The Effect of Firm Size on Gender Wage Discrimination in the Netherlands

Abstract
Despite the introduction of several restrictive regulations in the past decades, evidence of gender wage discrimination is still commonly found in the Netherlands. This study aims to create a better understanding of this phenomenon by linking it with the firm size-wage effect, a commonly observed relationship between firm size and wages. An extensive Mincerian wage equation is estimated using a generalized linear model with Huber-White standard errors on yearly panel data. The results indicate the existence of a significant interaction effect between the FSWE and gender wage discrimination in the Netherlands.

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This paper makes use of data from the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by CentERdata (Tilburg University, The Netherlands).

Contents

1. Introduction

Differences in the average wage earned by men and women, more commonly referred to as the gender wage gap, have frequently and persistently been observed in most developed economies globally. While the phenomenon is often deemed socially undesirable and inequitable, the complexity of defining and disentangling its causes makes it a challenging and controversial subject for policy intervention (Cain, 1986).

In the European Union (EU), elimination of gender wage discrimination has been a fundamental policy objective since the Union's inception in the EC Treaty of 1957, which unequivocally states that each member *"shall ensure that the principle of equal pay for male and female workers for equal work or work of equal value is applied"* (U.N.T.S., 1957). Later, in 1999, the Treaty of Amsterdam strengthened the EU's commitment to gender equality by creating an obligation for its member states to not only eliminate inequalities but also to actively advocate equality between men and women.

While several regulations and guidelines are thus in place to protect individuals from gender discrimination in the labour market, the earlier mentioned complexity in disentangling its causes still make it a challenging policy objective. A recent study in the Netherlands, a founding member of the EU, confirmed persisting gender wage differentials not attributable to indicators of human capital[1] such as education or experience (van Doorne-Huiskes & Luijkx, 2014). It thus seems that, at least in the Netherlands, the current policies are insufficient in tackling the gender wage discrimination.

Nevertheless, it is important to note that there is a possible discrepancy in the definition of a gender wage gap employed in the aforementioned study and as defined in the EU's treaties. The notion of *equal work* is unfortunately difficult to measure in practice, and is often substituted for the more easily measured worker productivity. Accordingly, Doorne-Huiskes & Luijkx make use of individual indicators of human capital in a regression. While such methods are frequently employed, some factors other than worker productivity are commonly shown to have a significant influence on wages.

For a more concrete understanding and quantification of the gender wage gap it is important to analyze which factors may have a discriminatory influence on wages, without

[1] The term human capital was introduced by Becker (1964), and assumes that the extent of an individual's investment into skills development (such as schooling and work experience) increases their productivity and is therefore expected to positively affect their earnings.

an exclusive focus on human capital indicators.

A notable and frequently observed wage predictor is the size of the firm one is employed at, more commonly referred to as the *firm size-wage effect* (FSWE) (Brown & Medoff, 1989; Criscuolo, 2000). After accounting for several indicators of human capital, Akar, Balkan & Tümen (2014) found an interaction effect between firm size and gender wage discrimination in Turkey, indicating the FSWE could be a valuable contribution to a quantification of the gender wage gap.

While the results found in Turkey possibly are present in other countries as well, no research on the FSWE and its applicability to gender wage discrimination in the Netherlands has been conducted. From a policy perspective, a deeper understanding of the effect the FSWE has on gender wage discrimination, and whether such effects are indeed present in the Netherlands, might provide valuable insights for both Dutch and European policy makers.

Research Question: *What is the effect of firm size on gender wage discrimination in the Netherlands?*

In this paper, important factors on gender wage discrimination and the FSWE will be addressed in theoretical framework, after which a range of academic literature into these fields will be reviewed. Based on the theoretical framework and literature review, concrete expectations regarding the interaction between firm sizes and gender wage discrimination in the Netherlands can be formed. Subsequently, these will be tested in an empirical setting after the structure and analysis methods have been discussed in the data & methodology section, which will provide an answer to the research question, as well as highlight any possible additional findings. Lastly, the limitations of this research will be discussed, as well as policy recommendations and suggestions for further research.

2. Theoretical Framework

2.1. Labour market discrimination

The existence of wage discrimination in the labour market has been indicated by many studies in the past centuries, and was a phenomenon which classical economic theory was unable to explain. That changed with the publication of Gary Becker's *The Economics of Discrimination* in 1957, which provided a major breakthrough and a formal approach to analyzing discrimination in the labour market. Becker's analysis was based on the assumption that labour market participants have a specific "taste" for discrimination towards other market participants, causing some employers to regard certain workers more expensive than they actually are.

Using the example of market participants having an aversion to cross-racial interactions in a short-run model of relative demand, Becker showed how pressures in the labour market cause black workers to find employment from the least prejudiced employers, and thus automatically sort out of the most prejudiced employers. The equilibrium wage for black workers in then decided by the marginal discriminator – the most prejudiced employer that still employs black workers. As an increase in the number of black workers would require employment at increasingly prejudiced employers, the wage gap would rise. Similarly, an increase in overall prejudice, keeping the number of black workers fixed, would cause a rise in the wage gap (Becker, 1957). Although Becker used a racial wage gap, the theory's foundation on employer taste makes it widely applicable for most discriminatory factors, including gender.

While Becker provided the first model on labour market discrimination with precise predictions, it received sharp criticism for possible theoretical flaws. In his famous criticism, Arrow (1971) argued that in a fully competitive market discrimination by employers would force them to sacrifice profits, and that as such in the long run, prejudiced employers must ultimately be driven from the market. Nonetheless, if a market were to be not perfectly competitive, Arrow agreed that Becker's proposed relationship between prejudice and wages would be able to survive in the long run.

Others have argued that the observed wage inequalities need not necessarily arise due to an employer's "taste", and that these might be due to other reasons such as imperfect information (Phelps, 1972; Altonji & Pierret, 2001). Nevertheless, such notions have predominantly aimed at refining Becker's theory on discrimination, instead of completely rejecting it. As such, the theory is generally regarded as a useful starting point in defining and explaining labour market discrimination.

While Becker's theory provided labour economists with a theoretical explanation to the occurrence of the gender wage gap, it was unsuitable to be used in an empirical setting, and as such, they remained unable to make a quantification on the exact size of the gap. An important contribution to empirical analyses on the gender wage gap was made in 1974, when Mincer published his now-famous model of earnings (Mincer, 1974), more commonly referred to as the Mincer equation. Based on his 1954 publication on compensating wage differentials for education, Mincer proposed earnings to be a function of both formal schooling and on-the-job investment:

$$\ln[w(s,x)] = \alpha_0 + \rho_s s + \beta_0 x + \beta_1 x^2 + \varepsilon \qquad \textbf{(1)}$$

where $w(s,x)$ is the wage at education level s and work experience x, ρ_s the rate of return to schooling (with no separation between levels of schooling), and ε is a mean zero residual with $E(\varepsilon|s,x) = 0$ (Mincer, 1974). The quadratic expression for work experience $\beta_1 x^2$ was introduced by Mincer to describe cross-sectional and longitudinal patterns of wage growth often observed in careers (Heckman, Lochner, & Todd, 2003).

In applications of the Mincer equation it is often assumed the intercept α_0 as well as the coefficients ρ_s, β_0 and β_1 are identical across individuals, and thus an individual's gender is not taken into account. In order to further disentangle wage differences and to find the possibility of wage inequalities that seem to be due to gender differences, gender is often included as an additional predictor variable. [2] Accordingly, a basic form of the Mincer equation introducing gender effects is commonly employed to study gender wage discrimination:

$$\ln[w(s,x,g)] = \alpha_0 + \rho_s s + \beta_0 x + \beta_1 x^2 + \beta_2 g + \varepsilon \qquad \text{where } g = \{f,m\} \qquad \textbf{(2)}$$

where g is introduced as an individual's gender. Further specification of the model is similar to Mincer's original equation (1).

[2] A noteworthy and commonly observed alternative method of introducing gender into equation (1) has been developed by Oaxaca (1973) and Blinder (1973), who use separate intercepts and coefficients for males and females.

Finally, it must be noted that equation (2) is a highly generalized model for studying the gender wage gap, and that since the publication of Mincer's original model several additional factors have been found to affect wages. For an appropriate theoretical base, it must be determined which additional factors are important for inclusion in a labour market discrimination context. One of such factors is the FSWE, which will be discussed in the upcoming subsection.

2.2. The Firm Size-Wage Effect

The relationship between firm size and wages was first discovered by Moore (1911). After reviewing data on the daily wages of women in the Italian textile industry, Moore found that correlation between the rate of wages and the size of the establishment was significantly larger than between the rate of wages and the age of the worker (.318 and .25 respectively). Moore observed two additional findings: (i) the relationship between a worker's age and wage was the same in firms of different sizes, and (ii) the larger the firm, the higher the wages at all ages.

Moore hypothesized that the abovementioned findings were caused by large firms using more fixed capital as well as being better organized, and that as a result they are able to benefit from and select efficient laborers more effectively, and thus can offer higher wages than smaller firms (p. 163). In later decades, several alternative theoretical explanations for the FSWE have been proposed in the academic literature. Due to this study's focus on the occurrence of labour market discrimination - a phenomenon which theoretically could only exist in conditions of imperfect markets[3] - two of the proposed explanations seem most suitable for discussion due to their assumptions of imperfect competition in either the labour or product markets. [4]

Firstly, Doeringer and Piore's (1971) description of an internal labour market (ILM) – an administrative unit such as a firm in which the price and allocation of labour is governed internally – provides a possible explanation to the FSWE. In an ILM, worker performance is measured internally, something which Doeringer and Piore believe can be done more efficiently by larger firms due to the use of scale advantages. As such, the increased accuracy on estimating worker profitability allows larger firms to make better selections on which workers to retain, and thus be able to offer higher than average wages to those it chooses to retain. Additionally, in a labour market discrimination context, a more accurate estimation of worker profitability could decrease the reliance on possibly taste-biased subjective estimations. As a result, the gender wage gap is expected to be lower for larger firms.

Secondly, several authors have highlighted the possibility of monopsony effects in the

[3] As proven by both Becker (1957) and Arrow (1971).
[4] Interested readers are encouraged to consult Criscuolo (2000) for an excellent review on other proposed explanations of the FSWE.

labour market. The most notable study is undertaken by Green, Machin & Manning (1996), who describe a dynamic monopsony model. Contrarily to a static monopsony model, a dynamic monopsony model still allows for the simultaneous existence of multiple employers in the labour market.

Where in a perfectly competitive labour market firms paying above the market wage would instantaneously attract all workers, a dynamic monopsony model assumes that it takes some time before changes in the wages offered by a firm affect the supply of labour. Nevertheless, firms paying above average wages still experience lower quit rates and find recruitment easier, and are therefore able to capture a larger part of the labour market over time, whereas firms paying below the average wage shrink in size. And, using the same logic, a large firm can therefore only maintain its size if it pays relatively higher wages.

While such dynamic monopsony explanations of the FSWE have not focused on labour market discrimination, using Becker’s taste-theory large firms could possibly prevent wage increases by reducing the impact of their taste preferences, and thus paying the generally discriminated group wages more similar to those received by other groups. Again, this would result in a smaller gender wage gap in larger firms.

It remains important to note that while the direct definition of FSWE is concerned with firm size, the phenomenon and its proposed explanations need not necessarily relate only to overall firm size (in which all branches of a firm are grouped). The ILM and monopsony models are equally suitable for an application using branch or plant sizes, as noted by, among others, Albaek (1998) and Manning (2003).

Concluding, while in the academic literature no specific theory combining labour market discrimination and the FSWE has been proposed yet, a certain level of compatibility between their separate proposed theoretical explanations can be observed. Such compatibilities provide a theoretical justification for the use of a joint approach as employed in this study.

Whilst Mincer’s equation provides the foundation needed for an analysis of gender wage discrimination in an empirical setting, unfortunately no such concrete method exists for an analysis of the FSWE. The following section will therefore provide a review of researches with a specific focus on the FSWE, after which a review of more comparable researches adopting a combinatory focus on labour market discrimination and the FSWE can be conducted.

3. Literature Review

Evans & Leighton (1989) examined wage differences on an individual basis using a longitudinal panel survey of 5,225 males living in the US. While they found that common predictors of human capital were only able to explain about a third of the wage differences in the panel, once a fixed individual effect was introduced as an indicator for unobservable ability characteristics over 60 percent could be explained. Additionally, when firms with less than 25 employees were excluded from the analysis, over 99 percent of the wage differential could be explained by the observable and unobservable human capital indicators combined. These findings suggest that the wages offered by larger firms are more closely related to (unobserved) worker productivity than those offered in smaller firms, and support the earlier mentioned ILM theory of the FSWE.

Contrarily to the results found by Evans & Leighton, Brown & Medoff (1989) find that while a fixed individual effect does reduce the FSWE, a sizeable effect still remains. After analyzing several datasets on the United States related to population, employment quality, employee compensation, and wage distribution, they proposed a set of ten stylized facts much more detailed than those found in earlier works on the FSWE:

i. The FSWE is both an establishment- and a firm-size effect
ii. Even when workers are grouped by collar type, union membership, or industry, those working for larger firms receive higher wages
iii. The FSWE is smallest (in relative terms) in the highest pay grades
iv. Assessing job-movers between firms does not significantly reduce the FSWE
v. Worker retention is much higher at larger firms, even holding wages constant
vi. The FSWE persists in contexts of unionization threats
vii. Controlling for industries does not noticeably affect the FSWE
viii. Large firms more often have single-rate wage policies for specific job categories
ix. The single-rate wage policies do however not lead to lower wage dispersion for larger firms due to larger between-occupation dispersion
x. Even among piece-rate workers, larger employers pay higher wages.

Despite the extensive set of stylized facts presented by Brown & Medoff, they admit being *"uncomfortably unable"* to fully explain the FSWE, and they offer two observations which might contribute to an explanation. First, they argue that while larger employers have higher expenditures on labour, they can compensate these with lower expenditures on their other inputs due to them being charged a lower interest rate for loans as well as quantity discounts for their purchases. Second, they noticed that larger firms also tend to be older firms, and that it could be possible that the FSWE is actually more of a relationship between employer age and wages.

Additionally, a study by Criscuolo (2000) using a panel dataset on 1% of the German labour force from 1975 to 1995 was also unable to replicate Evans & Leighton's result. While the use of individual indicators representing unmeasured worker heterogeneity (in addition to standard human capital indicators) significantly improved wage predictions for job movers, it could only partly explain the observed FSWE effects. Additionally, Criscuolo found that unobserved heterogeneity in the firms also served as a significant predictor of wages when assessing movers in the labour force – and that therefore, after accounting for firm size, some firms pay consistently higher wages than other firms.

A particularly interesting study is undertaken by Albaek et al. (1998) who analyzes the FSWE using plant size measures instead of overall firm size. Additionally, with its focus on the Nordic countries (Denmark, Finland, Norway & Sweden) and a results comparison with the United States, it provides one of the few cross-country contributions to the FSWE research. Using comparable data from national registers and surveys, their results suggest that the Nordic countries show similar magnitudes of an unexplained plant-size effect on wages, and that these are comparable to Brown & Medoff's firm-size results for the US. As the Nordic countries and the US are said to have totally different wage bargaining institutions, the authors note that the FSWE is likely to be uninfluenced by national wage policies.

A final noteworthy study on the FSWE is conducted by Lallemand, Plasman & Rycx (2007). Focusing on five European countries (Belgium, Denmark, Ireland, Italy & Spain) through use of a European harmonized matched employer-employee data set from 1995 the paper aims to examine the magnitude and determinants of the FSWE. While a positive FSWE was found in each of the studied countries, contrarily to the study by Albaek et al. the findings suggest that the magnitude of the FSWE fluctuates considerably across countries. Upon closer examination, the authors believe that national collective bargaining characteristics strongly impact the FSWE magnitude, and state that the findings suggest that the FSWE is greater in less corporatist countries.

Concluding, while there exists a copious amount of research on the FSWE, there is no consensus on its cause(s). Studies attempting to quantify the FSWE have either used wage equations similar to Mincer's, or predominantly relied on the use of individual fixed effects for workers and/or firms. It must be noted that while such individual effects are useful in assessing the FSWE through a focus on job-movers, the technique is unfortunately incompatible with an additional focus on gender wage discrimination as it is likely to greatly limit if not omit observable discrimination effects. Nonetheless, the FSWE's existence is robust and consistently holds across studies regardless of region, year, or industry, and is therefore expected to be present in the Netherlands as well.

Now that expectations for the existence of the FSWE in the Netherlands have been justified through a review of a selection of its wide range of existing academic literature, an analysis into researches focusing on labour market discrimination (and with a possible inclusion of the FSWE as well) can be conducted.

By use of an Oaxaca wage decomposition, a wage regression method similar to Mincer's equation, Jolliffe & Campos (2005) assess whether the post-socialism increase in market liberalization in Hungary from 1986-1988 has helped reduce gender wage discrimination. In addition to the predictor variables earlier found in equation (2), the authors make use of dummy variables for eight industry types in order to control for potential differences across industries. Additionally, while there is no specific mentioning of the FSWE, the authors' notion that *"the extent of discrimination may be a function of firm size; […] it might be that larger firms are more rigid in how they evaluate and reward their employees […] and therefore are less likely to discriminate based on sex."* (p. 22) are highly similar to those made earlier by Moore (1911) in an FSWE context. To account for the possibility of such interaction effects, Joliffe & Campos disentangle the aggregate results on the basis of 3 levels for firm size. They find that the largest firms showed the greatest decline in the log wage difference between men and women of 85 percent, compared to 13 percent for the smallest firms. These findings provide support for their earlier notions that gender wage discrimination may be a function of firm size.

Another interesting approach is taken by Akar, Balkan & Tümen (2014), who research the possibility of an informal/formal sector difference in the relationship between the FSWE and gender wage discrimination in Turkey. Using an extensive micro-level data set available yearly from 2006 to 2012, the authors first estimate the firm size wage gap separately using a Mincerian wage equation similar to equation (2) formulated earlier.

These initial estimates show that there is a 16.8% wage gap between the smallest and largest firms in the formal sector, and that the gap increases to 26.7% in the informal sector. Moreover, the results suggest that while the wage gap increases with each firm size increase in both sectors, its slope is steeper in the informal sector. Similarly, Akar et al. estimate separate regressions on the gender pay gap for both sectors and each of their six firm size categories. These results show that the gender wage gap with respect to size is roughly constant in the formal sector, whereas in the informal sector a positive relationship can be found, with the gap being 24% in the smallest firms and 11.5% in the largest ones.

Nevertheless, contradicting results on the existence of a gender wage gap can be found in a recent study by Vandenberghe (2011), which makes use of a matched employer-employee data set to investigate the presence of gender wage discrimination in the private sector labour market in Belgium. While the data set comprising data of 79,220 individuals of almost 9,000 firms can be considered extensive, a lack of information on the level of education is a notable shortcoming. In order to account for this unavailability of data the author creates productivity estimates based on the net value added per worker of the firm an individual is employed at. Additional predictor variables used are a worker's market sector of employment, firm size, gender, and job type ("blue-collar" vs. "white-collar").

Vandenberghe's analysis shows that in small firms the productivity and wage of women diverge from those of men, but that interestingly the wages are misaligned in the sense that women get paid above their productivity. The results also show that in large firms of 100 employees or more, there is no divergence between men and women in terms of productivity and wage. Nevertheless, the amount of predictor variables used is considerably limited, and use of a productivity estimate instead of education levels is an uncommon approach which may be subject to bias.

Turning to a focus on the Netherlands, Tijdens & van Klaveren (2011) provide an excellent review of 20 studies on gender wage differentials in the Netherlands. While some studies used quartile regressions or bivariate analysis, the majority used an OLS approach such as the Mincer equation.

Additionally, some studies have included an individual's marital status in the wage decomposition, and it has been noted to have an insignificant effect if included (Albert, Van

Vuuren, & Vroman, 2004). While inconsistent with many applications of the Mincer equation in other areas of the world[5], the cultural structure in the Netherlands, where increasing secularization in the past decades caused the importance of marriage to decline much faster than in most parts of the world, could provide an explanation for this finding and thus a justification for its omittance in the wage equation.

Based on the literature review it can be concluded that transforming the original Mincer equation (1) to include several additional measures, such as firm size, is a commonly conducted practice and is suitable for an analysis of gender wage discrimination accounting for the size of the firm an individual is employed at.

[5] see, for instance, Toutkoushian, Bellas & Moore (2007) and Hartog (2011).

4. Data & Methodology

In order to analyze the effect of firm size on gender wage discrimination in the Netherlands in an empirical setting, longitudinal data from the Longitudinal Internet Studies for the Social sciences panel (LISS panel) will be used.

The LISS panel currently consists of approximately 8,000 individuals aged 16 and above of 5,000 different households. The panel members are based on a true probability sample randomly drawn from the population register by Statistics Netherlands and the panel is administered by CentERdata. Due to certain individuals not having completed some questionnaires, the panel is unfortunately unbalanced.

The core study of the LISS panel is a longitudinal study consisting of a specific set of questions from a wide array of topics administered in seven annual waves from November 2007 to December 2013. In addition to the core study, several additional studies were conducted over the years. While most of these studies have been conducted on a singular basis, each respondent's unique identifier allows such studies to be used in combination with the core study, and can therefore also provide useful information for longitudinal purposes.

Relevant indicators have been primarily drawn from the *Background Variables* category and the *Work and Schooling* and *Economic Situation: Income* categories of the core study.

The background variables database comprise various general characteristics of the panel members, and are measured each month using a separate questionnaire to ensure these are up-to-date. While some variables relate to the household level, this study will only employ variables at the individual level. While it is important to note that the completion of the questionnaire for an entire household is done by one contact person, the general nature of the variables used should greatly limit the possibility for discrepancies.

As mentioned earlier, the background variables category is of longitudinal form. For practicality purposes only variables which can be classified as preceding to wages will be used from this particular dataset, so that individual values can be matched to longitudinal variables from the second category used without much consequence. The variable *Gender* is selected as it is unarguably the most necessary indicator in a gender wage discrimination context. This study will further use a selection of additional background variables based on availability and existing empirical research.

Firstly, contrarily to equation (2) mentioned in the theoretical framework, indicators for work experience are unfortunately unavailable in the LISS data set. To compensate for this unavailability of data, an individual's age will be used as a predictor variable, an approach consistent with earlier mentioned studies by Brown & Medoff (1989) and Akar, Balkan & Tümen (2014).

Secondly, the variable *Education* is retrieved for each individual, which is given in six categories as defined by Statistics Netherlands: (i) primary school, (ii) VMBO (intermediate secondary education), (iii), HAVO/VWO (higher secondary education), (iv) MBO (intermediate vocational education), (v) HBO (higher vocational education), and (vi) WO (university). In order to account for possible time order issues, only individuals who stated not to have followed education in the past study period are assessed, and measures on the level of education completed are then taken from the month and year in which wage information is available respectively.

The other data set of the LISS panel which will be used is the core study, from which the categories *Economic Situation: Income* and *Work and Schooling* will be used. The former category focuses on the economic well-being and income of individuals, and includes the variable *Gross wages in the past year*. In order to account for the effect of inflation on wages, this variable will be transformed to a real gross wage (in 2008 terms) measure using yearly inflation rates obtained from the Statistics Netherlands (*CBS*) website. It must be noted that said category only has data availability on the first six waves, and a seventh wave is yet to be conducted. This data unavailability unfortunately restricts the scope of this study slightly to the first six waves only.

Additionally, the work and schooling survey focuses on labour market participation, job characteristics, pensions, schooling, and courses. The survey is completed individually by each panel member, and the reported values are therefore expected to be reliable representations of their true values. In addition to the dependent variable *Gross Wages in the past year*, a selection of variables based on availability and existing empirical research is made for inclusion in a Mincerian wage equation.

Firstly, it is important to note that Mincer's original equation was intended for a relatively small-scale analysis based on a group of individuals that work an equal amount of time. As such, no corrections on the hours worked are present in the Mincer equation. For an analysis of the larger and more heterogeneous group of individuals present in the LISS panel it is important to include the amount an individual has worked, as noted by many authors such as Vandenberghe (2011) and Green, Machin & Manning (1996). The variable *Hours worked per week on average* present in the survey will therefore be used as a predictor of wages.

Secondly, the literature on the FSWE has frequently included an individual's occupation for its disentanglement (Brown & Medoff, 1989; Criscuolo, 2000), and it might also show to have an effect on gender wage discrimination. The variable *Occupation* available in the work and schooling survey is therefore another important addition to a wage equation, and is given in nine categories: (i) agrarian profession, (ii) unskilled and trained manual work (e.g. cleaner), (iii) semi-skilled manual work (e.g. driver), (iv) skilled and supervisory manual work (e.g. car mechanic or foreman), (v) other mental work (e.g. accountant), (vi) intermediate supervisory or commercial (e.g. department manager), (vii) intermediate academic or independent profession (e.g. teacher), (viii) higher supervisory profession (e.g. director), and (ix) higher academic or independent profession (e.g. physician).

Additionally, studies by Akar, Balkan & Tümen (2014) and Green, Machin & Manning (1996) make a distinction between the (semi-)public sector and private sector in their wage estimations. Consistent with these approaches, the variable *Organization type* will be used, an indicator which takes the value 1 for the (semi-)public sector and 2 for the private sector.

Evidently, one of the most crucial indicators in the context of this research is firm size. While a measure of employer size is available in the work and schooling study, it unfortunately measures the amount of people employed in an individual's branch/location of the firm instead of overall firm size. Nevertheless, the theories on the FSWE discussed in previous sections need not necessarily be applicable to overall firm sizes exclusively. Moreover, an FSWE study by Evans & Leighton (1989) using two US panel databases, with one having the same discrepancy in the measure of firm size, found that the estimated FSWE was qualitatively similar in the two panels. The *Branch size* variable present in the LISS database is therefore expected to be an acceptable measure for FSWE estimations in the Netherlands.

Also, it must be noted that all longitudinal waves of the LISS panel data will be combined to allow for the estimation of a single Mincerian wage equation. While the longitudinal characteristics allow for a wider range of methodologically more complex approaches, a combinatory approach in the observations increases the sample size available for a unique regression. Nevertheless, a total disregard for the longitudinal characteristic could potentially disregard cyclical economic patterns which are likely to be an additional predictive factor for wages. As such, dummy variables for each study wave's corresponding year will be included in the regression.

Lastly, some alterations in the indicators obtained from the LISS panel have been made, which must be discussed. Firstly, the *Branch size* variable is given in integers. While this unarguably allow for the highest level of accuracy, such accuracy is not necessary for an FSWE and gender wage effect analysis and makes an interpretation more challenging. In order to improve the workability of the data the variable will thus be transposed into a measure with five mutually exclusive size categories: size 1 (1-10), size 2 (11-24), size 3 (25-49), size 4 (50-249), and size 5 (250+). Such an approach is consistent with similar studies by Akar, Balkan & Tümen (2014) and Albaek (1998). Secondly, the *Organization type* indicator is transformed into a dummy variable which takes value 1 if an individual works in the (semi-)public sector, and a similar approach is undertaken with the *Gender* indicator, which is transformed into a dummy variable with value 1 for females. These transformations allow these variables to be used as covariates in the model.

The predictor variables defined above will be incorporated into a Mincerian wage model based on the earlier mentioned equation (2). Additionally, in order to account for this study's focus on the effect of firm size on gender wage discrimination, an interaction effect between gender and firm size will be included, leading to the following wage equation:

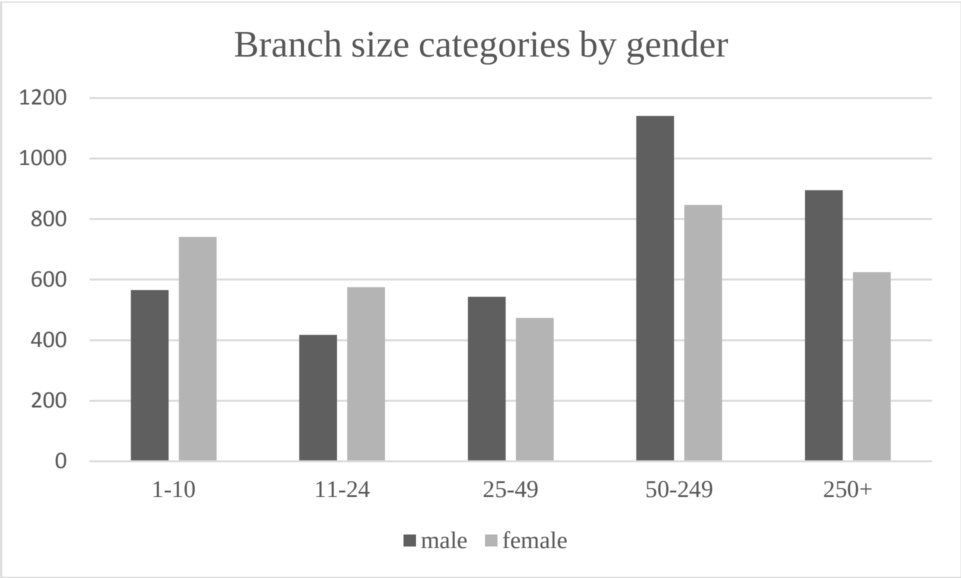
$$\ln(w_y) = \alpha_0 + \alpha' \rho_s + \beta_1 h + \beta_2 x + \beta_3 x^2 + \beta' \lambda + \beta_4 f + \delta' f \lambda + \beta_5 \sigma + \eta' \omega + \kappa' y + \varepsilon \qquad \textbf{(3)}$$

where w_y is an individual's yearly real gross wage, α_0 the intercept, ρ_s represents the level of schooling completed by an individual (representing five dummy variables for each education category with the lowest category as reference), h is the hours worked per week on average, x is the individual's age, λ represents five categories for the branch size one is employed at, f is a dummy variable which takes value 1 for females, σ is a dummy variable with value 1 if the individual works in the (semi-)public sector, ω represents eight dummy variables on an individual's occupation category with the agrarian profession category as reference, y corresponds to dummy variables for each year in order to account for cyclical economic circumstances, and ε is a mean zero residual. Lastly, the β's show the return to wages to the respective covariate (e.g. β_1 shows the return to hours worked on wages), and the vectors (indicated with a prime) show the return to wages for the categorical indicators.

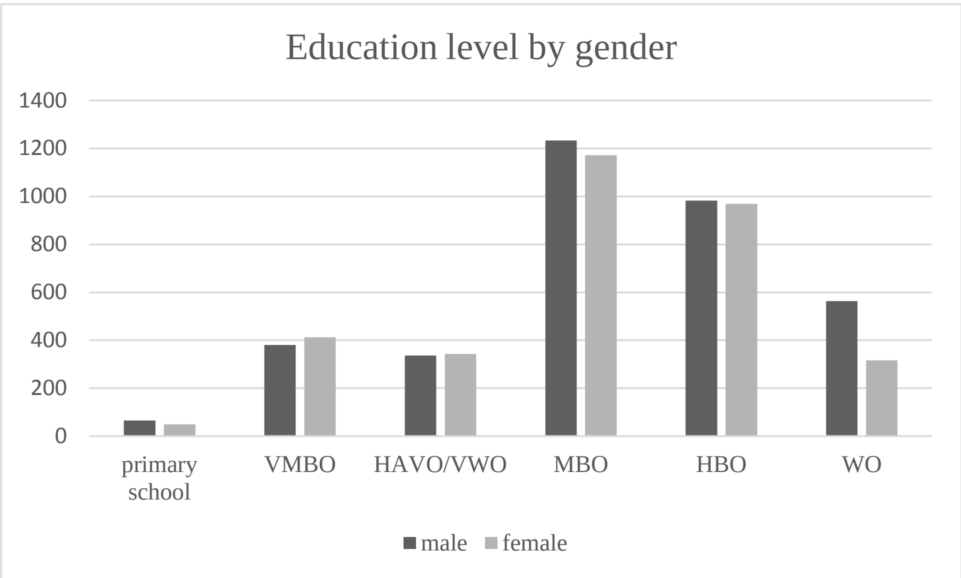
Unfortunately, not all observations retrieved from the LISS panel can be employed in this study. Firstly, observations which are found to have invalid entries in at least one predictor variables will be excluded from analysis. While the extensiveness in the amount of predictor variables is able to more accurately define FSWE and gender effects, it also reduces the amount of observations for which full data is available. Particularly the branch size and gross wage measures are found to have a high number of invalid entries, mostly due to respondents having selected the *I don't know* or *Prefer not to disclose* options in the survey. Secondly, only individuals who stated they have been in employment in the study period will be used in this study. The above corrections result in 6,825 valid observations, of which 3,262 (47.8%) correspond to females and 3,563 (52.2%) to males. Before these are used in the upcoming analysis, some descriptive statistics and graphs will be discussed.

	Yearly real gross wages		Hours worked	
	Mean	Std. Dev.	Mean	Std. Dev
Females	23,951.96	45,162.87	26.02	11.981
Males	41,956.53	61,579.49	36.31	14.092

First of all, a preliminary test on the means of the yearly real gross wages between males and females shows that there is a significant difference, with the mean for females being 23,951.96 and the mean for males being 41,956.53, indicating that within the LISS panel on average females earn less than males, and thus provides an initial indication of gender wage discrimination. Nonetheless, the statistics on the amount of hours worked per week show that males also on average work 10 hours more per week, and as such, the gross mean difference in wages is not necessarily caused only by gender wage discrimination, highlighting the importance of a more complete model as in equation (3).



Secondly, the distribution of the branch size categories is slightly different between males and females, and the above graph shows that in the two smallest size categories relatively more females can be found in the sample set, whereas in the two largest size categories relatively more males are found. Additionally, the above graph shows that the most common size category is 50-249.



Lastly, the above graph on levels of education between the two genders show that there is a similar distribution of females and males across the education levels, except for the highest level of education WO (university), where almost double as much males are found than females, and it is possible this discrepancy accounts for another part of the gender wage gap.

Now that some initial statistics and graphs about the sample set have been reviewed, a more exhaustive analysis into the gender wage gap observed can be performed. In order to so, the Mincerian wage equation in (3) will be estimated based on these 6,825 observations in a generalized linear model, using a 95% Wald confidence interval and Type III tests of model effects. Since this study will use six different waves from the panel, multiple observations are present in the data set for each unique individual. While the six waves separately can be seen as independent clusters of observations with homoscedastic properties, combining several of these waves, as will be done in the upcoming regression, is likely to cause heteroscedasticity. In order to account for this and improve the robustness of the estimations the Huber-White standard errors method will be employed.

5. Results

Parameter:	Coefficient	Standard Error
Constant:	5.075***	.2505
Year dummies:		
2008	0 [a]	-
2009	.020	.0278
2010	.057*	.0299
2011	.072**	.0309
2012	.072**	.0321
2013	.077**	.0316
Organization sector:		
Private sector	0 [a]	-
(Semi-)public sector	.046**	.0228
Level of education:		
Primary school	0 [a]	-
VMBO	.355***	.0846
HAVO/VWO	.425***	.0798
MBO	.377***	.0791
HBO	.624***	.0804
WO	.718***	.0836
Profession type:		
Agrarian	0 [a]	-
Unskilled Manual	.138	.2151
Semi-Skilled Manual	.545**	.2117
Skilled Manual	.827***	.2127
Other Mental Work	.790***	.2098
Intermediate Supervisory	1.017***	.2106
Intermediate Academic	.860***	.2109
Higher Supervisory	1.121***	.2138
Higher Academic	.975***	.2122
Age:	.134***	.0072
Age squared:	-.001***	.0001
Hours worked per week:	.020***	.0011
Branch Size:		
1-10	0 [a]	-
11-24	-.093*	-.093
25-49	-.066	-.066
50-249	.020	.020
250+	.133***	.133
Female:	-.494***	.0451
Branch Size × Female:		
1-10	0 [a]	-
11-24	.194***	.0677
25-49	.172**	.0685
50-249	.273***	.0546
250+	.195***	.0540

Method: Generalized Linear Model - Dependent Variable: $ln(real\_gross\_wage)$
Number of Observations: 6,825
a: Reference category
*Significant at 10%
**Significant at 5%
***Significant at 1%

The regression estimates on the previous page show the effect of several indicators on (the natural logarithm of) gross wages based on 6,825 observations in the period from 2008 to 2013. In total, the main effects of nine predictor variables as well as an interaction effect between branch size and gender have been included. Before this interaction effect, which is crucial in answering the research question, can be discussed it is however important to first describe the full regression results.

Firstly, it is interesting to note the strictly positive time trend of wages found in the coefficients for the yearly dummies. These show that in the sample observed, from 2008 to 2013 the real gross wages of those working have risen by about 7.7%, holding the other variables constant. These results are especially striking due to the financial crisis and its after-effects that have caused Dutch GDP to stay almost stable over the time period observed.

Secondly, an interesting finding is a significant and positive relationship between working in the (semi-)public sector and wages: being employed in the (semi-)public sector is associated with a 4.6% wage increase, holding other variables constant.

Consistent with the notions on human capital theory mentioned earlier in the theoretical framework, education is found to be a highly significant predictor of wages. In similar fashion, the type of profession and the hours worked per week are found to be significant predictors of wages.

While a correct measure for job seniority was unfortunately unavailable in the LISS panel, it seems that the methodological approach of using age as an alternative indicator is acceptable, as it is also found to be a highly significant predictor of wages with a positive effect. Furthermore, the squared age term shows a slight negative slope, indicating that while seniority comes with higher wages, a peak is reached when at increasingly high ages the coefficient of the squared effect tends to dominate, after which wages are expected to decrease over time.

The five categories for branch size further show being employed in the largest category of 250+ is associated with a 13.3% increase in wage relative to being employed in the smallest 1-10 category, holding the other wage indicators included equal. Furthermore, the results show a slightly significant negative wage premium in the 11-24 category when compared to the 1-10 size category, whereas for the larger 25-49 and 50-249 categories no significant effect on wages is found. These results provide support for the presence of the

FSWE in the Netherlands, although the only clear effect is found in the largest size category, which is nonetheless quite sizeable. The negative wage premium for the second-smallest category might be due to relatively successful entrepreneurs that employ only a small number of staff.

Gender wage discrimination is further clearly present, and, holding all other wage predictors included constant, being male is found to be associated with a 49.4% increase in real gross wages. While the degree of discrimination is much more sizeable than in comparable studies, the results show that the degree of gender wage discrimination is reduced significantly in larger branch size categories, and it must thus not be interpreted as an overall estimate. Most interestingly however, the results do not indicate a clear linear relationship between the gender wage gap and branch size, as it seems that in the 25-49 category gender wage discrimination is higher than both the slightly larger and slightly smaller branches, and that the largest category of 250+ shows a larger gender wage gap than its smaller counterpart, 50-249.

It further remains important to analyze the sensitivity of the above-found results, and see whether a similar interaction effect between the FSWE and gender wage discrimination can be found between distinct groups of individuals within the sample. As such, separate regressions have been run for each of the six education level groups, from which the most important results – the overall measure of gender wage discrimination as well its interaction with the FSWE – will be briefly compared on the following page.[6]

[6] Apart from the level of education, the same control variables as in the previous regression have been used.

Parameter:	Level of Education Completed:					
	Primary School	VMBO	HAVO/VWO	MBO	HBO	WO
Female:	-.002 (.2842)	-.875*** (.1258)	-.572*** (.1305)	-.509*** (.0746)	-.272*** (.0852)	-.528*** (.1787)
Branch Size × Female:						
1-10	0 a	0 a	0 a	0 a	0 a	0 a
11-24	.261 (.3084)	.573** (.2239)	.346* (.1989)	.195* (.1114)	-.111 (.1082)	-.061 (.2497)
25-49	.225 (.3740)	-.070 (.2324)	.129 (.1917)	.161 (.1200)	-.039 (.1171)	.529*** (.2022)
50-249	.118 (.4555)	.374** (.1792)	.619*** (.1589)	.178* (.0904)	.030 (.0987)	.425** (.1959)
250+	0 b	.350** (.1661)	.434** (.1698)	.052 (.0890)	-.048 (.0977)	.381** (.1940)
# Of Obs.:	114	792	680	2,406	1,952	881

Method: Generalized Linear Model - Dependent Variable: $ln(real\_gross\_wage)$
Standard errors given in parentheses
a: reference category
b: no relevant observations present
*Significant at 10%
**Significant at 5%
***Significant at 1%

The above results indicate that, within the LISS panel observations, both the overall level of gender wage discrimination as well as the influence the FSWE has on it show a relatively high level of fluctuation between individuals grouped by their education level.

All categories except the primary school category show highly significant indicators for gender wage discrimination in the smallest branch size category of 1 to 10, and in all cases females are found to be paid less relative to their male counterparts. The most extreme value is found for individuals whose highest level of education completed is *VMBO,* for which being male is associated with a 94.5% increase in wages in the 1-10 size category, holding the other variables constant.

The effect of firm size on gender wage discrimination is less profound between the levels of education, and found to be altogether insignificant (at $\alpha = .05$) for the primary school, MBO and HBO education categories. Nevertheless, the VMBO, HAVO/VWO, and WO categories each show a generally significant effect in all but one category (the 25-49 category twice and the 11-24 category respectively), yet of a different trend than those found in the aggregate results on page 20. While the HAVO/VWO category again shows the largest interaction effect between the FSWE and gender wage discrimination in the 50-249 category, the VMBO category shows the lowest level of discrimination in the 11-24 category, and the WO category shows the lowest level of discrimination in the 25-49 category.

The sensitivity analysis above suggests that the results found on page 20 are unfortunately relatively sensitive to changes in the model assumptions, and could indicate a possible misspecification of the wage model in equation (3).

6. Conclusion

This study was set out to research the existence of a relationship between gender wage discrimination and the effect of firm size on wages, the FSWE, in the Netherlands. Previous theoretical literature using a combination of these phenomena has been relatively limited in forming an appropriate theoretical foundation, and while empirical studies linking the two wage predictors have found evidence of its existence in some countries, no such study has been previously conducted in the Netherlands. This study sought to clarify this issue by attempting to answer the following question: *What is the effect of firm size on gender wage discrimination in the Netherlands?*

The theoretical foundations for gender wage discrimination (through its base in theories on labour market discrimination) and the FSWE which were analyzed separately in the theoretical framework highlighted a certain degree of compatibility between the drivers of the two effects, and thus provided the theoretical support necessary for a research approach employing a combination of both concepts and the expectation of a decreasing sense of gender wage discrimination as firm size increased. Based on the subsequent review of relevant academic literature, the wage equation popularized by Mincer in 1974 proved to allow for a starting point in empirical analysis. Introducing both gender and firm size into the equation, in addition to a plurality of background human capital indicators, the resulting equation was able to be used in an empirical study accounting for both gender wage discrimination and the FSWE.

For the empirical analysis, data on the wage predictors as defined in the Mincerian wage equation were obtained from the LISS panel database on several Dutch individuals. The aggregate results show that, in the Netherlands, significant evidence on the existence of both gender wage discrimination - in the direction that women get paid less than their male counterparts - as the FSWE can be found. They further highlight the existence of a hyperbolic FSWE being present in the Netherlands, in which wages gradually increase with branch size, except between the highest category of 250+ workers and the second-highest category of 50 to 249 workers.

Most importantly, a significant interaction effect is found to be present between firm size (approximated by the size of the branch one is employed at) and gender wage discrimination. The aggregate results show that the FSWE generally benefits women more than their male counterparts, and that the lowest wage increase associated with being male, 22.1%, is found in the second-largest size category of 50 to 249 workers, whereas the highest, 49.4%, is found in the smallest 1-10 size category. While these findings are consistent with results found in similar studies by Jolliffe & Campos (2005) and Akar, Balkan & Tümen (2014), the sensitivity analysis showed that these findings are relatively sensitive to changes in the study sample, and as such caution must be taken when interpreting the aggregate results.

Based on these results, recommendations can be made in relation to discrimination legislation in the Netherlands. Firstly, gender wage discrimination is still found to be clearly present both in the (semi-)public and private sector, and the implementation of stricter regulation is thus likely to be necessary if it is to be eliminated. Most importantly, the results show that the smallest firms show the highest degree of gender wage discrimination, and anti-discriminatory regulation aimed specifically at these smaller firms could prove highly efficient in reducing the overall gender wage gap.

The existence of a dynamic relationship between gender wage discrimination and the FSWE in the Netherlands is unlikely to be a phenomenon unique to the country. Future research of a similar nature in other countries similar to the Netherlands, such as those in the European Union, could prove vital for the explanation of this phenomenon, as well as provide support for the implementation of international anti-discriminatory legislation accounting for different measures of firm size.

The approach applied in this study causes a number of limitations, which must be considered. Most importantly, it must be noted that for practicality purposes this study employed the LISS panel data in an unbalanced pooled manner. While the panel is based on a true probability sample of the Dutch population, pooling several waves consisting of mostly the same individuals creates the possibility of heteroscedasticity. While robust standard errors have been used as a correction measure, a more extensive methodological approach could be able to more effectively exploit the longitudinal nature of the panel, and the sensitivity analysis indeed suggests there is still room for improvement.

Additionally, as mentioned in the data & methodology section, measures for firm size were unfortunately unavailable, and an indicator for branch size was used as an alternative. Nevertheless, some theoretical explanations of the FSWE could also be applicable to a large firm with several small branches, and future research including correct measures for firm size might be able to quantify the FSWE more accurately.

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