



# An issue of equality: analysis of the evolution and patterns of the Belgian gender wage gap from 2014 to 2015 with the Oaxaca-Blinder decomposition method

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## Abstract

The phenomenon where women seemingly earn less money than men in the labour market, while performing essentially identical efforts is depicted as the gender wage gap. If we compare men's and women's wages based on objective criteria and cannot explain this difference, the latter could be assigned to discrimination. This particular problem of the gender wage gap appears to be a tenacious problem and cannot be ignored considering plausible consequences such as risk of poverty and lowered pension for women. Belgium hasn't been spared and the gender wage gap is an issue that seems to survive and thrive. Based on the WageIndicator Survey consisting of 1408 male and 1174 female workers for 2014 and 748 male and 665 female workers for 2015 in Belgium, this study examines the gender wage gap and decomposes it with the help of both the three-fold and two-fold versions of the Oaxaca-Blinder decomposition method. The Belgian gender wage gaps of 2014 and 2015 are decomposed into an explained and an unexplained part. The explained part consists of group differences based on the observed variables, whereas the remaining part, i.e. the unexplained part, can only prudently be assigned to discrimination. The unexplained part may also emanate from the influence of unobserved variables. Several findings have been made after this study: the unexplained Belgian gender wage gap seems to have decreased with 3% from 2014 to 2015, the variable age is the only significant variable having an influence on the Belgian gender wage gap and the "discrimination against women" is more responsible for the magnitude of the gap than the "discrimination in favour of men". Furthermore, patterns in the Belgian gender wage gap based on several factors such as employment characteristics, human capital, function characteristics, organization characteristics and family characteristics, have been analysed and compared with the findings of the study of Delmotte, Sels, Vandekerckhove and Vandenbrande (2010).

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# 1 | Introduction

## 1.1 Context

Unfortunately, we don't live in a perfect world. Since the very beginning of the world's existence, there always have been some injustice and the labour market has not been an exception. According to various studies, it seems that the average woman in the Belgian labour market generally earns less than the average man (Bever, Gilbert, & Van Hove, 2007). The wage difference between men and women, although seemingly performing identical work, is not a new topic in the literature but it appears to be particularly persistent and this even in the current era (Bertrand & Hallock, 2001). The wage gap is clearly not a myth. Essentially identical labour services are considered as such when they have the same productivity in the physical or material production process (Crain, 1986). This phenomenon, where a man and a woman ostensibly perform the same work but don't get the same wage for it, is commonly designated as the "gender wage gap". The importance of the gender wage gap is substantial, considering that if women perceive relatively less than men over a whole life-time, this would result in lower pensions and in a risk of poverty at old age (European Commission, 2014).

Becker (1971) was one of the pioneers discussing inequality in the labour market. He discussed the fact that it seems logic that if a certain group discriminates another group, it is merely in order to increase their own income. However, the contrary has been proven: discrimination by a certain group reduces their own income as well as the income of the other group (Becker, 1971). While taking such important evidence into account, it can seem odd that such gender wage gap still exists and also persists over the years. Many initiatives have been taken on both the micro and macro level, but studies show that the gender wage gap remains a tenacious problem (Kunze, 2008).

Belgium hasn't been left out concerning the gender wage gap. Many reports show that there remains an apparent difference between the males' and females' wages in Belgium (Oostendorp, 2009; Schäfer & Gottschall, 2015). Whether this difference in wages can be explained or not will be the topic of this study. The Belgian gender wage gap of 2014 and 2015 between male and female workers will be thoroughly examined and decomposed based on data of the WageIndicator Survey of the Institute for the Study of Labor.

## 1.2 Research question and hypothesis

The general research question of this study is: "What is the evolution of the gender wage gap in Belgium from 2014 to 2015?". For both years, the gender wage gap will be decomposed according to the three-fold



and the two-fold decomposition of the Oaxaca-Blinder method. Doing this will allow us to analyse the evolution of the Belgian gender wage gap from 2014 to 2015 by determining whether there was an increase, decrease or no change in the gender wage gap. Two subquestions can be derived from the general research question. The first subquestion is: “Which are the variables, in both 2014 and 2015, that have a significant influence on the gender wage gap?”. Answering this question will be done by a variable-per-variable decomposition that will orient us towards the variables that reach a statistically significant influence on the gender wage gap. The second subquestion reads: “Was there any discrimination in favour of men or any discrimination against women in both 2014 and 2015? The variable-per-variable decomposition will allow us to define whether there was any “discrimination in favour of men” or any “discrimination against women” in 2014 and 2015. Furthermore, we will analyse the patterns in the gender wage gap that have been thoroughly discussed by Delmotte, Sels, Vandekerckhove and Vandenbrande (2010). The validity of their findings about the Belgian labour market will be controlled for both 2014 and 2015.

Ideally, there should be no unexplained gender wage gap in Belgium. Belgian women should, based on objective criteria such as age, education level, work experience and so on, receive the same financial and material reward as their male counterparts. It should be possible to explain the difference in the wages that men and women receive based on the different factors that influence the wage on an objective basis. Therefore, the explained part of the gender wage gap should be 100% of the difference between the wage of the average Belgian man and the wage of the average Belgian woman. However, this will most probably not be true if we look at recent statistics from Eurostat, which can be found in Table 1.

<b>Gender wage gap in unadjusted form (%)</b>	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	9.5	10.1	10.2	10.1	10.2	10.2	10.0	10.0	9.9

Table 1: Percentage of gender pay gap in unadjusted form for Belgium. Retrieved from Gender pay gap statistics in unadjusted form, by Eurostat, 2016. Copyright [2016] by Eurostat.

We can expect an apparent gender wage gap for both 2014 and 2015. However, based on the statistics of Eurostat, we cannot make unambiguously an hypothesis about the change in the gender wage gap that occurred between 2014 and 2015 as there is no clear constant pattern in the evolution. But, we can observe a slight decrease over the last few years and we can therefore expect a decrease in the gender wage gap.

### 1.3 Research method

Analysing the gender wage gap is not an easy thing to do, as there are many variables that have to be taken into account. Moreover, the gender wage gap is a multi-dimensional phenomenon and thus there exist no clear boundaries between its different variables. There exist many ways to express the wage difference and there are various methods to analyse and evaluate it. One of the many ways to investigate the gap in mean wages between male and female is the Oaxaca-Blinder decomposition method, which has been developed simultaneously by Blinder (1973) and Oaxaca (1973). It was actually first employed in

demography by Kitagawa (1955) and later in the field of sociology by Duncan (1968) and Althauser and Wigler (1972) (Cotton, 1988). Blinder (1973) and Oaxaca (1973) have then later on introduced it in the economics literature (Cotton, 1988).

The Oaxaca-Blinder procedure is specifically used for analysing the gender wage differential, but it can be employed in order to study group differences of any kind of outcome variable, as long as the outcome variable is continuous and unbounded (Jann, 2008). This approach divides the difference in wage between two groups, in this case male and female, into an “explained” part on the one hand and a residual part on the other hand (Blinder, 1973; Oaxaca, 1973). Furthermore the residual part, also called the “unexplained” part, is used as a measure for discrimination, but the reader needs to keep in mind that it also includes the effects of group differences in probable unobserved predictors (Jann, 2008).

## 1.4 Structure of the thesis

Firstly, a brief literature review will be presented in Section 2 to introduce the phenomenon of the gender wage gap. Secondly, the methodology will be clarified in Section 3 by giving first of all the basic mathematical background required to understand the Oaxaca-Blinder decomposition procedure and its results. Afterwards, the chosen implementation in R together with the preferred dataset for the analysis are presented in the second part of Section 3. Thirdly, the results of the decompositions of the gender wage gaps of 2014 and 2015 will be extensively discussed in Section 4 and accompanied by an analysis of the patterns present in the Belgian gender wage gap. Lastly, a concrete summary of the results will be given followed by the discussion of the limitations and possible future work in Section 5.

# 2 | Literature review

The framework of the factors of the gender wage gap will be introduced together with additional information for the various characteristics. This will be followed by a focus on the unexplained part where the distinctions between lawful and unlawful, and direct and indirect discrimination will be made. At the end, Belgium’s case concerning the gender wage gap will be very briefly discussed to sketch the country’s situation.

## 2.1 Factors of the gender wage gap

There are many reasons why a man could be seemingly more paid than a woman. As stated before, the gender wage gap can be divided into an explained part that can be attributed to gender-specific factors (Blau & Kahn, 1992) and an unexplained part which can, but only carefully, be attributed to discrimination. There exist many grounds on which the gender-specific factors can be classified. Some

characteristics of employment, human capital, function, organization and family all have an impact on the wage of a person (Delmotte et al., 2010; Delmotte, Sels, Vandekerckhove, Vandenbrande, & Vermandere, 2011). The characteristics of employment are the status, the labour regime and the type of contract of the Belgian workers. The human capital of a person is constituted of his or her age, work experience together with the education that the person has followed. Function characteristics such as the functional level, the authority and functional domain also have an impact on the gender wage gap. The size and the sector of an organization, which are organization characteristics, also influence the gender wage gap. The phenomenon of vertical and horizontal segregation also play a part. Finally, the presence of a partner and the presence of children, which are family characteristics, should not be forgotten. All of these factors will be extensively reviewed, as these are required for the understanding of the Oaxaca-Blinder decomposition and the analysis of patterns in the Belgian gender wage gap. Moreover, there exist many models in the literature for the visualization of the factors of the gender wage gap. The main factors are contained in the following conceptual framework illustrated in Figure 1, which is partly based on the study and classification of Delmotte et al. (2010).

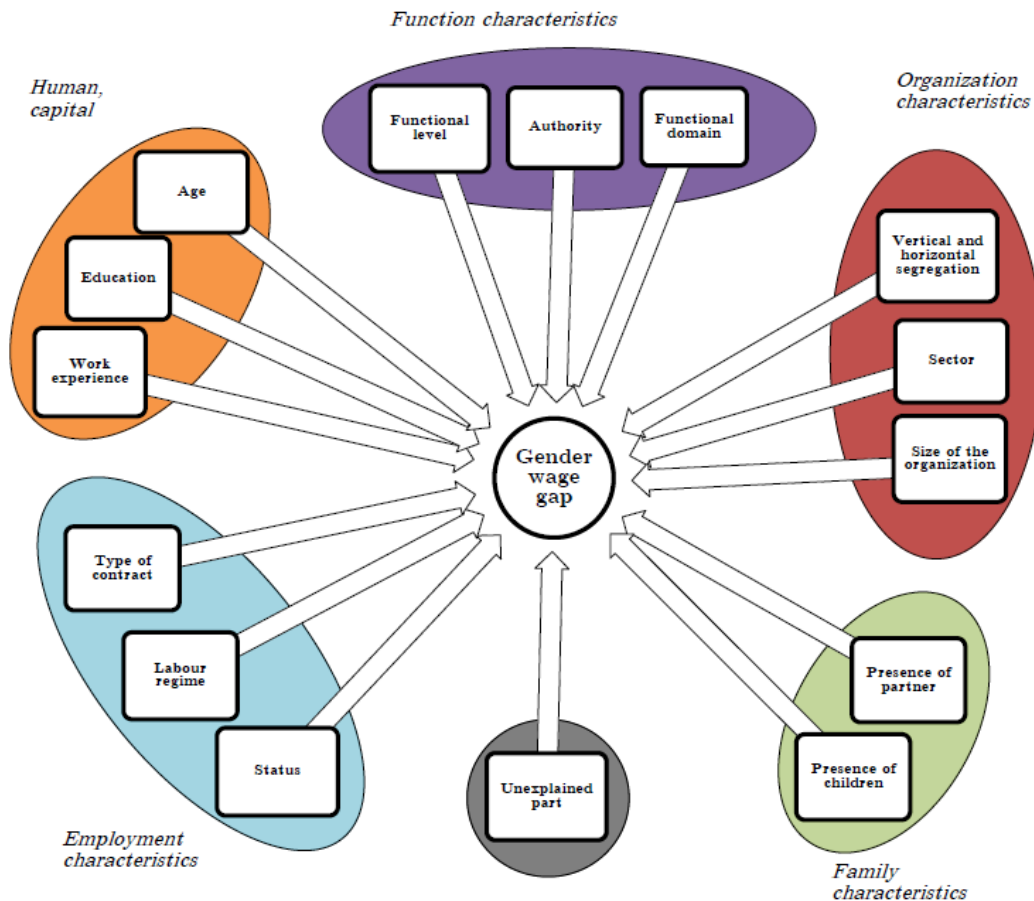


Figure 1: Factors of the gender wage gap. Adapted from De samenstelling van de loonkloof in België. Een onderzoek op basis van de Vacature Salarisenquête 2008, by J. Delmotte, L. Sels, S. Vandekerckhove, T. Vandenbrande, 2010 in *Steunpunt WSE*, 2010, Retrieved from [http://www.steunpuntwse.be/system/files/wse-report 2010 07.pdf](http://www.steunpuntwse.be/system/files/wse-report%2010%2007.pdf). Copyright 2010 by FBE Research Report.

### **2.1.1 Employment characteristics**

Depending on his or her status, an employee will have a different wage since each status category has a different wage computation structure. Therefore, it is important to comprehend that the wage gap for the private sector will be different from the wage gap for the public sector. The public sector has strict predefined rules for the wage determination, whereas there reigns some sort of liberty in the private sector when defining the employees' wages (Fogel & Lewin, 1974). Blue collars, white collars, and government officials are the different possible employee status in Belgium (Buelens & Van den Broeck, 2007). White collars and blue collars are defined by the Business Dictionary (n.d.) as "employees whose job entails, largely or entirely, mental or clerical work, such as in an office" and "employees whose job entails, largely or entirely, physical labour, such as in a factory or workshop". For the sake of the analysis, we will only make the difference between the private sector, representing both blue and white collars, and the public sector, representing the government officials. The study conducted by Delmotte et al. (2010) has shown that the gender wage gap is the smallest within the category of government officials and the largest for the private sector.

Furthermore, a Belgian employee can either have a full-time contract or a part-time contract, which defines his or her labour regime (Conway & Briner, 2002). A large part of the wage differences between men and women is typically due to the fact that women are much more strongly represented within the category of part-time workers (Delmotte et al., 2010). Women opt relatively more for part-time contracts in order to be able to take care of the children and household (Booth & Van Ours, 2008). This aspect will have an influence on the interpretation of our results as this could bias the gender wage gap. According to the study of Delmotte et al. (2010), it seems that the gender wage gap is higher when the analysis is restricted to the part-time workers than when the analysis is limited to the full-time workers only.

Additionally, an employee's salary will vary depending on the type of contract the employee possesses. Therefore, the type of contract will consequently have an influence on the magnitude of the gender wage gap. There exist various types of contracts in Belgium, however we will divide these in the following three categories for the sake of simplification: fixed contract, temporary contract and other contracts. No evidence has been found that a certain gender group is relatively more represented in a certain category. Delmotte et al. (2010) found out that the other contracts have the highest wage gap and the temporary employment contracts the lowest gap.

### **2.1.2 Human capital**

The number of years of experience and the education that the employee has followed, which is represented by the degree of the diploma obtained by the employee, have a significant impact on the wage. The age of the employee also has a notable impact as in general the gender wage gap increases with age (Beverly et al., 2007). Some authors, such as Hlavac (2016), even argue that the age is less pertinent than work

experience in this particular context of labour market.

The work experience of a worker is defined as the number of years that the person in question has already worked in his life. Work experience can be estimated by taking the actual age of an individual minus the estimated age at completion of schooling (Mincer, 1975). During their career, the wages of employees appear to increase. The latter is due to two factors: on the one hand their wages generally rise as the employees get older and acquire more seniority, but on the other hand also because employees throughout their careers ascend to higher levels of hierarchy and to better paid jobs (Delmotte et al., 2010). However, according to Santos and Varejao (2007) but also Thrane (2008), there exist a sort of concave, i.e. an inverted U, relationship between work experience and annual wages for both female and male employees. In other words, when the work experience increases, so does the annual wage, until the work experience reaches a certain point where the annual wage actually decreases (Mincer, 1975). It appears that this pattern is much less distinct for females (Thrane, 2008). In general, the wage gap increases with the seniority, thus the greater the number of years of experience, the larger the wage difference between men and women (Delmotte et al., 2010).

Since the wage gap is increasing with the seniority, this may indicate that women are confronted with obstacles during their careers such as temporary interruptions of their careers (for instance for taking care of the children) (Delmotte et al., 2010). Evidently, career interruptions can have serious consequences on the future career. Such consequences can be divided into a wage penalty, which represents a lower hourly salary for the employee, and a career penalty, which results in limited further opportunities for going up the hierarchical ladder (Vandenbrande & Pauwels, 2006; Theunissen, Verbruggen, Forrier, & Sels, 2007). When defining the wage of a certain employee, the employer evidently considers the probability that the employee, that already has interrupted its carrier, will ever interrupt it again (Delmotte et al., 2011). This may be because of the erroneous signal that such interruption can give to employers: limited motivation of the employee or lower productivity of the employee because of diminished capabilities and missed training during the career interruption (Delmotte et al., 2011). The career penalty can also be related back to the phenomenon called 'glass ceiling effect' where women, despite getting through the front door of managerial hierarchies, eventually hit an invisible barrier that blocks any further upward movement (Baxter & Wright, 2000).

Furthermore, the differences in access to additional training and promotions and the financial implications of these two aspects seem to prevent women from keeping pace with the wage growth of men (Bever et al., 2007). However, the generation effect pointed out by Bever et al. (2007) actually suggests that the wage gap would, because of the younger generation of women becoming older and the older generation of women going on retirement, gradually disappear. However, Bever et al. (2007) believe that this process should not be overestimated as there is also a significant gender wage gap among the younger generations of workers.

Moreover, the education of a worker obviously also has an impact on his or her wage. The different types of education institutions in Belgium are high school, college and university. The possible education levels within the college are bachelor and master, while the education levels at the university are bachelor, master and PhD. The additional level of bachelor after bachelor, which is called *banaba* in Belgium and the degree of master after master, which is referred to as *manama* in Belgium can be ignored in this case since these are relatively less frequent than the other types (Vlaamse Overheid, 2015). It should be evident that generally the higher the education level, the higher the salary (Walker & Zhu, 2008). Also, according to Bevers et al. (2007), the higher the education level, the higher the chance of employment both for men and women. All of this seems to be true, however, it appears that the benefits of education are greater for men than for women: at the lowest level of education men already have a higher salary than women and the salaries of men rise more strongly when going up the ladder of the hierarchy (Delmotte et al., 2010).

### 2.1.3 Function characteristics

The different levels of functions as defined by Cadden and Lueder (2012) are: top management, middle management and first-line management. Some authors do add additional layers such as the executive staff and administration and support staff to give a better overview of the whole organization consisting of employees with a certain degree of authority and those without any authority (Delmotte et al., 2010). The Belgian law provides some basic requirements for scaling and rewarding according to the different functions such as the guaranteed minimum wage and the gender-neutral job classifications (Delmotte et al., 2011). Intuitively, if there are objective wage structures in place enforced by law, there should be no gender wage gap. However, this does not seem to be true according to various studies, reports and statistics such as the ones of Eurostat with their Gender Pay Gap Statistics.

Barnard (1938) defines authority as “the character of communication by which an order is accepted by an individual as governing the actions that individual takes within the system”. Three pure different types of legitimate authority are identified by Weber (1947) in his ‘Theory of Social and Economic organization’: traditional authority, charismatic authority and rational-legal authority. Traditional authority is resting on “an established belief in the sanctity of immemorial traditions and the legitimacy of the status of those exercising authority under them”, while charismatic authority is resting on “devotion to the specific and exceptional sanctity, heroism or exemplary character of an individual person, and of the normative patterns or order revealed or ordained by him” (Weber, 1947). The last one, legal authority, or also called rational-legal authority, is resting on “a belief in the ‘legality’ of patterns of normative rules and the right of those elevated to authority under such rules to issue commands” (Weber, 1947). The first two forms of authority are irrelevant for the labour market, but the rational-legal authority does have an impact on the wage of an employee. According to the study of Delmotte et al. (2010), it seems that the degree of authority that an employee has within an organization also has a significant impact on the gender wage gap. The gender wage gap for employees with authority is way larger than the one for the category of

employees who don't have any authority (Delmotte et al., 2010).

The functional domain in which the company where the employee works is active influences the gender wage gap. Delmotte et al. (2010) analysed the gender wage gap for different functional domains. The different functional domains ranged from general management, to logistics, IT department and accounting. The functional domain where the gender wage gap is the largest is in "sales and commercial functions" and the smallest in the domain of "technical after-sales service" (Delmotte et al., 2010). No arguments have been put forward to why there is a bigger gender wage gap in certain functional domains compared to others.

#### **2.1.4 Organization characteristics**

Firstly, two concepts called the horizontal segregation and the vertical segregation will be introduced. The male half of the population is different from the other female half in terms of job preferences. Typically, men attend different study programs than women attend, they practice other professions than women practice and they work in different kinds of enterprises and in other sectors than do women (Manhardt, 1972; Daymont & Andrisani, 1984). These differences have resulted in typical 'male' jobs and typical 'female' jobs between the different rungs on the hierarchical ladder, which is referred to as vertical segregation, but also on equal hierarchical level, which is then referred to as horizontal segregation (Charles, 2003; Meulders, Plasman, Rigo, & O'Dorchai, 2010; Delmotte et al., 2011). Evidently, these two types of segregation will have an impact on the gender wage gap.

Blau and Kahn (2007) state that men are "more likely to be in blue-collar jobs and to work in mining, construction or durable manufacturing". On the other hand, women are "more likely to be in clerical or professional jobs and to work in the service industry" (Blau & Kahn, 2007). This represents the phenomenon of vertical segregation. Theunissen and Sels (2006) and Blau and Kahn (2007) argue that the vertical segregation is responsible for almost 50% of the gender wage gap. This points out the ultimate relevance of this segregation.

Delmotte et al. (2011) argue that the gender wage gap is deeply ingrained in our Belgian wage structure, even if job classifications and related salary scales are supposed to be guaranteed gender neutral by law. Moreover, the horizontal segregation that is established in the Belgian market also shows that the inequality has not disappeared. A nurse for instance is more likely to be a woman, whereas a fire-fighter is presumed to be a man. Note that the job name on its own already is accompanied with a gender connotation. According to Guy and Newman (2004), even if we compare men and women with the same training and the same hierarchical level, women will still be more represented in the lower-paid positions, sectors and organizations. Consistent with the glass ceiling effect, this phenomenon is also commonly nicknamed the "glass walls effect" (Guy & Newman, 2004). However, during the last few years, this horizontal segregation seems to be diminishing with the emergence of gender neutral jobs (Blau & Kahn, 2000; Delmotte et al., 2011).

Depending on the sector in which the company of the worker is active, which is either primary, secondary, tertiary, or quaternary, the gender wage gap will be different (Delmotte et al., 2010). Kenessey (1987) gives a general overview of the markets that are covered by each sector. The primary sector includes the agriculture, forestry, fishing and mining markets, whereas the secondary sector consists of the construction and manufacturing markets. The tertiary sector covers the transportation, electric, gas and sanitary services, wholesale and retail trade markets, while the finance, insurance, real estate, services and public administration markets are gathered together in the quaternary sector. According to Delmotte et al. (2010), the gender wage gap can be relatively smaller in some sectors where the wages are already low. Here again we have a horizontal segregation: a person performing a certain work in one sector can be better paid than a person performing the exact same work but in a different sector (Delmotte et al., 2011).

Furthermore, there exist a positive relationship between the size of an organization and the wage of its employees (Delmotte et al., 2010). Men work more often in large and internal companies, while women are found more frequently in small and local business (Delmotte et al., 2011). This can be assigned to the so-called close-to-house effect: women prefer to work at local businesses which are not so far from home in order to better combine home and work life (Delmotte et al., 2011; Sandberg, 2013). However, we can notice that how bigger the organization, how larger the gender wage gap (Beverly et al., 2007; Delmotte et al., 2010).

### **2.1.5 Family characteristics**

Having a partner results in a significantly larger gender wage gap than when not having a partner (Delmotte et al., 2010). Moreover, the gender wage gap appears to be considerably bigger when there are children in the family than when there or not (Delmotte et al., 2010). A positive relationship has even been found between the number of children at home and the employee's salary, but also with the gender wage gap (Delmotte et al., 2010). The more the children an employee has, the higher the employee's salary, but also the bigger the gender wage gap.

## **2.2 The unexplained part of the gender wage gap**

Once we have an explained part of the gender wage gap, we can carefully assign the remaining part, which is the unexplained part of the gender gap, to discrimination. However, as stated before, the unexplained part can also be attributed to group differences in predictors that we have not taken into account (Plantenga & Remery, 2006; Jann, 2008). There will always be some factors that do play a role on the labour market, but that are impossible to capture with one set of variables (Rubery, Grimshaw, & Figueiredo, 2005). Recent literature do not easily connect this unexplained part with discrimination, but rather prefer to relate it to a so-called gender-effect (Delmotte et al., 2011).



Discrimination in general has been defined by the Cambridge Dictionary (n.d.) as “the unjust or prejudicial treatment of different categories of people, especially on the grounds of race, age, or sex”. The Merriam-Webster Dictionary (n.d.) defines it as “the practice of unfairly treating a person or group of people differently from other people or groups of people”, while the Oxford Dictionaries (n.d.) give a very similar definition: “make an unjust or prejudicial distinction in the treatment of different categories of people, especially on the grounds of race, sex, or age”. The different definitions previously given have the terms unfair treatment in common.

There are many reasons why one person would discriminate another. One group of persons could be prone to discriminate another individual or group of persons when they consider them as a threat (Scheurs & Reuskens, 2012). Moreover, such behaviour could also emanate from the fact that the people who are discriminating want to belong to a certain group and act in such a way to emphasize even more the we-they status (Scheurs & Reuskens, 2012). Furthermore, people tend to blame others when things go wrong. In such situations, individuals or groups of persons of which we have a negative perception will probably be accused (Kroon, 2011).

Before discussing discrimination in the labour market, we need to define what we actually mean with discrimination and make some differentiations between lawful and unlawful discrimination on the one hand, and direct and indirect discrimination on the other hand.

### **2.2.1 Lawful and unlawful discrimination**

A first distinction between lawful and unlawful discrimination has to be made. Unlawful discrimination, unlike lawful discrimination, isn’t punishable by law (Gardner, 1989). A proprietor of an apartment who would like to rent his apartment, but refuses any applicant that has a dog for instance, is an illustration of unlawful discrimination (FindLaw, n.d.). Such discrimination is manifestly not punishable by law.

The differentiation between lawful and unlawful discrimination is very subtle; it all lies in the reasons of the discrimination. The US Equal Employment Opportunity Commission (n.d.) gives the twelve different types of possible discriminations that are forbidden by the US Federal law: age, disability, equal pay, genetic information, harassment, national origin, pregnancy, race or color, religion, retaliation, sex or sexual harassment. In Belgium this list is even more extensive and any type of discrimination is in Belgium punishable and is outlawed by articles 11 and 11bis of the Belgian Constitution (Belg. Const. art. XIV; Belg. Const. art. XIV bis). Unequal treatment in Belgium is forbidden on the grounds of alleged race, nationality, ethnicity, ethnic origin, national origin, sex, age, sexual orientation, civil registry, birth, ability, political beliefs, philosophical beliefs, religion, language, health status, handicap, physical characteristics, genetic features and social origin (Federal Service of Justice Belgium, n.d.). Therefore, it is clear that “having a pet” doesn’t constitute a punishable form of discrimination recognized by the law.

### **2.2.2 Direct and indirect discrimination**

A second essential distinction has to be made between direct discrimination and indirect discrimination (Tobler, 2005). Tobler (2005) defines the direct discrimination as the discrimination “caused by express reliance on grounds of criterion prohibited by law as disadvantageous treatment”. While this is a quite vague definition, the Federal Service of Justice of Belgium (n.d.) gives a more accurate interpretation of direct discrimination. They state that a person is subject to direct discrimination only and only if the person in question receives a “less favourable treatment, based on a protected criterion, than anyone else in a similar situation and this in the absence of justification”. The so-called protected criteria are the types of discrimination listed in the law article previously mentioned. Indirect discrimination on the contrary is not based on the protected criteria. You may also be disadvantaged by seemingly neutral measures such as regulations or a particular company culture. If these measures can not be justified then, by law, the discrimination is considered to be indirect (Federal Service of Justice Belgium, n.d.).

### **2.2.3 Discrimination in the labour market**

The discrimination existing in the labour market has been spreading under many forms, ranging from employee discrimination and employer discrimination to customer and government discrimination (Becker, 1971). Some of the indicators of the human development index used by the United Nations Development Program are a composite measure called the Gender Inequality Index and a measure called the Income Gini coefficient (UNDP, 2014). The Gender Inequality Index reflects the inequality in achievements between men and women based on three dimensions: reproductive health, empowerment and the labour market, while the Income Gini coefficient measures “the deviation of the distribution of income among individuals or households within a country from a perfectly equal distribution” (UNDP, n.d.).

Additionally, one of the main goals of the UN towards the end of 2015 is to promote gender equality in all its forms and empower women, which indicates the importance of those perspectives (UN, n.d.). It is clear that the inequality between men and women has gain in attention over the last decades. An interesting quote comes from Pope Francis I that stated that “human rights are violated not only by terrorism, repression or assassination, but also by unfair economic structures that create huge inequalities”.

Although the majority of people assume that employee discrimination is a relic of the past and that it has been eliminated by a mix of empower enlightenment, action programs carried out by governmental agencies or the profit-maximization motive, various recent studies have shown that this is incorrect (Moore, 1983; Bertrand & Mullainathan, 2004; Skalpe, 2007; Munoz-Bullon, 2009; Moral-Arce, Sperlich, Fernandez-Sainz, & Roca, 2012; Duncan & Sandy, 2013). It appears that there exist some kind of negative discrimination by the employers against different demographical and ethnographical groups based respectively on their sex and race (Moore, 1983). It is merely the minorities, or at least more than the majorities, that are the groups suffering from discrimination (Becker, 1971).

Not only older studies (Sanborn, 1964; Cohen, 1971; Fuchs, 1971; Malkiel & Malkiel, 1973) but also more recent studies have shown that discrimination is still very present in the labour market. Recent studies among groups of diversified industries conducted around the world, while having a different focus, have shown that inequality in the labour market is still an ongoing phenomenon. There surely is a focus contrast: while the focus in the US studies has been on discrimination because of race, in European studies the focus has been mainly made on gender discrimination (Moral-Arce et al., 2012).

### **2.3 Belgium and the gender wage gap**

The gender wage gap appears at regular intervals in the Belgian media, and several initiatives, that are supposed to eliminate this gap, are communicated to the public (Delmotte et al., 2011). However, concretely, what is Belgium's current state concerning the gender gap? The Global Gender Gap Report published every year by the World Economic Forum (2014) provides a ranking of the wage differential by country and offers different indexes comparing male and female. Belgium does score quite well on the economic participation and opportunity and ranks 27th out of 142 countries with a score of 0.758 with 0 representing inequality and 1 equality. However Belgium scores, for one of the measures included in the index, namely the ratio of female legislators, senior officials and managers over male value, very badly. Belgium scores 0.48, which tends more the inequality side of the scope.

Despite all this media attention, what is explicitly done legally to prevent unfair treatment to take root in the labour market? When the world realized that there existed a significant unfair difference between the wage of men and women, people and organizations started to move heaven and earth in order to make everyone aware of it. A lot of campaigns in Europe, such as the Equal Pay Day, were conducted to create public awareness around this issue. However, nothing really changed until 2000. A European directive was adopted in 2000 that prohibits discrimination based on religion or philosophical belief, disability, age and sexual orientation (European Commission, 2013). This directive is applicable to different situations, including i.a. the labour market. Unlike European regulations that are self-executing and don't require additional measures to be taken by the member states, European directives still need to be endorsed independently by the member states. The member states themselves decide which means are deemed necessary to them in order to attain the pursued result described in the directive (Prechal, 1995). Therefore, this European directive of 2000 has been converted into Belgian National Law with the law of 10 May 2007, which is referred to as the anti-discrimination law and which includes an entire paragraph dedicated to the labour market (Vrielink, Sottiaux, & De Prins, 2003). It is clear that the Belgian law is not very tolerant towards discrimination, since it provides both civil and criminal penalties (Scheurs & Reuskens, 2012). Moreover, a Belgian federal institution called the Institute for the Equality of Women and Men has been founded in 2002 that is committed to decreasing the differences between men and women on many levels.

However, despite the constant mentioning of the principle of equal pay between men and women in

various Belgian legal articles, and evidently also in international ones, nothing has really dramatically changed in practice. Although there exist a strong current legal basis, the equality of wages just doesn't seem to become a reality. Therefore, supplementary measures have been introduced in Belgium and this to three different levels; the intersectorial level, the sectorial level and on the level of the companies themselves too (Institute for the Equality of Women and Men, 2014). All those different measures aim to establish a gender-neutral remuneration structure within the different sectors and companies located in Belgium.

## 3 | Methodology

### 3.1 Mathematical background

#### 3.1.1 Basic approach

The following methodology is partly based on the original work of Blinder (1973) and Oaxaca (1973) and also on Darity, Guilkey and Winfrey (1996), but mainly on the updated version of the methods and formulas developed by Jann (2008).

Firstly we need to define the two different groups that we want to compare, the outcome variable and the set of predictors that we will further use. The first group is going to represent the males, and will be referred to as group  $M$  and the second group represents the females and which we will label as group  $F$ . Wages are chosen as outcome variable  $W$  and several indicators such as age, education or work experience are taken as predictors for  $W$  (Blinder, 1973; Oaxaca, 1973; Jann, 2008). The mean outcome difference  $D$  between group  $M$  and group  $F$  can be written as:

$$D = E(W_M) - E(W_F), \quad M = \text{males}, F = \text{females} \quad (1)$$

where  $E(W)$  designates the expected value of the outcome variable  $W$ . The main goal is to discover how much of the outcome difference  $D$  is accounted for by group differences in the defined predictors and how much cannot be explained by those differences in predictors and could be, at least carefully, assigned to discrimination. The outcome variable  $W$  can be written out as the following equation, based on the linear approach of the Oaxaca-Blinder method:

$$W_g = X'_g \beta_g + \epsilon_g, \quad g \in M \cup F \quad (2)$$

where  $X$  is a vector containing the predictors previously defined,  $\beta$  is a vector that contains the slope parameters and the intercept and  $\epsilon$  is the error parameter. By assumption  $E(\epsilon)$  is equal to 0. The vector  $X$  is a column vector and since it has to be multiplied with  $\beta$ , which is also a column vector, we need to transpose it to a row vector so that the multiplication can be possible. The transposed vector  $X$  is here

written as  $X'$  and is thus a row vector. Notice that each group has a specific vector  $X$  and  $\beta$ , which we from now will define as  $X_M, X_F, \beta_M$  and  $\beta_F$ .

The outcome difference  $D$  expressed in equation (1) can now be rewritten as “the difference in the linear prediction at the group-specific means of the regressors” based on equation (2) (Jann, 2008). Since

$$E(W_g) = E(X_g' \beta_g + \epsilon_g) = E(X_g' \beta_g) + E(\epsilon_g) = E(X_g' \beta_g)$$

because  $E(\epsilon_g)$  is equal to 0 by assumption and  $E(\beta_g)$  is equal to  $\beta_g$  as the expected value of a constant is the exact same constant, we can express  $E(W_M)$  and  $E(W_F)$  as

$$E(W_M) = E(X_M)' \beta_M \text{ and } E(W_F) = E(X_F)' \beta_F$$

where  $E(X_i)$  with  $i \in M, F$  symbolizes the averages of the independent variables from the males and females samples (Duncan, 2012). This allows us to express (1) as

$$D = E(W_M) - E(W_F) = E(X_M)' \beta_M - E(X_F)' \beta_F \quad (3)$$

### 3.1.2 Decomposition possibilities

Based on the decomposition of Blinder (1973), Jones and Kelley (1984), Daymont and Andrisani (1984) and Jann (2008) we can decompose equation (3) according to two different decompositions: a three-fold decomposition or a two-fold decomposition. Firstly we will discuss the three-fold decomposition of equation (3) and later on the two-fold decomposition. The three-fold decomposition consists of decomposing the mean outcome difference  $D$  into three parts: an endowment effect, a coefficient effect and an interaction effect. There exist two viewpoints for the three-fold decomposition since the wage differential  $D$  can be expressed from group  $M$ 's point of view, as from group  $F$ 's point of view. On the other hand, the two-fold decomposition decomposes  $D$  into two components: a quantity effect and an unexplained part. Moreover, the unexplained part can also be further decomposed in order to define the discrimination in favour of group  $M$  and the discrimination against group  $F$ . An important assumption on which the interpretation of those decompositions lies is that there are no relevant unobserved predictors that could bias the results.

#### 3.1.2.1 First decomposition approach: three-fold

For the sake of the three-fold decomposition, equation (3) can already be converted to

$$D = [E(X_M) - E(X_F)]' \beta_F + E(X_F)' (\beta_M - \beta_F) + [E(X_M) - E(X_F)]' (\beta_M - \beta_F) \quad (4)$$

when formulated from the viewpoint of group  $F$  or to

$$D = [E(X_M) - E(X_F)]' \beta_M - E(X_M)' (\beta_M - \beta_F) + [E(X_M) - E(X_F)]' (\beta_M - \beta_F) \quad (5)$$

when expressed from group  $M$ 's point of view. We can easily demonstrate that this is true for equation (4):

$$\begin{aligned}
D &= [E(X_M) - E(X_F)]'\beta_F + E(X_F)'(\beta_M - \beta_F) + [E(X_M) - E(X_F)]'(\beta_M - \beta_F) \\
&= E(X_M)'\beta_F - E(X_F)'\beta_F + E(X_F)'\beta_M - E(X_F)'\beta_F + E(X_M)'\beta_M - E(X_M)'\beta_F \\
&\quad - E(X_F)'\beta_M + E(X_F)'\beta_F \\
&= E(X_M)'\beta_M - E(X_F)'\beta_F \quad q.e.d.
\end{aligned}$$

The reasoning is the same for the perspective given in equation (5). The updated version of the outcome difference, first of all from the viewpoint of group  $F$  in equation (4), can be divided into three parts. It can be divided in various components namely a part  $\zeta$ , a part  $C$  and a part  $I$  with the subsequent definitions:

$$\begin{aligned}
\zeta &= [E(X_M) - E(X_F)]'\beta_F \\
C &= E(X_F)'(\beta_M - \beta_F) \\
I &= [E(X_M) - E(X_F)]'(\beta_M - \beta_F)
\end{aligned}$$

Those equations allow us to redefine equation (4) as:

$$D = \zeta + C + I$$

The first component  $\zeta$  stands for the “endowments effect”, which represents the wage differential between group  $M$  and group  $F$  that is due to the differences in the predictors between the two groups (Jann, 2008). The second component  $C$  symbolizes on the one hand the contribution of the differences in the coefficients and on the other hand the differences in the intercept and can be referred to as the “coefficients effect” (Jann, 2008). The third component  $I$  denotes the “iteration effect” between the endowments and coefficients, which actually means that it measures the differences in endowments and coefficients that exist simultaneously between the two groups  $M$  and  $F$  (Jann, 2008).

Now remains the question: What do the two viewpoints given by equation(4) and (5) of the three-fold decomposition concretely stand for? The wage differential expressed from group  $F$ 's point of view given in equation (4) in fact measures first of all with component  $\zeta$  the “group differences in the predictors weighted by the coefficients of group  $F$ ” and measures by the means of component  $C$  the differences in coefficients weighted by the predictors of group  $F$  (Jann, 2008). Jann (2008) explains that in this version of the three-fold decomposition both the endowments effect and the coefficient effect measure the expected change in the mean outcome of group  $F$  but with a slightly different approach. The endowments effect measures the change in the mean outcome if group  $F$  had the levels of predictors of group  $M$  and the coefficients effect measures the change in the mean outcome if group  $F$  had the coefficients of group  $M$ .

The reasoning for (5) is similar to the one for (4), but then component  $\zeta$  is weighted by the coefficients of group  $M$  and component  $C$  is weighted by the predictors of group  $M$ .

### 3.1.2.2 Second decomposition approach: two-fold

The two-fold decomposition divides the mean outcome differential  $D$  into two parts. The alternative approach proposed affirms that there exist some sort of non-discriminatory coefficients vector  $\beta^*$  that should be used to determine the contribution of the differences in the predictors (Jann, 2008). Instead of having a three-fold decomposition as for equations (4) and (5), we now have a two-fold decomposition. Equation (3) can now be expressed as

$$D = [E(X_M) - E(X_F)]'\beta^* + [E(X_M)'(\beta_M - \beta^*) + E(X_F)'(\beta^* - \beta_F)] \quad (6)$$

since it can be easily demonstrated that

$$\begin{aligned} D &= E(X_M)'\beta^* - E(X_F)'\beta^* + E(X_M)'\beta_M - E(X_M)'\beta^* + E(X_F)'\beta^* - E(X_F)'\beta_F \\ &= E(X_M)'\beta_M - E(X_F)'\beta_F \quad q.e.d. \end{aligned}$$

Equation (6) can also be formulated as a summation of two components:

$$D = Q + U \quad (7)$$

with the summand  $Q$  that stands for the ‘quantity effect’ and is the part of the outcome variable difference that can be explained by the differences in the predictors between the two groups  $M$  and  $F$ , thus representing the ‘explained’ part and the remaining component  $U$ , which symbolizes the ‘unexplained part’. The components  $Q$  and  $U$  are therefore defined as:

$$\begin{aligned} Q &= [E(X_M) - E(X_F)]'\beta^* \\ U &= E(X_M)'(\beta_M - \beta^*) + E(X_F)'(\beta^* - \beta_F) \end{aligned} \quad (8)$$

The component  $U$  can represent the unexplained part of the wage differential and thus, in theory, should be completely attributable to discrimination. However, the latter is not true as it possibly also could include unobserved variables (Jann, 2008). This unexplained part in equation (8) is in the literature also decomposed in:

$$U = E(X_M)'\delta_M - E(X_F)'\delta_F \quad \text{with } \beta_M = \beta^* + \delta_M \quad \text{and} \quad \beta_F = \beta^* + \delta_F \quad (9)$$

where  $\delta_M$  and  $\delta_F$  are discrimination parameter vectors specific for each group. Those vectors are either positive or negative, representing either positive or negative discrimination. The validity of equation (9) can easily be demonstrated:

$$\begin{aligned} U &= E(X_M)'\delta_M - E(X_F)'\delta_F \\ &= E(X_M)'(\beta_M - \beta^*) - E(X_F)'(\beta_F - \beta^*) \\ &= E(X_M)'(\beta_M - \beta^*) + E(X_F)'(\beta^* - \beta_F) \end{aligned}$$

Thus equation (9) can be subdivided into two parts  $U_m$  and  $U_f$  that respectively stand for the discrimination in favour of group  $M$  and discrimination against group  $F$ . The distinction of discrimination in favour of a group and the discrimination against a group should be clearly made. Here again the decomposition is only valid if there are no unobserved. The predictors  $U_M$  and  $U_F$  are therefore defined as the following:

$$U_M = E(X_M)' \delta_M$$

$$U_F = -E(X_F)' \delta_F$$

This allows us to rewrite the unexplained part  $U$  as:

$$U = U_M + U_F$$

The unexplained part is the summation of the discrimination in favour of group  $M$  and of the discrimination against group  $F$ .

### 3.1.3 Estimation of components

#### 3.1.3.1 Three-fold decomposition

For further analysis we need to make estimations for the different components of the wage differential  $D$  and from now on we will refer to it as  $\hat{D}$  (the estimation of  $D$ ).  $\beta_M$  and  $\beta_F$  have to be estimated and Jann (2008) proposes to use the least square estimates, which we will refer to as  $\hat{\beta}_M$  and  $\hat{\beta}_F$ . Moreover, we also need to estimate the expected wages we defined as  $E(X)$ . Therefore,  $\bar{X}_M$  and  $\bar{X}_F$  are estimations for respectively  $E(X_M)$  and  $E(X_F)$ . Based on those estimations we now can rewrite equations (4) from group  $F$ 's point of view and equation (5), which was from group  $M$ 's point of view:

$$\begin{aligned} \hat{D} &= [E(X_M) - E(X_F)]' \beta_F + E(X_F)' (\beta_M - \beta_F) + [E(X_M) - E(X_F)]' (\beta_M - \beta_F) \\ &= (\bar{X}_M - \bar{X}_F)' \hat{\beta}_F + \bar{X}_F' (\hat{\beta}_M - \hat{\beta}_F) + (\bar{X}_M - \bar{X}_F)' (\hat{\beta}_M - \hat{\beta}_F) \end{aligned} \quad (10)$$

$$\begin{aligned} \hat{D} &= [E(X_M) - E(X_F)]' \beta_M + E(X_M)' (\beta_M - \beta_F) + [E(X_M) - E(X_F)]' (\beta_M - \beta_F) \\ &= (\bar{X}_M - \bar{X}_F)' \hat{\beta}_M + \bar{X}_M' (\hat{\beta}_M - \hat{\beta}_F) - (\bar{X}_M - \bar{X}_F)' (\hat{\beta}_M - \hat{\beta}_F) \end{aligned} \quad (11)$$

#### 3.1.3.2 Two-fold decomposition

Estimations for the two-fold decomposition are much more complicated since we have to make estimations for the non-discriminatory coefficients  $\beta^*$  (Jann, 2008). Oaxaca (1973) suggests that the discrimination is only direct towards one of the groups, which means that either  $\beta^* = \beta_M$  or  $\beta^* = \beta_F$  (Jann, 2008). Here we have two possible ways to look at the differential wage  $D$ :



1. Discrimination is only directed against women and there is no discrimination (positive or negative) of men.

If this is the case, then we can use  $\hat{\beta}_M$  as an estimate for  $\beta^*$  and thus we can rewrite equation (6), using  $\beta^* = \hat{\beta}_M, \beta_M = \hat{\beta}_M$  and  $\beta_F = \hat{\beta}_F$ , as:

$$\begin{aligned}
D &= [E(X_M) - E(X_F)]'\beta^* + [E(X_M)'(\beta_M - \beta^*) + E(X_F)'(\beta^* - \beta_F)] \\
&= [E(X_M) - E(X_F)]'\hat{\beta}_M + [E(X_M)'(\hat{\beta}_M - \hat{\beta}_M) + E(X_F)'(\hat{\beta}_M - \hat{\beta}_F)] \\
&= [E(X_M) - E(X_F)]'\hat{\beta}_M + E(X_F)'(\hat{\beta}_M - \hat{\beta}_F)
\end{aligned} \tag{12}$$

2. No discrimination (positive or negative) of women, but only discrimination of men.

In this case we can estimate equation (6) with  $\hat{D}$ , using  $\beta^* = \hat{\beta}_F, \beta_F = \hat{\beta}_F$  and  $\beta_M = \hat{\beta}_M$ , as:

$$\begin{aligned}
D &= [E(X_M) - E(X_F)]'\beta^* + [E(X_M)'(\beta_M - \beta^*) + E(X_F)'(\beta^* - \beta_F)] \\
&= [E(X_M) - E(X_F)]'\hat{\beta}_F + [E(X_M)'(\hat{\beta}_M - \hat{\beta}_F) + E(X_F)'(\hat{\beta}_F - \hat{\beta}_F)] \\
&= [E(X_M) - E(X_F)]'\hat{\beta}_F + E(X_M)'(\hat{\beta}_M - \hat{\beta}_F)
\end{aligned} \tag{13}$$

According to Chiplin (1979), it should be better to use  $\hat{\beta}_M$  as the non-discriminatory vector of coefficients. However, alternatively Jann (2008) states that there is “no specific reason to assume that the coefficient of one or the other group are non-discriminating” and Cotton (1988) states that doing this would result in “either underestimating or overestimating the hypothesized skills and treatment differences”. This means that there is no reason for  $\beta_M = \hat{\beta}_M$  or  $\beta_F = \hat{\beta}_F$  to be true. The choice of the reference coefficients vector is generally up to the researcher (Hlavac, 2016). Jann (2008) gives us an overview of all the suggested alternatives. Two alternatives for the estimations of the vector  $\hat{\beta}^*$  are given by Reimers (1983) and by Cotton (1988). However, none of those two methods are completely satisfactory since the weights are chosen arbitrarily (Oaxaca & Ransom, 1994). Reimers (1983) suggests to just take the average of the two coefficients, while Cotton (1988) suggest to weight the coefficient by the size of group  $M$  and group  $F$ . Furthermore, Neumark (1988) gives us a pooled regression method for the estimation of  $\hat{\beta}^*$ .

- **Average coefficients**

Reimers (1983) suggests to estimate the non-discriminatory parameter vector  $\hat{\beta}^*$  by taking the average coefficients of the two groups  $M$  and  $F$ ;  $\hat{\beta}_M$  and  $\hat{\beta}_F$ . The non-discriminatory vector  $\hat{\beta}^*$  becomes:

$$\begin{aligned}
\hat{\beta}^* &= \frac{\hat{\beta}_M + \hat{\beta}_F}{2} \\
&= 0.5\hat{\beta}_M + 0.5\hat{\beta}_F
\end{aligned} \tag{14}$$

If we would use this equation (14) in equation (6) then we would get:

$$\begin{aligned}
\hat{D} &= [E(X_M) - E(X_F)]'(0.5\hat{\beta}_M + 0.5\hat{\beta}_F) + [E(X_M)'(\hat{\beta}_M - (0.5\hat{\beta}_M + 0.5\hat{\beta}_F)) \\
&\quad + E(X_F)'((0.5\hat{\beta}_M + 0.5\hat{\beta}_F) - \hat{\beta}_F)] \\
&= [E(X_M) - E(X_F)]'0.5(\hat{\beta}_M + \hat{\beta}_F) + [E(X_M)'(0.5\hat{\beta}_M - 0.5\hat{\beta}_F) + E(X_F)'(0.5\hat{\beta}_M - 0.5\hat{\beta}_F)] \\
&= [E(X_M) - E(X_F)]'(0.5\hat{\beta}_M + 0.5\hat{\beta}_F) + (0.5\hat{\beta}_M - 0.5\hat{\beta}_F)[E(X_M)' + E(X_F)']
\end{aligned} \tag{15}$$

- **Group sizes**

Alternatively, Cotton (1988) suggests to use the size of group  $M(n_M)$  and group  $F(n_F)$  as weights for the estimation of  $\hat{\beta}^*$ . Thus, instead of multiplying the coefficients with 0.5, we will have to multiply them with  $\frac{n_M}{n_M + n_F}$  and  $\frac{n_F}{n_M + n_F}$ :

$$\hat{\beta}^* = \frac{n_M}{n_M + n_F}\hat{\beta}_M + \frac{n_F}{n_M + n_F}\hat{\beta}_F \tag{16}$$

- **Pooled regression**

Neumark (1988) proposes to estimate  $\hat{\beta}$  using common coefficients estimated from a pooled regression over the two groups  $M$  and  $F$ . This approach consists of using a group membership dummy in order to obtain a measure for the aggregate wage structure (Neumark, 1988; Fortin, Lemieux, & Firpo, 2011). To do so, Neumark (1988) proposes to use the least squares approach.

Let's define the observation matrix for the pooled sample as  $X_p$  and  $X_M$  and  $X_F$  as the observation matrix for group  $M$  and group  $F$  respectively. According to Neumark (1988), we can define  $X_p'X_p$  as the following:

$$X_p'X_p = X_M'X_M + X_F'X_F \tag{17}$$

## 3.2 Implementation

### 3.2.1 Data

#### 3.2.1.1 Database

Various databases containing numerical data are available in order to perform an Oaxaca-Blinder decomposition on Belgian workers information, with some being more appropriate than others. An overview of these relevant databases will be given, partly based on the overview of Delmotte et al. (2011), and arguments will be given of why a certain database was chosen in order to perform the decomposition.

1. *Enquête naar structuur en verdeling van de lonen (Algemene Directie Statistiek en Economische Informatie)*

This quite extensive database was from the start evicted from the possible sources for our analysis, as it would only have been available at least after one year and a half after the submission of an inquiry to access the data. This large timespan would have made it impossible to finish this thesis on time, considering the limited time granted.

2. ***Datawarehouse arbeidsmarkt en sociale bescherming*** (*Kruispuntbank van de Sociale Zekerheid*)

The *KSZ* database contains a lot of numerical data originating from various social institutions active in Belgium. However, the very long and complicated procedure and the big cost associated in order to acquire the data has made it an unwanted option for this study.

3. **Statistics on Income and Living Conditions** (Eurostat)

The European Commission only grants access to the SILC for “scientific purposes”, which doesn’t include studies done in the context of a thesis.

4. ***Salarisenquête*** (*Vacature*)

This database is the ideal source of information for an Oaxaca-Blinder decomposition method and has been used before in studies such as the one of Delmotte et al. (2011). However, they don’t allow students to access the data, as they “cannot supervise them”.

5. **WageIndicator Survey** (International Data Service Center of the Institute for the Study of Labor)

This survey is a multilingual questionnaire and its purpose is to collect information on wages and working conditions. As labour markets and wage setting processes vary across countries, country specific translations have been favoured over literal translations (IDSC, 2016).

In order to gain access to the data gathered from the WageIndicator survey, a so-called “user contract”, where the research project has to be described and the type of data needed has to be defined, has to be filled in and signed. Afterwards, it is either accepted or refused by the database manager. Moreover, there is no cost associated with the access to the data. Therefore, the WageIndicator was the final and best choice as the source of numerical data for this study.

### 3.2.1.2 Limitations of dataset

The WageIndicator data is gathered through non-probability web based surveys (IDSC, 2016). Such kind of surveys can be considered as being problematic, as not every individual has the same probability of being included into the survey. According to the IDSC (2016), the probability of an individual being selected depends on both national or regional internet access rates and on numbers of visitors accessing the website. Accordingly, data originating from such surveys form a convenience sample, where individuals are included into the survey because of their availability or easy access (De Pelsmacker & Van Kenhove,

2006). A convenience sample allows for the gathering of data to happen quite quickly, however because of the non-probability nature of the WageIndicator survey, the results obtained in this study will not be generalized for the Belgian labour force. Therefore, the representativeness is not assured. According to the IDSC (2016), the survey contains an underrepresentation of male labour force, part-timers, older age groups, and low educated persons.

### **3.2.2 Statistical treatment**

#### **3.2.2.1 The wage**

The most important variable of the analysis is evidently the wage of the Belgian workers as we are trying to subdivide it. Therefore, we firstly need to define which is the wage that we will further use and discuss. First of all, the distinction between hourly, monthly and annual wages needs to be made (Lazear, 2000). Moreover, there is also a difference between gross and net wages (Burtless & Hausman, 1978). The net wage that the employees get is computed by taking the gross wage and deducting taxes, compulsory social insurance contributions and other payments (Livchen, 1944). Additionally, the amount of net wage is also based on the family situation. The choice of which variable will be chosen as the wage is very important since it will have an important impact on our further analysis. As a result, we need to be very cautious with this definition.

The wage gap in hourly wages is smaller than the wage difference in monthly wages because women in average perform fewer paid hours than men and this even true if they work full-time (Delmotte et al., 2010). Comparing wages is easier when only considering full-time employees. However, women are more strongly represented in the part-time employees and thus the wages of part-time employees must also be taken into account (Bever et al., 2007; Delmotte et al., 2010). Moreover, the difference in net wages is evidently smaller than the difference in gross wages. The reason for this is that in Belgium the tax system is progressive and therefore the taxes, in percentages, are higher for the higher wages (Bever et al., 2007). Although some progression has been made and it is not as much the case as it was before, men are still more strongly represented in the higher wages categories than women (Bever et al., 2007).

Based on the chosen dataset of the WageIndicator Survey, the yearly wage seems to be the most appropriate variable as it is the wage data that is the most available. Other wage data such as the hourly and monthly salaries don't seem to be complete. It is the gross yearly wage that will be further adopted as the net yearly wage is not given. Unfortunately, there is no possibility to analyse the full-time equivalent monthly or yearly salary, which would have allowed us take into account the percentage of part-time work. Furthermore, there is no possibility to integrate fringe benefits such as a company car, a mobile phone or a laptop into the analysis. But, according to Theunissen and Sels (2006) and Vermandere, Vandenbrande, Delmotte, Theunissen and Sels (2010) men get such benefits more often than women. Given these points, the chosen outcome variable will be the gross yearly wage.

### 3.2.2.2 Variables

The WageIndicator dataset is enormously extensive and we only need a subset of it to conduct this research. Therefore, the first logical step is to only retain the employees working in Belgium by excluding self-employed individuals and individuals not working in Belgium. Evidently, we also exclude individuals with no gender or wage specified from the dataset.

The factors of the gender wage gap have previously been discussed in the literature review of Section 2. In order to analyse the patterns of the Belgian gender wage gap, we need to perform additional restrictive filters to obtain the strict necessary subset. An overview of the WageIndicator variables corresponding with the previously discussed wage gap characteristics can be found in Table 2. Unfortunately certain factors, i.e. functional level and functional domain, do not have an equivalent WageIndicator variable, and will therefore have to be omitted from the analysis. Moreover, the retained variables will be transformed into the following variables that can be found in Table 3. The transformation performed is relatively straightforward for all variables as can be observed in Table 4 with the example of the factor “Education”.

After filtering out the unnecessary data, we end up with a subset of 2585 Belgian individuals in 2014, and 1413 Belgian individuals in 2015. No explicit reason has been found to why there is such a huge difference between the sample of 2014 and the one of 2015. Perhaps, there was a much lower response rate to the WageIndicator Survey. A copy of both the original and the final subsets used for the analysis will be added to this thesis on a CD.

Characteristic	WageIndicator Variable	Label
<b>Employment characteristics</b>		
Status	FIRMPRI	Public or private sector
Labour regime	CONTR7	Has permanent employment contract
Type of contract	contract	Employment contract type
<b>Human capital</b>		
Work experience	TENUEXPE	Years of service?
Education	EDUCAT1	Highest level of education
Functional level	/	/
Authority	SUPVDICH	Has supervisory position
Functional domain	/	/
<b>Organization characteristics</b>		
Sector	NACE2000	NACE-rev20 industries four groups
Size of organization	firmsize	Firm size workplace
<b>Family characteristics</b>		
Presence of partner	HHSTAT	Current marital status
Presence of children	chld & chldhome	Has children & number of children

Table 2: Mapping the WageIndicator variables with the factors of the gender wage gap

Variable	Details
female	an indicator for female gender 0: male 1: female
age	the worker's age, expressed in years
real.wage	the worker's real yearly wage in Euro
LTHS	an indicator for having completed less than a high school education
high.school	an indicator for having completed a high school education
some.degree	an indicator for having completed some degree
college	an indicator for having completed a college education
advanced.degree	an indicator for having completed an advanced degree
private.firm	an indicator for working in a private company 0: working in public company 1: working in private company
authority	an indicator for having a supervisory position 0: not having a supervisory position 1: having a supervisory position
full.time	an indicator for working full-time 0: part-time 1: full-time
fixed.contract	an indicator for the contract type 0: temporary contract 1: fixed contract 2: other contract
work.experience	expressed in years, divided into 3 groups 1: 0 to 15 years experience 2: 16 to 30 years experience 3: 31 to ... years experience
firm.size	an indicator for size of working place 0: micro 1: small 2: medium 3: large 4: enterprise
sector	an indicator for the sector in which the individual is working 1: agriculture, manufacturing and construction (primary sector) 2: trade, transport and hospitality (secondary sector) 3: commercial services (tertiary sector) 4: public sector, health care and education (quaternary sector)
presence.partner	an indicator for the presence of a partner 0: no partner 1: partner
children	an indicator for the presence of children 0: no children 1: child(ren)
number.children	indicator for the number of children can either be 0, 1, 2, 3, 4, 5, or 6 or more

Table 3: Variables of final dataset

WageIndicator variable EDUCAT1 values	Organized within education level
<i>BEL Lagere school niet afgemaakt</i>	Less than high school (LTHS)
<i>BEL Lagere school afgemaakt</i>	LTHS
<i>BEL algemeen hoger secundaire onderwijs</i>	High.school
<i>BEL Universiteit Master</i>	College
<i>BEL Post-Universitaires doctoraat</i>	Advanced.degree
<i>BEL 1e graad A-stroom</i>	LTHS
<i>BEL 1e graad B-stroom</i>	LTHS
<i>BEL 2de graad ASO</i>	LTHS
<i>BEL 2de graad KSO-TSO</i>	LTHS
<i>BEL deeltijds beroepsonderwijs</i>	High.school
<i>BEL SYNTRA-VIZO</i>	High.school
<i>BEL 3de graad ASO</i>	High.school
<i>BEL 3de graad KSO-TSO</i>	High.school
<i>BEL 3de graad BSO</i>	High.school
<i>BEL 7de jaar TSO</i>	High.school
<i>BEL 7de jaar BSO</i>	High.school
<i>Bel 4de graad BSO</i>	High.school
<i>BEL HOKT - professionele bachelor</i>	Some.college
<i>BEL HOLT - academisch BA of MA</i>	College

Table 4: Example transformation of WageIndicator variable EDUCAT1

### 3.2.2.3 Oaxaca package

The data will be analysed with the *oaxaca* package for the R statistical programming language. The *oaxaca()* function performs both the three-fold and the two-fold variants of the Blinder-Oaxaca decomposition for linear models, while also providing estimates for a detailed, variable-by-variable decomposition (Armah, Boamah, Quansah, Obiri, & Luginaah, 2016; Hlavac, 2016). Furthermore, this package also allows for a visualization of the results in the form of bar charts. Also, standard errors are calculated using a non-parametric bootstrapping approach (Efron 1979; Hlavac, 2016). Bootstrapping treats the sample as if it is the whole population (Amiri, Von Rosen, & Zwanzig, 2008). Therefore, the “sampling distribution can be estimated by generating a large number of new sample from the original samples” (Amiri, Von Rosen, & Zwanzig, 2008). The following code has been used on the 2014 data, while the R code used for 2015 is evidently similar:

```
R> install.packages(oaxaca)
```

```
R> install.packages(library)
```

```
R> library(foreign)
```

```

R> library(oaxaca)

R> file.choose()

R> data2014=read.spss("C:\\Documents and Settings\\admin-belgium\\Desktop\\2014 yearly wages.sav",
  to.data.frame=TRUE)

R> results2014 <- oaxaca(formula = real.wage ~ AGE + LTHS + high.school + some.degree + college
  + advanced.degree | GENDER | LTHS + some.degree + college + advanced.degree, data = data2014,
  R = 1000)

```

The *results2014* R object will be computed using the *oaxaca* formula. The dependent variable is the variable *real.wage*, while the education levels will be used as explanatory variables. *GENDER* is defined as the indicator variable, that indicates whether an observation belongs to group A (when *GENDER* is 0) or group B (when *GENDER* is 1) (Hlavac, 2016). Furthermore, the data used will logically be the WageIndicator data of 2014. The user-specified number of sampling replicates is randomly set at 1000. This chosen number seems to be a large enough in order to get as accurate results as possible (Hlavac, 2016). The *results2014* and *results2015* objects consist of the two decomposition approaches and additional information. These objects will be used in order to answer our research questions.

## 4 | Results

Firstly, the analysis of the Belgian gender wage gap in 2014 will be given, both according to the three-fold and two-fold decomposition. Secondly, the Belgian gender wage gap of 2015 will be analysed, again according to both decomposition methods. Finally, the difference and evolution of the Belgian gender wage gap between 2014 and 2015 will be briefly discussed, while the validity of the findings of Delmotte et al. (2010) will be verified for both 2014 and 2015. In order to interpret the results appropriately, the interpretation will be done based on the work of Hlavac (2016).

### 4.1 Results of 2014

The primary results of the *oaxaca* object are the *n* and *y* components. Keep in mind that in R group *A* represents the male workers and group *B* the female workers. The *n* component indicates that the number of Belgian male workers ( $n_M$ ) in our subset is equal to 1408 and the number of Belgian female workers ( $n_F$ ) amounts to 1174.

```

R> results2014$n

```



```

$n.A
[1] 1408

$n.B
[1] 1174

$n.pooled
[1] 2582

```

The  $y$  component indicates that the mean real yearly wage of the Belgian male workers ( $W_M$ ) equals to an amount of €39.658,25, whilst the one of Belgian female workers is €29.871,23. The remaining part of €9.787,025, representing the difference between the two mean real yearly wages, corresponds to men earning approximately 33% more than women do on a yearly basis. This remaining part will be scrutinized minutely using the Oaxaca-Blinder decomposition, according to both the three-fold and two-fold decomposition.

```

R> results2014$y

$y.A
[1] 39658.25

$y.B
[1] 29871.23

$y.diff
[1] 9787.025

```

#### 4.1.1 Three-fold decomposition

```

R> results2014$threefold$overall

      coef(endowments)  se(endowments)  coef(coefficients)  se(coefficients)
129.239735           293.592476       9655.150267         795.942611
coef(interaction)     se(interaction)
2.639129              268.865086

```

The three-fold decomposition of the 2014 gender wage gap of €9.787,03 is subdivided into 3 different parts. Nearly €129,24 of the total difference can be attributed to the difference in endowments, while the amount of €9.655,15 can be attributed to the differences in coefficients and €2,64 is accounted for by the interaction of the endowments and the coefficients.

$$D = \zeta + C + I$$

$$\underbrace{\text{€}9.787,03}_D = \underbrace{\text{€}129,24}_\zeta + \underbrace{\text{€}9.655,15}_C + \underbrace{\text{€}2,64}_I$$

The results per variable of the endowments and the coefficients of the three-fold decomposition method can be found on the graph in Figure 2. Regarding the endowments, almost all variables, except for the variable LTHS, seem to have a statistically insignificant influence on the gender wage gap. This observation actually means that an important part of the gender wage gap between male and female is driven by “group differences in the proportion of individuals with less than a high school education” (Hlavac, 2016).

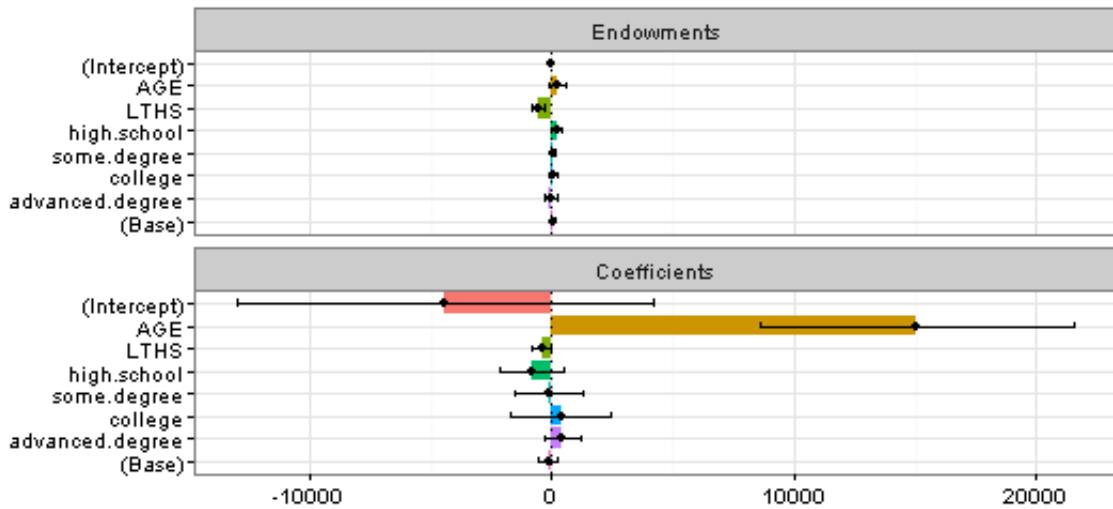


Figure 2: The endowments ( $\zeta$ ) and coefficients ( $C$ ) components of the three-fold Oaxaca-Blinder decomposition of the Belgian gender wage gap in 2014.

```
R> summary(results2014$reg$reg.pooled.2)$coefficients["LTHS",]
      Estimate      Std. Error    t value    Pr(>|t|)
-6.833159e+03  1.492901e+03  -4.577100e+00  4.938386e-06
```

If we look at the results of the pooled regression coefficient on the variable LTHS, we notice that, as one would expect, the less human capital an individual has, the less the individual tends to earn. This is exactly the same conclusion that Delmotte et al. (2010) made where they state that the higher the education level, the higher the salary of a person. However, no proof has been found that one of the two gender groups is generally “less educated” than the other. Therefore, it cannot be concluded that the difference in education between men and women accounts for the higher wages of the male population.

Furthermore, if we take a closer look at the coefficients on the graph, we can clearly see that the variable AGE is the only statistically significant variable in the coefficients component. Moreover, the differences in the regression coefficients on AGE account for the biggest portion of the Belgian gender wage gap in

2014. The wage pay-off of an additional year of age is greater for male workers by € 432,06. This is the same conclusion made by Bevers et al. (2007).

```
R> results2014$beta$beta.diff["AGE"]
```

```
AGE
432.0649
```

#### 4.1.2 Two-fold decomposition

```
R> results2014$twofold$overall
```

	weight	coef(expl)	se(expl)	coef(unexpl)	se(unexpl)
[1,]	0.0000	129.23974	293.5925	9748.790	752.5724
[2,]	1.0000	126.60061	508.9901	9660.430	795.9426
[3,]	0.5000	127.92017	393.1433	9659.110	762.8059
[4,]	0.4547	128.03976	383.2447	9658.990	760.9060
[5,]	-1.0000	47.96196	404.8934	9739.068	757.0531
[6,]	-2.0000	145.57779	407.4055	9641.452	766.6110
		coef(unexpl A)	se(unexpl A)	coef(unexplained B)	se(unexpl B)
[1,]		9.748790e+03	7.525724e+02	0.000	0.0000
[2,]		9.660430e+00	0.000000e+00	9913.626	795.9426
[3,]		4.958132e+03	3.762862e+02	4700.978	397.9713
[4,]		5.407475e+03	4.103880e+02	4251.515	361.9042
[5,]		4.471834e+03	3.562230e+02	5267.234	426.9166
[6,]		5.327683e-13	5.997229e-12	9641.452	766.6110

The *weight* column of the two-fold decomposition represents the relative weights of coefficients from a regression on observations on group A and group B in the non-discriminatory vector  $\hat{\beta}^*$  previously discussed (Hlavac, 2016). Again remember that group A represents the male and group B the female population. Therefore, the *weight* column stands for the following equations in Table 5.

	weight	equal to	theory
[1,]	0.0000	$0 * \hat{\beta}_M + 1 * \hat{\beta}_F$ $= \hat{\beta}_F$	Discrimination direct towards men
[2,]	1.0000	$1 * \hat{\beta}_M + 0 * \hat{\beta}_F$ $= \hat{\beta}_M$	Discrimination directed towards women Chiplin (1979)
[3,]	0.5000	$0,5 * \hat{\beta}_M + 0,5 * \hat{\beta}_F$	Average coefficients Reimers (1983)
[4,]	0.4547	$0,5453 * \hat{\beta}_M + 0.4547 * \hat{\beta}_F$	Group sizes Cotton (1988)
[5,]	-1.0000		$\hat{\beta}^*$ comes from pooled regressions without the group indicator variable included as a covariate Neumark (1988)
[6,]	-2.0000		$\hat{\beta}^*$ comes from pooled regressions with the group indicator variable included as a covariate Neumark (1988)

Table 5: Column *weight* of R result linked to theory of non-discriminatory vector

According to the weights that the coefficients  $\hat{\beta}^M$  and  $\hat{\beta}^F$  are given, the explained and unexplained part of the gender wage gap differ widely. This again shows how the subdivision of the gender wage gap has to be done carefully and prudently. Moreover, the standard errors also provide a sense of the uncertainty that accompanies the estimates we make with such decomposition method (Hlavac, 2016). Furthermore, remember that for the two-fold decomposition, the gender wage gap is divided into a quantity effect (explained part) and an unexplained part ( $D = Q + U$ ).

There is no preferred choice to what weighting method is the most appropriate. Therefore, we will focus arbitrarily on Reimers' (1983) and the Neumark's (1988) weighting methods. On the one hand, according to Reimers' (1983) weighting, the Belgian gender wage gap of €9.787,03 can be broken down into an explained part of €127,92 and an unexplained part of €9.659,11.

$$\underbrace{\text{€}9.787,03}_{D} = \underbrace{\text{€}127,92}_{Q} + \underbrace{\text{€}9.659,11}_{U}$$

This results in an unexplained part of 98,69% of the difference in wage, which is surprisingly high. This signifies that the difference of €9.659,11 between the men's yearly real wages and the women's yearly real wages cannot be explained based on the observed variables. The unexplained gender wage gap therefore amounts to 32% of the women's yearly wages. Again, we must not lose sight of the fact that this can only prudently be assigned to discrimination, as there might (certainly) be unobserved predictors or other factors. On the other hand, Neumark's (1988) decomposition results in an explained part of €47,96 and an unexplained part of €9.739,07, resulting in an explained part that is almost negligible. The alternative unexplained gender wage gap therefore adds up to 33% of women's yearly wages. Here again we can clearly witness the volatility of the decomposition according to the choice of the weights in the non-discriminatory vector  $\hat{\beta}^*$ .

$$\underbrace{\text{€}9.787,03}_{D} = \underbrace{\text{€}47,96}_{Q} + \underbrace{\text{€}9.739,07}_{U}$$

As previously mentioned, the unexplained part can only prudently be assigned to discrimination. If we now assume that the unexplained part of the gender wage gap is effectively due to discrimination, we can subdivide the unexplained part of the gender wage gap into two parts: "discrimination in favour of men" and "discrimination against women". Here again we will discuss the two-fold decomposition according to Reimers' (1983) and the Neumark's (1988) weighting methods. For Reimers' (1983) method, €4.958,13 come from "discrimination in favour of men" and €4.700,98 originates from "discrimination against women". Alternatively, based on Neumark (1988), €4.471,83 emanate from "discrimination in favour of men" and €5.267,23 stem from "discrimination against women". Both visual variable-per-variable decompositions can be found in Figure 3 and Figure 4. As one would expect, the composition and structure of the unexplained part of the two weighting methods is similar.

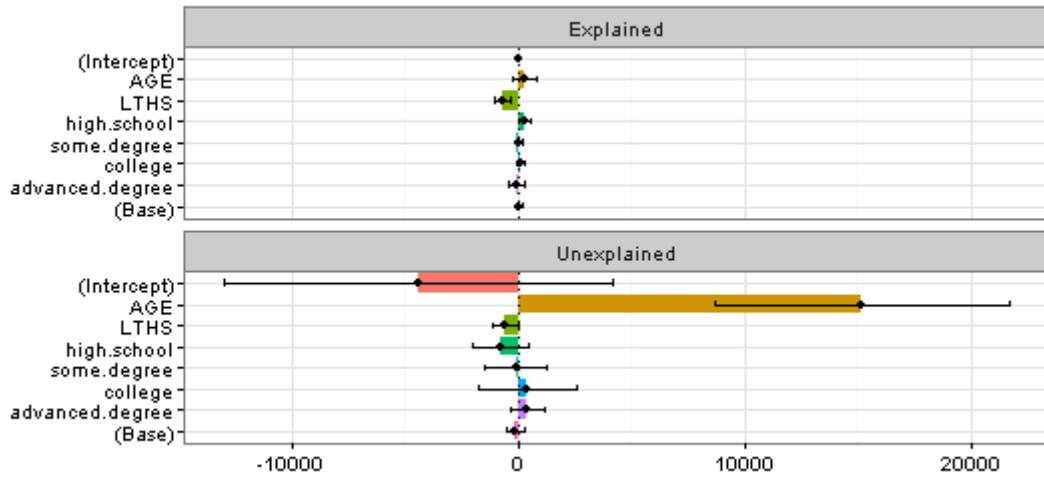


Figure 3: Variable-per-variable two-fold decomposition of the Belgian gender wage gap in 2014 according to Reimers' (1983) weighting method for the non-discriminatory vector.

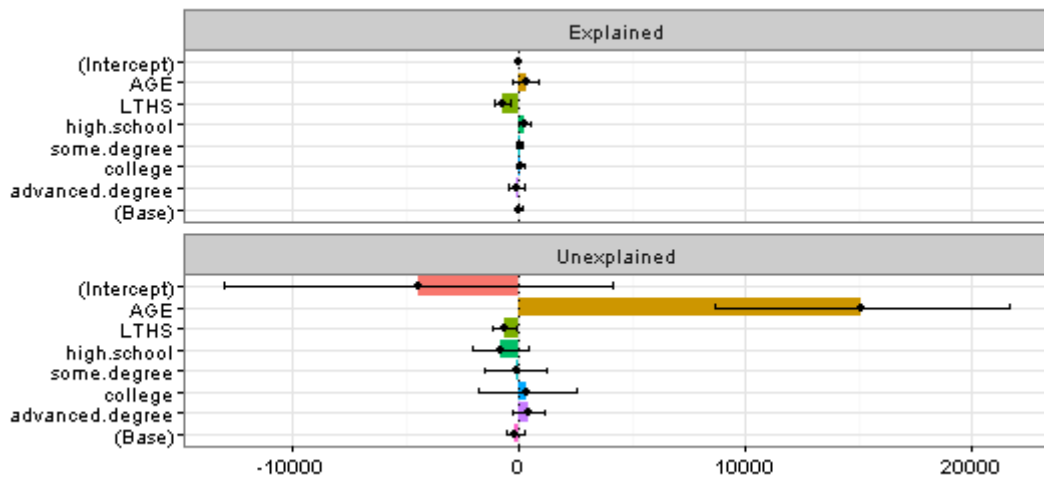


Figure 4: Variable-per-variable two-fold decomposition of the Belgian gender wage gap in 2014 according to Neumark's (1988) weighting method for the non-discriminatory vector.

Moreover, the results of the two-fold decomposition of the Belgian gender wage gap in 2014 are consistent with the findings of the three-fold decomposition. We can definitely conclude that the gender wage gap seems to be driven by the males' greater return to age as was previously indicated by the three-fold decomposition. This could be linked back to the vertical segregation and the glass-ceiling phenomenon discussed in Section 2 in the fourth paragraph about the organization characteristics, where women face with time obstacles to get a promotion or higher position in a company.

We can further analyse the "discrimination in favour of men" and the "discrimination against women". Let's only take the variables AGE, LTHS, and college for the illustration in Figure 5 and Figure 6, based on

the pooled regression of Neumark (1988). We can clearly see that the only statistically significant variable is the variable AGE. If we look at the size of the bars of the variable AGE, the “discrimination against women” is bigger than the “discrimination in favour of men” and this by almost  $\frac{1}{4}$ . Note that this is only true if the assumption that the choice of Neumark’s (1988) weighting method applied on the coefficients reflects a state of non-discrimination (Hlavac, 2016).

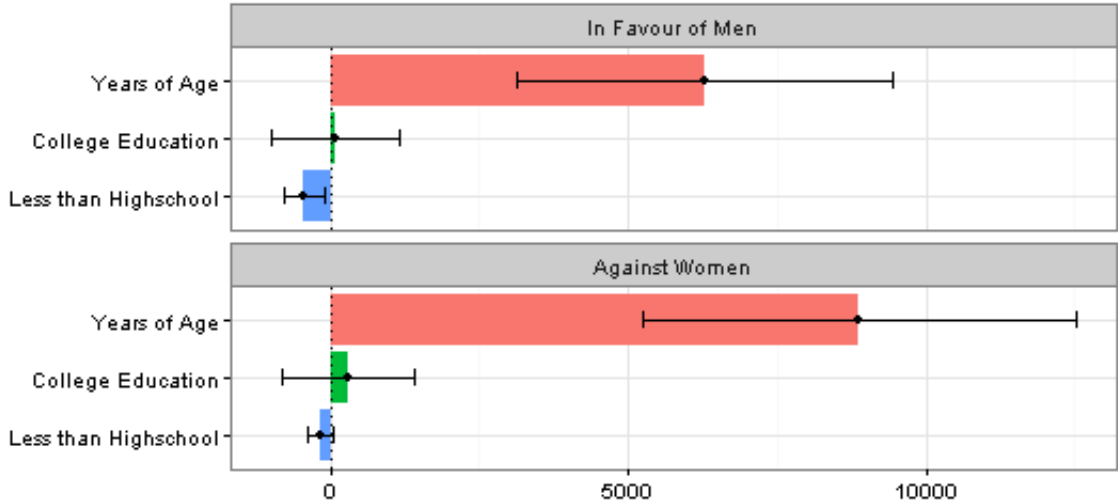


Figure 5: Variable-per-variable decomposition of the unexplained part of the two-fold decomposition of the Belgian gender wage gap in 2014 according to Neumark’s (1988) weighting method for the non-discriminatory vector.

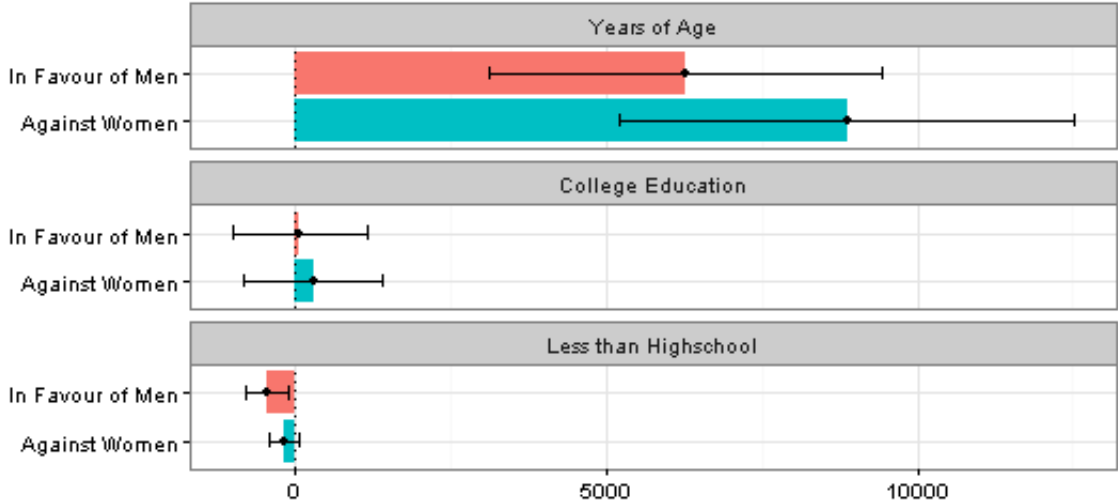


Figure 6: Alternative visualization of the variable-per-variable decomposition of the unexplained part of the two-fold decomposition of the Belgian gender wage gap in 2014 according to Neumark’s (1988) weighting method for the non-discriminatory vector.

## 4.2 Results of 2015

The decomposition of the Belgian gender wage gap of 2015 will be analysed, but detailed additional information will be omitted as these were already enclosed with the results of 2014. The subset of Belgian workers of 2015 consists of 1413 workers consisting of 748 male workers and 665 female workers.

The mean real yearly wage of the Belgian male workers equals to an amount of €40.084,98, whilst the one of Belgian female workers is €30.774,36. The remaining part of €9.310,64, representing the difference between the two mean real yearly wages, is almost 30% of the women's yearly wage. Again, this remaining part will be decomposed with the Oaxaca-Blinder decomposition, according to both the three-fold and two-fold decomposition.

```
R> results2015$y
```

```
$y.A
```

```
[1] 40084.98
```

```
$y.B
```

```
[1] 30774.36
```

```
$y.diff
```

```
[1] 9310.642
```

### 4.2.1 Three-fold decomposition

```
R> results2015$threefold$overall
```

coef(endowments)	se(endowments)	coef(coefficients)	se(coefficients)
44.94900	340.32966	9219.97579	867.82586
coef(interaction)	se(interaction)		
45.70724	315.56702		

The 2015 gender wage gap of €9.310,64 is subdivided into 3 different parts according to the three-fold decomposition. Nearly €44,95 of the total difference can be attributed to the difference in endowments, while the amount of €9.219,98 can be attributed to the differences in coefficients and €45,71 is accounted for by the interaction of the endowments and the coefficients. Again, remember that  $D = \zeta + C + I$  for a three-fold decomposition:

$$\underbrace{\text{€}9.310,64}_D = \underbrace{\text{€}44,95}_\zeta + \underbrace{\text{€}9.219,98}_C + \underbrace{\text{€}45,71}_I$$

The results per variable of the endowments and the coefficients of the three-fold decomposition method can be found on the graph in Figure 7. Regarding the endowments, none of the variables reaches statistical

significance. For the coefficients, the variable AGE, as was the case in 2014, is the only statistically significant component and accounts for the biggest portion of the Belgian gender wage gap in 2015. The wage pay-off of an additional year of age is greater for male workers by € 448.36, which is even higher than the € 432,06 of 2014.

```
R> results2015$beta$beta.diff["AGE"]
```

```
AGE
448.3564
```

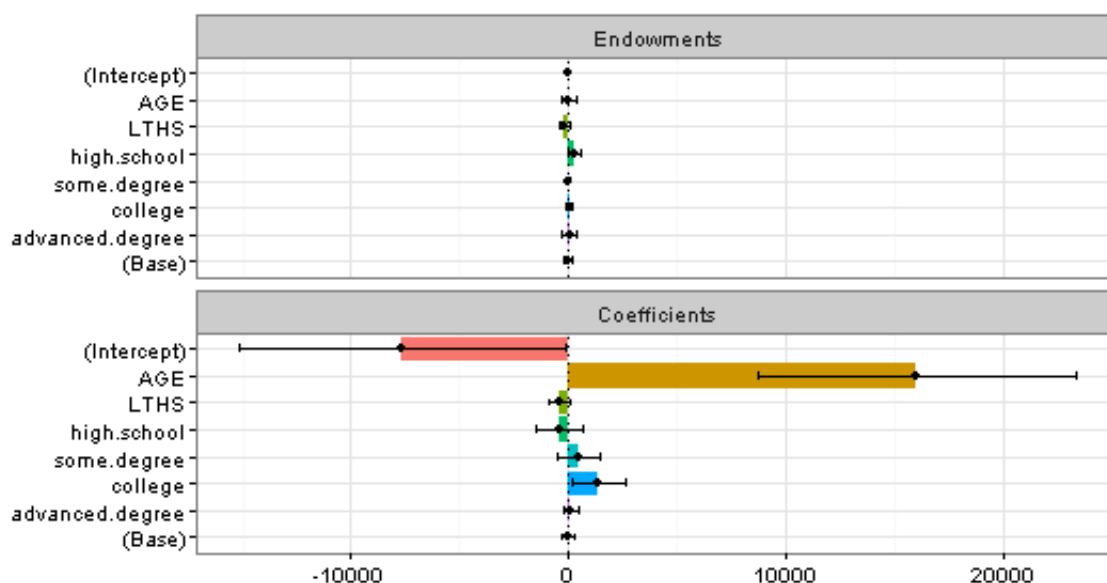


Figure 7: The endowments ( $\zeta$ ) and coefficients ( $C$ ) components of the three-fold Oaxaca-Blinder decomposition of the Belgian gender wage gap in 2015.

#### 4.2.2 Two-fold decomposition

```
R> results2015$twofold$overall
```

	weight	coef(expl)	se(expl)	coef(unexpl)	se(unexpl)
[1,]	0.0000	44.948999	340.3297	9265.675	867.7249
[2,]	1.0000	0.758238	571.8704	9311.382	867.8259
[3,]	0.5000	22.095381	443.3220	9288.529	854.3278
[4,]	0.4706	23.437808	436.3679	9287.186	854.4348
[5,]	-1.0000	38.425434	460.0900	9272.199	848.2997
[6,]	-2.0000	16.252004	457.2661	9294.372	853.5388



	coef(unexpl A)	se(unexpl A)	coef(unexplained B)	se(unexpl B)
[1,]	9.265675e+03	8.697249e+02	0.000	0.0000
[2,]	0.000000e+00	0.000000e+00	9311.382	867.8259
[3,]	4.632837e+03	4.348625e+02	4655.691	433.9129
[4,]	4.904972e+03	4.604064e+02	4382.215	408.4248
[5,]	4.363774e+03	4.169642e+02	4908.425	467.1233
[6,]	8056888.-13	7.126945e-12	9294.372	853.5388

For the sake of consistency, we will again focus on the method of Reimers (1983) (weight=0,5) and Neumark (1988) (weight=-1). The wage difference of €9.310,64 is subdivided into an explained part of €22,10 and an unexplained part of €9.288,53 based on the average coefficients method of Reimers (1983). This means that the difference of €9.288,53 between the men’s and the women’s yearly wage cannot be explained by the observed variables. This weighting method results in an unexplained gender wage gap of 30% of women’s wages on a yearly basis.

$$\underbrace{\text{€}9.310,64}_{\text{D}} = \underbrace{\text{€}22,10}_{\text{Q}} + \underbrace{\text{€}9.288,53}_{\text{U}}$$

Alternatively, Neumark’s (1988) approach results in an unexplained part of €38,43 and an unexplained part of €9.272,20. For this weighting method, this means that the difference of €9.272,20 between the men’s and the women’s yearly wage cannot be explained by the observed variables of our dataset. This amount equals to nearly 30% of women’s yearly wages. Thus, we can conclude that, for 2015, Belgian men earned in general 30% more than women did.

$$\underbrace{\text{€}9.310,64}_{\text{D}} = \underbrace{\text{€}38,43}_{\text{Q}} + \underbrace{\text{€}9.272,20}_{\text{U}}$$

The structure of the variable-per-variable decomposition of the explained and unexplained part for 2015 in Figure 8 is similar to the one of 2014. Moreover, the variable AGE is again the only statistically significant variable as was the case for 2014. However, the relative difference in size of the variable AGE between “discrimination in favour of men” and “discrimination against women” is smaller than the one in 2014 (see Figure 9). In 2015, the “discrimination in favour of men” is only smaller of less than  $\frac{1}{5}$  compared to “discrimination against women”.

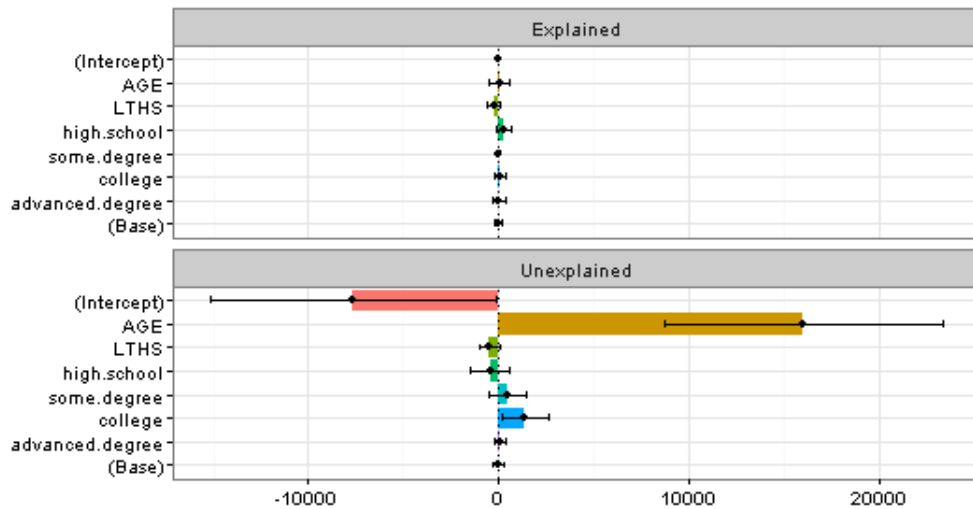


Figure 8: Variable-per-variable two-fold decomposition of the Belgian gender wage gap in 2015 according to Neumark’s (1988) weighting method for the non-discriminatory vector.

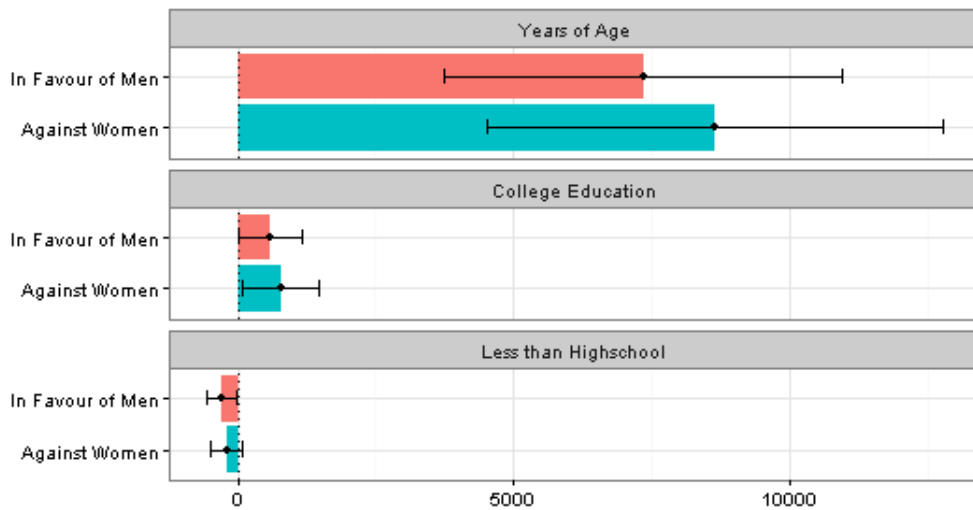


Figure 9: Visualization of the variable-per-variable decomposition of the unexplained part of the two-fold decomposition of the Belgian gender wage gap in 2015 according to Neumark’s (1988) weighting method for the non-discriminatory vector.

When we compare Figure 6 of 2014 and Figure 9 of 2015, we can notice that the “discrimination against women” has approximately remained the same. However, The “discrimination in favour of men” appears to have increased if we compare 2014 and 2015. No explanatory reasons have been found for such an increase.

### 4.3 Evolution of the gender wage gap

In order to analyse the evolution of the Belgian gender wage gap between 2014 and 2015, the unexplained part of the two-fold decomposition of both years will be compared. The weights for the non-discriminatory vector will come from pooled regressions without the group indicator variable included as a covariate (Neumark, 1988; Hlavec, 2016). The unexplained part of the 2014 Belgian gender wage gap amounts to €9.739,07, whereas the unexplained part for 2015 equals to €9.272,20. The difference between 2014 and 2015 equals to not less than €466,87. In 2014, the unexplained gender wage gap amounted to 33%, whereas in 2015 it amounted to 30% of women's wages. Therefore, the Belgian gender wage gap has decreased from 2014 to 2015 with approximately 3%. Again, we need to take into account that there are unobserved predictors and that the data of the dataset used has been gathered on a convenience basis.

### 4.4 Factors of the gender wage gap: patterns

The validity of the patterns findings of Delmotte et al. (2010) will be verified for 2014 and 2015. The five types of characteristics will be briefly discussed for both years based on accompanying figures. Again, the *oaxaca* function will be used to decompose the gender wage gap. We will use the unexplained part of the gender wage gap to control the validity of the patterns of Delmotte et al. (2010). Moreover, an simple independent t-test in SPSS will be used for the control of horizontal segregation.

#### 4.4.1 Employment characteristics

Consistent with the conclusion of Delmotte et al. (2010), it appears that the gender wage gap, expressed by the unexplained part in Figure 10, is much larger in the private sector than in the public sector. The difference in the gender wage gap between the two sectors appears to remain rather constant. This difference could be assigned to previously mentioned reasons in the part about employment characteristics in Section 2, such as the stricter wage determination rules in the public sector.

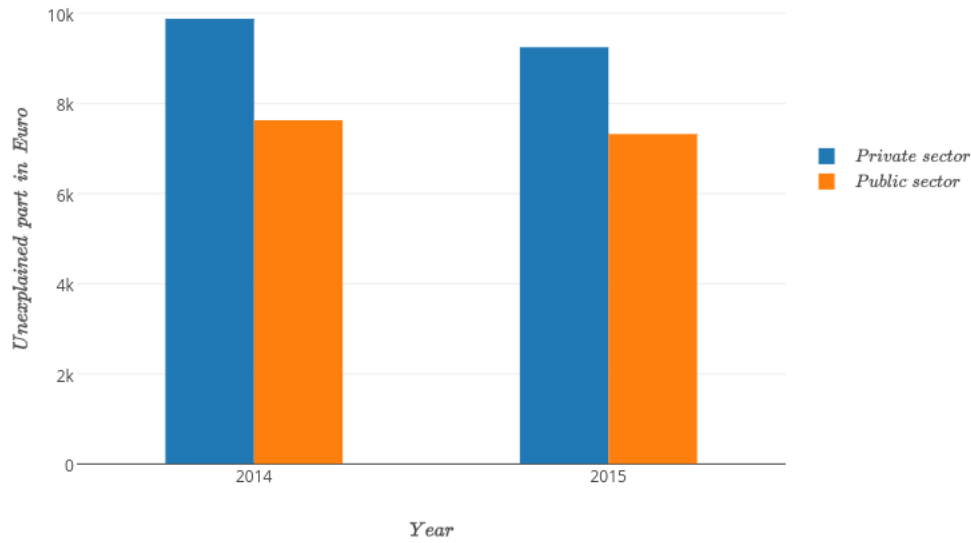


Figure 10: Private versus public Belgian gender wage gap comparison of 2014 and 2015

However, based on the WageIndicator data, the gender wage gap is larger when the analysis is restricted to full-time workers, than when it is analysed for the part-time workers only as can be seen in Figure 11. This is the complete opposite of the results presented by Delmotte et al. (2010), where it is the part-time regime gender wage gap that is relatively larger. A reason for such a shift could be that we weren't able to use the full-time equivalent wage, which means that the dataset probably contains a lot more female part-time workers than male part-time workers. If women are overrepresented in the part-time sub-sample, this would result in a lower gender wage gap for the part-time regime. Usually, women opt more for part-time contracts than men do (Booth & Van Ours, 2008). When analysing the composition of the datasets in Table 6 and Table 7, remember that for the variable GENDER the value 0 equals to male and 1 to female, while the value 0 of the full-time variable represents the part-time workers and the 1 full-time workers. We can definitely note that male workers are more strongly represented in the full-time regime sub-sample, while the female workers are more strongly represented in the part-time regime sub-sample.

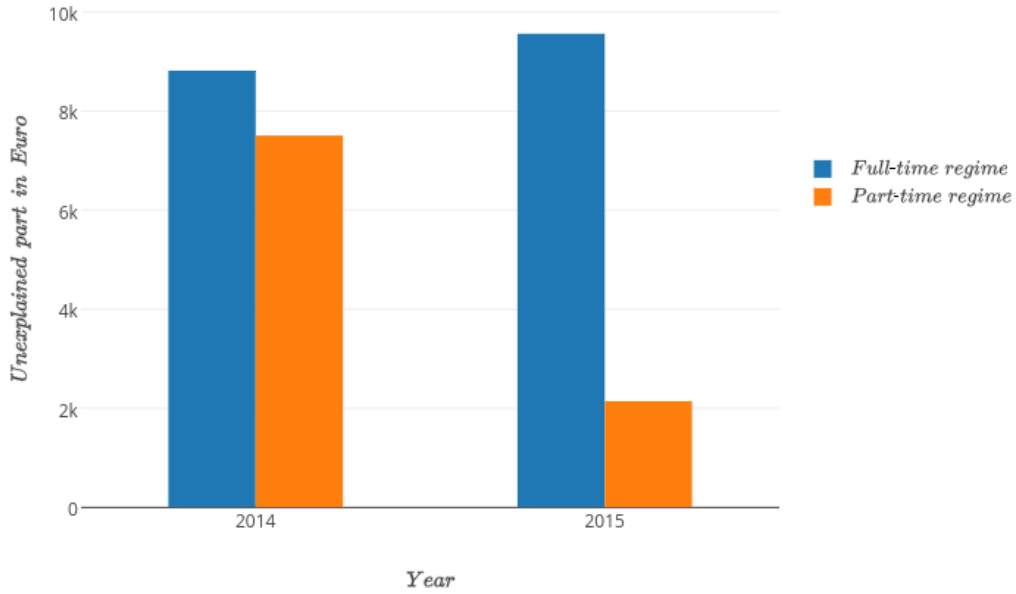


Figure 11: Full-time versus part-time regime Belgian gender wage gap comparison of 2014 and 2015

		Full.time	
		0	1
GENDER	0	106	1241
	1	147	974

Table 6: Cross table GENDER  $\times$  full.time for 2014

		Full.time	
		0	1
GENDER	0	60	664
	1	85	555

Table 7: Cross table GENDER  $\times$  full.time for 2015

Therefore it can be concluded that this is a determinant factor in such a switch in the gender wage gap of our findings compared to those of Delmotte et al. (2010). As a result, we cannot conclude that the gender wage gap of full-time workers is bigger than the gender wage gap of part-time workers.

Moreover, the gender wage gap based on the type of contract can be found in Figure 12. As expected from the study of Delmotte et al. (2010), the gender wage gap is the biggest for other contracts, such as apprentice contracts, no written contracts and so on, and the smallest for temporary contracts. This observation is the same for both years. Note that the difference in gender wage gap between 2014 and 2015 is not negligible. However, the relative differences between the gender wage gaps according to the type of contract remain quite constant if we compare 2014 and 2015.

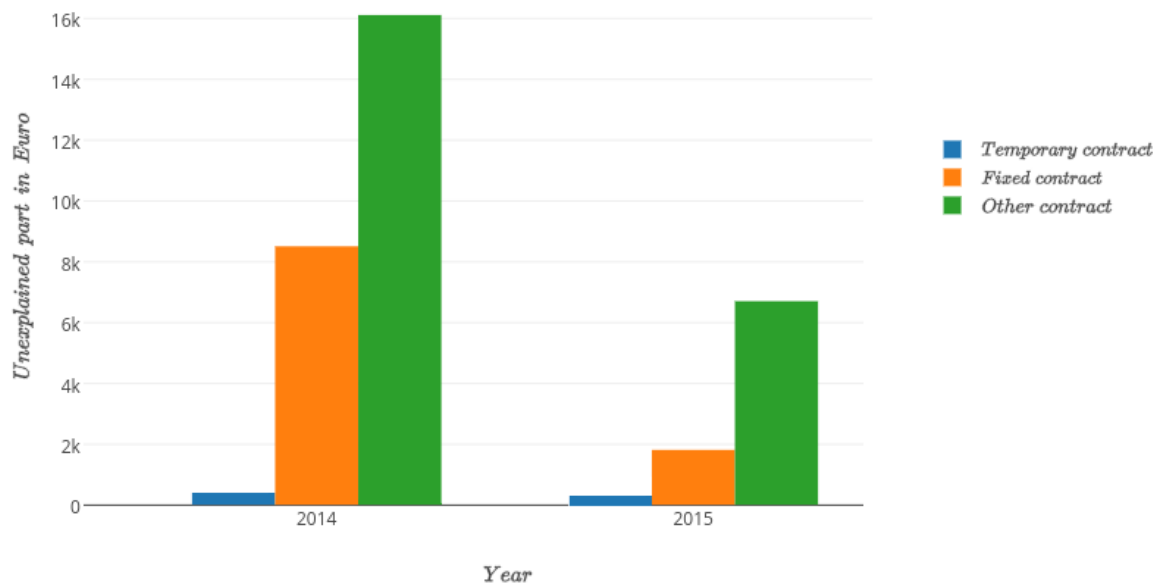


Figure 12: Belgian gender wage gap according to contract type for 2014 and 2015

#### 4.4.2 Human capital

The wage pay-off of an additional year of age is greater for male workers by €432,06 as was previously discussed in the results of 2014 in Section 4. The gender wage gap increases with the age of the workers, which is exactly the same finding as Bevers et al. (2007). However, the findings about the education of the workers have been previously discussed in Section 4, in the paragraphs about the results of 2014 and the results of 2015. Therefore, these will not be discussed again here.

Moreover, Delmotte et al. (2010) have found out that the gender wage gap increases with the seniority. As can be seen in Figure 13, we found consistent results for both 2014 and 2015. The relative difference in gender wage gap between the work experience groups appears to be approximately the same for 2014 and 2015.

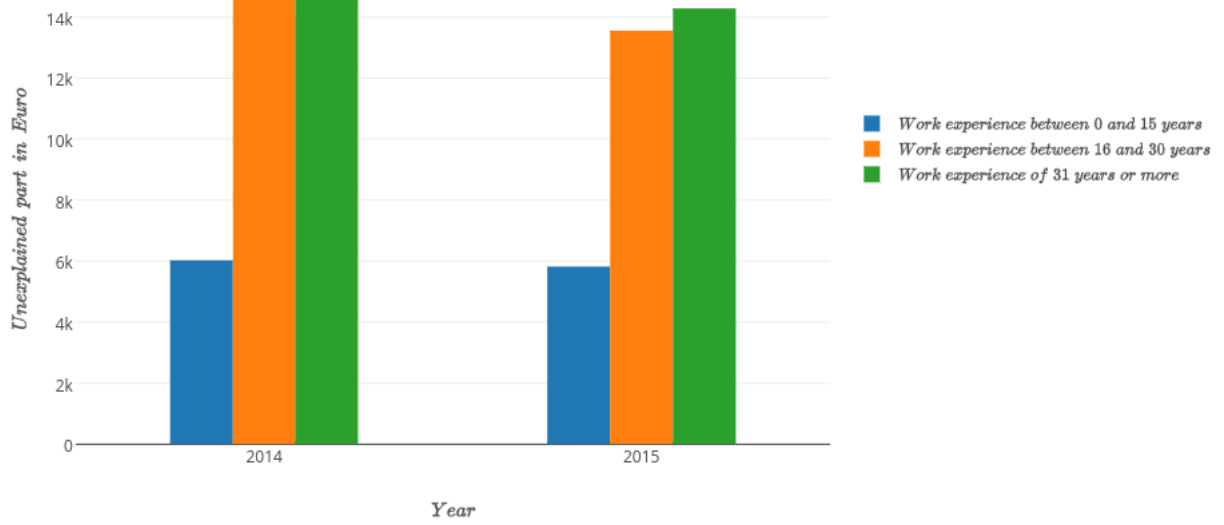


Figure 13: Belgian gender wage gap divided into 3 work experience groups for 2014 and 2015

#### 4.4.3 Function characteristics

When having authority, the Belgian gender wage gap seems to be much larger (Delmotte et al., 2010). This hypothesis appears to be true for 2015, however this is not the case for 2014, where the gender wage gap is bigger for individuals without any authority.

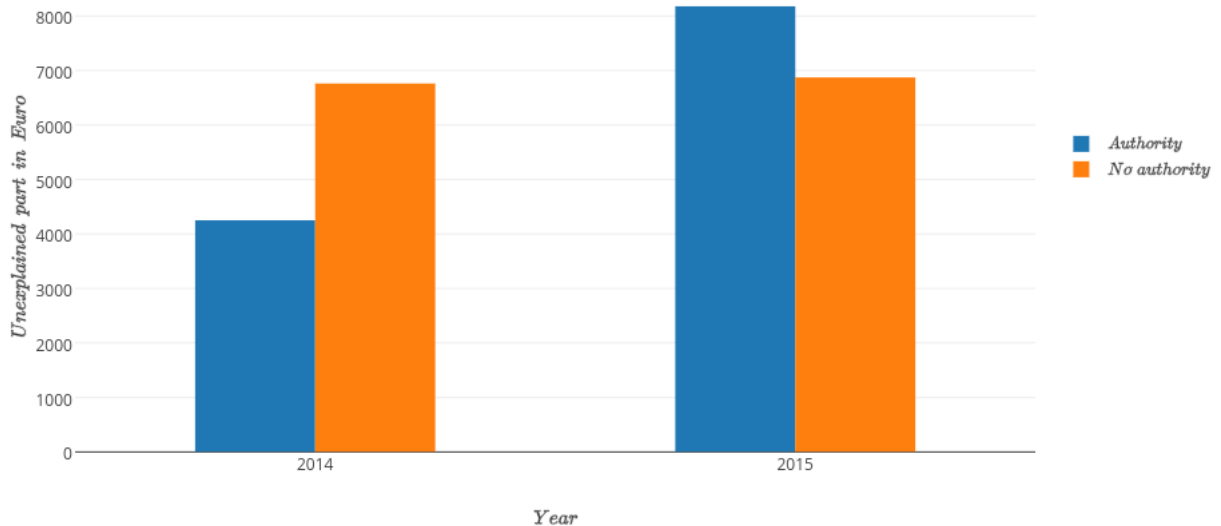


Figure 14: Authority versus no authority Belgian gender wage gap for 2014 and 2015

This difference in the pattern can be due to the fact that in 2014 men are more than two times more strongly represented in the subsample containing only workers with authority. This could result in a reduced gender wage gap for workers with authority as is the case in 2014.

#### 4.4.4 Organization characteristics

In order to have an estimation of our dataset's vertical segregation, where the career progression of women is obstructed over the years, we will compare the number of women and men having a position with authority and those without any authority. Moreover, we will also analyse how the authority develops over time with the work experience of women, by analysing a graph based on a cross table of the two latter variables. Linear regressions will be made of the graphs in order to have a grasp of the evolution of the attribute authority over the gain in work experience (and therefore over the years).

As can be seen in Table 8 and 9, both women and men are more represented in the no authority class. However, for both years, women without authority are more numerous than men without authority and vice versa, there are more men with authority than women with authority.

		authority	
		0	1
GENDER	0	876	524
	1	947	221

Table 8: Cross table GENDER  $\times$  authority for 2014

		authority	
		0	1
GENDER	0	479	269
	1	542	123

Table 9: Cross table GENDER  $\times$  authority for 2015

To have a sense of the glass ceiling that may be present in the Belgian labour market, we will analyse how the number of men and women with authority evolve over the years of work experience. An additional linear regression is performed in order to make an estimation of the evolution. A linear regression is represented by the following general formula:  $f(x) = ax + b$ . Evidently, if the regression coefficient  $a$  is positive, it means a positive relationship, while if the regression coefficient  $a$  is negative, the relationship will be negative.

Figure 15 and Figure 16 have been defined by dividing the male population per work experience year and taking the percentage of men having a job with authority and the percentage of men without any authority per work experience year. Such visualization allows us to examine the evolution of the position of men over their career. For both 2014 and 2015, we can clearly see that with relatively few work experience, there are more men without authority than with authority, which is evident. With the men's work experience growing, they access higher positions with authority, which can be deduced from the linear regression  $f(x) = 0,00832x + 0,0969$  for 2014 and  $f(x) = 0,00623x + 0,301$  for 2015.



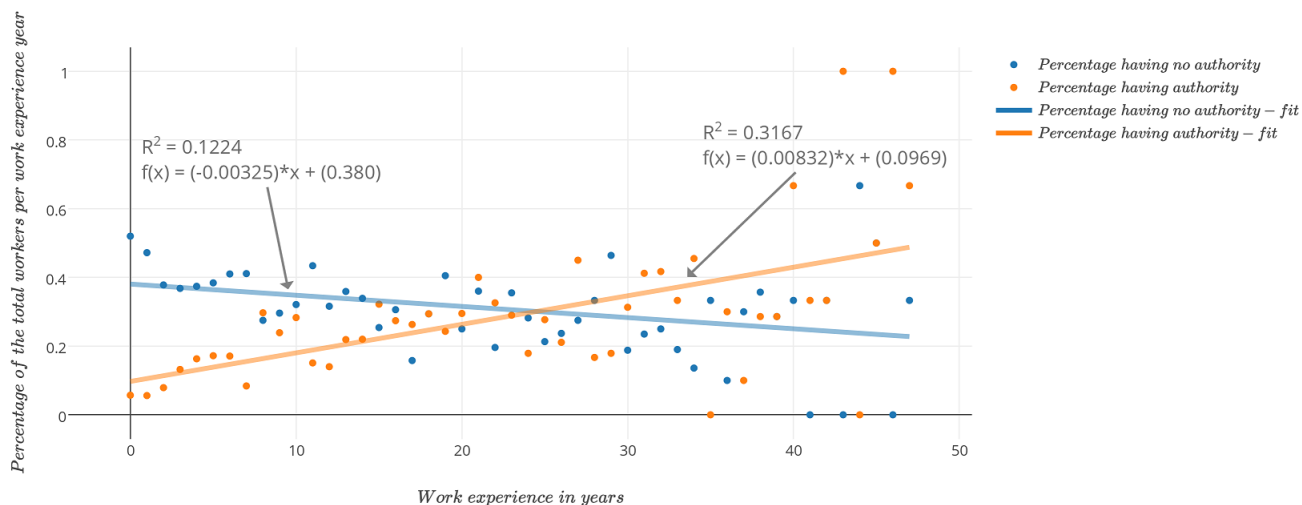


Figure 15: Linear regression of the work experience in terms of number of males having a job with authority or no authority in 2014.

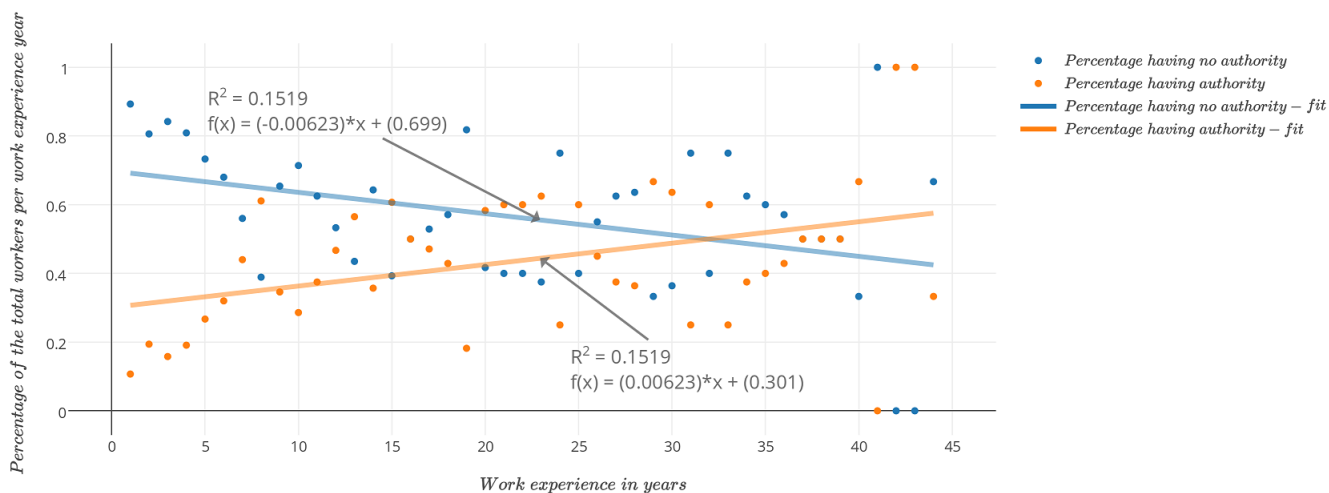


Figure 16: Linear regression of the work experience in terms of number of males having a job with authority or no authority in 2015.

Alternatively, Figure 17 and Figure 18 have been represented for the women’s career evolution. In 2014, the linear regression  $f(x) = 0,00495x + 0,133$  shows a positive relationship between the percentage of women having authority and their work experience. However, we can clearly observe that even though there is a slight evolution in the number of women having positions with authority over the years this is much lower than the men’s career evolution. If we compare the regression coefficient of men (0,00831 for 2014 and 0,00623 for 2015) with the one of women in 2014 (0,00495), we can definitely conclude that there

is a relatively large difference. This difference indicates that women generally have less access to ‘higher’ positions with authority compared to men, and suggests the existence of vertical segregation in the Belgian labour market. Moreover, it goes even further when we consider the linear regressions in Figure 18, where there is even a decreasing percentage of women having authority when their work experience increases as can be derived from  $f(x) = -0,00126x + 0,219$ . This also gives an indication of the vertical segregation that prevails in the Belgian labour market.

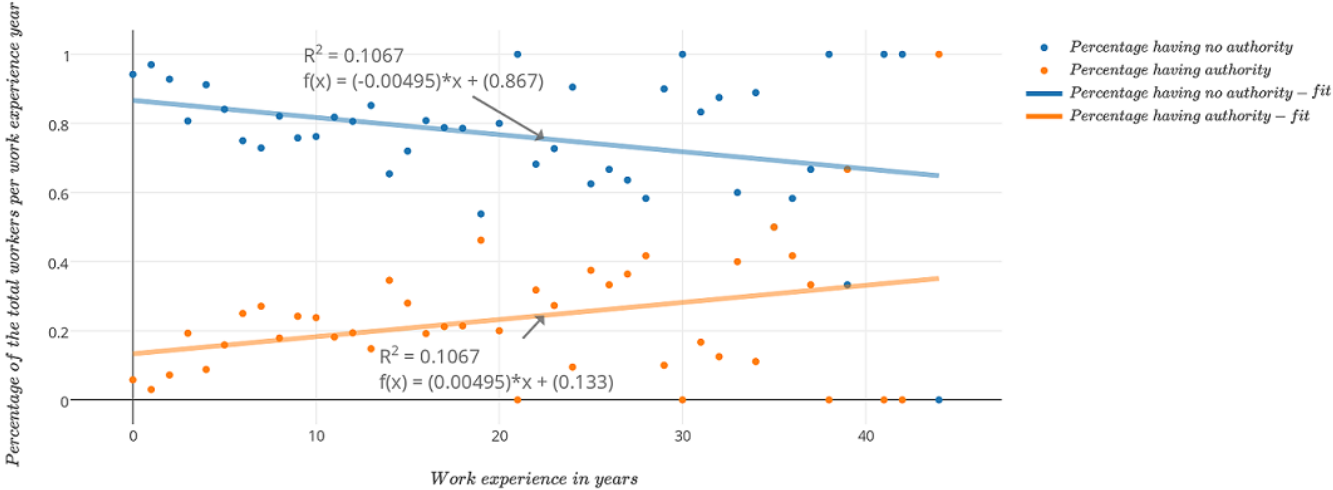


Figure 17: Linear regression of the work experience in terms of number of females having a job with authority or no authority in 2014.

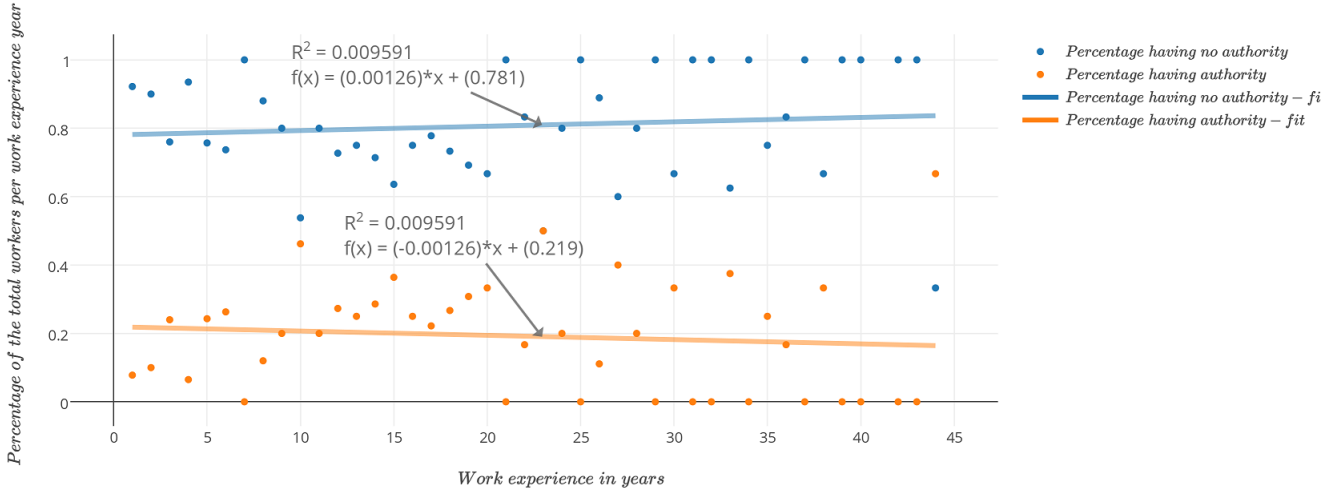


Figure 18: Linear regression of the work experience in terms of number of females having a job with authority or no authority in 2015.

Furthermore, in order to have a sense of the present horizontal segregation in the dataset, we will analyse the distribution of the wages of men compared to those of women. Figure 19 and Figure 20 represent how the wage of both men and women are distributed by representing the wage on the x-axis and the number of workers having a particular x value as wage on the y-axis. For both 2014 and 2015, we can identify some sort of distinction between the two distributions. Women seem to be concentrated on the left hand side of the graphs, whereas men slightly shift to the right of the graph. It appears that men have relatively more “better” paid jobs, while women seem to be stuck in “lower” paid positions.

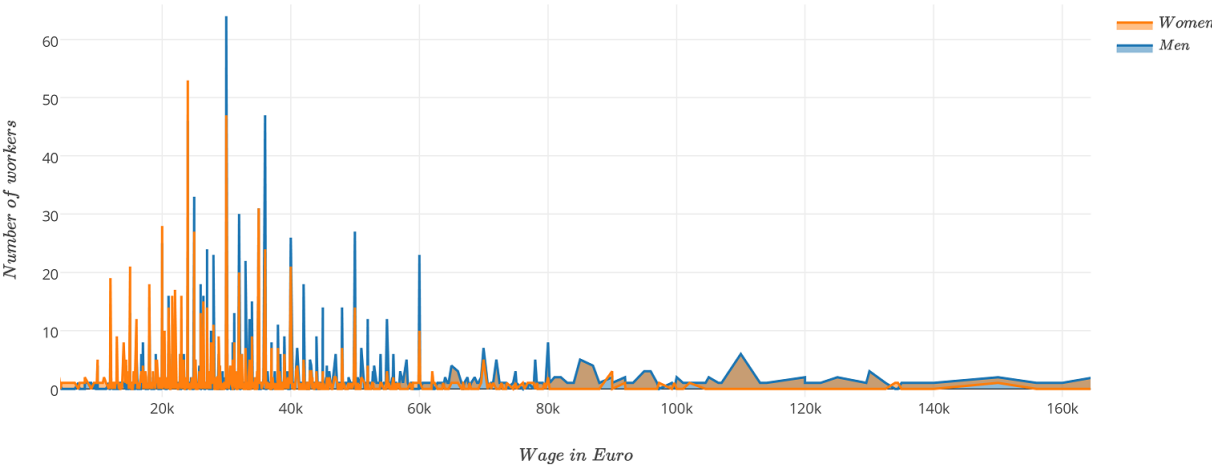


Figure 19: The distribution of the Belgian men and women wages in 2014



Figure 20: The distribution of the Belgian men and women wages in 2015

Figure 21 shows the variations in the Belgian gender wage gap according to the sector. The gender wage gap appears to always be the lowest in the primary sector. However, no clear statement can be done about the sector in which the gender wage gap is the highest, as this is different in 2014 and 2015. In 2014, except for the primary sector, the “higher” the category of the sector, the lower the gender wage gap. While in 2015, it’s the complete opposite, the gender wage gap becomes bigger when we go up a higher class of sector. Delmotte et al. (2010) have found that the gender wage gap is the largest in the tertiary sector, while the lowest in the primary sector. We found the same conclusion for the lowest sector, while the sector in which the gender wage gap is the largest vary. No evident reason explains this difference, perhaps because the chosen datasets do not include the same individuals. Moreover, the reader needs to keep in mind that a low gender wage gap in a particular sector may also signify that the wages for both men and women in that sector are generally low.

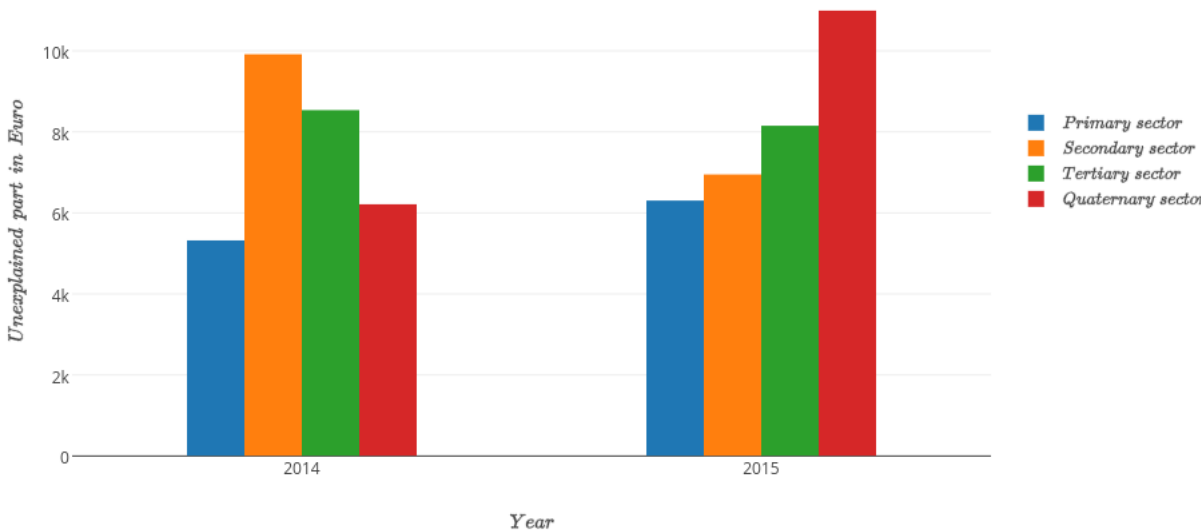


Figure 21: The Belgian gender wage gap according to the sector in which the company of the worker is active for 2014 and 2015.

The size of the organization in which the worker is active also influences the gender wage gap. Generally it applies that the bigger the organization, the bigger the gender wage gap as has been stated by both Bevers et al. (2007) and Delmotte et al. (2010). This pattern appears to be true for 2014 (see Figure 22). However, for 2015 this also seems to be true, with the exception of the gender wage gap in big enterprises of more than 2000 employees. The enterprise gender wage gap seems to be even smaller than the gender wage gap in medium enterprise. Unfortunately, no clear evidence have been found of guidelines or directives that have been put in place in order to achieve such a lower gender wage gap. But, the gender wage gap has

gained more attention in the last years, and especially within big enterprises that are often multinationally active. Equality has become a major part of such enterprises' corporate and social responsibility programs. This all may have resulted in such a steep decrease in the Belgian enterprise gender wage gap.

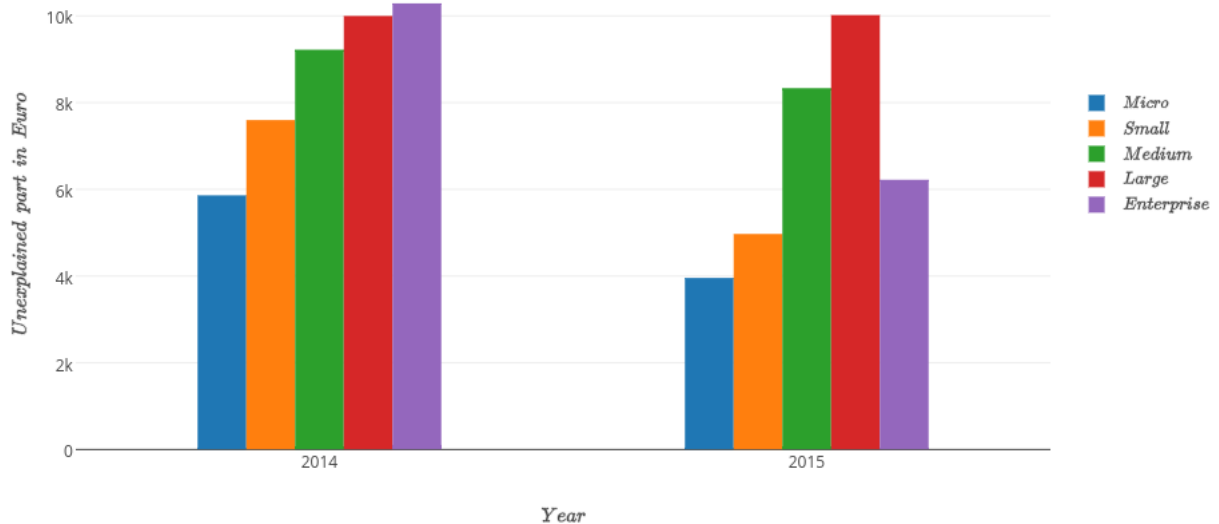


Figure 22: The Belgian gender wage gap according to the size of the organization in which the worker is active for 2014 and 2015.

#### 4.4.5 Family characteristics

Consistent with the pattern described by Delmotte et al. (2010), the difference in wages between men and women is much bigger when the worker has a partner as can be seen in Figure 23. The wage gap of workers with a partner is almost three times bigger than the non-married workers in 2014. For 2015, the gender wage gap of married workers is almost two times bigger than the one of non-married workers. The same pattern can be found in Figure 24, where the gender wage gaps when having children and when having no children is compared. Similarly, the gender wage gap for workers who do have children is way larger than the one of workers without children. This could be related back to the age and work experience of Belgian workers. We have established that the gender wage gap increases if the age of the workers increases too, and the same is true when the seniority of the workers increases. While, generally, Belgian individuals tend to have children in a later stage of their career. Therefore, increased age and work experience could explain the larger gender wage gap when the analysis is restricted to people who have children. Furthermore, when having children, women may also opt for part-time contracts instead of full-time contracts. Men may do so too, but women chose for this option relatively more often (Booth & Van Ours, 2008). We did not use the full-time equivalent, which means that we are using both the

full-time and part-time workers together. If women opt for a part-time contract after having children, this could also explain the larger gender wage gap of workers with children.

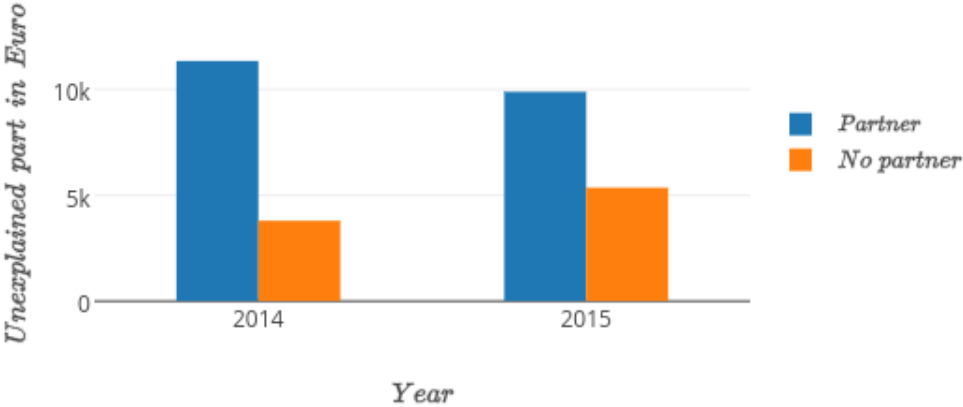


Figure 23: Having a partner versus having no partner Belgian gender wage gap for 2014 and 2015

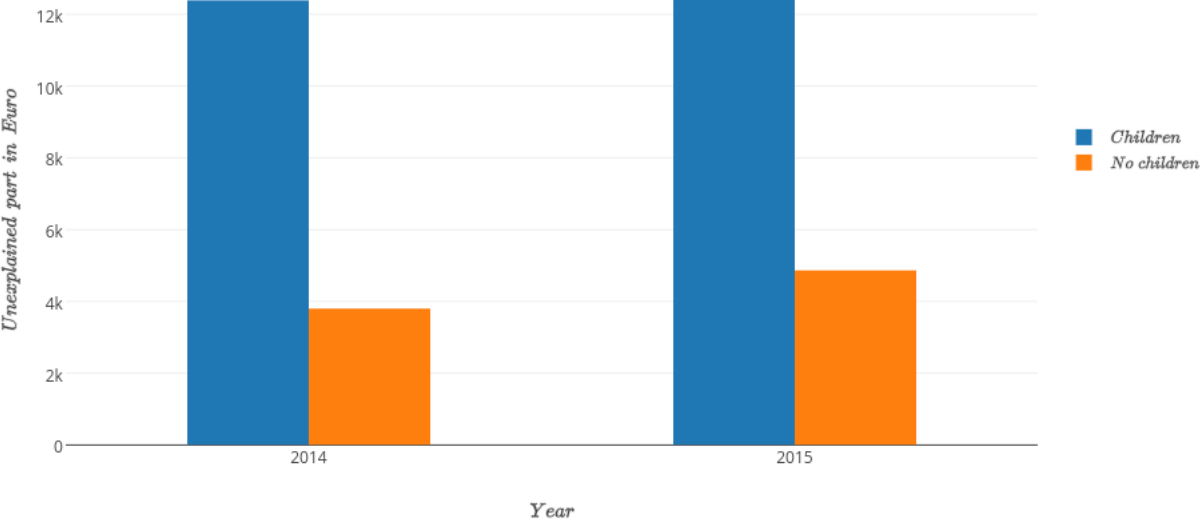


Figure 24: Authority versus no authority Belgian gender wage gap for 2014 and 2015

Also, having Delmotte et al. (2010), stated that the more children a worker has, the bigger the gender wage gap. This seems to be true for our dataset too: the more children a Belgian worker has, the bigger the gender wage gap will be (see Figure 25). Again, this can be related back to the age and seniority patterns that we just defined.

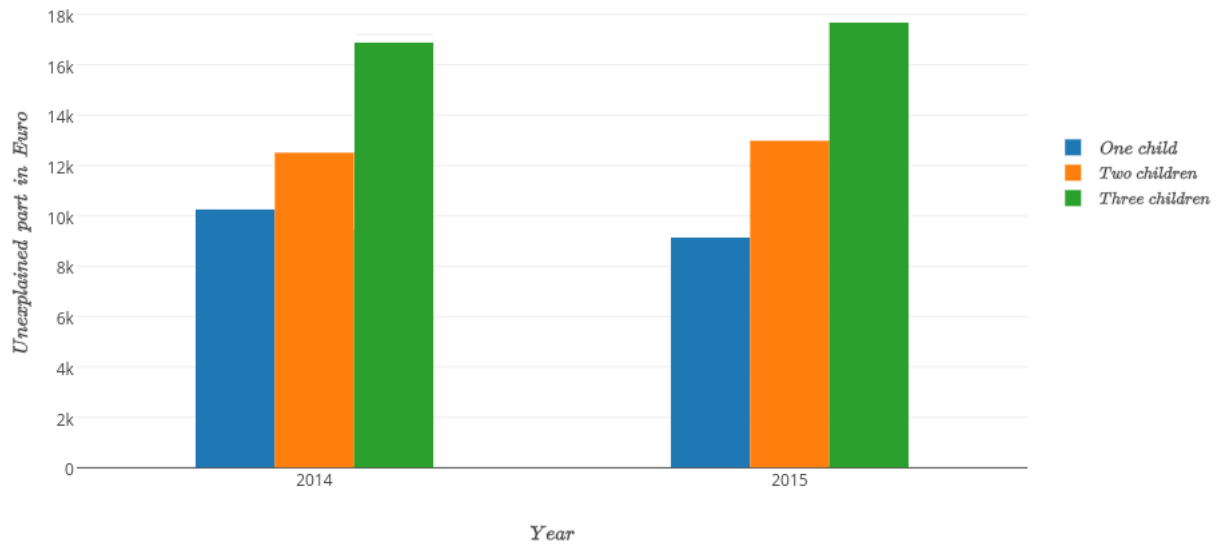


Figure 25: Authority versus no authority Belgian gender wage gap for 2014 and 2015

## 5 | Conclusions

### 5.1 Summary and contributions

The phenomenon where women seemingly earn less money than men in the labour market, while performing essentially identical efforts is depicted as the gender wage gap. They earn less if we compare men's and women's wages based on objective criteria, and cannot explain this difference. The latter difference can then only prudently be assigned to discrimination. This particular problem of the gender wage gap appears to be a tenacious problem and cannot be ignored. Belgium hasn't been spared and the gender wage gap is an issue that seems to continue to survive and thrive.

However, it appears that the gender wage gap in the Belgian market has decreased with 3% from 2014 to 2015. The unexplained part of the gender wage gap has diminished with a force portion of €466,87 in a year. Moreover, the only variable that attained a statistically significant influence on the Belgian gender wage gap is the variable age. Furthermore, the unexplained gender wage gap in both 2014 and 2015 can be attributed to discrimination, however only conscientiously. The discrimination against women seems to be larger than the discrimination in favour of men, meaning that the unexplained gender wage gap is more due to women being discriminated than to men being favoured.

The patterns present in the Belgian gender wage gaps of 2014 and 2015 have been assessed to find out whether these correspond to the findings of the study of Delmotte et al. (2010). For the two studied years, the gender wage gap seems to be higher for the private sector than for the public sector. The presence

of rigid wage determination structures in the public sector is a plausible reason for this difference. The gender wage gap also appears to be larger when the analysis is restricted to full-time workers, than when it is analysed for the part-time workers only. This is contradictory to what Delmotte et al. (2010) found, but our findings could have been biased by the fact that we couldn't use the full-time equivalent wage for the analysis and the overrepresentation of women in the part-time subsample. The subsample containing only workers with temporary contracts has the smallest gender wage gap as was expected from the study of Delmotte et al. (2010). Moreover, workers with other contracts encounter the biggest gender wage gap.

The wage pay-off of an additional year of age is greater for male workers by €432,06 compared to women. Therefore, the gender wage gap increases with the age of the Belgian workers. Consequently, the gender wage gap increases with their work experience. Moreover, based on the work of Delmotte et al. (2010), the gender wage gap should be larger when the Belgian workers attain job positions with authority. This seems to be true for 2015, however not for 2014. The strong overrepresentation of men with jobs with authority appears to be a determinant factor in the reduced gender wage gap for workers with authority in 2014. Furthermore, both vertical and horizontal segregation seem to be present in the Belgian labour market in both years. The vertical segregation becomes apparent when women face the glass ceiling as can be proven by the decreasing percentage of women having authority when their work experience increases over the years. The presence of a horizontal segregation was proven by men having "better" paid jobs and women being stuck in "lower" paid positions.

The Belgian gender wage gap is the smallest in the primary sector of the Belgian industry. However, no clear statement can be made about the sector having the largest gender wage gap, as this is the secondary sector for 2014 and the quaternary sector for 2015. Moreover, consistent with the findings of Delmotte et al. (2010), the bigger the organization, the bigger the gender wage gap. This appears to be true for 2014 and 2015, however for 2015 the gender wage gap in big enterprises appears to be much lower. The gained attention to the gender wage gap phenomenon in enterprises' corporate and social responsibility programs could be a valid explanation for this change. Moreover, the gender wage gap seems to be increasing when a worker is married and when he or she has children. The more children a Belgian worker has, the larger the gender wage gap will be.

## 5.2 Limitations

Unfortunately, the 3% decrease in the Belgian gender wage gap from 2014 to 2015 cannot be compared to the results of other studies. First of all, other studies don't use the same dataset and therefore get slightly or completely different results than the ones of this study. The chosen source of data for this study also contains certain drawbacks such as an underrepresentation of the male labour force, part-timers, older age groups and low educated persons. The WageIndicator Survey dataset is a convenience sample, which means that representativeness cannot be assured and the results can therefore not be generalized for the whole Belgian population. Secondly, the decomposition methods used in alternative studies are different



from the one used in this study or the Oaxaca-Blinder decomposition method is used but with different assumptions. The uncertainty of the decomposition method has already been shown with the available standard errors and the choice of weights for the non-discriminatory vector for the two-fold decomposition. Therefore, the volatility between different decomposition methods can definitely not be ignored. Moreover, the computation can also be different. The *oaxaca* package in R has been used for this study, while other possible implementation and computations are possible, resulting in different results. Finally, women seem to be more present in lower paying positions or work more on a part-time basis in the WageIndicator dataset. These facts also bias the gender wage gap towards a larger outcome.

### 5.3 Future work

The WageIndicator Survey is an extensive dataset that contains information about not less than 47 countries. Therefore, the same study could be conducted for the other 46 available countries. The WageIndicator Survey is performed every year, thus the evolution of the gender wage gap over bigger periods could be done and predictions could be made about the coming years. Other related topics such as the glass ceiling effect and the sticky floor could be further studied based on the, almost, freely available WageIndicator Survey.

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