in insteda of a total worldwide income and cost report. The CbC report would allow tax transparency in which one can determine whether the multinational is diverging its profits to a tax haven, and ensure that the company's tax profits are collected accordingly and used for the welfare of society. According to the Tax Justice Network (n.d), "*Despite being dismissed at first as unfeasible and being strongly opposed by the OECD, a watered down form of country by country reporting was adopted as a global standard by the OECD in 2014 after G20 countries mandated it.* " According to OECD (2019), there are currently 90 countries that oblige large multinational enterprises to file the CbC report.

Unitary taxation

In an unitary taxation system, multinationals are treated as a group made up of all its local branches instead of treating each individual branch as an individual entity. The multinationals declare their global profits but then they are allocated to each country based on the real economic activity that took place in that country. In other order, it works by taking the multinationals total profit and calculating what each country's profit is via its sales and costs, and tax the country accordingly. Each individual entity would have to file its own accounts, generating enormous amounts of paperwork for each multinational corporation (Turner, 2019). This taxation system is extremely complex and would require multinationals' accountants to do a lot of work (Turner, 2019). To implement such a tax system would require the agreement of worldwide governments.

So far, the profit taxation has been discussed, along with a profit tax estimate for each country based on the case study, the difficulties that arise from profit taxes, and their proposed solutions. There is a long way to go in terms of redistributing funds from the progressive to the stagnant sector, especially in terms ensuring the profit taxation system at place ensures there is no profit tax avoidance. Nevertheless, assuming that each country has in place a tax system which is able to tax productivity gains, is this sustainable in the long-term?

5.3.4 Profit taxation: its viability in the long-term

The *annual increases* in profit taxation that would be required to fund the required *annual increments* in stagnant sector work were computed in Section 5.3.1. The estimation and obstacles of profit taxation have been discussed in the previous section. This section will now provide an analysis of the total amount of profit taxation that would be required to support the stagnant sector.

A problem stated by Baumol (1993) is that in the future, taking into account that prices in the stagnant sector will inevitably rise, more than half of the value of the economy's output will be devoted to the stagnant sector whose funding mostly comes from the public sector (government). The public sector in most countries is responsible for funding health care, education, protection (police officers, fire fighters) and welfare. With the cost disease, the public sector would have to gain more revenues to keep up with the funding.

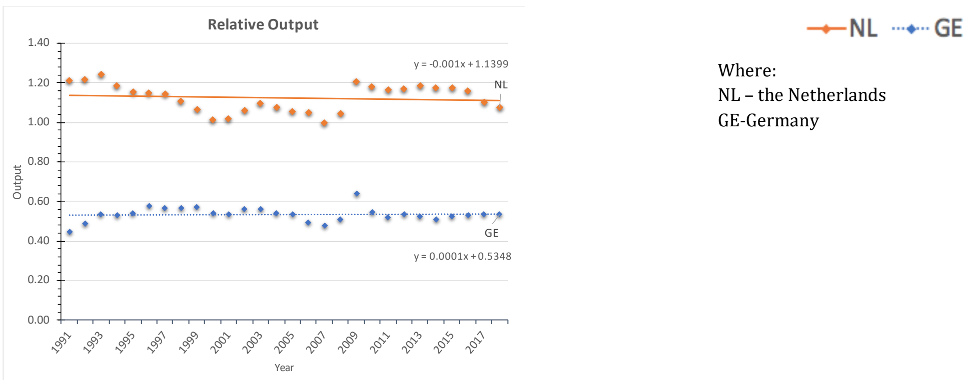
To test whether this is indeed the case for the focused case study, the relative output is computed with the following equation:

$$RY = \frac{Y_S}{Y_P}$$

Equation 23

Where RY is the relative output
Y is the output
The subscript S and P refer to the stagnant and progressive sector respectively.

An increase in the output added over time would depict an increase in the output of the stagnant sector relative to the progressive sector, meaning that Baumol's posed problem is correct. The relative output is illustrated in the figure below, the regression analysis and the data points can be found in table 5d and 5e in the appendix.



Where:
NL – the Netherlands
GE-Germany

Figure 14

OECD (2020)

The Netherlands has a small decrease in relative output of 0.001 per annum, whereas Germany has a small increase of 0.0001 per annum. Both trend lines are however statistically insignificant and have a low R-square value of 0.015 for the Netherlands and 0.001 for Germany, meaning that the trendline does not reflect the data points well. As a consequence, no results can be concluded from this analysis.

Assuming Baumol's (1993) proposed problem is correct despite being unable to prove it does to insignificant results, the growth rate of the stagnant sector relative to the progressive sector will increase even further in the upcoming years. This would mean that the required funds transfer would extensively increase as the stagnant sector starts to take up more than half of the economy's GDP. That is, of every Euro, half would go to the stagnant sector. This is only possible if half of total income is taxed. If only a progressive sector profit tax is considered, and if (with rising capital intensity) profit income also increases to around half of total income, this would imply a profit tax of around 100 per cent.

5.4 Is it viable to maintain a technologically progressive economy, while preventing unemployment?

Section 5.3 looked into profit taxation as a solution to maintain a technologically progressive economy while preventing unemployment. The first part of this chapter investigated whether it would be viable to fund new work in the stagnant sector by redirecting funds from the progressive sector via profit taxation. The conclusion is that both countries would be able to fund a growing stagnant sector if 50-70% of newly generated freed capital is fully used to fund it, and as long as the average wage rate in the stagnant sector is not consistently higher than the average wage rate in the progressive sector. The answer to the second part of the research questions is therefore: Baumol's solution to the cost disease could be realized if 50-70% of newly generated freed capital in the progressive sector is fully used to fund additional work in the stagnant sector, and as long as the average wage rate in the stagnant sector is not consistently higher than the average wage rate in the progressive sector. This could be achieved via the method of profit taxation.

Profit taxation has, however, by itself problems mentioned in the last section, such as profits being used for stock buybacks and pay dividends and problems with loopholes of profit taxation via tax havens. The problem of tax evasion or 'legal' loopholes could be solved by prohibiting stock buybacks, imposing a mandatory country-by-country (CbC) form and imposing a unitary taxation system. Such solutions could ensure that the correct amount of productive gains is retrieved from progressive sectors' profit taxation.

If work in the stagnant sector is funded, this means that education is also funded (since it is part of the stagnant sector), meaning that everyone could go to school or university, and to hospitals, nursing homes and concert halls free of charge or at a subsidized rate. The part of the solution which entails a transfer of funds from the progressive to the stagnant sector would require great planning to be implemented. However, with a vast amount of organization, this solution could make not just the future of work, but also cultural progress much more secure. As a matter of fact, one could ask whether all this would need to be organised either by the government, or by a private commercial sector (as Baumol assumes), or whether there are also other options, such as new forms of organisation by civil society (private, but non-commercial).

The amounts to be transferred from the progressive to the stagnant sector will, however, be substantial. The previous section discussed that the growth rate of the stagnant sector relative to the progressive sector will increase even further in the upcoming years. This would mean that the required funds transfer would keep growing as the stagnant sector starts to take up more than half of the economy's GDP. Still, according to Baumol (2012), this would be viable. That is, the problem is not economic, but rather a matter of will.

Part 3

Chapter 6. Conclusions and recommendations

This final chapter will highlight the conclusions within this thesis, limitations of the research, recommendations for further research and end with the theoretical and course relevance.

6.1 Conclusion

This thesis addressed issues regarding work due to the technological advancements and creations of general purpose technologies (GPTs). The 'productivity paradox', also called the 'Solow Paradox', was defined, and conventional solutions and their consequences for unemployment were discussed. Following, labour productivity was defined, and the factors driving its growth discussed. Furthermore, a connection was made between Solow's paradox (Dewan & Kraemer, 1998) and Baumol's writings (1967, 1993 & 2012), which led to a new perspective on the paradox, namely, that it could be a reflection of the unbalanced productivity growth between the technologically progressive and technologically stagnant sector. This unbalanced productivity growth leads to the so-called cost disease, a universal disease in which the costs in the stagnant sector are rising and will keep rising. Different solutions to the cost disease were explored, Baumol's (2012) solution of transfer of income from the progressive to the stagnant sector, Rehn-Meidner's solidaristic wage policy (European Central Bank, 2021) and lastly Salter's idea to use productivity growth to lower prices (European Central Bank, 2021). Rehn-Meidner's model does have potential to alleviate the cost disease by removing the wage-pressure, however, its implementation would be extremely complex, requiring a labour market with high power, an extensive study into the appropriate wage for each job, constant updates on new wages that come with new jobs, and face external factors such as globalisation. Salter's idea to use productivity gains to lower the prices of products from the progressive sector is promising approach, but unfortunately, it would be extremely unlikely to be implemented by companies due to the market power that many technologically progressive companies have. Baumol's 2012 proposed solution is the only one that takes a completely different stance than the other two proposed solution. Instead of trying to eliminate the cost disease, he (finally, in 1993 and 2012) accepts it, and then explains how we can live with it. The real solution comes from Baumol (1993, 2012), when he says that society can afford the rising costs, because we can pay for them out of the productivity gains reached in the progressive sectors. Baumol's solution to redistribute productivity gains from the progressive sector to the stagnant sector was therefore classified as the most optimum choice. The suggested implementation for Baumol's solution was profit taxation.

The first part of this paper closed off by answering the first part of the research question: Yes, Baumol's solution to the cost disease (the transfer of productivity gains form the technologically progressive to the technologically stagnant sector) does help maintain a technologically progressive economy, while preventing unemployment.

To tackle the second part of the research question, ‘under what conditions would Baumol’s solution to the cost disease be feasible?’, a case study was used as a research methodology. The case studied was narrowed down geographically to the Netherlands and Germany between the time period of 1991 and 2018, and between 1996 and 2018 due to data restrictions. Health care, education and social work were selected to represent the technologically stagnant sector and the manufacturing industry to represent the technologically progressive sector.

It was important to determine whether the two selected countries have the cost disease to proceed with proposing and evaluating solutions. Therefore, four hypotheses were proposed in order to determine whether a country has the cost disease. The analysis revealed that the four hypotheses could not be falsified for both countries, meaning that they both have the cost disease.

Following, it was quantitatively tested whether the freed capital from the progressive sector would match the required transfer of funds from the stagnant sector. This quantitative analysis led to the answer of the second part of the research question: Baumol’s solution to the cost disease could be realized if 50-70% of newly generated freed capital in the progressive sector is fully used to fund work in the stagnant sector, and as long as the average wage rate in the stagnant sector is not consistently higher than the average wage rate in the progressive sector. Freed capital, however, in accounting terms, is shown as profit in the income-expense account (Naastepad & Houghton Budd, 2019). Profit taxation was therefore suggested as a method to distribute funds from the freed capital from the progressive to the stagnant sector. It was estimated how much profit in the stagnant sector would need to be taxed in contemplation of funding new work in the stagnant sector.

Profit taxation does have its difficulties, downsides and long-term implications. Implementing profit taxation faces some difficulties such as stock buybacks, dividend payments and tax havens, which were discussed, followed by a discussion of the proposed solutions: banned stock buybacks, mandatory country-by-country report, and unitary taxation. It also does have a downside: if the profit tax is too high, it will hinder progressive firms investing in and renovating their physical capital due to their lower profit after tax, possibly hindering economic growth. When implementation profit taxation, it therefore needs to be ensured that progressive firms can still invest in themselves.

6.2 Limitations of research

Every research has its own limitations, including this one. The limitations of this particular research will now be discussed.

The method of a case study is used to answer a question based on data from a particular case, to make the research feasible in a short time-range. This thesis has focused on two countries, a time range of 23-27 years (1991-2018, 1995-2018), and education, health-care and social work for the stagnant sector and manufacturing for the progressive sector. To expand the case study to reach a real-life situation as much as possible, the research can be re-done with a focus on a longer time period and with more countries. To ensure that the most diverse data is collected, countries with different cultural and economic background could be investigated, for example, by investigating a country within each continent should allow for cultural and economic diversity within the study.

The most important sectors considered by Baumol (2012) have been looked at (manufacturing for the progressive sector and education and health care and social work for the stagnant sector) but one can take it further and expand the number of economic activities. This would require research on how to classify economic activities that have not been mentioned in this study. As already discussed in chapter 2.3, Baumol (1967) stated that there is a scale with a completely stagnant industry at one extreme, and a completely progressive industry at the other extreme, and in some cases an industry could be anywhere in between (Baumol, 1967). To tax technologically progressive firms, one has to research how to classify economic activities in terms of how technologically progressive they are. This solution would also require a trustworthy and fair government for the redistribution of funds in order to prevent corruption.

Another limitation this study faces is that the analysis is incremental. The estimated required transfer of funds, freed capital and profit taxation are all annual values with the aim to fund work for those who lost their job at that certain year, *t*. If 50-70% of the freed capital from year *t* is used to fund new work required in the stagnant sector in year *t*, it would cover only people who have become unemployed in year *t*, and not the total number of unemployed people over time. The required money transfer estimated in this thesis is, therefore, only a small percentage of what would actually be needed to fund work for every unemployed person from for eg. year *t-10* to *t*. This thesis has not estimated the *total* amount of money that would be required to fund *total* employment in the stagnant sector (a point that has been briefly touched upon at the end of Section 5.3.2 and in Section 5.3.4).

6.3 Recommendations for further research

This paper opens the door to other opportunities of research within this field, and such are now discussed.

Solutions to the cost disease

There is the opportunity to research further possible solutions for the cost disease. This paper discussed only three possible solutions to the cost disease, which were Baumol's (2012), Rehn-Meidner's and Salter's (Groot & Schettkat, 1999). The suggested idea from Salter and Baumol to reduce output prices in the progressive sector via productivity gains can be further explored. One can further explore and estimate the effects of this idea, for example, if this were implemented by the whole progressive sector, how much would real income rise? It has been discussed that this is not something that can be enforced on firms, especially if they collude to function as a monopoly. Therefore, there is further room to explore on methods to prevent monopoly collusion and to stimulate competition between oligopolistic firms, which can compete in the form of lower prices. One could also explore the effects of a mix of utilizing the productivity gains for both lowering output prices and funding the stagnant sector.

Apart from the proposed solutions in this thesis, it is recommended for further research into new solutions that may shine new light on how to maintain a technologically progressive economy while preventing unemployment. An example of further exploration of these proposed solution is to explore how much would real income rise if Baumol's and Salter's idea to reduce output prices in the progressive sector via productivity gains is implemented.

Broaden case study

There is also the opportunity to do different case-studies with broader boundaries. The case study presented in this paper had a very narrow focus by focusing on two countries, four economic activities, and a time period of 27 years. It is recommended for the geographical focus, time period and economic activity focus to be broadened to gain more precise and general results. It is recommended to continue the study with more countries, specifically, countries which have very different characteristics to each other, which could be done by for example by focusing on one country per continent. It is, additionally, recommended to pursue a case study in which the technologically progressive and stagnant sector include more industries. Ideally, all industries taken into account would result in very precise results. However, it would be difficult to categorize certain industries into either a stagnant or progressive category. A criteria would have to be designed in order to assign each industry to its sector. It is also recommended to have a longer time-period for the case study. This case study's time period was limited to a lower time range than specified in the research design due to the restriction of data available.

The broader-focused case study recommended above would lead to more accurate results, such as the estimated freed capital, the estimated tax on profit for the progressive sector and the analysis of the relative output. The freed capital was estimated by using values from the output, labour productivity, hourly wages and hours worked from only four industries. The tax on profit was estimated based on how much one industry would need to be taxed in order to fund new work in three industries. Lastly, the relative output was estimated with values only from the selected industries, not reflecting the overall economy.

Viability of profit taxation in the long-run

The proposed solution in this thesis may also encounter difficulties in the upcoming years due to the growth of the stagnant sector relative to the progressive sector, consequently increasing profit taxation (as discussed in section 5.3.4). Therefore, if the government faces a situation where the progressive sector's profit is no longer enough, further research can be done on how the public sector can continue funding the stagnant sector. An example would be research on privatization to ease the burden put in the public sector of future increases in funding required and its limitations and downsides.

Privatization

As discussed in section 5.3.4, the proposed solution of profit taxation may encounter dramatic increases in the upcoming years due to the higher growth rate of the stagnant sector compared to the progressive sector. The public sector would therefore be responsible for finding new ways to fund the stagnant sector, leaving room for research on the public sector could do so. A suggestion is a solution proposed by Baumol (1993) himself: privatization. Privatizing some public sector would put more and more of the stagnant economic activities in the hands of a private enterprise. This would ease the burden put in the public sector of future increases in funding required. There are however downsides of privatization that should also be investigated, such as privatized health care and education being high-priced services, which will not be affordable to many. In addition, as a recent NBER study shows, privatisation may lead to serious reductions in the quality of services.[11]

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[11] For example, regarding private equity (PE) funding of health care in the U.S.A., estimates by Gupta *et al.* (2021) show that "PE ownership increases the short-term mortality of Medicare patients by 10%, implying 20,150 lives lost due to PE ownership over our twelve-year sample period"; See Gupta, Atul, Sabrina T. Howell, Constantine Yannelis, and Abhinav Gupta (2021) Does private equity investment in healthcare benefit patients? Evidence from nursing homes, *NBER Working Paper* 28474 (http://www.nber.org/papers/w28474).

Model including total require transfer of funds and freed capital

The limitation this study faces of an incremental analysis also leaves room for further research into a model that estimates the *total* amount of money that would be required to fund *total* employment in the stagnant sector.

Fourth industrial revolution

A huge and pertinent problem, not discussed in this thesis for lack of space and time, but certainly a topic for future research, regards the extent to which the productivity of different activities can be or should be increased. Many do not agree with Baumol and think productivity in education, health care and so on can be increased just like it has been growing in manufacturing.[12] This is a main discussion that will become increasingly relevant as the 'Fourth Industrial Revolution' takes off.

According to Poloz (2021), the fourth industrial revolution would involve machine learning, big data and artificial intelligence to further digitalize our world. The first three industrial revolutions resulted in a significant disruption of workers, and there is no reason to expect anything less from the fourth one. There is therefore an additional research gap within the fourth industrial revolution: research is very much needed into whether technology should be allowed to grow without any restraints, displacing human labour.

This research has nonetheless closed the knowledge-gap of how to maintain a technologically progressive economy while preventing unemployment. It is possible to maintain a technologically progressive economy with Baumol's solution to the cost disease if realized if 50-70% of newly generated freed capital in the progressive sector is fully used to fund work in the stagnant sector, and as long as the average wage rate in the stagnant sector is not consistently higher than the average wage rate in the progressive sector. The proposed method for this transfer was profit taxation.

[12] See, for example, Bailey, S. J., Anttiroiko, A. V., & Valkama, P. (2016) Application of Baumol's Cost Disease to public sector services: Conceptual, theoretical and empirical falsities, *Public Management Review* 18 (1), 91–109.

6.4 Relevance

The last section of this thesis will touch upon the theoretical relevance of the thesis, its relevance to society and lastly its relevance to the Management of Technology course, for which this thesis is written for.

This thesis has brought together two theoretical works, the productivity paradox and the cost disease. A new perspective into the productivity paradox was brought to light using the works by Baumol (1967, 1993, 2012), which revealed that the slow-paced labour productivity growth despite considerable investments, is due to unbalanced labour productivity growth within the different economic sectors that has been the consequence of structural economic change. This thesis then quantitatively assess' Baumol's (2012) proposed theoretical solution to the cost disease – transfer of funds from the progressive to the stagnant sector- for Germany and the Netherlands, by first determining if these two countries have the cost disease and lastly under what conditions would these two countries need to be able to afford this transfer of funds.

Beyond the theoretical relevance of the thesis, there is also societal relevance. While some types of work become obsolete by new innovations, this thesis suggests new work should be funded in a sector where it is less likely become obsolete by innovations, the technologically stagnant sector. The stagnant sector is likely to create benefits for society as a whole as well as for the technologically progressive sector itself, because healthy and creative people with more education can keep up the quality of research and development which may be good for economic growth but also for cultural wellbeing and progress itself. Additionally, at the end of this thesis, it is briefly proposed for further research to be carried out on the ethical aspect of whether technology should be allowed to grow without any restraints, displacing human labour.

The problems highlighted in this introduction are well connected to the master program 'Management of Technology'. The course 'technology, strategy and entrepreneurship' teaches students about different types of technologies such as incremental, modular, architectural, radical, and others. In this case, GPTs are categorized as radical innovations because these technologies replace a system or process with something entirely new. The course 'social and scientific value' then teaches the importance to study the effects that these technologies have in society, whether they are positive or negative. In this thesis, a solution proposed by Baumol (2012) is explored under what terms can an economy fund new work as a method to prevent high unemployment arising from innovative technologies. Lastly, the course 'economic foundations' has taught the basis of economics which was an essential tool in this thesis to tackle the second part of this thesis, the quantitative analysis. Overall, the thesis combines an analysis on how general purpose technologies affects certain aspects of society and economy, and how to benefit from them while decreasing the negative outcomes.

Appendix

Table 1a : Summary of Regression Results for Labour Productivity and Relative Labour Productivity						
Type of Analysis	Regression analysis					
Variable	Labour Productivity				Relative Labour Productivity	
Country	Netherlands		Germany		Netherlands	Germany
Sector	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
Linear equation:	y=-0.0928x+29.321	y=1.3364x+24.048	y=-0.0074x+31.138	y= 1.0699x+30.48	y=-0.0281x+1.2607	y=-0.0171x+0.9492
Time coefficient	-0.093	1.336	-0.007	1.070	-0.0281	-0.017
Regression's:						
R Square	0.341	0.981	0.012	0.960	0.897	0.929
F value	13.46	1318.89	0.31	623.88	225.53	340.17
F-significance	0.11%	0.00%	58.41%	0.00%	0.00%	0.00%
Coefficient's:						
t Stat	-3.67	36.32	-0.55	24.98	-15.02	-18.44
p-value	0.11%	0.00%	58.41%	0.00%	0.00%	0.00%

Table 1b: Labour Productivity and Relative Labour Productivity (data)						
Variable	Labour Productivity				Relative Labour Productivity	
Units	Output (euros) / per hour				Unitless	
Type of variable	Processed				Processed	
Equation:	$\lambda_t^i = \frac{Y_t^i}{H_t^i}$ *Equation 8*				$RLP = \frac{\lambda_t^s}{\lambda_t^p}$ *Equation 3*	
Variable used to process data:	Output				Employment	
Source:	OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#				OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked-total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#	
Reference Year:	2015		2015		Not applicable	Not applicable
Country:	Netherlands		Germany		Netherlands	Germany
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
1991	40.4	30.0	30.0	31.8	1.349	0.942
1992	39.5	30.0	31.2	32.2	1.318	0.969
1993	40.1	31.4	31.5	32.9	1.278	0.957
1994	40.1	33.8	30.9	35.4	1.187	0.873
1995	39.9	34.7	30.8	36.0	1.151	0.856
1996	39.4	35.2	31.0	36.1	1.117	0.860
1997	39.1	35.9	31.6	38.2	1.089	0.828
1998	38.8	37.2	31.6	38.0	1.041	0.832
1999	38.1	38.9	31.4	38.7	0.979	0.812
2000	38.1	41.5	31.6	41.5	0.917	0.760
2001	37.6	42.7	31.4	42.4	0.881	0.742
2002	37.2	43.7	31.4	42.3	0.851	0.742
2003	36.4	44.8	31.4	43.8	0.813	0.717
2004	36.7	47.5	31.2	45.6	0.773	0.684
2005	36.7	50.4	31.2	47.6	0.728	0.657
2006	36.7	52.2	30.3	51.7	0.703	0.586
2007	36.0	55.1	30.2	53.1	0.654	0.570
2008	36.0	54.9	31.1	50.9	0.655	0.611
2009	36.5	51.8	31.2	45.1	0.704	0.692
2010	37.0	54.7	30.5	52.6	0.676	0.581
2011	37.6	57.4	31.0	55.0	0.655	0.563
2012	37.1	57.8	31.0	54.2	0.643	0.572
2013	37.5	57.7	30.1	53.8	0.650	0.559
2014	38.2	59.2	29.8	55.6	0.646	0.535
2015	38.6	59.7	30.4	55.7	0.647	0.546
2016	38.4	60.4	31.3	58.1	0.635	0.538
2017	37.9	63.9	32.0	59.7	0.594	0.535
2018	37.6	65.3	31.6	59.7	0.577	0.530

Table 2a: Summary of Regression Results for Gross Value Added				
Type of Analysis	Regression analysis			
Variable	Value added			
Country	Netherlands		Germany	
Sector	Stagnant	Progressive	Stagnant	Progressive
Linear equation:	y=1262.5x+55882	y=1147.1x+49551	y=4487.7x+215777	y=8340.3x+404153
Time coefficient	1262.5	1147.1	4487.7	8340.3
Regression's:				
R Square	0.977	0.910	0.955	0.828
F value	1096.68	261.70	549.99	125.34
F-significance	0.00%	0.00%	0.00%	0.00%
Coefficient's:				
t Stat	33.12	16.18	23.45	11.20
p-value	0.00%	0.00%	0.00%	0.00%

Table 2b: Output (data) and otuput growth (data)								
Variable	Output				Output Growth			
Units	euros, millions				%			
Type of variable	Raw				Processed			
Equation:	not applicable							
Variable used to process data:	Output				Output			
Source:	OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#				OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#			
Reference Year:	2015		2015		1991		1991	
Country:	Netherlands		Germany		Netherlands		Germany	
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive	Stagnant	Progressive	Stagnant	Progressive
1991	59'797	49'330	215'556	479'815				
1992	60'450	49'714	227'823	465'305	1.09%	0.78%	5.69%	-3.02%
1993	61'441	49'412	231'892	430'481	1.37%	0.08%	3.72%	-5.28%
1994	61'508	51'933	235'434	442'954	0.94%	1.73%	2.98%	-2.63%
1995	62'204	53'795	240'136	441'040	0.99%	2.19%	2.74%	-2.08%
1996	62'778	54'710	247'488	429'185	0.98%	2.09%	2.80%	-2.21%
1997	64'210	56'091	254'103	446'164	1.19%	2.16%	2.78%	-1.20%
1998	65'111	58'729	256'864	450'795	1.22%	2.52%	2.54%	-0.89%
1999	65'321	61'214	260'095	455'549	1.11%	2.73%	2.38%	-0.65%
2000	65'602	64'598	265'288	488'336	1.03%	3.04%	2.33%	0.20%
2001	67'404	66'240	265'609	495'128	1.20%	2.99%	2.11%	0.31%
2002	70'002	65'871	271'956	483'087	1.44%	2.66%	2.14%	0.06%
2003	71'451	65'226	273'768	488'027	1.49%	2.36%	2.01%	0.14%
2004	72'810	67'730	274'858	505'809	1.53%	2.47%	1.89%	0.41%
2005	73'811	69'911	276'538	514'392	1.52%	2.52%	1.80%	0.50%
2006	75'055	71'593	276'421	558'724	1.53%	2.51%	1.67%	1.02%
2007	75'635	75'581	279'400	582'310	1.48%	2.70%	1.63%	1.22%
2008	78'382	75'121	290'637	570'085	1.60%	2.50%	1.77%	1.02%
2009	81'450	67'550	295'800	460'057	1.73%	1.76%	1.77%	-0.23%
2010	83'262	70'468	300'627	547'857	1.76%	1.89%	1.77%	0.70%
2011	85'976	73'657	308'449	593'548	1.83%	2.02%	1.81%	1.07%
2012	85'593	72'966	312'524	582'866	1.72%	1.88%	1.78%	0.93%
2013	85'899	72'284	306'998	582'496	1.66%	1.75%	1.62%	0.89%
2014	87'134	74'004	311'012	611'639	1.65%	1.78%	1.61%	1.06%
2015	87'595	74'533	325'879	617'443	1.60%	1.73%	1.74%	1.06%
2016	88'177	76'137	342'357	643'067	1.57%	1.75%	1.87%	1.18%
2017	88'990	80'769	356'370	663'196	1.54%	1.91%	1.95%	1.25%
2018	90'217	83'977	359'868	673'075	1.53%	1.99%	1.92%	1.26%

Table 2c: Summary of Regression Results for Hourly Wage -				
Type of Analysis	Regression analysis			
Variable	Real Hourly Wage			
Country	Netherlands		Germany	
Sector	Stagnant	Progressive	Stagnant	Progressive
Linear equation:	y=-0.0042x+29.868	y=0.8092x+35.285	y=0.1405x+21.118	y=0.1708x+43.833
Time coefficient	-0.0042	0.8092	0.1405	0.1708
Regression's:				
R Square	0.001	0.628	0.767	0.040
F value	0.03	35.44	69.19	0.88
F-significance	87%	0%	0%	36%
Coefficient's:				
t Stat	0.73	5.95	8.32	0.94
p-value	87.44%	0.00%	0.00%	35.89%

Table 2d: Hourly Wage per sector (data) and Employment weight for education (data)				
Variable	**Hourly wage (real)**			
Units	Euros/ hour			
Type of variable	Processed			
Equation:	$w_t^i = \frac{COMP_t^i / Deflator_t^i}{E_t^i}$ Where: COMP is the compensation of employees (Current prices)			
Variable used to process data	Hourly wage, the Netherlands			
Source:	Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019): Industry level growth and productivity data with special focus on intangible assets, wiiw Statistical Report No. 8. Retrieved from https://euklems.eu/download/			
Reference Year:	2010			
Country:	Netherlands		Germany	
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive
1995	29.34	33.44	21.32	37.54
1996	28.39	33.26	21.62	40.56
1997	29.08	35.14	21.47	42.05
1998	29.37	35.10	21.55	42.95
1999	29.93	35.56	21.58	45.66
2000	31.21	41.81	22.20	55.15
2001	30.77	44.34	22.30	50.40
2002	30.76	44.22	22.73	52.55
2003	30.95	44.53	22.92	52.90
2004	30.32	50.10	23.08	49.76
2005	29.97	52.40	23.10	50.00
2006	29.31	48.38	21.95	40.61
2007	28.93	47.47	21.51	42.52
2008	29.20	54.51	22.44	34.71
2009	29.65	41.81	22.88	43.53
2010	29.85	45.43	22.91	42.68
2011	30.15	44.14	23.45	37.52
2012	30.76	44.02	24.32	44.80
2013	30.61	47.75	23.66	46.89
2014	30.43	51.96	23.88	45.42
2015	29.40	50.70	24.36	51.16
2016	28.87	51.19	24.06	53.30
2017	28.57	57.66	25.18	52.68

Table 3a: Summary of Regression Results for Employment and Relative Employment						
Type of Analysis	Regression analysis					
Variable	Employment				Relative Employment	
Country	Netherlands		Germany		Netherlands	Germany
Sector	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
Linear equation:	y=37.282x+1420	y=-16.302x+1662.2	y=146.7x+6925.4	y=-101.04x+13036	y=0.0421x+0.7974	y=0.0185x+0.5264
Time coefficient	37.3	-16.3	147	-101	0.0421	0.0185
Regression's:						
R Square	0.965	0.920	0.984	0.568	0.963	0.967
F value	710	300	1648	34.1	670	773
F-significance	0%	0%	0%	0%	0%	0%
Coefficient's:						
t Stat	26.7	-17.3	40.6	-5.84	25.9	27.8
p-value	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 3b: Employment and Relative Employment (data)						
Variable	Employment				Relative employment	
Units	millions of hours				millions of hours	
Type of variable	not applicable				processed	
Equation:	not applicable				$\mathrm{RE}_t = \frac{\mathrm{E}_t^s}{\mathrm{E}_t^p}$ Equation 4	
Variable used to process data:	Employment					
Source:	OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked – total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#					
Reference Year:	Not applicable					
Country:	Netherlands		Germany		Netherlands	Germany
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
1991	1'480	1'647	7'191	15'086	0.90	0.48
1992	1'530	1'658	7'299	14'439	0.92	0.51
1993	1'531	1'573	7'370	13'099	0.97	0.56
1994	1'532	1'536	7'609	12'504	1.00	0.61
1995	1'558	1'551	7'802	12'267	1.00	0.64
1996	1'595	1'553	7'973	11'889	1.03	0.67
1997	1'642	1'562	8'041	11'686	1.05	0.69
1998	1'680	1'577	8'120	11'853	1.07	0.69
1999	1'715	1'573	8'287	11'782	1.09	0.70
2000	1'723	1'555	8'403	11'753	1.11	0.71
2001	1'791	1'550	8'450	11'687	1.16	0.72
2002	1'881	1'506	8'656	11'411	1.25	0.76
2003	1'962	1'457	8'719	11'137	1.35	0.78
2004	1'983	1'426	8'817	11'102	1.39	0.79
2005	2'011	1'386	8'852	10'813	1.45	0.82
2006	2'046	1'372	9'123	10'800	1.49	0.84
2007	2'099	1'371	9'237	10'971	1.53	0.84
2008	2'180	1'368	9'357	11'207	1.59	0.83
2009	2'232	1'304	9'469	10'190	1.71	0.93
2010	2'252	1'289	9'842	10'422	1.75	0.94
2011	2'288	1'283	9'962	10'785	1.78	0.92
2012	2'304	1'263	10'083	10'763	0.229	0.264
2013	2'290	1'252	10'200	10'819	0.230	0.263
2014	2'280	1'251	10'446	10'999	0.227	0.260
2015	2'268	1'248	10'714	11'080	0.221	0.259
2016	2'299	1'260	10'938	11'061	0.218	0.261
2017	2'346	1'264	11'141	11'102	0.209	0.257
2018	2'397	1'287	11'371	11'268	0.205	0.256

Table 4a: Summary of Regression Results for Unit Labour Cost and Relative Unit Labour Cost						
Type of Analysis	Regression analysis					
Variable	Unit Labour Cost				Relative Unit Labour Cost	
Country	Netherlands		Germany		The Netherlands	Germany
Sector	Stagnant	Progressive	Stagnant	Progressive	Not applicable	Not applicable
Linear equation:	y=0.0009x+0.7821	y=-0.0082x+1.0179	y=0.0052x+0.6725	y=-0.019x+1.2126	y=0.009x+0.7727	y=0.0213x+0.5381
Time coefficient	0.0009	-0.0082	0.0052	-0.0190	0.0091	0.0199
Regression's:						
R Square	0.032	0.398	0.845	0.481	0.423	0.600
F value	0.70	13.89	114.32	19.48	15.41	31.56
F-significance	41%	0%	0%	0%	0.08%	0.00%
Coefficient's:						
t Stat	0.84	-3.73	10.69	-4.41	3.93	5.62
p-value	41.08%	0.12%	0.00%	0.02%	0.08%	0.00%

Table 4b: ULC and ULC Growth (data)								
Variable	ULC				ULC Growth			
Units	Unitless				Unitless			
Type of variable	Processed				Processed			
Equation:	$\text{ULC}_t^i = \frac{w_t^i}{\lambda_t^i}$ Equation 9				$U\dot{L}C_t^i = \frac{ULC_t^i - ULC_{t-1}^i}{ULC_{t-1}^i}$ Equation 11			
Variable used to process data:	Wage rate (real)		Output	Employment	Wage rate (real)		Output	Employment
Source:	Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019) 13		OECD (2020)14	OECD (2020)15	Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019) 16		OECD. (2020) 14	OECD. (2020)] 15
Reference Year:	2010		2015	Not applicable	2010		2015	Not applicable
Country:	Netherlands		Germany		Netherlands		Germany	
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive	Stagnant	Progressive	Stagnant	Progressive
1995	0.73	0.964	0.693	1.044				
1996	0.72	0.944	0.697	1.124	-1.85%	-2.08%	0.55%	7.61%
1997	0.74	0.979	0.679	1.101	3.10%	3.65%	-2.45%	-1.97%
1998	0.76	0.943	0.681	1.129	1.90%	-3.68%	0.27%	2.54%
1999	0.79	0.914	0.688	1.181	3.70%	-3.05%	0.93%	4.57%
2000	0.82	1.006	0.703	1.327	4.31%	10.14%	2.27%	12.40%
2001	0.82	1.038	0.709	1.190	-0.26%	3.09%	0.89%	-10.37%
2002	0.83	1.011	0.723	1.241	1.09%	-2.56%	1.98%	4.34%
2003	0.85	0.995	0.730	1.207	2.82%	-1.61%	0.90%	-2.75%
2004	0.83	1.055	0.740	1.092	-2.84%	6.04%	1.43%	-9.53%
2005	0.82	1.039	0.739	1.051	-1.12%	-1.51%	-0.13%	-3.77%
2006	0.80	0.927	0.724	0.785	-2.15%	-10.75%	-2.03%	-25.31%
2007	0.80	0.861	0.711	0.801	0.48%	-7.13%	-1.84%	2.05%
2008	0.81	0.993	0.722	0.682	1.15%	15.28%	1.59%	-14.82%
2009	0.81	0.807	0.732	0.964	0.05%	-18.69%	1.38%	41.30%
2010	0.81	0.831	0.750	0.812	-0.63%	2.96%	2.40%	-15.79%
2011	0.80	0.769	0.757	0.682	-0.62%	-7.48%	0.98%	-16.03%
2012	0.83	0.762	0.785	0.827	3.20%	-0.90%	3.60%	21.34%
2013	0.82	0.827	0.786	0.871	-1.44%	8.54%	0.19%	5.28%
2014	0.80	0.878	0.802	0.817	-2.43%	6.20%	2.03%	-6.22%
2015	0.76	0.849	0.801	0.918	-4.40%	-3.35%	-0.15%	12.40%
2016	0.75	0.847	0.769	0.917	-1.12%	-0.21%	-4.02%	-0.14%
2017	0.75	0.902	0.787	0.882	0.06%	6.52%	2.41%	-3.81%

13 Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019): Industry level growth and productivity data with special focus on intangible assets, wiiw Statistical Report No. 8. Retrieved from https://euklems.eu/download/

14 OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

15 OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked – total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

16 Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019): Industry level growth and productivity data with special focus on intangible assets, wiiw Statistical Report No. 8. Retrieved from https://euklems.eu/download/

Table 4c: Relative Unit Labour Cost (data)			
Variable	RULC		
Units	Unitless		
Type of variable	processed		
Equation:	$\mathrm{RULC}_t = \frac{\mathrm{ULC}_t^s}{\mathrm{ULC}_t^p}$ Equation 5		
Variable used to process data:	Wage rate (real)	Value added	Employment
Source:	Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019)[17]	OECD (2020)[18]	OECD (2020)[19]
Reference Year:	2010	2015	Not applicable
Country:	Netherlands	Germany	
Year, Sector:	not applicable	not applicable	
1995	0.76	0.66	
1996	0.76	0.62	
1997	0.76	0.62	
1998	0.80	0.60	
1999	0.86	0.58	
2000	0.81	0.53	
2001	0.79	0.60	
2002	0.82	0.58	
2003	0.85	0.60	
2004	0.78	0.68	
2005	0.79	0.70	
2006	0.86	0.92	
2007	0.93	0.89	
2008	0.82	1.06	
2009	1.01	0.76	
2010	0.97	0.92	
2011	1.04	1.11	
2012	1.09	0.95	
2013	0.99	0.90	
2014	0.91	0.98	
2015	0.90	0.87	
2016	0.89	0.84	
2017	0.83	0.89	

[17] Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019): Industry level growth and productivity data with special focus on intangible assets, wiiw Statistical Report No. 8. Retrieved from https://euklems.eu/download/

[18] OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

[19] OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked – total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

Table 4d: Relative Unit Labour Cost Growth (data)			
Variable	RULC Growth		
Units	%		
Type of variable	processed		
Equation:	$\dot{RULC_t} = \dot{ULC_t^s} - \dot{ULC_t^p}$ Equation 10		
Variable used to process data:	Wage rate (real)	Output	Employment
Source:	Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019)[20]	OECD (2020)[21]	OECD (2020)[22]
Reference Year:	2010	2015	Not applicable
Country:	Netherlands	Germany	
Year, Sector:	not applicable	not applicable	
1996	0.29%	0.96%	
1997	-0.64%	-0.41%	
1998	5.71%	-2.26%	
1999	6.82%	-3.72%	
2000	-6.51%	-11.04%	
2001	-3.43%	11.46%	
2002	3.70%	-2.36%	
2003	4.41%	3.74%	
2004	-9.27%	11.32%	
2005	0.49%	3.81%	
2006	8.97%	25.56%	
2007	8.00%	-3.94%	
2008	-14.07%	15.84%	
2009	17.68%	-35.27%	
2010	-3.77%	20.74%	
2011	7.22%	17.77%	
2012	4.06%	-17.40%	
2013	-10.00%	-5.06%	
2014	-8.83%	8.43%	
2015	-1.06%	-12.58%	
2016	-0.90%	-3.99%	
2017	-6.83%	6.37%	

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Table 4e: Hourly Wage Growth and Relative Hourly Wage Growth (data)						
Variable	Hourly Wage Growth				Relative Hourly Wage Growth	
Units	%				%	
Type of variable	Processed				processed	
Equation:	$\dot{w}_t^i = \frac{w_t^i - w_{t-1}^i}{w_{t-1}^i}$ Equation 13				$Relative\ hourly\ wage\ growth = (\dot{w}_s - \dot{w}_p)$ Equation 14	
Variable used to process data:	Wage rate (real)				Wage rate (real)	
Source:	Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019)[23]				Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019)[24]	
Reference Year:	2010				2010	
Country:	Netherlands		Germany		Netherlands	Germany
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
1996	-3.24%	-0.54%	1.41%	8.04%	-2.70%	1.41%
1997	2.43%	5.65%	-0.69%	3.67%	-3.22%	-4.37%
1998	1.00%	-0.11%	0.37%	2.14%	1.11%	-1.77%
1999	1.91%	1.31%	0.14%	6.31%	0.60%	-6.17%
2000	4.28%	17.58%	2.87%	20.78%	-13.30%	-17.91%
2001	-1.41%	6.05%	0.45%	-8.61%	-7.46%	9.06%
2002	-0.03%	-0.27%	1.93%	4.27%	0.24%	-2.34%
2003	0.62%	0.70%	0.84%	0.67%	-0.08%	0.17%
2004	-2.04%	12.51%	0.70%	-5.94%	-14.54%	6.63%
2005	-1.15%	4.59%	0.09%	0.48%	-5.75%	-0.40%
2006	-2.20%	-7.67%	-4.98%	-18.78%	5.47%	13.80%
2007	-1.30%	-1.88%	-2.00%	4.70%	0.58%	-6.71%
2008	0.93%	14.83%	4.32%	-18.37%	-13.90%	22.69%
2009	1.54%	-23.30%	1.96%	25.41%	24.84%	-23.45%
2010	0.67%	8.66%	0.13%	-1.95%	-7.98%	2.08%
2011	1.01%	-2.84%	2.36%	-12.09%	3.84%	14.45%
2012	2.02%	-0.27%	3.71%	19.40%	2.30%	-15.69%
2013	-0.49%	8.47%	-2.71%	4.67%	-8.96%	-7.38%
2014	-0.59%	8.82%	0.93%	-3.13%	-9.40%	4.06%
2015	-3.38%	-2.42%	2.01%	12.64%	-0.96%	-10.63%
2016	-1.80%	0.97%	-1.23%	4.18%	-2.77%	-5.41%
2017	-1.04%	12.64%	4.66%	-1.16%	-13.68%	5.82%
Average (1996-2017)	-0.10%	2.88%	0.78%	2.15%	-3.00%	-1.12%

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Table 4f: Labour Productivity Growth and Labour Productivity Growth (data)						
Variable	Labour Productivity Growth				Relative Labour Productivity Growth	
Units	%				%	
Type of variable	Processed				Processed	
Equation:	$\dot{\lambda}_t^i = \frac{\lambda_t^i - \lambda_{t-1}^i}{\lambda_{t-1}^i}$ Equation 13				$Relative\ labour\ productivity\ growth = (\dot{\lambda}_s - \dot{\lambda}_p)$ Equation 15	
Variable used to process data:	Output		Employment		Output	Employment
Source:	OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#		OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked-total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#		OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#	OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked-total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#
Reference Year:	2015		Not applicable		2015	Not applicable
Country:	Netherlands		Germany		Netherlands	Germany
Year, Sector:	Stagnant	Progressive	Stagnant	Progressive	not applicable	not applicable
1992	-2.21%	0.11%	4.13%	1.32%	-2.32%	2.81%
1993	1.57%	4.76%	0.81%	1.98%	-3.19%	-1.17%
1994	0.04%	7.63%	-1.66%	7.79%	-7.59%	-9.46%
1995	-0.56%	2.58%	-0.53%	1.49%	-3.14%	-2.02%
1996	-1.42%	1.57%	0.85%	0.41%	-2.99%	0.45%
1997	-0.65%	1.93%	1.80%	5.76%	-2.58%	-3.96%
1998	-0.89%	3.71%	0.10%	-0.39%	-4.60%	0.49%
1999	-1.72%	4.50%	-0.78%	1.66%	-6.22%	-2.45%
2000	-0.04%	6.75%	0.59%	7.46%	-6.79%	-6.87%
2001	-1.15%	2.87%	-0.44%	1.96%	-4.03%	-2.40%
2002	-1.11%	2.35%	-0.05%	-0.07%	-3.46%	0.02%
2003	-2.14%	2.35%	-0.06%	3.51%	-4.49%	-3.57%
2004	0.82%	6.10%	-0.72%	3.97%	-5.27%	-4.69%
2005	-0.04%	6.20%	0.21%	4.41%	-6.24%	-4.20%
2006	-0.05%	3.45%	-3.01%	8.75%	-3.50%	-11.76%
2007	-1.77%	5.65%	-0.17%	2.60%	-7.42%	-2.77%
2008	-0.22%	-0.39%	2.69%	-4.16%	0.17%	6.85%
2009	1.49%	-5.67%	0.57%	-11.25%	7.16%	11.82%
2010	1.32%	5.53%	-2.22%	16.43%	-4.22%	-18.65%
2011	1.63%	5.01%	1.37%	4.69%	-3.38%	-3.33%
2012	-1.14%	0.63%	0.11%	-1.60%	-1.77%	1.70%
2013	0.97%	-0.06%	-2.89%	-0.58%	1.04%	-2.31%
2014	1.88%	2.46%	-1.08%	3.28%	-0.58%	-4.36%
2015	1.06%	0.96%	2.16%	0.21%	0.10%	1.95%
2016	-0.69%	1.18%	2.91%	4.33%	-1.87%	-1.42%
2017	-1.10%	5.75%	2.20%	2.75%	-6.85%	-0.55%
2018	-0.78%	2.11%	-1.06%	-0.01%	-2.89%	-1.06%
Average (1992-2018)	-0.26%	2.96%	0.22%	2.47%	-3.22%	-2.26%

	Table 5a: $H_1^*, H_1^p, \Delta H_1^p$							
Variable	The Netherlands				Germany			
Country	H_1^*	H_1^p	ΔH_1^p	$\Delta H_1^p\ /H_1^p$	H_1^*	H_1^p	ΔH_1^p	$\Delta H_1^p\ /H_1^p$
Equation	$H_1^* = \frac{Y_1^p}{\lambda_0^p}$ Equation 17	Not applicable	$\Delta H_1^p = H_1^* - H_1^p$ Equation 18	$\Delta H_1^p\ /H_1^p$	$H_1^* = \frac{Y_1^p}{\lambda_0^p}$ Equation 17	Not applicable	$\Delta H_1^p = H_1^* - H_1^p$ Equation 18	$H_1^p\ /H_1^p$
Units:	Millions of hours			%	Millions of hours			%
Year:								
1992	1660	1'658	2	0.11%	14630	14'439	191	1.26%
1993	1648	1'573	75	4.52%	13358	13'099	259	1.80%
1994	1653	1'536	117	7.45%	13479	12'504	975	7.44%
1995	1591	1'551	40	2.61%	12450	12'267	183	1.46%
1996	1577	1'553	24	1.57%	11937	11'889	48	0.39%
1997	1592	1'562	30	1.94%	12359	11'686	673	5.66%
1998	1635	1'577	58	3.74%	11807	11'853	-46	-0.39%
1999	1644	1'573	71	4.48%	11978	11'782	196	1.65%
2000	1660	1'555	105	6.67%	12630	11'753	877	7.44%
2001	1595	1'550	45	2.86%	11916	11'687	229	1.95%
2002	1541	1'506	35	2.28%	11403	11'411	-8	-0.07%
2003	1491	1'457	34	2.27%	11528	11'137	391	3.42%
2004	1513	1'426	87	5.97%	11543	11'102	441	3.96%
2005	1472	1'386	86	6.03%	11290	10'813	477	4.30%
2006	1419	1'372	47	3.42%	11745	10'800	945	8.74%
2007	1448	1'371	77	5.64%	11256	10'971	285	2.64%
2008	1363	1'368	-5	-0.39%	10741	11'207	-466	-4.25%
2009	1230	1'304	-74	-5.40%	9044	10'190	-1146	-10.23%
2010	1360	1'289	71	5.47%	12135	10'422	1713	16.81%
2011	1347	1'283	64	4.99%	11291	10'785	506	4.86%
2012	1271	1'263	7.96	0.62%	10591	10'763	-172	-1.60%
2013	1251	1'252	-0.81	-0.06%	10756	10'819	-63	-0.58%
2014	1282	1'251	30.79	2.46%	11360	10'999	361.3	3.34%
2015	1260	1'248	11.94	0.95%	11103	11'080	23.4	0.21%
2016	1275	1'260	14.86	1.19%	11540	11'061	478.8	4.32%
2017	1337	1'264	72.66	5.77%	11407	11'102	305.2	2.76%
2018	1314	1'287	27.20	2.15%	11267	11'268	-0.6	-0.01%
Average (1992-2018)	-	-	-	2.94%	-	-	-	2.49%

Sources from table 5a:

OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked-total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

Table 5b.1: Required money transfer, freed capital, freed capital$_t^p$ /Y_t^p, and M value						
Country	The Netherlands					
Variable	Require money transfer	Freed Capital	Ratio of F to outputF_t^p/Y_t^p	Ratio RMT_t^s/Y_t^s	M value	Required Money Transfer /Freed Capital
Equation	$= \Delta H_t^p * w_t^s$ *Equation 24*	$= w_t^p \Delta H_t^p$ *Equation 25*	$= F_t^p/Y_t^p$	Required money tranfer$_t^s/Y_t^s$	=freed capital – required money transfer *Equation 26*	=required money transfer/freed capital
Units:	Millions of Euros				%	
Year:						
1995	1176	1340	2.49%	1.89%	164.4	88%
1996	692	811	1.48%	1.10%	118.9	85%
1997	878	1061	1.89%	1.37%	182.7	83%
1998	1717	2052	3.49%	2.64%	334.7	84%
1999	2117	2515	4.11%	3.24%	398.0	84%
2000	3276	4388	6.79%	4.99%	1112.2	75%
2001	1370	1974	2.98%	2.03%	604.0	69%
2002	1088	1564	2.37%	1.55%	476.0	70%
2003	1060	1525	2.34%	1.48%	465.2	70%
2004	2636	4356	6.43%	3.62%	1720.0	61%
2005	2575	4503	6.44%	3.49%	1927.7	57%
2006	1388	2291	3.20%	1.85%	902.7	61%
2007	2240	3676	4.86%	2.96%	1435.4	61%
2008	-156	-291	-0.39%	-0.20%	-135.2	54%
2009	-2190	-3089	-4.57%	-2.69%	-898.5	71%
2010	2129	3240	4.60%	2.56%	1111.3	66%
2011	1939	2840	3.86%	2.26%	900.5	68%
2012	245	351	0.48%	0.29%	105.6	70%
2013	-25	-38	-0.05%	-0.03%	-13.8	64%
2014	937	1600	2.16%	1.08%	662.9	59%
2015	351	605	0.81%	0.40%	254.4	58%
2016	429	761	1.00%	0.49%	331.7	56%
2017	2076	4189	5.19%	2.33%	2113.7	50%
Average (1995-2018)	-	-	-	-	-	50%

Sources from table 5b.1:

OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked-total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

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Table 5b2: Required money transfer, freed capital, freed capital$_t^p$ /Y$_t^p$, and M value						
Country	Germany					
Variable	Require money transfer	Freed Capital	Ratio of F to outputF_t^p/Y_t^p	Ratio RMT$_t^s$/Y$_t^s$	M value	Required Money Transfer /Freed Capital
Equation	$= \Delta H_t^p * w_t^s$ *Equation 27*	$= w_t^p \Delta H_t^p$ *Equation 28*	$= F_t^p/Y_t^p$	Required money tranfer$_t^s$/Y$_t^s$	=freed capital – required money transfer *Equation 29*	=required money transfer/freed capital
Units:	Millions of Euros				%	
Year:						
1995	3901	6868	1.43%	1.62%	2967	57%
1996	1044	1958	0.42%	0.42%	914	53%
1997	14460	28311	6.58%	5.69%	13851	51%
1998	-985	-1963	-0.44%	-0.38%	-978	50%
1999	4230	8948	2.03%	1.63%	4718	47%
2000	19471	48366	11.27%	7.34%	28895	40%
2001	5118	11564	2.59%	1.93%	6447	44%
2002	-187	-432	-0.10%	-0.07%	-245	43%
2003	8955	20666	4.54%	3.27%	11711	43%
2004	10175	21934	4.49%	3.70%	11759	46%
2005	11027	23868	4.82%	3.99%	12841	46%
2006	20743	38368	7.94%	7.50%	17625	54%
2007	6129	12115	2.48%	2.19%	5986	51%
2008	-10462	-16188	-3.20%	-3.60%	-5725	65%
2009	-26216	-49881	-9.70%	-8.86%	-23665	53%
2010	39239	73099	13.08%	13.05%	33860	54%
2011	11871	18994	3.26%	3.85%	7123	62%
2012	-4186	-7710	-1.35%	-1.34%	-3524	54%
2013	-1487	-2946	-0.64%	-0.48%	-1459	50%
2014	8627	16411	3.00%	2.77%	7784	53%
2015	569	1196	0.20%	0.17%	627	48%
2016	11522	25519	4.38%	3.37%	13997	45%
2017	7687	16080	2.76%	2.16%	8393	48%
Average (1995-2018)	-	-	-	-	-	50%

Sources from table 5b.2:

OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

OECD. (2020) STAN Industrial Analysis (2020 ed.) [HRSN : Hours worked-total engaged] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#

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Table 5c: Profit Taxation (data)		
Variable	Profit Taxation	
Units	%	
Type of variable	Processed	
Equation:	$\text{profit taxation} = \frac{\text{required money transfer } (p \rightarrow s)_t}{\text{profit before tax}_t^p}$ Equation 22	
Variable used to process data:	Operating income, the Netherlands	Operating income, Germany
Source:	Eurostat (2020) Annual detailed entreprise statistics for industry (NACE Rev.2, B-E) Retrieved from https://ec.europa.eu/eurostat/cache/scoreboards/BSP/#	Eurostat (2020) Annual detailed entreprise statistics for industry (NACE Rev.2, B-E) Retrieved from https://ec.europa.eu/eurostat/cache/scoreboards/BSP/#
Reference Year:	Not applicable	
Country:	Netherlands	Germany
Year, Sector:	Not applicable	Not applicable
2005	11.09%	10.96%
2006	5.53%	16.85%
2007	10.17%	4.37%
2008	-0.61%	-8.43%
2009	-10.94%	-36.42%
2010	8.47%	29.39%
2011	7.52%	7.86%
2012	0.98%	-3.23%
2013	-0.11%	-1.17%
2014	4.12%	6.03%
2015	1.33%	0.40%
2016	1.43%	6.67%
2017	6.45%	4.32%
Average (2005-2017)	3.50%	2.89%

Table 5d: Summary of Regression Results for Relative Output		
Type of Analysis	Regression analysis	
Variable	Output	
Country	The Netherlands	Germany
Sector	not applicable	not applicable
Linear equation:	y=-0.001x+1.1399	y=0.0001x+0.5348
Time coefficient	-0.0010	0.0001
Regression's:		
R Square	0.015	0.001
F value	0.39	0.02
F-significance	53.52%	88.80%
Coefficient's:		
t Stat	-0.63	0.14
p-value	53.52%	88.80%

Table 5e: Relative Output (data)		
Variable	Output	
Units	Unitless	
Type of variable	processed	
Equation:	$RY = \frac{Y_S}{Y_P}$ Equation 23	
Variable used to process data:	Output	
Source:	OECD. (2020) STAN Industrial Analysis (2020 ed.) [VALK: Value added, volumes, 2015] Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#	
Reference Year:	2015	
Country:	Netherlands	Germany
Year, Sector:	not applicable	not applicable
1991	1.212	0.449
1992	1.216	0.490
1993	1.243	0.539
1994	1.184	0.532
1995	1.156	0.544
1996	1.147	0.577
1997	1.145	0.570
1998	1.109	0.570
1999	1.067	0.571
2000	1.016	0.543
2001	1.018	0.536
2002	1.063	0.563
2003	1.095	0.561
2004	1.075	0.543
2005	1.056	0.538
2006	1.048	0.495
2007	1.001	0.480
2008	1.043	0.510
2009	1.206	0.643
2010	1.182	0.549
2011	1.167	0.520
2012	1.173	0.536
2013	1.188	0.527
2014	1.177	0.508
2015	1.175	0.528
2016	1.158	0.532
2017	1.102	0.537
2018	1.074	0.535

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