Gender & Productivity in the European Labour Markets

An Analysis Across Sectoral and National Boundaries

Economic research on gender has predominantly been focussed around discrimination and selection. The inherent productivity effects that are theoretically possible with these phenomena are hard to test due to the restricted availability of the precise contributions of males and females to the production process. By correlating the changes in productivity with changes in the male fraction of the workforce we hope to provide an alternative way of testing for suboptimal allocation of labour. We find some significant results for a number of sectors and countries. Although we are not able to precisely determine the specific causes of these productivity effects, we hope it provides an incentive for more focussed research of the sectors and countries in question. Additionally, the method used by us can be implemented to filter out specific areas where it is most likely to find discrimination or selection effects.

Master Thesis

Erasmus School of Economics

Economics of Markets, Organization, and Policy

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1. Introduction

It was not so long ago that the western world excluded half of their native population from basic human rights like the ability to own property or to acquire an education. Formal and informal institutions prevented equal opportunities for not only females, but also those of differing origins and cultures. Acemoglu & Robinson (2001) have shown that these institutions can be persistent in their influence on daily life. Even after the abolishment of discriminatory laws in most of the developed nations there is still doubt that the playing field has been levelled. Due to the persistent nature of culture we cannot truly say that the effect of formal laws vanish as easily as the laws themselves. This is also why we still see significant attention being given to gender issues by policy makers at various levels of government. But this also poses the question what we should expect to see in this ongoing process. Can we automatically assume that equal opportunities lead to equal outcomes? Can we even have true equality in opportunities? There is a large body of research literature and experiments that show different groups with their own specific characteristics can react differently to incentives and opportunities. If we consider these findings to be the result of either nature or nurture, it follows that equal opportunities do not automatically lead to equal outcomes. To truly be able to determine whether discrimination or selection results in suboptimal allocation of labour researchers would need data on individuals. This can be very difficult to acquire, and this difficulty might impede researchers from shedding light on the gender outcome debate. By detecting correlations between changes in relative gender activity rates and changes in productivity we hope to legitimise the acquisition of costly data by first using more readily available macro-level numbers.

In this paper we will look into the current state of labour market outcomes from a gender perspective. Our first stepping stone will be to examine literature on gender and productivity, thus establishing the premise on which we will examine labour market outcomes. The main focus of economic gender literature has been on discrimination and selection effects. We will see how these effects can influence group productivity and if it would be possible to detect such effects by examining productivity differentials. The next step will be to provide information on the variables we will use in our dataset. By combining what we discover in the theoretical section with data that is more readily available than the specific data on individuals, we hope to establish a premise that would increase the incentive of other researchers to acquire the necessary data. Therefore, once we have presented our variables in the data section we will continue with an examination of the fraction of active males across countries and sectors. In the final section we will connect the developments of

the male fraction with changes in productivity on a sectoral and country level. We will summarise our findings in the conclusion.

2. Literature

We will start the examination of current literature and research with the results found by Seguino (2000). She concluded that the Asian countries with the greatest gender wage gap correlated with those that experienced the highest growth rates. Broadly speaking, the unfavourable female position in terms of income equality in some Asian societies enabled export driven growth. This process was enabled by the acquisition of productivity enhancing technologies acquired thanks to the foreign exchange benefits of the exports. These exports were competitive due to the low wages received by females. In this light, discriminatory behaviour contributed to the rapid economic growth witnessed in Asia in the period examined. It is not very likely that we will be able to see a similar process taking place in the European Union. First of all, the countries of the EU are closer to the World Technology Frontier (WTF) and would not necessarily require foreign technology to increase productivity. Second, female educational attainment and labour participation in EU is very different to that of the Asian economies in the 1980's and 1990's. To be able to make a prediction through which channels we should expect to see changes in productivity we would have to look into theory on selection and discrimination.

Selection effects occur due to differing preferences and abilities of individuals. The scope of these abilities and preferences on which selection can be based is almost inexhaustible. People can be placed into identifiable groups based on these characteristics, and from there researchers can make reasonable assumptions on the possible choices that group members will make on average. As an example, people with high mathematical proficiency have a high probability to select into studies like physics or engineering. The literature on selection seems to indicate risk attitudes as the most identified preference. Bonin et.al. (2006) find that their measure of risk taking is a large determinant for sorting into certain occupations. Furthermore, Dohmen & Falk (2010) find differences in selection between genders due to differences in risk taking attitudes. Although many laboratory experiments find similar results concerning the correlation of risk attitudes and gender, these findings may be heavily influenced by cultural norms that shape gender stereotypes. Gneezy et.al. (2009) conducted a field experiment examining selection into different payment schemes for competitive behaviour. As the majority of laboratory experiments find males being more willing to compete relative to females, Gneezy and his co-authors found evidence that suggests that the role of 'nurture' is more pronounced in willingness to compete. What would this imply for our sample? Since we are going to

focus on developed western nations the risk attitudes will be more in line with the results found by Bonin et.al. and Dohmen & Falk. Additionally, we can also consider males in our sample to still be the dominant gender culturally, and in that way the results of Gneezy et.al. also coincide with males more willing to take risks and being more competitive as a result. Since we are interested in (detecting) productivity effects, we should pose the question how (self) selection fits into the picture. The usual suspect in this case is selection into sectors and occupations with a lower innate productivity in terms of output. Livanos & Pouliakas (2008) found females selecting into Greek sectors with a lower wage premium. This choice started at the educational attainment decision, and the authors suspected it to be primarily driven by gender stereotypes. Lower innate output productivity can be expected in light of lower wage premiums if we assume workers are paid their marginal product. Gender dominance might be of importance for the ability to succeed on the firm level. Delfgaauw et.al. (2009) found that the success of incentive schemes introduced into a Dutch firm was influenced by the gender match of the manager and his or her subordinates. This leads to the assumption that the success of males and females depend on the dominant gender of the firm and the associated firm culture. Selection ultimately affects the supply side of the labour market, and it might be the case that any productivity effects we find simply coincide with an increase in the supply of labour from a specific gender. This in turn leads to more people of that specific gender being hired at a time where sectoral productivity is increasing due to technological change or market conditions. We will now discuss an important factor on the demand side of the labour market, namely discrimination.

The economic literature on discrimination has identified two main ways of modelling discrimination, namely as a taste for discrimination (Becker 1971), or statistical discrimination (Arrow, 1973, 1998) and (Phelps, 1972). Taste based discrimination is characterised by a clear preference of one group over the other, whereas statistical discrimination is based on an information problem. In Becker's theory of taste based discrimination employers maximise utility which not only depends on profit or productivity, but also the composition of the workforce employed. In this case the discriminator is content with hiring less productive candidates of the favoured group even though there are better candidates in the disliked group. When we look into statistical discrimination the main difference with its taste based counterpart is the absence of formal prejudice. This does not necessarily mean that the most productive candidates are hired though. Statistical discrimination implies decisions being made on the basis of group identity because precise information is costly or unavailable. In the case of hiring new employees this comes down to not being able to perfectly determine the precise ability of potential candidates or the effort levels one can expect from them

once hired. Because of this, employers base their hiring decisions on their prior beliefs concerning the group identity ascribed to candidates. Group identities are often formed and labelled on the basis of easily determined characteristics like ethnicity or gender.

From an economical perspective both statistical and taste based discrimination can lead to suboptimal allocation of resources on the firm level. Concerning the taste based variant, suboptimality only occurs when there are not enough favoured candidates with a higher (potential) productivity compared to the candidates from the disadvantaged group. When this is the case more productive candidates are overlooked due to the taste of the employer. Considering that educational attainment and productivity amongst females have caught up implies that if there is taste based discrimination in the hiring process it should certainly lead to a misallocation of resources. Statistical discrimination can also cause more productive candidates to be passed by. As already mentioned, statistical discrimination hinges on the beliefs people have about certain groups. When these beliefs are correct there are only limited consequences for the employer. For example, if there is a minority group that only consists of low skilled first generation immigrants, the belief of an employer that potential candidates from that group are low skilled would probably be correct. But if the second generation of that group does invest in education and skills and the beliefs of employers do not adjust to this adequately, we would see minority members with sufficient skills not being hired. Again, this leads to a suboptimal allocation of resources. From the perspective of optimality and discrimination, we would expect less discrimination in highly competitive sectors or jobs where skill can easily be determined.

The theoretical literature on discrimination discussed so far has shown us that discriminatory firms should have less than optimal productivity unless discriminated groups actually fit the discriminatory beliefs. Subsequently these firms would theoretically be at a disadvantage compared to non-discriminatory firms and should not be able to compete in competitive markets. In a perfect world discrimination should therefore correct itself. However, it seems reasonable to assume that most markets are not perfectly competitive, and various market failures make it possible for discriminatory firms to have enough market power to stay in business in spite of the non-optimality of their hiring policies. This reasoning implies that if we are able to observe suboptimal outcomes, it might be an indication of discriminatory behaviour of employers in the acquisition of employees. To actually determine whether suboptimal outcomes are due to discriminatory practices, selection, or other causes would require information on individual hiring and firing instances and the specific characteristics of the individuals involved. As we will show in the next section, our dataset should be

able to detect whether outcomes are optimal. However, specifically determining discrimination, selection, or a random walk lies beyond the scope of our research.

3. Data

In this section we will give an overview of the data we are going to use in our analysis. Besides providing the sources, we will discuss the possibilities and limitations of the variables. Our main sources are Labour Force Surveys (LFS) which are conducted in each European member state individually and are collected and distributed by Eurostat. Additionally, various variables which are publicly available through the Eurostat statistical database were added to supplement the LFS figures. The additional variables mainly regard productivity indicators. The chosen time period for our analysis runs from 1998 to 2007.

First, the LFS provided information on the amount of people currently employed. These figures have been broken down according to country of activity, sector of activity, gender, and the highest attained level of education. The 19 countries included are either part of the European Union or are in the process of joining the union. The sectors have been broken down by using the NACE revision 1.1 economic activity standard. This enables us to look at the relative amount of males and females that are active in each country and/or sector. Furthermore, the division between skilled and unskilled jobs can also be viewed from a gender perspective due to the additional breakdown according to education. The division of education levels used in our analysis are determined with the help of the ISCED 1997 classification system. We have chosen to divide educational attainment as follows: Primary (ISCED levels 0-2); Secondary (ISCED levels 3 and 4); and Tertiary (ISCED levels 5 and 6). We still have some steps to take in order to easily analyse the data discussed here. The next step is to construct indicators that show the representation of males and females for each sector. We do this by dividing the amount of males by the total amount of people employed for a specific sector, country, and education level. The result is that we have a variable that is bounded between 0 and 1, which indicates the relative gender division of labour for a specific sector and/or country. As the variable approaches 1 more males relative to females are active in the given area of interest and as such the examined sector can be described as male dominated. When the variable approaches 0 for a given area we can conclude that this area is female dominated. When the variable is 0.5 males and females are equally represented.

Second, we add two more variables that can provide a measure of the level of productivity, namely output and hours worked. These variables have been taken from the online statistical database of Eurostat. As with the LFS variables, these have been broken down according to country

and sector. Output is measured in current and constant Euro/ECU and is therefore internationally comparable and suitable for our analysis. By dividing the output of a sector by the total amount of hours worked in the same sector we obtain a sectoral measure of output per hour. Although output per hour is not the best possible proxy for productivity, it is one of the few measures available that we can also link to the LFS data. Unfortunately, it was not possible to break output per hour down along the dimensions of gender and educational attainment without severely reducing the amount of observations. Further information like date of access and specific variable names of the chosen variables can be found in appendix A. We now move on to the discussion concerning data reliability.

As the LFS is an international survey done separately in each member state there might be some issues regarding comparability of different countries. For instance, Denmark was not included in our dataset due to the lack of information on educational attainment, which was probably not collected by the Danish statistical bureau responsible for doing the survey. Furthermore, different cultural influences can have an effect on what people in different countries prefer to disclose. An example of this is the option of 'no answer' with regards to educational attainment and sector of activity. Respondents who did not wish to answer certain questions were not included in the aggregates. This might introduce a bias if differences in cultural attitudes dictate the probability of disclosure. As an example, suppose there are some cultural influences that prevent lower level educated individuals in country A from giving up information about their attainment level. This would result in a sample where activity levels for primary education are lower than what they are in reality. Because we do not have the necessary information concerning disclosure attitudes we were unable to accommodate for this discrepancy. Therefore, we will have to assume that disclosure attitudes are fairly similar along the chosen breakdowns of gender and educational attainment. Another concern with the survey data is that the level of detail is restricted. What we mean with this is that breakdowns result in fewer observations per category which in turn can result in figures from being omitted due to privacy reasons. Small sectors that employ a limited amount of males or females will be dangerously close to the confidentiality threshold, and choosing too many breakdowns can cause the threshold being breached. This is the main reason why we were unable to add a disaggregate measure of hours worked for each gender individually. Additionally, this has also prevented us from adding various characteristics that would have enabled us to look into any discrimination effects.

Apart from the concerns regarding the survey data, there are some additional issues we have to consider in order to give valid conclusions at the end of our analysis. First of all, the effects of prices and competition on productivity or output are not accounted for in our data. Although our output variable has been corrected for changes in price indices this merely alleviates problems with

potential bias when comparing sectors in different countries. The effects of prices and competition can still have an indirect effect on labour productivity due to the demand side of the markets, for example due to a loss of competitiveness compared to non EU countries not in the sample. The availability of further corrections for this is unavailable to us and would limit our sample severely. Secondly, in the standard economic sense output is determined by capital, labour, and technology. There is no measure of capital, technology, and their corresponding effects on productivity in our dataset. Again, availability issues in combination with our chosen level of aggregation have forced us to exclude capital productivity from our analysis. Even though the absence of these measures could limit the validity of any outcomes we find, we feel that there is enough information to be had in looking into changes in the gender composition of the labour market in relation to changes in output. Since we are considering fairly comparable countries over a relatively short timeframe, changes in technology and capital should not be too severe. Researchers that want to investigate the division of labour and include changes in technology, competition and price effects, or capital will either have to collect the data from a source other than ours, or focus on a lower level of aggregation. Now that we have discussed the contents and shortcomings of our dataset we can continue to the next section where we will present our analysis of the European labour market.

4. Trends in the division of labour

In this section we will have a look at the division of labour across the various sectors and countries over the period 1998 until 2007. Each level of educational attainment will be considered separately. One important thing to note is that the fractions are calculated using the number of male and female employees and not the number of male and female hours worked. Any changes we see are a result of changes in activity on the labour market and do not necessarily reflect true changes in the gender specific contribution to output. Female activity might increase in a certain sector, but if the females that join only work a limited amount of hours their contribution to the production process might be overstated. Furthermore, the averages presented in this section are calculated from the fractions of the underlying sectors or countries. For example, instead of using the total amount of males and females active in a certain sector across all countries and calculating the fraction, we will present the average of the sectoral fractions of each country. This results in very large and small sectors to have the same weight when calculating the averages across years. Additionally, the chosen method provides us with the ability to look at how sectors and countries develop in the sense of gender domination. The downfall of this approach is that the true lump sum averages (i.e. the total amount of males in a country divided by the total working population) are not presented and will most likely deviate from the means presented in the tables accompanying this

section. Nonetheless, we will continue with the proposed method because it will give some insight in how sectors and countries are dominated. For example, if a country has many dominated sectors it will have a high average fraction regardless of the size of those dominated sectors.

We will start with the information presented in table 4.1, which shows the yearly sector averages of the fraction of males with a high level of educational attainment. What we can clearly

Table 4.1

Sector	High Fraction									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Agriculture	.726	.721	.703	.742	.696	.693	.708	.695	.685	.698
Construction	.848	.850	.841	.829	.841	.839	.813	.836	.832	.822
Education	.348	.362	.343	.334	.336	.322	.327	.322	.316	.313
Electricity gas and water supply	.738	.774	.746	.755	.774	.753	.719	.759	.744	.745
Financial intermediation	.563	.561	.568	.576	.532	.541	.566	.531	.524	.513
Health and social work	.329	.346	.341	.327	.313	.327	.330	.318	.306	.289
Hotels and restaurants	.458	.483	.472	.488	.445	.485	.450	.455	.453	.436
Manufacturing	.707	.720	.716	.701	.679	.700	.695	.690	.684	.681
Mining and quarrying	.778	.810	.823	.744	.859	.791	.735	.776	.743	.725
Other community social and personal service	.542	.546	.538	.529	.535	.508	.502	.486	.493	.495
Public administration	.601	.602	.587	.587	.569	.571	.572	.554	.549	.533
Real estate renting and business activities	.658	.657	.657	.642	.631	.644	.635	.622	.621	.617
Transport storage and communication	.698	.719	.680	.668	.663	.662	.677	.658	.650	.666
Wholesale and retail trade	.590	.598	.579	.596	.584	.564	.563	.555	.554	.547

Source: Eurostat

see is that all sectors, with the exception of the sector 'Electricity, gas, and water supply', have a lower fraction in 2007 compared to the starting values. What we can conclude from this is that females have become more active relative to males in skilled labour for our sample. Considering the increased number of females attaining higher level education over the past decade this should not be a surprising result. Lower fractions across the board also means female dominated sectors like 'Education' and 'Health and Social work' are trending towards an even more dominated status. In light of possible gender specific selection effects into certain sectors and their corresponding educational requirements (doctors need to study medicine, bankers need to study economics) this should again not be too surprising. Besides the slight trend we additionally see that the fractions display some cyclical behaviour of falling and rising. We can see this behaviour more clearly in Graph 4.1 (All graphs are presented in Appendix B). The trend is very subtle, and combined with the cyclical

behaviour gives rise to the question whether the 2008 figures would also be lower than the starting values in 1998. To answer this question we will have to know what causes the cyclical behaviour. This will either be the result of actual changes in the underlying fractions, measurement error, or a combination of both. All things considered, we can conclude that the fractions of skilled females are increasing in all but one sector, regardless of the dominant gender present in those sectors. This means male dominated sectors are becoming less male dominated, equally dominated sectors are skewing towards female dominated status, and female dominated sectors are becoming increasingly female dominated. These trends should be reassuring for European policy makers since they are moving in the direction of increased participation of highly educated females. However, it does give some hints towards possible corrections for policy makers if they wish to see a more equal division of labour in predominantly female sectors or a stabilisation of the 'equal' sectors. It is probably not a coincidence that the sector where governments traditionally have the most influence in hiring and firing shows one of the highest changes over time (11,34% drop) in the male activity fraction. The highest change, a 12% drop, can be seen in the female dominated 'Health and social work' sector.

Table 4.2

Sector	Average medium fraction									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Agriculture	.700	.703	.701	.704	.693	.700	.700	.699	.701	.702
Construction	.899	.901	.897	.901	.907	.907	.902	.908	.914	.912
Education	.280	.278	.284	.283	.286	.262	.261	.271	.269	.258
Electricity gas and water supply	.802	.807	.780	.801	.786	.790	.776	.788	.776	.770
Financial intermediation	.429	.458	.430	.432	.433	.410	.404	.410	.404	.400
Health and social work	.181	.164	.168	.163	.178	.179	.168	.165	.163	.165
Hotels and restaurants	.420	.436	.429	.440	.428	.422	.433	.415	.413	.405
Manufacturing	.676	.678	.679	.673	.678	.677	.677	.683	.685	.686
Mining and quarrying	.839	.864	.874	.855	.861	.863	.869	.840	.860	.860
Other community social and personal service	.456	.444	.445	.436	.433	.443	.434	.433	.424	.424
Public administration	.578	.589	.570	.576	.570	.565	.560	.562	.563	.564
Real estate renting and business activities	.518	.521	.524	.531	.528	.533	.531	.539	.533	.522
Transport storage and communication	.713	.706	.712	.718	.724	.722	.719	.726	.728	.732
Wholesale and retail trade	.518	.505	.492	.498	.503	.505	.497	.490	.486	.489

Source: Eurostat

Table 4.2 also shows the sectoral averages of the male fractions, except here we look into our intermediary educational attainment level titled 'medium'. As explained in the data section, our definition of medium education coincides with attaining a secondary level of education (ISCED levels

3 and 4). We can immediately see that the trends of the various sectors are not as unified in their direction as the tertiary education level trends. To be precise, eight out of the fourteen sectors have seen a decrease in the fraction of male activity when we compare 1998 to 2007. These changes are very subtle in most cases; in fact we can barely see any changes if we convert the numbers into lines as shown in Graph 4.2. Besides the difference seen in the direction of the trends we also see a less pronounced or even absent cyclical effect. The two most female dominated sectors 'Health and social work' and 'Education' show the highest change over time with roughly 8,7% and 7,8% respectively. Both percentages represent a relative drop in male activity, thus increasing the female domination in those sectors. The highest male dominated sectors here are 'Construction', 'Mining and quarrying', 'Electricity', 'Transport', and 'Agriculture'. With the exception of 'Electricity', all these sectors show an increase in domination over time, although 'Agriculture' only shows an increase of 0,25% and can therefore be better described as being stable. Apart from 'Real estate', the more equally distributed sectors all show a decline in the relative male activity over time. If we rank all the sectors according to the fraction of males employed and subsequently look at the direction of the changes we see that increased female participation is limited to sectors that either have a high female presence or are at least more or less equally distributed. It seems that there are gender specific selection effects present in this part of our sample, which in turn result in the consolidation of the distribution of labour for the intermediary-skilled jobs. This is somewhat at odds with the picture painted by our skilled labour data. To look into this difference in further detail we return to the female dominated sectors 'Health and social work' and 'Education'. Compared to table 4.1, both sectors show higher gender domination in the medium educational bracket. Furthermore, if we look at all sectors, half of them show a lower amount of females relative to males when compared to the 'high' educational fractions of the same sectors. These sectors just so happen to be the male dominated sectors. Combining this result with what we see happening over time shows that the increase in female participation is less pronounced for females with a secondary level of education compared to their tertiary counterparts, and is limited to sectors that are not dominated by males. As already mentioned this can be due to selection effects into certain sectors and thus originating from the supply side of the labour market. Alternatively, discriminatory beliefs in the hiring and firing, the demand side of the labour market, can also be the cause of such movements in the fractions. Unfortunately, we would need a more detailed dataset to be able to determine with certainty which side of the labour market is responsible. But the results we find here show that policy makers still have some work to do if they want to prevent gendered sectoral developments in the middle educational bracket.

Table 4.3

Sector	Average low Fraction									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Agriculture	.602	.602	.600	.616	.623	.614	.614	.619	.631	.632
Construction	.941	.928	.940	.940	.939	.940	.944	.944	.947	.946
Education	.248	.230	.245	.224	.227	.229	.236	.216	.207	.223
Electricity gas and water supply	.826	.811	.791	.797	.778	.784	.786	.776	.752	.773
Financial intermediation	.477	.422	.402	.393	.399	.400	.430	.370	.390	.416
Health and social work	.203	.180	.173	.175	.169	.175	.167	.174	.171	.183
Hotels and restaurants	.352	.345	.370	.335	.382	.353	.359	.353	.328	.322
Manufacturing	.578	.596	.601	.599	.600	.608	.606	.619	.624	.626
Mining and quarrying	.843	.825	.814	.859	.838	.837	.828	.847	.910	.911
Other community social and personal service	.480	.454	.434	.476	.476	.467	.456	.482	.492	.467
Public administration	.576	.573	.541	.549	.527	.536	.552	.557	.548	.536
Real estate renting and business activities	.478	.444	.455	.469	.459	.447	.447	.476	.485	.470
Transport storage and communication	.765	.746	.761	.762	.758	.772	.785	.785	.785	.801
Wholesale and retail trade	.508	.517	.498	.512	.501	.505	.502	.494	.507	.499

Source: Eurostat

Moving on to the lowest educational bracket of our sample, those with a primary education, we turn to the table and graph numbered 4.3. It shows a similar time trend as table 4.2, namely that the male dominated sectors have become increasingly dominated over time. And again, the exception is 'Electricity, Gas, and Water supply' which shows a lower fraction in 2007 compared to 1998. The more equally represented sectors in terms of gender generally show an increase in the relative activity of females, as well as the female dominated sectors. Manufacturing, which was very close to a 0.5 fraction in 1998, displayed an increase in the fraction of active males and is therefore moving towards a male dominated status. The largest change we see here is in the 'Financial intermediation' sector with a 12,8% drop in the fraction. It is clear that the low educational bracket is following similar patterns to the medium educational bracket, namely the pattern of stronger genderisation and relatively stable movements. When we compare the low educational attainment fractions to the high and medium fractions we see some small differences in the absolute values of the fractions. A more insightful comparison is shown in table 4.4, where we see how the various sectors rank in 2007 for each educational bracket. The ranks for the medium and low are exactly the same and are additionally quite similar to the high ranking. We only see a maximum ranking difference of two places comparing high to the other two rankings, with the exception of 'Transport'.

Table 4.4 : Sectoral Rankings according to male fraction			
Sector	High	Medium	Low
Agriculture	4	5	5
Construction	1	1	1
Education	13	13	13
Electricity gas and water supply	2	3	4
Financial intermediation	10	12	11
Health and social work	14	14	14
Hotels and restaurants	12	11	12
Manufacturing	5	6	6
Mining and quarrying	3	2	2
Other community social and personal service	11	10	10
Public administration	9	7	7
Real estate renting and business activities	7	8	9
Transport storage and communication	6	4	3
Wholesale and retail trade	8	9	8
Source: Eurostat			

This tells us two things: there might not be enough difference between the two lower educational brackets to justify dividing them into two groups, and the genderisation of sectors does not change much when comparing different educational attainment levels. If we add what we have learned from the other tables in this chapter it seems clear that we see a relative increase in participation of highly educated females in all but one sector. Furthermore, this can also be said of positions with a lower educational requirement with the exception of those in relatively male dominated sectors. Oddly enough, the only male dominated sector that showed an increase in female participation in the unskilled jobs, 'Electricity and water supply', saw an increase in male domination for the skilled jobs. All things considered, the increased tertiary educational attainment rates of females are certainly visible in the activity rates as we have seen an increase in active females in almost all sectors. However, increased relative female participation in unskilled jobs seems to be concentrated around sectors without a clear male majority.

In the preceding part of this section we have focussed on a division along sectoral lines. Our dataset allows us to additionally look at how the fractions behave over time on a country by country basis. Table 4.5 shows the developments of the 'high' male fractions for each country in our sample. There are four things to note in this table. The first thing we notice is the absence of extreme values, in other words the fractions of the different countries are more concentrated around the 0.5 mark. Second, as expected the majority of countries have a fraction value higher than 0.5. Third, female

participation is higher in 2007 compared to 1998 for all countries except Lithuania (LT) and Austria (AT). Lastly, the cycling effect we have seen in the sectoral breakdown for high education seems to be present here as well. Explaining the lack of extreme values like we have seen in sectors like 'Construction' seems straightforward enough. When we examine country data the available pool of labour will be more equally divided amongst the two genders due to a lack of sectoral selection and

Table 4.5

Country	High Male Fraction									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Austria	.651	.686	.649	.659	.646	.625	.636	.631	.643	.668
Switzerland	.739	.735	.735	.732	.735	.726	.732	.724	.701	.709
Czech Republic	.680	.676	.683	.661	.666	.666	.654	.671	.639	.640
Germany	.[a]	.690	.690	.691	.673	.669	.676	.667	.659	.660
Denmark	.604	.604	.557	.552	.545	.581	.589	.582	.611	.582
Estonia	.420	.444	.370	.415	.385	.391	.436	.432	.424	.404
Spain	.656	.628	.618	.613	.610	.599	.580	.577	.580	.575
Finland	.505	.527	.510	.510	.498	.492	.494	.498	.497	.499
Greece	.668	.635	.659	.655	.641	.630	.644	.643	.634	.605
Hungary	.608	.577	.605	.590	.565	.571	.573	.570	.556	.568
Italy	.640	.649	.634	.607	.619	.616	.605	.587	.561	.556
Lithuania	.456	.458	.464	.467	.432	.431	.503	.469	.458	.464
Luxembourg	.[a]	.692	.628	.664	.635	.654	.615	.638	.630	.575
Netherlands	.673	.661	.637	.658	.657	.647	.638	.646	.613	.622
Poland	.[a]	.[a]	.572	.570	.549	.553	.534	.535	.528	.506
Portugal	.528	.514	.530	.503	.468	.501	.479	.481	.505	.506
Romania	.588	.598	.604	.583	.574	.577	.556	.553	.555	.548
Sweden	.594	.589	.550	.549	.563	.572	.550	.562	.557	.575
Slovakia	.619	.603	.619	.606	.567	.577	.573	.614	.597	.578

a=data unavailable
Source: Eurostat

size effects. Combining this with more a or less equal amount of males and females living in Europe results in activity rates being closer to 0.5 than can be expected of sectoral activity rates. One thing to note is that the mean fractions that are displayed in the tables are not weighted across sectors or countries. This means that larger sectors contribute as much as small sectors to the determination of the means. Therefore, the activity rates do not necessarily reflect the true division of labour for the country as a whole. This mismatch was less problematic for the section regarding sectoral means for all countries, but should be handled with more care when considering the country data as the country mean reflects the average of the fractions of the different sectors in that country. If we take a look at graph 4.4 we can clearly see that the average fractions for most countries in our sample are

skewed towards male dominated sectoral fractions. Although the graph is fairly messy in terms of identifying the developments of individual countries, it still provides a nice visual representation of the differences in participation rates. Estonia (EE) is clearly the country with the highest average female participation rate in terms of tertiary educated individuals, while Switzerland (CH) shows the highest male fraction for each year. Germany (DE) was second in that respect up until 2006, but was surpassed by Austria (AT) in the last year of our sample. The volatility we see in the lines is mainly a result of changes in the different sectoral fractions from year to year. If we were to look at total 'lump sum' participation the lines would be more stable.

Table 4.6

Country	Medium Male Fraction									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Austria	.580	.573	.577	.569	.546	.548	.541	.557	.560	.557
Switzerland	.551	.544	.534	.538	.520	.554	.528	.551	.530	.524
Czech Republic	.535	.537	.537	.539	.542	.540	.543	.549	.550	.553
Germany	.[a]	.551	.548	.546	.555	.546	.548	.547	.551	.548
Denmark	.566	.556	.542	.584	.547	.567	.582	.559	.594	.579
Estonia	.505	.529	.560	.493	.530	.540	.538	.507	.508	.519
Spain	.619	.628	.609	.612	.613	.609	.580	.602	.596	.597
Finland	.516	.534	.521	.535	.521	.532	.531	.562	.563	.563
Greece	.633	.627	.620	.628	.606	.595	.609	.619	.601	.596
Hungary	.566	.563	.559	.559	.562	.549	.545	.559	.557	.556
Italy	.611	.608	.606	.596	.595	.596	.598	.591	.591	.592
Lithuania	.554	.532	.514	.495	.490	.482	.475	.509	.517	.493
Luxembourg	.[a]	.596	.619	.627	.613	.609	.596	.627	.616	.599
Netherlands	.627	.594	.604	.617	.612	.608	.607	.587	.588	.593
Poland	.[a]	.[a]	.537	.538	.540	.540	.543	.549	.548	.547
Portugal	.524	.524	.538	.558	.543	.527	.532	.556	.536	.535
Romania	.552	.550	.550	.563	.581	.579	.550	.564	.562	.560
Sweden	.552	.567	.540	.574	.572	.571	.576	.578	.586	.586
Slovakia	.533	.539	.548	.537	.553	.554	.553	.552	.553	.554

a=data unavailable
Source: Eurostat

In table 4.6 and graph 4.5 we can see the averages of the sectoral fractions for medium educated individuals. If we look at the starting values we can see that all countries displayed an average above 0.5. With the exception of two nations, Estonia (EE) and Lithuania (LT), the fractions stay above that mark. We can also see that the values are even more concentrated in a narrower range. Where table 4.5 showed values ranging between 0.75 and 0.35, we now see a range of 0.65 and .45 in terms of fractional averages. The volatility within these bounds seems to be more severe for a few countries.

The most notable change seems to be the change displayed by EE from 2000 to 2001, where the fraction drops below the starting value after rising by 10% only to rise again afterwards. The biggest downward shifts in averages are seen in Lithuania (LT), Greece (GR), and the Netherlands (NL) with changes of 11%, 5.8%, and 5.33% respectively. The other side of the coin has Finland (FI) and Sweden (SE) showing the highest increase in the average fractions. The Finnish increase amounts to 9.15%, while the Swedish numbers show a 6.2% increase. Where the 'High' fractions all showed a decline or very modest increase over time, the 'medium' figures show a more divided picture in terms of increasing or decreasing average sectoral fractions. To be precise, nine countries display a lower fractional average compared to ten countries experiencing higher averages. If we compare the fractions for 2007 in tables 4.4 and 4.5 we see that there are ten countries that have a higher fractional average in the 'medium' bracket. And while the 'high' fractions have a downward trend the 'medium' fractions do not follow such a uniform direction. This results in the two upper educational brackets converging, or more precisely the upper bracket is converging towards the 'medium' values. And again, this should not be surprising considering the biggest changes in attainment rates are seen in tertiary level education. On the other hand, 'medium' attainment rates also displayed a significant increase but this does not translate into changes in the average activity rates as we can see for the 'high' segment. There are two explanations that can fit into this picture. First, cultural values that prevent females from participating in the labour force might have a more pronounced effect on the lower educational brackets. Second, government policy aimed at increasing female participation could possibly be focussed on the 'high' educational bracket. Both explanations cannot be tested with our dataset; therefore we will leave the precise determination of the cause to future research.

We can now move on to the final part of this section where we look at the developments of the 'low fractions. Table 4.7 and graph 4.6 show these developments. Eleven countries have seen an increase in the overall fraction since 1998 which consequently implies that eight countries experienced a decrease of their fraction. Switzerland (CH), Denmark (DK), Finland (FI), and Hungary (HU) show the biggest increase with percentage changes ranging from 15.75% to 8.84%. All these countries displayed starting values around the 0.5 mark, and the biggest change was seen in the country with the lowest fraction, namely CH. The countries that show the largest decrease of their fraction over time are Slovakia (SK), Spain (ES), and Luxembourg (LU) with changes of 8.09%, 8.02%, and 6.37% respectively. Due to the decrease SK ends up with the lowest average fraction in 2007 for our sample. The changes in the Spanish fractions were not enough to dislodge them from one of

Table 4.7

Country	Low Male Fraction									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Austria	.448	.433	.428	.456	.413	.431	.447	.483	.478	.472
Switzerland	.430	.463	.447	.450	.479	.481	.476	.467	.477	.498
Czech Republic	.444	.438	.430	.432	.417	.415	.421	.442	.444	.458
Germany	.[a]	.515	.517	.518	.506	.510	.533	.532	.536	.531
Denmark	.519	.516	.527	.526	.549	.535	.501	.538	.516	.586
Estonia	.506	.562	.529	.517	.597	.662	.669	.507	.496	.518
Spain	.687	.674	.664	.657	.657	.659	.644	.638	.641	.632
Finland	.493	.495	.497	.517	.472	.500	.497	.545	.538	.541
Greece	.636	.649	.645	.655	.635	.629	.633	.653	.665	.653
Hungary	.483	.466	.494	.494	.473	.481	.490	.484	.508	.526
Italy	.695	.686	.684	.666	.662	.666	.656	.669	.671	.673
Lithuania	.532	.453	.461	.560	.703	.525	.443	.580	.580	.526
Luxembourg	.[a]	.542	.502	.505	.519	.504	.518	.521	.546	.508
Netherlands	.574	.579	.589	.561	.568	.565	.558	.557	.577	.568
Poland	.[a]	.[a]	.542	.514	.542	.522	.502	.578	.598	.579
Portugal	.596	.597	.570	.589	.558	.562	.594	.589	.591	.595
Romania	.557	.534	.526	.524	.529	.503	.529	.542	.536	.538
Sweden	.557	.544	.519	.535	.559	.547	.554	.573	.553	.579
Slovakia	.462	.453	.458	.462	.409	.392	.405	.441	.425	.424

a=data unavailable
Source: Eurostat

the top positions, they move down one spot in the ranking from a second to third position. This cannot be said about LU, which dropped from an eight position in 1999 to a ranking of fifteen in 2007. These observations show that there is quite some variability in the lowest educational bracket when we compare countries. When we compare different educational brackets nine countries display a lower endpoint value compared to the 'high' bracket, and twelve nations displayed a lower fractional average versus the 'medium' bracket.

There are some changes which are hard to explain besides hinting towards exogenous shocks or measurement error. If we look at the values for EE and LT there seems to be some very drastic changes in the mean of the fractions. LT starts out with a position around the 0.5 mark that declines and subsequently stabilises in the first two years, only to rapidly rise to the highest value, after which it falls back to one of the lowest fractions for the sample. The average fraction for EE is higher in the period 2001-2005 compared to the other years in the sample. Both countries have introduced various amendments to their labour market policies in the timeframe of the sample, some of which directly targeting issues concerning gender. For example, LT passed a new equal opportunity law in

1998 which was further amended in the period 2002-2004 (Kanopiene, 2011). These kinds of shocks could cause fluctuations we see in the fractions, and adds to the importance of country fixed effects for the productivity analysis in the next section. However, the directions of the observed changes are counterintuitive as the fractions are initially increasing. It could be the case that the effects of the legislative changes are lagged and thus coincide with the subsequent decline of the fractions. Alternatively, the increase we witness might be due to anticipation effects or another unobserved shock. Unfortunately, the precise cause lies beyond the scope of our data, but these changes should be kept in mind in the next section where we examine productivity effects.

To conclude the examination of fractional trends, the different educational brackets do not follow a uniform direction, regardless of division by country or sector. However, we do see some similarities when we compare the country and sectoral division for each level of education. The 'high' educational fractions show a trend of increasing relative female participation resulting in less male dominated sectors. Consequently, female dominated sectors generally show a strengthening of the female position. In the next section we will see whether this has any consequences for productivity.

5. Productivity Analysis

In the previous section we have established that there is some variability in the participation of males relative to females across sectors, countries, and over time. Theoretically, these changes should go along with productivity effects if there are discriminatory hiring and firing practices or suboptimal selection effects in the labour market.

Assume a country consisting of one sector. Labour is supplied by households and demanded by one company. The production function for the country is determined by current technology A, capital K, and labour L. For our analysis we split the L into L_m (male) and L_f (female). Output is determined as shown in equation (5.1)

(5.1) $Y = F(K, A, L_m, L_f)$

The specific contribution of male and female workers is determined by their marginal product, which is found by taking the first derivative of equation (1) with respect to L_m and L_f. Equations (5.2) and (5.3) show this step.

(5.2) $$\frac{\partial F(K,A,L_m,L_f)}{\partial L_m} = f_m = MPL_m$$

(5.3) $$\frac{\partial F(K,A,L_m,L_f)}{\partial L_f} = f_f = MPL_f$$

When the company wants to maximise profit it will hire the marginal worker with the highest contribution to production. In a perfect world $MPL_m = MPL_f$ and potential productivity is maximised. In this case we should not be able to see changes in average productivity associated with changes in the fraction of males.

What would happen in the case of employer discrimination? First, let us consider taste based discrimination. When an employer dislikes a group he or she would be willing to sacrifice productivity to avoid hiring members of the group. Instead of basing the hiring decision on the marginal product, the employer uses the marginal contribution to his utility. This can be seen as adding a cost component C when determining the marginal contribution of potential employees.

(5.4) $$\frac{\partial U}{\partial L_f} = MPL_f - C \quad ; C > 0$$

As can be seen in equation (5.4), in this example the females are the disliked group, and the contribution of the male employees to the employers utility is the same as equation (5.2). The hiring decision is thus determined by equating (5.2) with (5.4):

(5.5) $$\frac{\partial U}{\partial L_m} = \frac{\partial U}{\partial L_f} \equiv MPL_m = MPL_f - C$$

It should follow from (5.5) that the cost component results in more able employees not being hired. This results in a suboptimal allocation of resources. When the employer changes his or her taste for one of the groups we should also see a change in the composition of the workforce and an associated change in the average productivity.

Statistical discrimination has a slightly different effect. The premise of statistical discrimination is the absence of all the relevant information necessary to determine the potential ability of new workers. The employer has to make a decision based on his or her beliefs about the abilities of the two groups. The adjustments needed for equations (5.2) and (5.3) can be seen in (5.6) and (5.7) respectively.

(5.6) $$\frac{\partial F(K,A,L_m,L_f)}{\partial L_m} = f_m = \emptyset MPL_m \quad ; \; 1 \geq \emptyset > 0$$

(5.7) $$\frac{\partial F(K,A,L_m,L_f)}{\partial L_f} = f_f = \delta MPL_f \quad ; 1 \geq \delta > 0$$

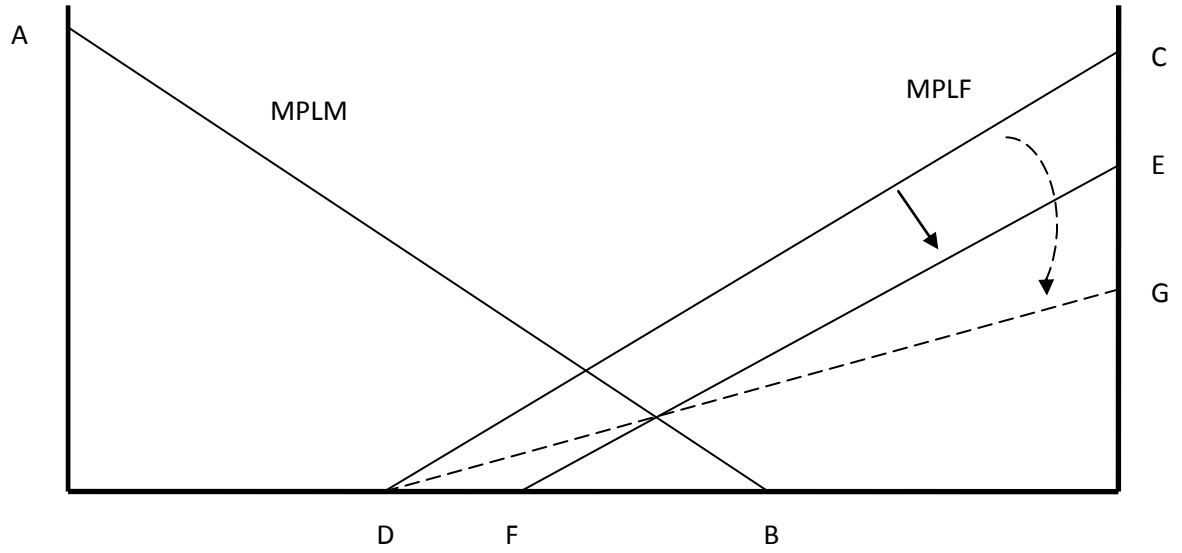
Strictly speaking the upper boundaries for the discrimination coefficients ø and δ do not have to be restricted to 1. It might well be the case that the potential abilities are exaggerated by the

employer's beliefs. For our example we will nonetheless assume that the beliefs either assess the marginal contribution correctly or understate them. In the long run, as the employer experiences the true productivity of the people he/she hire, the beliefs correct themselves until both ø and δ are equal to 1. Until this is the case the marginal contribution of a group experiencing statistical discrimination will be understated. As with the taste based variant we should be able to see productivity changes associated with changes in the composition of the workforce. Another consequence can be seen when we consider technological change. Even if the technological change is gender neutral (which is a very reasonable assumption), in the case of statistical discrimination we see that the productivity increase of the discriminated group is understated. This would result in an increase of the fraction of the group that is not discriminated against. Even though we see an increase in the average productivity of the economy as a whole there is still a suboptimal allocation of resources.

Since selection effects determine the shape of the production function and the resulting MPL lines it might be more intuitive to examine its effects graphically. Consider Figure 5.1, which presents a simplified labour market consisting of two groups, males and females. The vertical axis shows the contribution to employer utility or productivity, depending on the assumptions one makes on the relevant hiring decision. The horizontal axis represents the employed and is normalised to 1. The line AB gives the marginal product of male labour (MPLM), while the line CD gives the marginal product of female labour (MPLF). These lines are mirrored, with the MPLM line following the regular pattern where additional males are represented by a move from left to right. The MPLF originates from the right most axis and an increase in females can be seen as moving from right to left. In a perfect world the hiring decisions would be made in such a way that the available worker with the highest marginal contribution would be hired first, and the expected marginal product is the same as the true marginal product. This would result in the situation where the intersection between the MPLM (AB) and MPLF (CD) lines determines the proportions of males and females that are employed. Due to the normalisation of the horizontal axis we can read the resulting male fraction as the distance from the left vertical axis to the point of intersection between the two marginal product lines. Let us first consider discrimination again. Discrimination can be taste based or statistical, and there will be direct and indirect effects. Both forms of discrimination have the same result in our simplified model, namely that the expectations of employers concerning the marginal products do not coincide with the true productivity or contribution of the workers. In the case of statistical discrimination this would imply that employers do not recognise the true MLPF line CD, but instead base their hiring

decision on the DG line. The distinction between taste based and statistical discrimination is important here, as a taste for discrimination implies that there is a utility cost for the employer when

Figure 5.1



hiring someone from the distasted group. Therefore, the line EF would represent the true marginal productivity line in terms of contributions to the employer's utility. This would imply that there are no autocorrecting forces at work since the employer voluntarily chooses males over more productive females. The end result is a higher (suboptimal) male fraction with lower productivity at the margin. In the case of statistical discrimination the employer does not have a utility cost when employing certain workers, but he also does not have perfect information. In this situation it just might be the case that the CD line in figure 5.1 is the true marginal product line, but the employer does not know where the line is exactly. When there are negative prejudices concerning female productivity the expected marginal productivity line would shift from the true line CD to the DG line. Again, we see that less productive males are being hired before the more productive females. But in this case once the workers are hired the employer would experience the true productivity of the hired workers. From a rational point of view the employer would in this case be able to correct his beliefs concerning females. This would, in the long run, result in the expected marginal product line DG to converge towards the true marginal product line CD. Statistical discrimination would therefore only have temporary direct effects. However, the indirect effects of both forms of discrimination are the reduction of returns to education investment, and in turn give rise to issues regarding selection

effects. This could result in people selecting out of the workforce or never acquiring the relevant education to begin with.

When one group becomes smaller than the other we see a shift in the MPL lines. Due to the normalisation of the horizontal axis the position and slopes of the lines are determined by the relative sizes of the two groups and the marginal productivity distribution within the groups. Selection can occur at the entry-exit level, where females decide to either select out of the workforce or decline to select into the workforce in the first place. If we assume that the productivity distribution of the group stays the same due to a balanced exit of productive and unproductive females, selection out of the workforce would be represented by a shift from the CD to the EF line. Up until now we have only considered figure 5.1 to be a representation of a one sector economy with only one employer. If we assume multiple sectors, each with its own technology resulting in differing rates of productivity, we can see how selection into certain sectors would play out. Selection into less productive sectors would lead to the MPL lines to become flatter, which can be represented by the CD line shifting towards with the DG line. As can be seen in visually inspecting graph 5.1, selection effects also have consequences for the fraction of males in the workforce. Additionally, average productivity is also lower than in the perfect world case. But where discrimination is a demand side problem in the labour market, selection is a supply side effect. Selection occurs on the basis of individual responses to the market with consideration for specific preferences of the labour supplier. It is important to note that the perfect world scenario as exhibited by the lines AB and CD are based on assumptions that the underlying preferences and characteristics of the two groups are roughly the same and the sizes of the groups are more or less equal. Ultimately the position and slope of the lines are different for each country or sector due to the differences in underlying characteristics. The key thing to note here is the dynamics of the system. Namely, that changes in the average productivity that are caused by changes in the composition of the workforce represent either moving towards or away from the optimal allocation of labour.

We have seen that, theoretically, selection and discrimination results in suboptimal allocation. It is time to put this notion to the test, and we will start the productivity analysis with a multidimensional OLS regression as presented in equation (1).

$$(1)\ \Delta Output_{ijt} = \alpha + \beta * \Delta High_{ijt} + \gamma * \Delta Medium_{ijt} + \delta * \Delta Low_{ijt} + \varepsilon_{ijt}$$

The variables in equation (1) are in first difference form to accommodate for serial correlation and state that changes in output for sector *i* in country *j* at time *t* are equal to changes in the fractions of

the corresponding sector, country, and time interval. The results of the regression are listed in table 5.1. We do indeed see a significant result, namely the negative coefficient for the 'high' educational bracket which is significant at the 1% level. This would imply that an increase in the male fraction has a significant negative effect on productivity. Unfortunately, there are some issues with this result.

Table 5.1: Δ Output as the dependent variable				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	3.100	0.288	10.751	0.000
ΔHIGH	-17.319	5.419	-3.196	0.001
ΔMEDIUM	2.687	9.925	0.271	0.787
ΔLOW	6.319	5.051	1.251	0.211
N	1761			
Adjusted R^2	0.005			

Table 5.2: Δ Output as the dependent variable				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2.986	0.214	13.960	0.000
ΔHIGH	-1.761	4.095	-0.430	0.667
ΔMEDIUM	-6.200	7.436	-0.834	0.405
ΔLOW	-3.121	3.751	-0.832	0.406
N	1728			
Adjusted R^2	-0.001			

First, the coefficient values and corresponding confidence levels are not robust to the exclusion of sectors. As an example, table 5.2 shows the results of equation (1) with the exclusion of the sector 'mining and quarrying'. As we can see, the significance of 'high' disappears. Second, the R^2 is extremely low which indicates that the equation does not account for any meaningful variability. Third, it was not possible to include fixed effects due to the limited number of included time periods compared to the amount of cross sections. Considering the diverse nature and outcomes of sectors and countries this certainly needs to be included.

To accommodate for the shortcomings of the multidimensional regression the next step in our analysis will be to examine the sectors individually. Equation (2) shows the econometrical setup accompanying this change. As we can see the variables are the same and are still in first difference form. The differences with equation (1) are the two-dimensional OLS setup with country j and time *t,* and the inclusion of country and period fixed effects. The fixed effects are not included in the equation nor are they reported in the corresponding table. We run this regression for each sector

individually and the results are presented in table 5.3.

$$(2)\ \Delta Output_{jt} = \alpha + \beta * \Delta High_{jt} + \gamma * \Delta Medium_{jt} + \delta * \Delta Low_{jt} + \varepsilon_{jt}$$

As we can see the only significant result for the 'high' bracket is the sector 'mining and quarrying' with a 95% confidence interval. The coefficient value suggests a very large negative effect on sector

Table 5.3 Dependent Variable: Output per hour worked (First difference)

Sector	ΔHigh fraction		ΔMedium fraction		ΔLow fraction		Adjusted R^2
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	
Agriculture	1.505	(0.844)	-0.004	(-0.001)	-0.721	(-0.207)	0.212
Construction	0.523	(0.043)	46.839	(1.447)	-9.579	(-0.412)	0.146
Education	5.918	(1.198)	-4.787	(-1.660)***	-1.808	(-1.221)	0.105
Electricity	-35.711	(-0.905)	73.373	(1.081)	-40.843	(-1.486)	0.324
Financial	-17.557	(-0.628)	-117.060	(-2.822)*	27.068	(1.160)	0.672
Health	1.626	(0.210)	2.652	(0.235)	-4.180	(-0.653)	0.064
Horeca	0.214	(0.152)	0.519	(0.137)	-4.006	(-1.527)	0.084
Manufacturing	3.567	(0.430)	-28.589	(-1.622)	0.092	(0.011)	0.559
Mining	-234.586	(-2.187)**	-439.146	(-1.552)	618.316	(2.863)**	0.468
Other	-7.398	(-1.249)	7.331	(1.021)	-4.841	(-1.266)	0.156
Public Admin	-1.424	(-0.234)	7.393	(0.950)	-2.353	(-0.828)	-0.011
Real Estate	6.185	(0.224)	-15.384	(-0.532)	2.394	(0.186)	0.056
Retail	10.663	(1.583)	-24.238	(-1.876)***	-0.964	(-0.211)	0.210
Transport	11.454	(0.951)	78.479	(2.751)*	27.869	(1.861)***	0.129

Two sided confidence intervals: *=1%; **=5%; ***=10%

productivity when the male fraction increases. However, after examining the data it is clear that this result is not one to base policy on. When we exclude the Netherlands from the sample the coefficient value becomes -2.15 with a p-value of 0.85. The Dutch mining sector heavily relies on the extraction of natural gas which results in a very high contribution to the national output compared to the hours worked in that sector. The significant result we find for the 'low' coefficient of the mining sector remains significant despite the exclusion of the Netherlands. The coefficient value then becomes 46.98 and is significant at the 10% level (p-value equals 0.07). We should not place too much emphasis on this correlation due to the limited relevancy we can expect between natural resource extraction and true labour productivity. This also somewhat applies to the sector 'education' where we find a significant negative effect between changes in the medium fraction and output. Considering that, on average, the female domination of educational sectors has increased it seems selection has had a positive overall effect. Therefore, we can conclude that the sector is becoming

more efficient in terms of measured output despite the increasing female domination. More precisely, if we consider the theoretical discussion on gender dominance and productivity, we could even claim that the education sector is becoming more productive thanks to the increase of female dominance. It follows that labour market outcomes in 'education' cannot be viewed as discriminatory, and selection effects do not lead to suboptimal results for the medium educational bracket. There are three other sectors that display a significant (negative) result for the medium bracket: Financial Intermediation (99% confidence interval), Wholesale and Retail trade (90% confidence interval), and Transport (99% confidence interval). The two former sectors experienced a decrease in the mean medium fraction in our sample's timeframe, while the latter displayed an increase. The sign of the coefficients indicate that the relative increases of male and female participation in these sectors are correlated with an increase in measured output. The final significant result we see in table 5.3 is that of the low fraction for the transport sector.

The final step in our productivity analysis is presented in equation (3). Now we will focus on country based regressions with sectoral cross sections indicated by the subscript *i* and the inclusion of period and cross section fixed effects. Table 5.4 contains the outcomes of these regressions.

$$(3)\ \Delta Output_{it} = \alpha + \beta * \Delta High_{it} + \gamma * \Delta Medium_{it} + \delta * \Delta Low_{it} + \varepsilon_{it}$$

The significant results for the Netherlands can be dismissed at first hand following our discussion of the mining sector. Indeed, excluding mining from the sample results in the disappearance of the significant results for the high and low educational brackets. The other significant result we see for the high bracket is that of Sweden. The positive coefficient (which is significant at the 10% level) indicates that there are suboptimal outcomes since the corresponding mean fraction has decreased over time for our sample. This is at odds with the results we have found for the sectoral regressions where all results pointed towards increased output. This result certainly merits further investigation of labour market outcomes in Sweden as a relative increase of male participation would imply higher output growth. The positive and significant (1% level) result we observe for the' low' coefficient of the Swedish regression does follow the general picture painted by our sectoral results since the mean 'low' fraction has increased. There are four more significant results left to discuss, all concerning the changes in the low fractions. Spain and Romania both display positive effects significant at the 5% level. Additionally, both countries experienced a decline of the mean fractions for the low educational bracket. Coincidentally, the highly significant negative coefficients seen in the Danish and Czech regressions coincide with increased male fractions. Since a positive (negative)

coefficient implies that a decrease (increase) in the male fraction is correlated with lower output growth the results seem to suggest suboptimal outcomes. Therefore, with the exception of the

Table 5.4 Dependent Variable: Output per hour worked (First difference)							
Country	ΔHigh Ratio		ΔMedium ratio		ΔLow ratio		Adjusted R^2
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	
Austria	12.685	(1.059)	21.232	(0.574)	12.757	(0.827)	0.578
Czech Rep.	-6.014	(-1.397)	11.181	(1.181)	-13.712	(-5.155)*	0.606
Denmark	12.383	(1.220)	7.381	(0.469)	-34.160	(-3.291)*	0.146
Estonia	-2.248	(-0.611)	-1.192	(-0.206)	1.088	(0.313)	0.090
Finland	10.159	(0.818)	-26.582	(-1.250)	-0.588	(-0.055)	0.184
Germany	-24.710	(-1.364)	-5.252	(-0.211)	9.639	(0.766)	0.646
Greece	-15.547	(-1.168)	19.459	(1.067)	5.058	(0.461)	0.408
Hungary	-1.003	(-0.314)	2.744	(0.301)	-0.833	(-0.208)	0.399
Italy	12.247	(1.282)	-8.172	(-0.387)	-14.367	(-0.708)	0.598
Lithuania	-5.500	(-1.553)	-0.647	(-0.136)	-1.714	(-0.970)	0.295
Luxembourg	-21.640	(-0.674)	-110.234	(-1.580)	23.976	(0.589)	0.659
Netherlands	-314.050	(-4.564)*	-223.294	(-1.469)	234.345	(2.305)**	0.599
Poland	4.070	(1.116)	-12.371	(-1.436)	-2.420	(-1.095)	0.544
Portugal	1.107	(0.121)	23.763	(1.551)	-25.778	(-0.928)	0.425
Romania	0.867	(0.175)	-2.954	(-0.349)	7.340	(2.005)**	0.426
Slovakia	-4.277	(-1.382)	-5.784	(-0.588)	0.176	(0.080)	0.780
Spain	-13.657	(-0.687)	-27.194	(-1.343)	52.362	(2.051)**	0.548
Sweden	11.047	(1.766)***	-4.048	(-0.303)	23.833	(3.065)*	0.412
Switzerland	12.641	(0.871)	11.742	(0.525)	-2.292	(-0.179)	0.185
Two sided confidence intervals: *=1% confidence; **=5% confidence; ***=10% confidence							

Swedish 'low' coefficient, all significant results in our country based regressions hint towards suboptimal outcomes. Since correlation does not imply causation these results are tentative, and should be investigated further on a lower aggregation level with a dataset containing more precise and detailed factors concerning specific characteristics of individuals before we can conclude whether discriminatory or adverse selection effects are present in these countries. Furthermore, there is a very high probability of an omitted variable bias which could drastically change the outcomes of the regressions presented in this section. Further research on these results is therefore certainly warranted.

Are we able to deduce whether the observed correlations are due to discrimination and/or selection effects? As mentioned before, for a precise determination of the causes of the correlations we have found we would need detailed information on the characteristics of the individuals involved. What

can we say with the information we do have? If we take a lump sum look at Sweden we see an economy wide increase in low educated females, and a decrease in low educated males. Yet table 4.7 shows an increase in the sectoral average male fraction. This is an indication that selection effects are a big determinant of labour market outcomes. The unreported distribution of sectoral fractions show that the sectors with a fraction higher than 0,5 predominantly experienced a further increase of the male fraction. The same can be said for sectors with more females: the majority experienced a further decrease of the male fraction. Unfortunately, the observed selection effects do not exclude discrimination effects, as the witnessed selection movements might be the indirect result of discriminatory hiring policies. As expected, we are restricted in our analysis without the addition of additional information.

To summarise this section, we find that significant results on a sectoral level with country cross sections paint a picture of increased output. On the other hand, the results of the country regressions with sectoral cross sections show the opposite, namely a painting of suboptimality. It might be the case that productivity growth in the Euro area is hindered in some areas due to cultural influences and policy decisions. We have also seen that output might not be the best predictor of labour productivity for certain sectors due to the nature of the product. Do we really want to measure the productivity of education on the basis of quantity instead of quality? Additionally, international comparison has proven to be extremely tricky due to differences in cultural norms, specific policy measures, and the exact nature of capital and labour compositions of sectors.

6. Conclusion

We have now come to the final section of our research where we can summarise and conclude on our findings. We used information provided by Eurostat and the European Labour Force Survey to examine the developments of male and female participation in the labour markets. It seems clear that the increased attainment of higher education by females is visible in the participation rates on an employed/unemployed level. There is a clear trend of increased female participation relative to males in the higher educational bracket. The uniformity of directional change in terms of average fractions is absent when we look at the developments of the lower educational brackets.

When we combine the observed movements of male to female employment fractions with changes in output we find two distinct observations. On a country level there are some indications of suboptimal outcomes in Sweden, Spain, the Czech Republic, Denmark, and Romania. All significant results were found for the low educational bracket, with the exception of Sweden which also displayed a significant result for the high educational fraction. On the other hand, the sectoral regressions showed evidence of increased optimality of the labour market outcomes. It would seem these European sectors are becoming more productive while also experiencing changes in the composition of the workforce.

Ultimately, the goal of our research was to see if it was possible to find suboptimal allocation of labour by using national and sectoral aggregates. We were indeed able to find correlations between changes in the male fractions and changes in productivity. Additionally, we established that observing these changes can indicate the presence of discrimination and/or selection effects. However, we were unable to determine the exact cause of the productivity outcomes due to the chosen level of aggregation and the accompanying availability of specific data, but we hope that these results instigate further research into the specific cause of these productivity effects.

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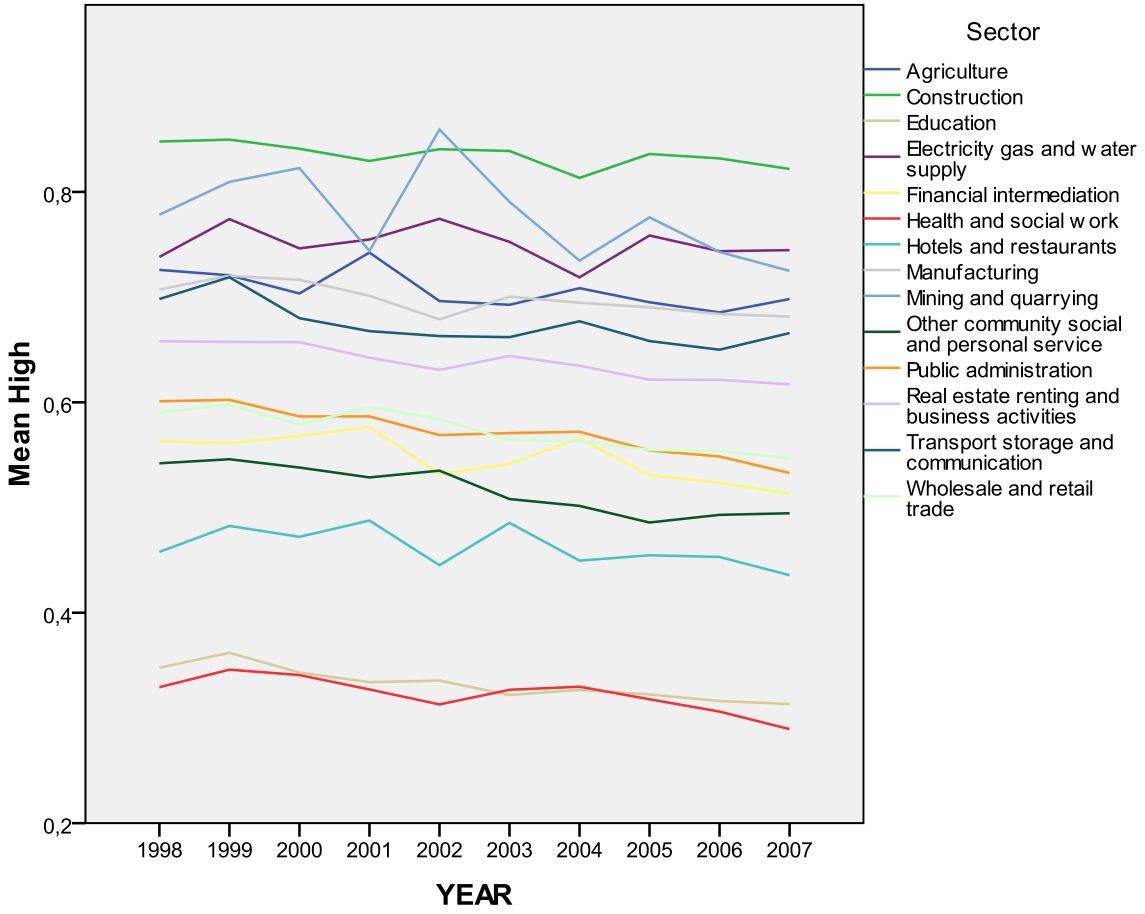
Appendix A

Used Variables Eurostat & Date of access

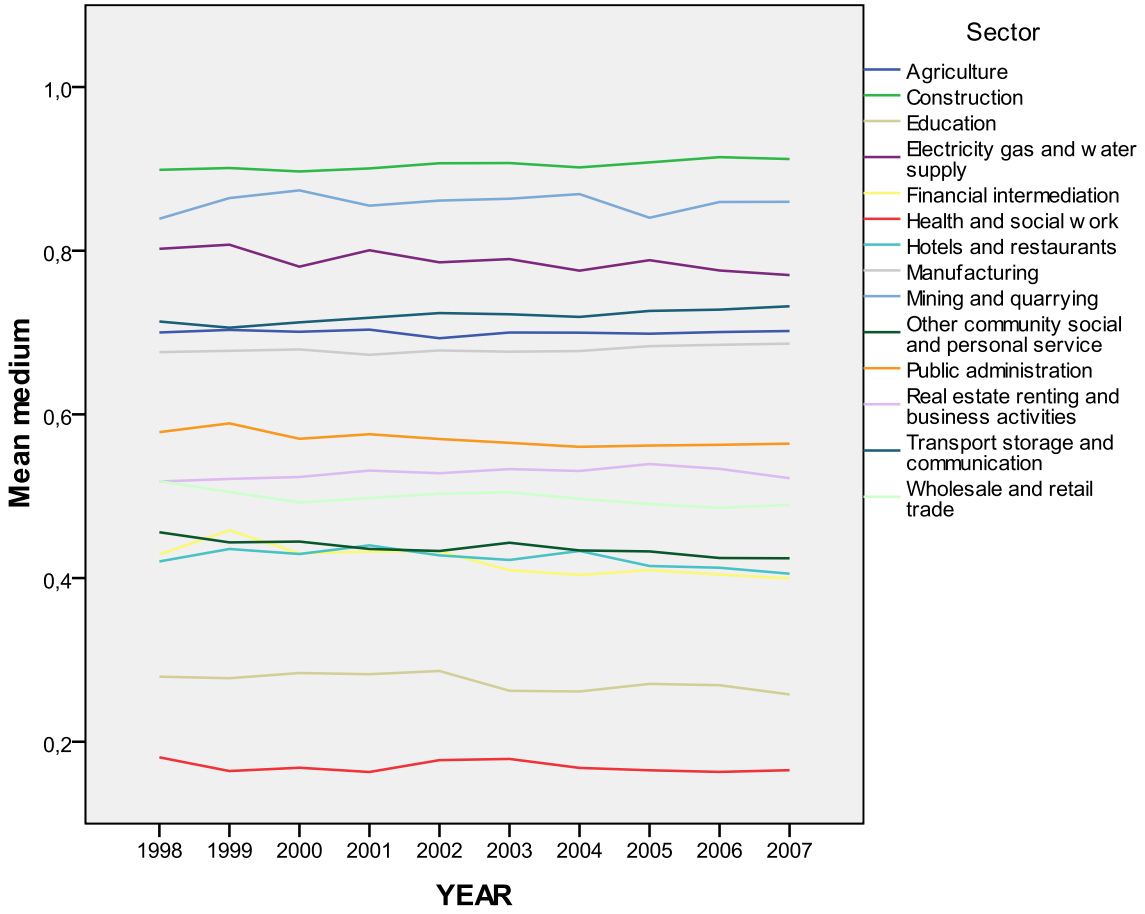
Variable	Variable Description	Accessed on	Unit
nama_nace31_e	Total Employment	27-09-11	Thousands of hours worked
nama_nace31_c	Output	28-09-11	Millions of euro
LFS Data: Employed	Ad-hoc request	15-09-11	various
LFS Breakdown HATLEV1D	Educational Breakdown	15-09-11	NA
LFS Breakdown NA111D	Sectoral breakdown	15-09-11	NA
LFS Breakdown Sex	Gender Breakdown	15-09-11	NA
LFS Breakdown Year	Breakdown by Year	15-09-11	NA
LFS Breakdown Country	Breakdown by Country	15-09-11	NA
edat_lfs_9903	Persons with a given education attainment level by sex and age groups (%)	15-03-12	thousands of persons employed

Appendix B: Graphs chapter 4

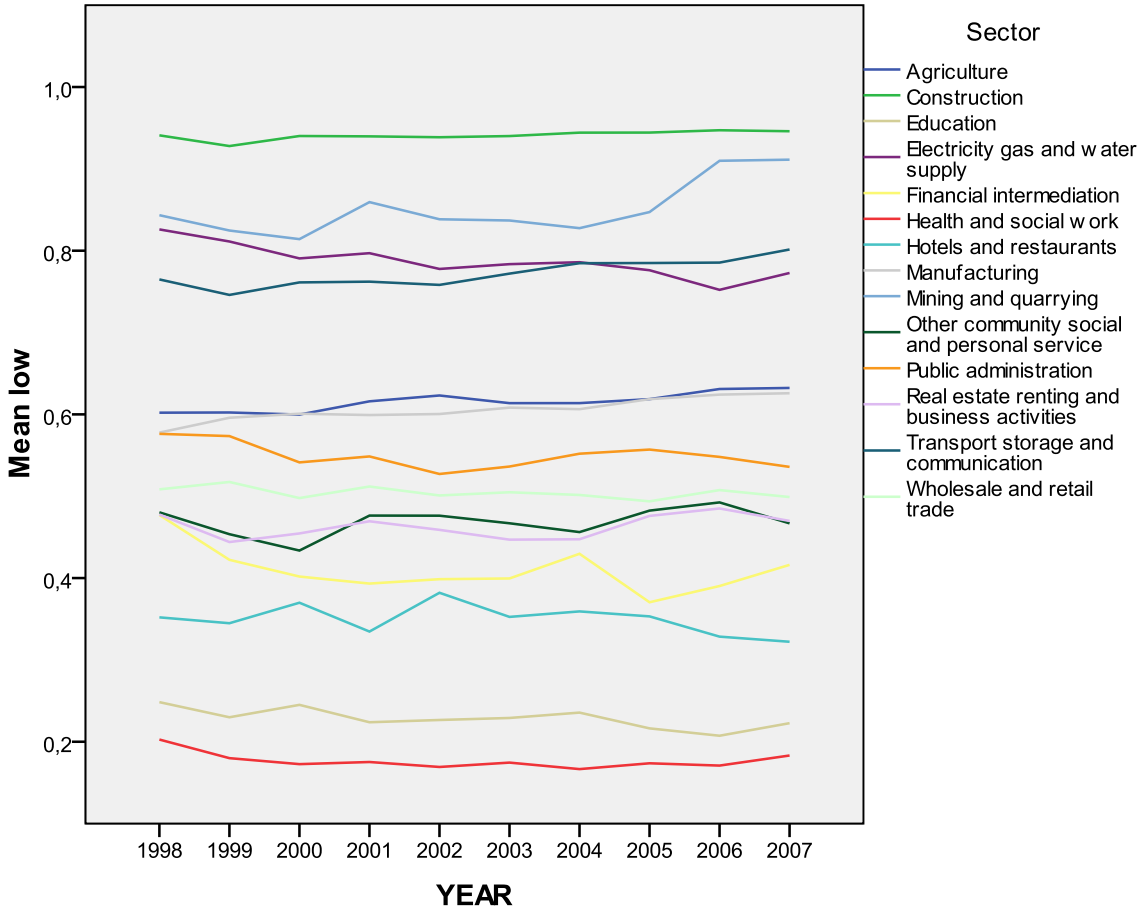
Graph 4.1



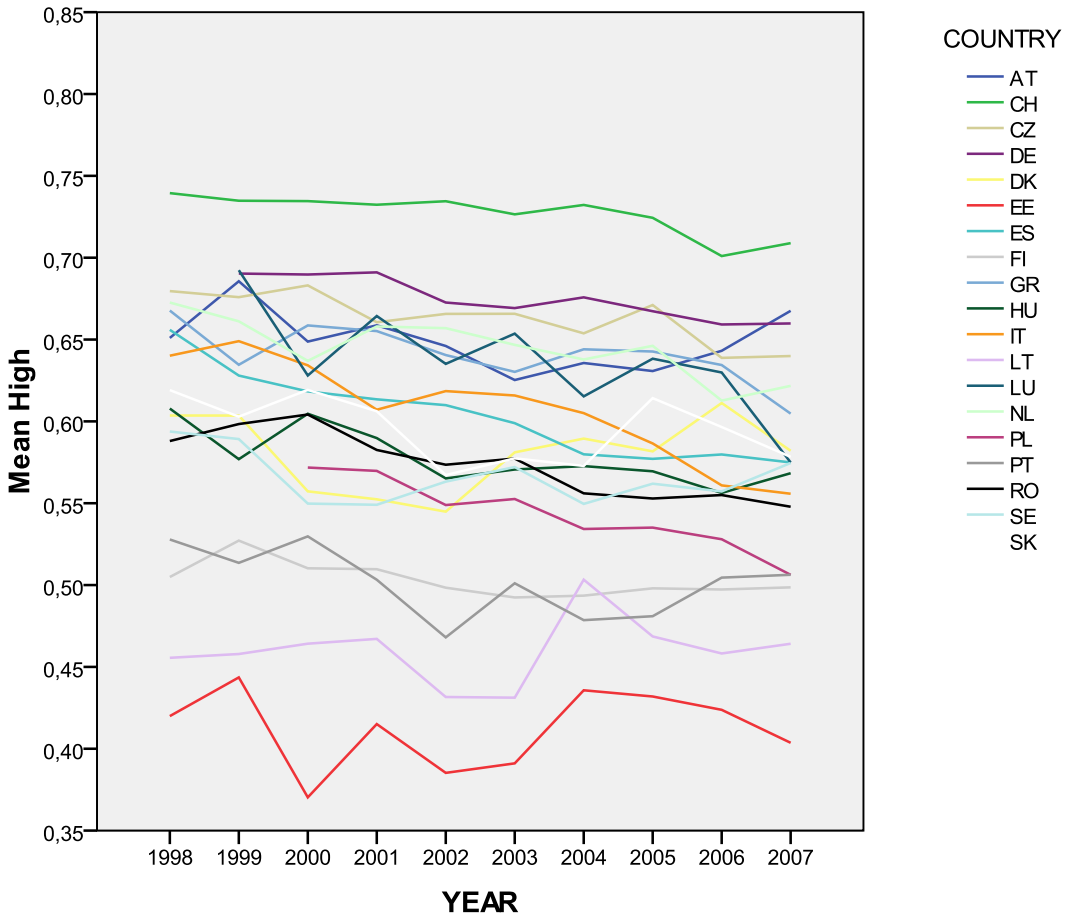
Graph 4.2


Mean medium
1,0
0,8
0,6
0,4
0,2
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR
Sector
Agriculture
Construction
Education
Electricity gas and w ater supply
Financial intermediation
Health and social w ork
Hotels and restaurants
Manufacturing
Mining and quarrying
Other community social and personal service
Public administration
Real estate renting and business activities
Transport storage and communication
Wholesale and retail trade

Graph 4.3


Mean low
1,0
0,8
0,6
0,4
0,2
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR
Sector
Agriculture
Construction
Education
Electricity gas and w ater supply
Financial intermediation
Health and social w ork
Hotels and restaurants
Manufacturing
Mining and quarrying
Other community social and personal service
Public administration
Real estate renting and business activities
Transport storage and communication
Wholesale and retail trade

Graph 4.4


Mean High
0,85
0,80
0,75
0,70
0,65
0,60
0,55
0,50
0,45
0,40
0,35
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR
COUNTRY
AT
CH
CZ
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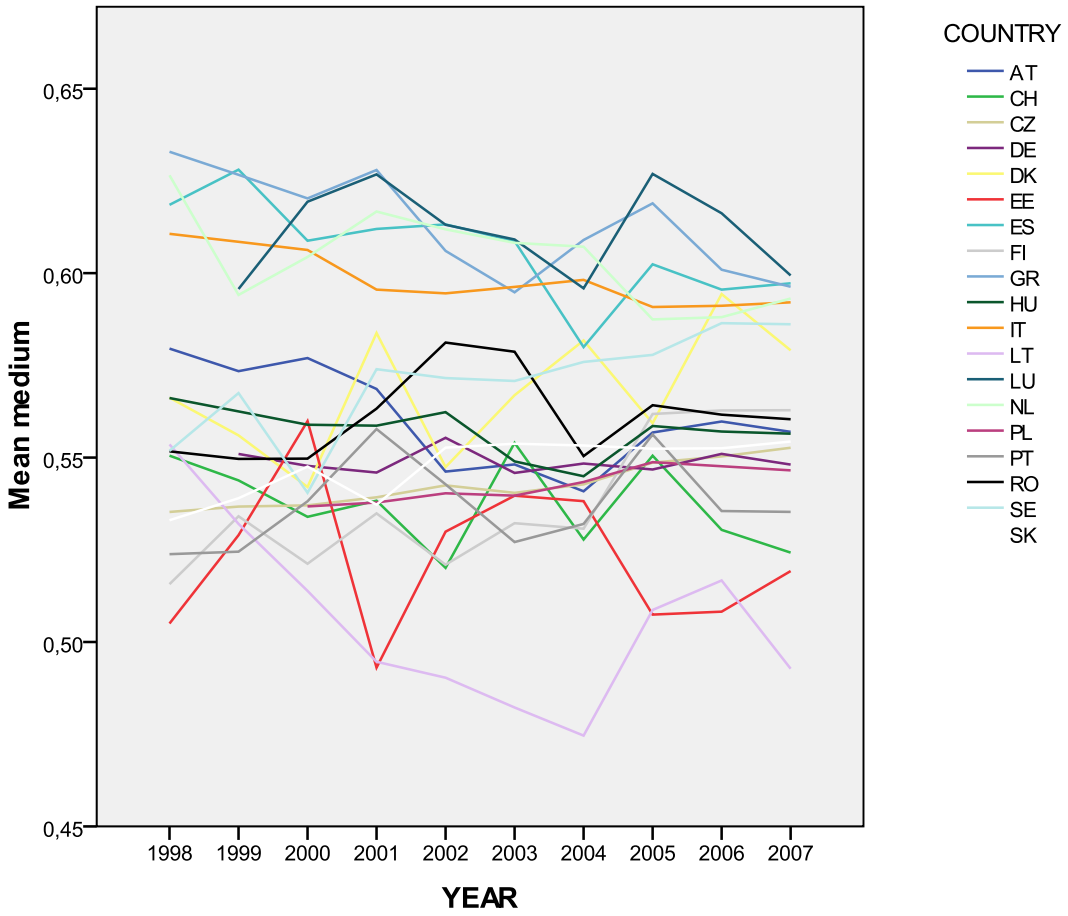
DK
EE
ES
FI
GR
HU
IT
LT
LU
NL
PL
PT
RO
SE
SK

Graph 4.5


Mean medium
0,65
0,60
0,55
0,50
0,45
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR
COUNTRY
AT
CH
CZ
DE
DK
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FI
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LU
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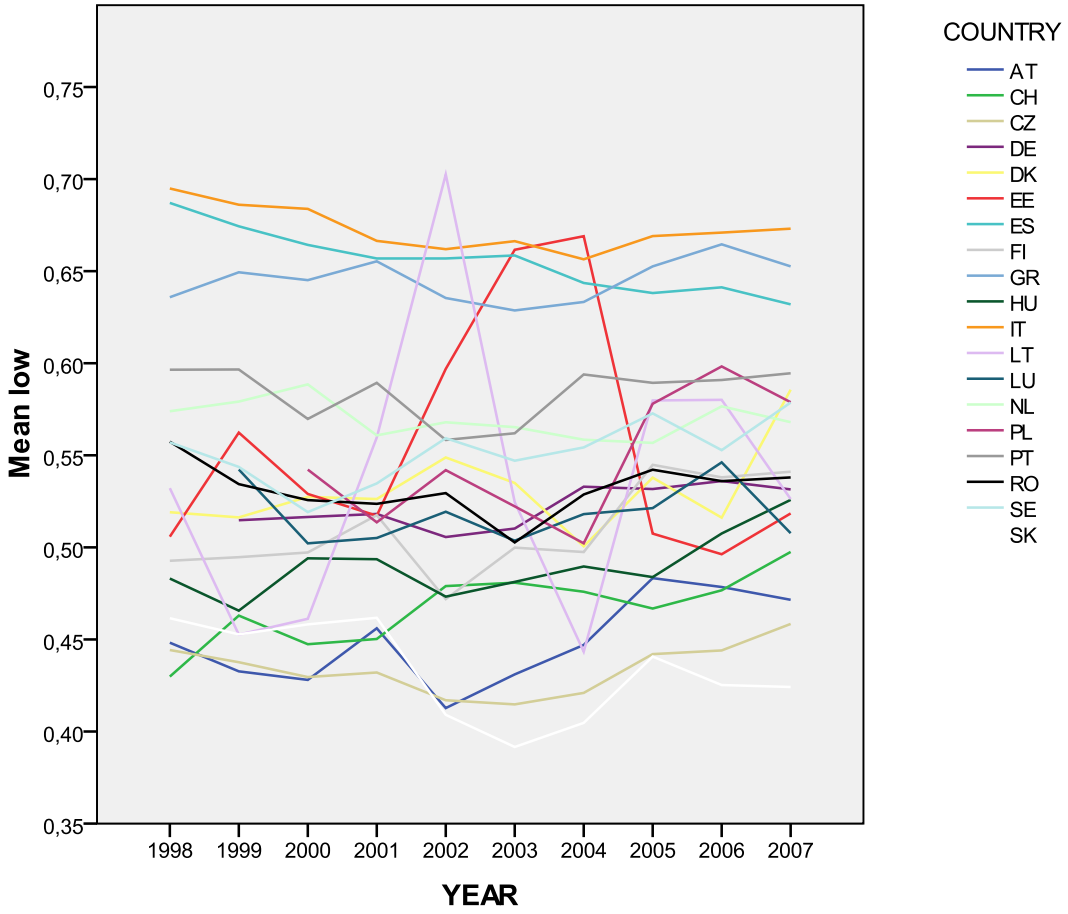
PT
RO
SE
SK

Graph 4.6


Mean low
0,75
0,70
0,65
0,60
0,55
0,50
0,45
0,40
0,35
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR
COUNTRY
AT
CH
CZ
DE
DK
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