The Role of the Gender Wage Gap in Overall Wage Inequality: A quantitative exercise*

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Abstract

This article presents a novel wage inequality decomposition to analyze the gender wage gap's impact on overall wage inequality. The decomposition determines the maximum relative wage between genders allowed before it begins to increase total inequality. In addition, I present a structural model of the labor market to evaluate the impact of establishing restrictions on intra-occupational gender pay gaps within each firm; specifically, a restriction in which the average wage of one gender cannot exceed α times the average wage of the other gender. For an $\alpha = 2$, the model predicts a 10% wage inequality reduction. However, with a tighter restriction of $\alpha = 1$, the inequality reduction dissipates and reverses into a wage inequality increment.

JEL Codes: J16, J31, D31, E64
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1. Introduction

In many cases gender wage gaps are persisting in time (Blau and Kahn (2017); Miller and Vaggins (2018); Hegewisch and Williams-Baron (2016)). In fact, according to the OECD (2015), currently, most of its country members present a substantial gender wage gap. Moreover, they are becoming more difficult to explain (Blau and Kahn (2017); Goldin (2014); Brynin (2017)). Therefore, to counter this persistence of the gender wage gap, several direct approaches, based on legal and compulsory regulation, have been proposed or implemented. Some examples are gender quotas (Bertrand et al., 2019), declaring pay secrecy illegal (Kim, 2015), banning past earnings questions (Hansen & McNichols, 2020), transparency laws (Baker et al., 2019) and publishing firms' gender wage gaps (Coghlan & Hinkley, 2018).

This paper explores the impacts of enforcing an intra-occupational gender wage gap limit within firms on overall wage inequality and on gender wage gaps in an upper level (occupations in the economy). Furthermore, such direct restrictions must be strategically designed to counter the gap's persistence. Blau and Kahn (2017) find that occupation and industry are the most important variables in explaining the gender wage gap, despite the occupational upgrading of women relative to men. Moreover, Goldin (2014) adds that the majority of the current gender earnings gap comes from within occupational differences rather than from between occupational differences; Card et al. (2016) points out as well that firm-specific pay policies may be important for understanding the gender wage gap. Accordingly, I consider direct restrictions on the intra-occupational gender wage gaps within each firm.

The impact evaluation of such restrictions on inequality and the occupational gender wage gaps in the economy is done for three specific years (2008, 2013, and 2018), with a rich employer-employee administrative dataset of Costa Rica's formal employment sector. The effect on total inequality is of particular importance not only because Costa Rica's Gini coefficient is already one of the highest among OECD's countries (OECD, 2020), but also because according to Piketty et al. (2018), the reduction in the gender wage gap has played an important role in mitigating the rise of inequality in the US since the late 1960s. Three steps are completed in order to achieve the objective.

A novel wage inequality decomposition by gender is developed as a first step, using wage dispersion as the measure for inequality. This will allow to mathematically materialize the link between gender wage gaps and total inequality that is empirically emphasized in Piketty et al. (2018). Furthermore, it will give rise to a candidate gender wage gap restriction since it determines the maximum relative wage between genders allowed before it begins to actually increase total inequality. An advantage of using variance as the definition of inequality is that according to Helpman et al. (2016), its decomposition allows quantifying the relative importance of possible sources of wage differences. More specifically, this definition, together with the decomposition in Section 3, is able to provide a clear mathematical expression of the gender wage gap's impact on the overall measure of inequality, buttressing previous motivations to incorporate a restriction on gender wage gaps. These connections and argumentation are not guaranteed to arise in an analytical form with other wage inequality measures.

Moreover, as Magda et al. (2019) states, "the wage variance is a common statistical measure of dispersion, and, unlike other popular measures of inequality such as the Gini coefficient and the 90-10 wage gap, the variance is additively decomposable into the between and within components", which are important when comparing gender wages. Finally, the variance definition was also chosen in order to expand further the literature that already uses wage variance decomposition (Goldschmidt and Schmieder (2017); Card et al. (2018); Bonhomm et al. (2019)); the new decomposition expands the previous literature not only in that it presents a relation between total inequality and gender wage gaps, but also in that it incorporates within-between components for several characteristics simultaneously.

In this new decomposition, wage inequality can be broken down into gender-related components, controlling for several characteristics of the economy: economic sector, type of firm (public or private), firm, and occupation. These components account for wage differences within the same gender across each controlling characteristic of the economy, as well as wage gaps between genders within each occupation for each firm. Furthermore, the gender wage gap component that arises from the decomposition sets the foundation for the gender wage gap restriction (α), since it establishes that inequality increases precisely when a gender average wage within an occupation of a specific firm is over **two** times the other gender wage; therefore, the decomposition gives a restriction of $\alpha = 2$. By means of this criterion, around 40% of all firms' departments (occupations within each firm) do not fulfill the gender wage gap restriction.

The gender-based wage decomposition shows that the growth in inequality between 2008 and 2018 is mainly explained by an increase in a segregation's effect (30% of total inequality increase), by the rise in the salary differences within men of the same occupation of each firm (26% of total inequality increase) and similarly for women (around 19% of the total increase). The importance of these past components lies not only in the fact that they account for most of the inequality growth, and therefore, provide specific areas to focus attention on, besides gender wage gaps, but primarily because they will act as transmitters of the gender wage gap restriction's effect on total inequality, as will be discussed in detail in Section 5. The mentioned transmission occurs because the restriction is imposed on wage averages, and therefore when firms make decisions to comply with specific relationships of averages, they will also impact individual wages and gender workplace composition that are the basis for the other components.

In the second step, I carry out a quantitative exercise using a novel heterogeneous agent labor model. I use the model, together with the employer-employee data from Costa Rica, to analyze the impacts of the gender wage gap restriction on the economy's occupational gender wage gaps and on total wage inequality. The model focuses on agents' reactions (firms and workers) to exogenous and unexpected restrictions on each firm's intra-occupational gender wage gaps. The first main stage concerns how each department (occupations within each firm) endogenously determines job growth based on: its expectations, complying with the restriction, and avoiding higher labor costs. The second main stage of the model comprehends the pressure on wages that the gender-occupation differentiated labor markets generate through supply and demand and the match of workers and employers through a series of characteristics such as: wage, gender, occupation, location, and experience.

In general, the model focuses on how firms adapt to the restriction in a shocked labor market and how the pairing between agents in this market is readjusted due to this distortion. In addition to heterogeneous (in wage) firms and workers, the model borrows search and matching intuition. However, the model differs from the common heterogeneous agent and search and matching models (see for example Taber and Vejlin (2020)) in that it focuses on each firm's coping process and their incentives to deviate from plans when taking their final decision in how to comply with the specific restriction; this materializes into a particular model with no analytical but numerical solution; Section 4 expands on how these differences are incorporated and how agents behave in the labor market.

In the third step, results from the labor model with the gender wage gap restriction incorporated are discussed. To do so, the economy's wages introduced into the model, and the ones the model produces are used to compute the change in: the economy's occupational gender wage gaps and the decomposition's components. First, the quantitative exercise shows that occupational gaps tend to deteriorate (move away from the equalization of averages) in favor of men for those occupations with little female participation, and tend to deteriorate in favor of women if the occupation has low male participation. Mechanic, builder, and transporter are some of the former occupations, whereas some of the latter are preschool and special education, domestic workers, beauty services and nutritionist. The model also shows that the constraint produces a decrease in total inequality of 10%. This reduction is mainly achieved through lesser wage differences among workers of the same gender within the same department. However, if the restriction is tightened too much ($\alpha = 1$), this overall inequality reduction dissipates and reverts into an increment.

This article relates mainly to two lines of research. First, I introduce a novel wage variance decomposition into the within-between inequality decomposition literature (Helpman et al. (2016); Barth et al. (2016); Song et al. (2018); Alvarez et al. (2018)). This new decomposition allows the within-between intuition to be present, simultaneously, for several aspects, such as: sector, type of firm (public or private), firm, occupation, and gender. More specifically, the decomposition isolates a single component that quantifies the impact of gender wage gaps and occupational segregation on total wage inequality. This further elucidates Piketty et al. (2018) empirical findings regarding the role of gender wage gaps on inequality. The computation of the decomposition using Costa Rican data shows that having intra-occupational gender wage gaps within firms under an $\alpha = 2$ limit has contributed to slow down inequality (without imposing any legal restriction). However, given that there are still many cases in which the previous limit is violated, there is still an opportunity to increase the role of the gender wage gaps in reducing inequality.

Second, the study relates to the literature on gender wage gaps' persistence (Bertrand et al. (2010); Blau and Kahn (2017); Cook et al. (2020)) and mechanisms to reduce it. In line with the latter, Bertrand et al. (2019) documents that the gender wage gap in earnings within boards fell substantially because of gender quotas. Kim (2015) compares the wages of 6 states that declared wage secrecy illegal before 2012, with states that did not, and finds that in the former, women's wages were 3% higher and the gender wage gap was reduced between 12 to 15% for women with a university degree. Also, transparency laws have shown the potential to reduce the gender wage gap by approximately 30% (Baker et al., 2019). The article brings into this line of research a within firm intra-occupational gender wage gap restriction that naturally arises from the novel wage inequality decomposition; more specifically, the decomposition isolates a gender wage gap component that determines the maximum relative wage between genders allowed before it begins to increase wage inequality. It is important to note that the article does not aim to argue that the direct restriction on gender average wage differences is more efficient than other legal regulations like gender quotas. Nevertheless, the study argues that if the gender wage gaps at the intra-occupational within-firm level are controlled, total inequality can be reduced. Still, the occupational gender wage gaps at the economy level may experience a deterioration (away from average equalization) for those occupations with a high gender concentration.

The rest of the article is organized as follows: section 2 presents the employer-employee administrative dataset used, section 3 explains the decomposition of wage inequality by gender, and section 4 the quantitative exercise; then, results are discussed in section 5, and finally, some concluding remarks are presented in section 6.

2. Administrative Data

I use the employer-employee administrative dataset of the Social Security in Costa Rica or *Caja Costarricense del Seguro Social* (henceforth, CCSS).[1] Observations in the database correspond to all people that contribute to the CCSS, either from public or private firms. Even though this base is not

[1] I obtained this base through the Institute for Research in Economic Sciences of the University of Costa Rica (IICE-UCR) and used it with the proper authorization and confidential agreements of the IICE. ID codes that the CCSS created protect the identity of workers and firms.

a sample, but a complete set of workers and firms, the informal sector is excluded, and it represents approximately 30% of all jobs (OECD, 2017). Therefore, all results are representative only of the formal sector of Costa Rica.

The previous base contains information about the characteristics of workers and their employers. Regarding workers, it has information about their salary (real January 2008 wages), gender, number of monthly contributions or quotas to the CCSS, date in which they started working for the current firm, occupation (in detail and code, based on the Costa Rican Occupation Classification, COCR, 2011 version) and respective employer, if there is any because there are independent workers in the dataset. Regarding employers, the following information is available: location (province, canton, and district), number of workers, economic sector (in detail and code, based on the International Standard Industrial Classification of all economic activities, ISIC, revision 3.1) and type of firm (public or private). Lastly, the base has a monthly frequency and is available for 2008, 2013, and 2018. For more details on the database's cleaning process, see Appendix A. I used complementary information from labor legislation to calibrate certain aspects of the labor market in the quantitative exercise, precisely, the dynamics corresponding to severance pay and annual bonuses.

The final base used contains information on $857,729$ workers and $21,279$ firms for 2008, $1,009,630$ and $24,687$ for 2013, and $1,225,068$ workers and $27,082$ firms for 2018; the percentage of workers in the private sector ranges from 72 to 75%, depending on the year. The economic sectors are classified into 20 categories and occupations into 43 classes; more precision on these classifications can be found in Appendix A, in Tables 5 and 6, respectively. Additionally, Table 5 present statistics on gender average wage, gender wage gaps and labor force gender composition by economic sector.

3. Wage inequality decomposition by gender

There are many ways to measure wage inequality in an economy; some of these are the distribution of wages, percentile curves, the ratio of salaries to specific percentiles (pcts: 50-10, 90-10, 90-50), the Gini coefficient, and others (Sarlo et al. (2015); Magda et al. (2019)). As motivated in the introduction, the dispersion of wages is used as the measure of inequality in this research. The variance of the wages of an economy with N workers in a specific period t, will be denoted as $\mathbb{T}$ and is defined as the average of squared deviations of each wage (ω_i) with respect to the average wage ($\overline{\omega}$); $\mathbb{T}$ describes how different or unequal workers' wages are from each other. Equation (1) expresses the definition of the wage inequality described.

$$\mathbb{T}(\omega) \equiv \frac{1}{N}\sum_{i=1}^{N}(\omega_i - \overline{\omega})^2 \tag{1}$$

Equation (2) presents the first phase of the decomposition of the variance of wages; total inequality can be broken down into five parts when taking into account the structure of the labor market (see Appendix B):

$$\mathbb{T}(\omega) = \mathbb{B}(s) + \mathbb{B}(T,s) + \mathbb{B}(f,T,s) + \mathbb{B}(\vartheta,f,T,s) + \mathbb{W}(i,\vartheta,f,T,s) \tag{2}$$

The $\mathbb{B}(\cdot)$ components from the previous decomposition show how different wages are between: i) sectors (s), ii) types of firms (T), public or private, controlling for sector s, iii) firms (f) controlling for type T and sector s, and iv) occupations ϑ in the same firm f, of type T and in sector s. For more details see equations (3) and (4), which present the components of inequality between sectors and between types of firms as an example.

$$\mathbb{B}(s) \equiv \frac{1}{N}\sum_{s\in S} N_s(\overline{\omega}_s - \overline{\omega})^2 \tag{3}$$

$$\mathbb{B}(T,s) \equiv \frac{1}{N}\sum_{s\in S}\sum_{T\in s} N_{T,s}(\overline{\omega}_{T,s} - \overline{\omega}_s)^2 \tag{4}$$

Next, equation (5) presents the last component of the decomposition, which takes the intuition of how unequal are the workers within the same occupation in a firm f, for each occupation of each firm.

$$\mathbb{W}(i,\vartheta,f,T,s) \equiv \frac{1}{N}\underbrace{\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}}_{\sum_{s,T,f,\vartheta}}\sum_{i\in\vartheta}(\omega_i - \overline{\omega}_{\vartheta,f,T,s})^2 \tag{5}$$

Then, from equation (2), the five components mentioned are broken down using the gender variable and equation (6) is obtained; Figure 6 in Appendix B presents a tree graph of the decomposition.

$$\begin{aligned}\mathbb{T}(\omega) = \mathbb{G}_M + \mathbb{G}_F + \mathbb{W}_M + \mathbb{W}_F + \mathbb{P}_M + \mathbb{P}_F + \mathbb{B}(s)_M + \mathbb{B}(s)_I + \mathbb{B}(s)_F + \mathbb{B}(T,s)_M + \mathbb{B}(T,s)_I + \mathbb{B}(T,s)_F +\\ \mathbb{B}(f,T,s)_M + \mathbb{B}(f,T,s)_I + \mathbb{B}(f,T,s)_F + \mathbb{B}(\vartheta,f,T,s)_M + \mathbb{B}(\vartheta,f,T,s)_I + \mathbb{B}(\vartheta,f,T,s)_F\end{aligned} \tag{6}$$

In general, each $\mathbb{B}(\cdot)$ inequality component is broken down into three subcomponents; equation (7) presents an example with $\mathbb{B}(s)$. The first subcomponent $\mathbb{B}(s)_M$ reflects: i) wage inequality between men from different sectors and ii) penalization (inequality increment) due to differences in gender composition (δ) between sectors (take as example: $\overline{\omega}_{s,M} = \overline{\omega}_M$). The above insights are analogous to the third subcomponent $\mathbb{B}(s)_F$ that is applied to women. Finally, the second subcomponent penalizes the correlation between $\mathbb{B}(s)_M$ and $\mathbb{B}(s)_F$ for a certain sector s; that is, if both men and women in sector s are, simultaneously, above or below the economy's average, in terms of wages and composition, it is taken as an inequality relative to the other sectors.

$$\mathbb{B}(s) = \underbrace{\sum_{s\in S}\frac{N_s}{N}[\delta_{s,M}\overline{\omega}_{s,M} - \delta_M\overline{\omega}_M]^2}_{\mathbb{B}(s)_M} + \underbrace{\sum_{s\in S}\frac{N_s}{N}2[\delta_{s,M}\overline{\omega}_{s,M} - \delta_M\overline{\omega}_M][\delta_{s,F}\overline{\omega}_{s,F} - \delta_F\overline{\omega}_F]}_{\mathbb{B}(s)_I} + \underbrace{\sum_{s\in S}\frac{N_s}{N}[\delta_{s,F}\overline{\omega}_{s,F} - \delta_F\overline{\omega}_F]^2}_{\mathbb{B}(s)_F}$$

$$\mathbb{B}(s) = \mathbb{B}(s)_M + \mathbb{B}(s)_I + \mathbb{B}(s)_F \tag{7}$$

Then, the intra-occupational inequality component, $\mathbb{W}(i,\vartheta,f,T,s)$, is broken down into six subcomponents. The first two are shown in equations (8) and (9), and refer to the wage inequality within men of the same specific occupation in f ($\mathbb{W}_M$), and the wage differences within women in the same specific occupation in f ($\mathbb{W}_F$). The subcomponents of equations (10) and (11) encompass a penalty (inequality increment) to each gender for not dominating the occupation completely: the more one group dominates in terms of composition, the more influence it has over the other. For example, the inequality within women of the same specific occupation ϑ in f receives a penalty the more segregated they become ($\uparrow N_{\vartheta,M} \Rightarrow \delta_{\vartheta,M} \to 1$), and this penalty disappears as the female gender dominates the composition ($\delta_{\vartheta,M} \to 0$); note that the penalty depends on the number of individuals affected and is quantified based on the respective gender average salary.

$$\mathbb{W}_M \equiv \sum_{s,T,f,\vartheta} \sum_{M\in\vartheta} \sum_{i\in M} (\omega_i - \overline{\omega}_{\vartheta,M})^2 \tag{8}$$

$$\mathbb{W}_F \equiv \sum_{s,T,f,\vartheta} \sum_{F\in\vartheta} \sum_{i\in F} (\omega_i - \overline{\omega}_{\vartheta,F})^2 \tag{9}$$

$$\mathbb{P}_M \equiv \sum_{s,T,f,\vartheta} N_{\vartheta,M} \overline{\omega}^2_{\vartheta,M} \delta^2_{\vartheta,F} \tag{10}$$

$$\mathbb{P}_F \equiv \sum_{s,T,f,\vartheta} N_{\vartheta,F} \overline{\omega}^2_{\vartheta,F} \delta^2_{\vartheta,M} \tag{11}$$

Finally, equations (12) and (13) show the subcomponents associated with intra-occupational gender wage gaps. A peculiarity of these gaps is their dual benefit-penalty character, similar to the $\mathbb{P}$ components. Within a firm's occupation, there are two components associated with the gaps, $\mathbb{G}_{\vartheta,M}$ and $\mathbb{G}_{\vartheta,F}$.

$$\mathbb{G}_M \equiv \sum_{s,T,f,\vartheta} N_{\vartheta,M} \delta^2_{\vartheta,F} \overline{\omega}_{\vartheta,F} (\overline{\omega}_{\vartheta,F} - 2\overline{\omega}_{\vartheta,M}) = \sum_{s,T,f,\vartheta} \mathbb{G}_{\vartheta,M} \tag{12}$$

$$\mathbb{G}_F \equiv \sum_{s,T,f,\vartheta} N_{\vartheta,F} \delta^2_{\vartheta,M} \overline{\omega}_{\vartheta,M} (\overline{\omega}_{\vartheta,M} - 2\overline{\omega}_{\vartheta,F}) = \sum_{s,T,f,\vartheta} \mathbb{G}_{\vartheta,F} \tag{13}$$

The duality of the gender wage gap components is understood as follows. Suppose the average male wage of a specific occupation in a firm f is 10 times the female. In that case, this causes $\mathbb{G}_{\vartheta,M}$ to be negative and therefore $W_{\vartheta,M}$ decreases ($\mathbb{G}_{\vartheta,M} + W_{\vartheta,M} < W_{\vartheta,M}$); inequality within men decreases because despite having inequality within them, there is a positive aspect, on average they are better in terms of wage than the other gender group, and this reduces the effect of inequality for the male gender; similarly, concerning the female group, not only there is inequality within them, but their group is on average below the male group, so their situation worsens ($\mathbb{G}_{\vartheta,F} + W_{\vartheta,F} > W_{\vartheta,F}$). This type of intuition of double impact by gender can also be observed in some discrimination models in the literature on gaps and wage decompositions using econometric estimation.[2]

An important aspect to note is that strict inequality between averages is not punished, but only inequality above a threshold; in this case, the threshold is two times the other wage average. This is convenient since the decomposition doesn't control all the individuals' characteristics; for example, variables such as education, age, experience, among others, are excluded. Similarly, an equalization of wage averages for each gender would lead to an absence of a gender wage gap in the firm's respective occupation f. This positive aspect is rewarded with a decrease in inequality for each gender, that is, $\mathbb{G}_{\vartheta,G} + W_{\vartheta,G} < W_{\vartheta,G}, \forall\, G \in \{M, F\}$.

Equation (6), and all those associated, allow calculations of various gender-specific origins of total wage inequality, as well as the gender-specific source of the growth of total inequality over time.

4. Quantitative Exercise

The previous inequality decomposition formalizes the link between the firm's intra-occupational gender wage gap and the total wage inequality. It also gives specific limits that the intra-occupational

[2]See Oaxaca and Ransom (1994) for an example of how discrimination can be divided into the advantage of one group and the disadvantage of the other.

gender wage gap can take before starting to penalize with more inequality. Therefore, the present quantitative exercise aims to capture the effects of implementing a gender wage gap restriction that aligns with the limits set by the inequality decomposition to the firm's intra-occupational gender wage gap. The model is solved in three stages: i) firms' reaction to the gender wage gap restriction, ii) workers' reaction to firms' decision and clearing of the labor market, and iii) computation of the effects using database and final wages produced by the model. Algorithm 1 shows a summary of the model's algorithm.

4.1. Environment

4.1.1. Timing

The model assumes two periods of interest. In the initial period, t, all firms are informed that the gender wage gap restriction has been approved and that they are required to comply before the next period of interest, $t+1$. I also assumed that the time difference between t and $t+1$ represents a short term since a longer time frame would introduce inevitable speculation regarding the timing of firms' reactions. Note that firms' response to the restriction, workers' response to firms' decisions, and the labor market's clearing are the specific components that give the transition between t and $t+1$.

4.1.2. Workers

There are three types of workers (i): employees, independents, and a new labor force between t and $t+1$. Each worker has a given wage $\omega_{i,\vartheta,f,t}$ at time t, along with a specific occupation ϑ and are associated with a specific firm f. In the case of independent workers, they are kept as an input for the labor supply in the quantitative exercise, but discarded besides that because the measures of inequality and gender wage gaps are analyzed for firms and therefore only for direct employees. Other characteristics that are observable to these workers are their gender, number of monthly contributions to the CCSS and amount of months worked in current firm.

4.1.3. Firms and departments

Each firm f has an economic sector, s, and type, T (public or private). All these firms are heterogeneous in their payroll structure, and therefore, in their gender wage gaps. Also, each firm has a specific country location (provincia-canton) associated and a set of occupations. Firms that are already registered at the initial period t are denoted as old or established, and those that arise after the initial period are denoted as new. Each occupation ϑ within a firm f will be defined as a department and will be denoted as ϑ, f.
Equation (14) computes the absolute growth (between t and $t+1$) of total job positions in each department, $h_{\vartheta,f,t+1}$, as the change in the number of workers in time; therefore, $L_{\vartheta,f,t}$ represents the number or workers (positions, L) in each department at time t. Equation (15) defines a labor cost, $\mathbb{C}_{\vartheta,f,t+1}$, for each department in each firm at time $t+1$. It accounts for payroll costs, $\mathbb{CP}_{\vartheta,f,t+1}$, hiring costs, $\mathbb{CH}_{\vartheta,f,t+1}$, and firing costs, $\mathbb{CF}_{\vartheta,f,t+1}$. The payroll costs (16) account for wages, $\omega_{i,\vartheta,f,t+1}$, of all workers currently employed (including newly hired and excluding previously fired) and a normalized bonus given by $\eta \cdot \omega_{i,\vartheta,f,t+1}$, where η is a frequency-normalizing constant and a month pay $\omega_{i,\vartheta,f,t+1}$ is the annual bonus by law. Firing costs (17), of workers laid off in between t and $t+1$, comprise the portion ι of the annual bonus gained until that point, $\iota \cdot \omega_{i,\vartheta,f,t}$, and a severance pay, $SV(\omega_{i,\vartheta,f,t})$, that depends on the time worked and wage; the definition of the severance pay and calibration of all parameters in the model are discussed in Section 4.5. The hiring costs (18), subsume all costs associated with interviews, initial productivity loss, training of newly incorporated workers

in between t and $t+1$. According to Blatter et al. (2012), average hiring costs differ substantially with respect to the sector of the firm, its size and the total amount of hires. Hence, the hiring cost of each new worker is calculated as a percentage $a_{\vartheta,f}(s, L_{f,t}, h_{\vartheta,f,t+1})$ of the wage that depends on those previously mentioned factors.

$$h_{\vartheta,f,t+1} \equiv L_{\vartheta,f,t+1} - L_{\vartheta,f,t} \tag{14}$$
$$\mathbb{C}_{\vartheta,f,t+1} \equiv \mathbb{CP}_{\vartheta,f,t+1} + \mathbb{CF}_{\vartheta,f,t+1} + \mathbb{CH}_{\vartheta,f,t+1} \tag{15}$$
$$\mathbb{CP}_{\vartheta,f,t+1} \equiv \sum_{i\in\vartheta,f} (1+\eta)\omega_{i,\vartheta,f,t+1} \tag{16}$$
$$\mathbb{CF}_{\vartheta,f,t+1} \equiv \sum_{i\in\vartheta,f(fired)} \left(\iota \cdot \omega_{i,\vartheta,f,t} + SV(\omega_{i,\vartheta,f,t})\right) \tag{17}$$
$$\mathbb{CH}_{\vartheta,f,t+1} \equiv \sum_{i\in\vartheta,f(hired)} a_{\vartheta,f}(s, L_{f,t}, h_{\vartheta,f,t+1}) \cdot \omega_{i,\vartheta,f,t+1} \tag{18}$$

4.1.4. The intra-occupational gender wage gap restrictions within each firm

The exogenous and unexpected restrictions imposed in the initial period establish that for each occupation within a firm, each gender average wage cannot be greater than α times the other. Equation (19) presents the restriction that must be fulfilled. The restriction arises from the $\mathbb{G}_{\mathbb{M}}$ and $\mathbb{G}_{\mathbb{F}}$ components, which emphasize that gender wage gaps increase inequality when surpasses a threshold of 2; so, an $\alpha > 2$ would be considered a more flexible restriction, since it allows gender wage gaps over the penalization threshold, and vice versa, a $\alpha < 2$ would be a more stringent constraint. Also, the restriction doesn't apply to firms of only one person (independent) or to those occupations within firms that consist of only one person. However, it does to those that consist of more than one worker and only one gender (occupational segregation). Suppose that an occupation in a firm f has no workers of a specific gender. In that case, it could be argued that a gender wage gap is not valid (even one of the $\mathbb{G}_{\vartheta,G}$ components would disappear since one of the gender proportions would be zero); however, in this wage inequality decomposition by gender, a value of zero will be assigned to a missing gender's average wage (as if this gender receives no retribution) with the specific objective of taking into consideration that occupational segregation is one of the documented causes of wage gender gaps. [3]

$$\max\{\overline{\omega}_{\vartheta,f,M}, \overline{\omega}_{\vartheta,f,F}\} \leq \ \alpha\ \min\{\overline{\omega}_{\vartheta,f,M}, \overline{\omega}_{\vartheta,f,F}\} \tag{19}$$

I assume the restriction is fully enforced; that is, all firms will comply with the restriction in the given time for adjustment based on: i) credible sanctions and strict vigilance on behalf of the regulatory agency, ii) threat of repercussion on behalf of the consumers since the intra-occupational gaps are to be public according to Coghlan and Hinkley (2018) (publicity factor). Some other assumptions are established to guarantee that the restrictions don't cease to have sense. Specifically, that some actions on behalf of the firms are restricted and the reasons such deeds might be in fact out of range: i) gender falsification since the regulatory agency can cross the employer-employee information with the one in Registry and Immigration; ii) faking the worker's occupation since the agency can corroborate it with his work history and his inscription to the respective professional association; iii) forge the employee's wage, since the employer-employee incentives could conflict on aspects such as taxes, social contributions, and pension; iv) forge a position in the firm for which social contributions are paid, but no wage payment is made, because of personal inspections made by the regulatory agency.

[3] See Blau and Kahn (2017), Coghlan and Hinkley (2018) and Khitarishvili et al. (2018).

Lastly, legally, firms cannot reduce wages unilaterally.
Furthermore, each department is classified into one of five categories according to their initial fulfillment of the restriction, R $\in \{0,1,2,3,4\}$. An R type 0 indicates that the department meets the restriction from the start. Type 1 and 2 refer to departments in which the restriction is not met, favoring men or women, respectively. Finally, R type 3 and 4 characterize departments that have no women or men, respectively.
Table 1 shows the percentage of departments (occupations within a firm, for all firms) that at the beginning of each period are not complying with the intra-occupational gender wage gap restriction; the statistics presented differentiate by those occupations in firms that experience a segregation problem (more than one worker and only one gender). The data shows that many occupations that must make adjustments to meet the restriction are due to a segregation issue. In general, around 38% of the occupations in firms are not meeting the restriction each year (with $\alpha = 2$), and of these, 94% are due to segregation problems.

Table 1: Number of departments (%) that violate gender wage gap restriction: 2008, 2013 and 2018.

Alpha	**(with segregation)**			**(without segregation)**		
	08	13	18	08	13	18
$\alpha = 1$	63.40	60.77	61.59	26.09	25.57	27.14
$\alpha = 1.5$	42.95	40.53	39.89	5.64	5.34	5.44
$\alpha = 2$	39.48	37.22	36.57	2.17	2.03	2.12
$\alpha = 2.5$	38.34	36.07	35.41	1.03	0.88	0.97
$\alpha = 3$	37.85	35.68	34.98	0.54	0.49	0.54

Note: Table 1 presents the percentage of occupations within firms that are not initially complying with the intra-occupational gender wage gap restriction for the years 2008, 2013 and 2018. These statistics are presented by different restriction's alphas or limits; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. Occupations in each firm that consist of more than one worker and contain only one type of gender (occupational segregation) are also subject to the intra-occupational gender restriction; the table differentiates by this effect.

4.2. Firms' reaction to the restriction

I assume that the gender wage gap restrictions represent, initially, an impact on firms' employee structure and the labor market, but not a shock on goods and services' demand or sales; that is, given that firms don't know how this novel shock will affect the demand for their product, they maintain their sales expectation prior restriction knowledge. In the beginning, firms' departments will have to review if their payroll meets the restriction, and if not, think about how this novel policy will affect their initial optimal path of action regarding employment, $h^*_{\vartheta,f,t+1}$; I will use the (*) notation to refer to optimal action (observable in the database) that each department would have taken without the restriction.
Note that the effective or final (with restriction) $h_{\vartheta,f,t+1}$ is endogenous to the model since the effective labor cost, $\mathbb{C}(h_{\vartheta,f,t+1})$, when adapting to the restriction could change the department's decision to open certain amount of positions. Also, note that a $h_{\vartheta,f,t+1} > h^*_{\vartheta,f,t+1}$ is not possible given that each firm maintains its sales expectation and therefore, no more positions are needed for production; hence, $h_{\vartheta,f,t+1} \leq h^*_{\vartheta,f,t+1} + \epsilon$, where $\epsilon = \mathbb{1}[R \in \{3,4\}]$ and it gives departments a hiring margin above their initial expectations in case they have no choice but to hire an additional worker (cases where there is only one gender and need both). Given the assumption that firms do not know how demand for their product will be affected, and therefore maintain their sales expectation for $t+1$ that gave rise

to $h^*_{\vartheta,f,t+1}$, the ideal scenario for the department would be to be able to comply with the restriction without deviations from $h^*_{\vartheta,f,t+1}$; the reason for this is that the lower the number of new positions, the harder will be for the firm to satisfy its sales expectations. Therefore, each department's decision can be summarized in choosing an $h_{\vartheta,f,t+1}$ that minimizes its distance with respect to $h^*_{\vartheta,f,t+1}$, equation (20), but simultaneously complying with the gender wage gap restriction and not violating sales expectations (21).

$$\min_{h_{\vartheta,f,t+1}} \{| \, h_{\vartheta,f,t+1} - h^*_{\vartheta,f,t+1} \, |\} \tag{20}$$

$$h_{\vartheta,f,t+1} \leq h^*_{\vartheta,f,t+1} + \epsilon \tag{21}$$

There is a third condition that must be satisfied when choosing $h_{\vartheta,f,t+1}$. I assume departments will be hesitant to choose a $h_{\vartheta,f,t+1}$ in which $\mathbb{C}(h_{\vartheta,f,t+1}) > \mathbb{C}^*(h^*_{\vartheta,f,t+1})$ since further costs and adjustments could emerge along the way during the clearing of the labor market (i.e., rising wages due to market pressure and more gender wage gap adjustment due to unexpected exit of workers going to other firms). Therefore, $\mathbb{C}(h_{\vartheta,f,t+1}) \leq \mathbb{C}^*(h^*_{\vartheta,f,t+1})$. Furthermore, when deciding if $h_{\vartheta,f,t+1} = h^*_{\vartheta,f,t+1}$ or lower, departments will take into account not only the labor costs in $t+1$ associated with that decision, but also the incentives they have to stay in $h^*_{\vartheta,f,t+1}$ or deviate to the left (lower value). For instance, a lower $h_{\vartheta,f,t+1}$ entails lower payroll and hiring (if any) costs, and higher values prevent revenue decrease (due to lower workers and production) and firing cost (if any). Equation (22) presents the **i**ncentives to **m**ove based on one less position to pay **w**age and compulsory bonus, $IMW_{\vartheta,f,t+1}$; the maximum of gender wage averages is chosen to compute the incentive since the new positions with those specific averages as wages do not engender changes in the gender wage gap. Then, equation (23) presents the **i**ncentives to **m**ove based on one less position (same as in $IMW_{\vartheta,f,t+1}$) to pay **h**iring costs (if any), $IMH_{\vartheta,f,t+1}$; note this incentive only makes sense when $h_{\vartheta,f,t+1} > 0$ and that is why the definition incorporates an indicator function.

$$IMW_{\vartheta,f,t+1} \equiv (1+\eta) \max\{\overline{\omega}_{\vartheta,f,M,t+1}, \overline{\omega}_{\vartheta,f,F,t+1}\} \tag{22}$$

$$IMH_{\vartheta,f,t+1} \equiv a_{\vartheta,f}(s, L_{f,t}, h_{\vartheta,f,t+1}) \cdot \max\{\overline{\omega}_{\vartheta,f,M,t+1}, \overline{\omega}_{\vartheta,f,F,t+1}\} \cdot \mathbb{1}[h_{\vartheta,f,t+1} > 0] \tag{23}$$

Equation (24) presents the **i**ncentives to **s**tay based on the **r**evenue reduction due to one less worker, $ISR_{\vartheta,f,t+1}$; the production of each department, $q_{\vartheta,f,t}$, is defined as a function of labor, $q_{\vartheta,f,t} = L^{\phi_s}_{\vartheta,f,t}$, in which ϕ_s is a sectoral output elasticity. Also, the product price $p_{\vartheta,f,t}$ is defined as a sectoral markup μ_s of average costs of each product unit, $p_{\vartheta,f,t} = \mu_s \cdot \frac{\mathbb{C}_{\vartheta,f,t}}{q_{\vartheta,f,t}}$. The latter is adjusted by $(h^*_{\vartheta,f,t+1} + 1 - h_{\vartheta,f,t+1})$ to account for increasing incentives when augmenting the deviation from $h^*_{\vartheta,f,t+1}$. Note that $IMW_{,\vartheta,f,t}$ and $IMH_{,\vartheta,f,t+1}$ do not need adjustment since $\mathbb{C}(h_{\vartheta,f,t+1})$ is updated with each $h_{\vartheta,f,t+1}$ value. Then, equation (25) presents the **i**ncentives to **s**tay based on lower **f**iring costs (if any), computed as an average, $ISF_{\vartheta,f,t}$. Similar to $ISR_{\vartheta,f,t}$, this incentive is multiplied by an adjustment factor. Note this incentive only makes sense when $h_{\vartheta,f,t+1} \leq 0$ and that is why the definition incorporates an indicator function.

$$ISR_{\vartheta,f,t+1} \equiv (h^*_{\vartheta,f,t+1} + 1 - h_{\vartheta,f,t+1})[p_{\vartheta,f,t} \frac{\partial q_{\vartheta,f,t}}{\partial L_{\vartheta,f,t}}] \tag{24}$$

$$ISF_{\vartheta,f,t+1} \equiv (h^*_{\vartheta,f,t+1} + 1 - h_{\vartheta,f,t+1})[\overline{\iota \cdot \omega_{i,\vartheta,f,t} + SV(\omega_{i,\vartheta,f,t})}] \cdot \mathbb{1}[h_{\vartheta,f,t+1} \leq 0] \tag{25}$$

Combining all incentives I obtain the third restriction of each department's decision:

$$IMW_{\vartheta,f,t+1} + [IMH_{\vartheta,f,t+1}] + \mathbb{C}(h_{\vartheta,f,t+1}) \leq \mathbb{C}^*(h^*_{\vartheta,f,t+1}) + \ ISR_{\vartheta,f,t+1} + [ISF_{\vartheta,f,t+1}] \tag{26}$$

Note that the incentives to stay in the third restriction increase the right-hand side of the inequality, making it easier for $h_{\vartheta,f,t+1}$ values to meet the inequality without deviating to lower values. Similarly, incentives to move increase the left side of the inequality, making it more challenging to meet the restriction and, therefore, stay at values near $h^*_{\vartheta,f,t+1}$.

Finally, each department's decision can be expressed as follows:

$$\begin{aligned}
&\min_{h_{\vartheta,f,t+1}} \{| \ h_{\vartheta,f,t+1} - h^*_{\vartheta,f,t+1} \ |\} \quad \text{subject to:} \\
&\qquad h_{\vartheta,f,t+1} \leq h^*_{\vartheta,f,t+1} + \epsilon \\
&\qquad \max\{\overline{\omega}_{\vartheta,f,M,t+1}, \overline{\omega}_{\vartheta,f,F,t+1}\} \leq \ \alpha \ \min\{\overline{\omega}_{\vartheta,f,M,t+1}, \overline{\omega}_{\vartheta,f,F,t+1}\} \\
&\qquad IMW_{\vartheta,f,t+1} + [IMH_{\vartheta,f,t+1}] + \mathbb{C}(h_{\vartheta,f,t+1}) \leq \mathbb{C}^*(h^*_{\vartheta,f,t+1}) + \ ISR_{\vartheta,f,t+1} + [ISF_{\vartheta,f,t+1}]
\end{aligned} \tag{27}$$

The previous optimization problem holds even with $h^*_{\vartheta,f,t+1} < 0$. In this case, the pessimistic department's expectations on sales require a minimum decrease of $h^*_{\vartheta,f,t+1}$ without the restriction. This decision process is done only once by each department of firm f between t and $t+1$ since it is only the initial reaction to the restriction. In the following section I will drop the subscripts of $h_{\vartheta,f,t+1}$ for convenience.

4.2.1. Complying with restriction and computing costs given a potential number of new job positions (h)

In general, for each possible h that the department considers, it generates a viable way to deal with the restriction and an associated labor cost for the final period $t+1$. Then, the final h is chosen to minimize the distance with respect to h^*, subject to the restrictions in (27). This section emphasizes how a department manages to comply with the restriction and computes the final labor cost given a possible h value. There are three potential cases to analyze, h positive, negative and equal to zero, but since there is heterogeneity in the circumstances each department experiences (types of R), then the three cases will differ slightly according to the situation; since R type 1 and R type 3 are analogous to R type 2 and type 4, respectively, only types 0, 1 and 3 will be explained according to the three possible cases of h. Also, there is an additional heterogeneity that depends on the firm's creation date; that is, if the firm or department within the firm arises in between the initial and final period in the economy (new), or if the department already existed in the initial period before the restriction.

First, departments or firms that arise after the restriction is established are viewed as payroll plans that are to be executed but haven't. Since these departments are just emerging, it makes no sense to see h as negative or zero, only positive. Since none of the workers have been hired yet, each department can change the gender of the positions to be filled so that if R is greater than zero, the restriction can be met, and so that the optimal path regarding $h^*_{\vartheta,f,t+1}$ and $\mathbb{C}^*$ can be maintained; this unofficial discrimination that dwells in assigning gender to jobs based on the firm's incentives to meet the restriction will be discussed promptly. Initially, since none of the departments know precisely the direction of the effect on wages by the forthcoming shock on the labor market, they determine the salaries of the positions based on their payroll plans and what they need to fulfill the restriction.

For departments that were already operating (not new), a positive h implies that they open positions with wages so that R becomes type 0 or stays 0. New jobs, h, are divided among genders according to the current department's gender composition; if the department has only men or women, then h is divided according to the respective occupation's gender composition in that sector. Regarding the new positions' wages, if the department already has R type 0, then the new positions will be assigned the gender's average wage. If the department has an R type 1, male positions will be given the male average wage, and the female positions' wages are set at the least sum possible but just enough so that the R type is transformed to 0. Finally, if the department has an R type 3 (only men), the male positions are given the average male wage, while the female positions are given wages such that at the least sum possible the R type is transformed to 0.

A h of zero means that the department doesn't expect hiring or firing. If its R is type 0, it already complies with the restriction. If R is type 1, then the adjustment is made through the increment of specific (strategic) wages in order to transform R to type 0 or through the increment of the lowest gender average wage and adjustment of all associated wages according to their deviations.[4] Then, if the department has an R type 3 (all men) it has no option but to hire one female worker with a wage such that the restriction is met. For a negative h, the department analyzes which workers' firing would reduce the R type and executes the firing for those that have the least firing cost associated. For the R type 3 and 4 cases, after the firing, the departments stills needs to hire a person of the opposite gender with a wage such that the payroll achieves an R type 0.

4.3. Labor market

After the number of positions h within each department is endogenously computed, there will be positions eliminated or some jobs created, as well as wage modifications and worker firings. These changes, along with new labor force entering, affect the labor market demand and supply and produce upward or downward pressure on the wages of the positions that are going to be placed in the market by the departments of all firms. The movement of a specific occupation's demand curve depends on new and eliminated positions in ϑ. Analogously, the supply curve movement depends on new workers that enter ϑ labor market and workers that exit that specific market.

Previously, it was shown that in order to complete each firm's strategy, they discriminate according to gender when filling each position (each position has an assigned gender); this informal (not official) discrimination when filling positions is a unique characteristic in these labor markets since it would not be realistic to expect that firms will consider both genders when they have incentives to fill them with a strategic one to meet the intra-occupational restriction. Therefore, since the labor market's impact on a specific occupation could be different for each gender, the exercise on moving curves will be done once for males and once for females. The model has one labor market for each gender-occupation in the economy. Each of these markets will determine the gender average wage in the occupation that must prevail in order to match the demand and supply of workers. I assume that supply and demand take a basic linear form presented in equations (28) and (29).

$$S : \overline{\omega}_{\vartheta,G} = \theta_{S,\vartheta,G} \cdot L^{S}_{\vartheta,G} \tag{28}$$

[4] Note that the associated cost ($n\gamma$) for moving the gender average wage or moving specific wages to finally change the gender average is the same; the change (γ) that the average salary of one of the genders requires to be optimal in satisfying R (that is, $\overline{\omega}^{*}$) can be redistributed equally (first option) or arbitrarily (second option).

$$take\ \overline{\omega} = \frac{\sum_{i=1}^{n} \omega_i}{n} \ \Rightarrow \ \overline{\omega}* = \overline{\omega} + \gamma = \frac{n\gamma + \sum_{i=1}^{n} \omega_i}{n}$$

$$D : \overline{\omega}_{\vartheta,G} = -\sigma_{\vartheta,G} \cdot L^{D}_{\vartheta,G} + \theta_{D,\vartheta,G} \tag{29}$$

The parameter $\sigma_{\vartheta,G}$ represents the impact wage decrease by an increase of demanded labor.[5] In the initial period, I have the average wage and the number of workers employed for each gender-occupation; this information is used in each of the market equations to compute $\theta_{S,\vartheta,G}$ and $\theta_{D,\vartheta,G}$ for the initial equilibrium; $\theta_{S,\vartheta,G}$ refers to the slope of the labor supply and $\theta_{D,\vartheta,G}$ the labor demand y-axis intercept. These parameters are used, along with the demand and supply movements after the departments' reaction to the restriction, to recalculate the average gender wage equilibrium in occupation ϑ, and therefore, compute the pressure on wages in that specific labor market for the new positions.

Equation (30) presents the pressure the wages may suffer during the negotiations of new posts because of the changes the labor market for each occupation and differentiated by gender is suffering; specifically, $\omega_{z,\vartheta,G}$ is the wage that the department assigned to the position it sent to the market and $\Delta\overline{\omega}_{\vartheta,G}$ the change in the average wage determined by the labor market for occupation ϑ and gender G; the updated wage for each position in the market is denoted as $\omega'_{z,\vartheta,G}$ in equation (30). Therefore, the new positions' final wages are determined by the departments' specific situation regarding the intra-occupational restriction in their initial state and pressure in the labor market. This is an important clarification because according to Card et al. (2016), in traditional competitive labor market models, wages are determined by market-level supply and demand factors rather than by the wage-setting policies of particular firms. Furthermore, Bertrand et al. (2010) and Card et al. (2016) put forward that wages can vary across firms if there are market-based compensating differentials for firm-wide amenities or disamenities, such as long hours of work. In this article, a new circumstance is introduced that justifies the wage differences across firms and pertains to the very different situations that a single occupation could be experiencing in two different firms regarding the gender wage gap compliance (the type of R and the gap magnitude).

$$\omega'_{z,\vartheta,G} = \omega_{z,\vartheta,G} + \Delta\overline{\omega}_{\vartheta,G} \tag{30}$$

4.4. Workers' decision and labor market clearing

Once the new positions have been incorporated into each labor market differentiated by occupation and gender, the matching between firm and worker starts. It is during this process that the pressure of the market materializes into a change of the initial wages associated with each position. It is important to point out that some workers experience wage rigidity. This assumption follows Jarosch (2015), in which wages can be re-bargain by workers only when they have a credible threat; in this case, workers that did not apply to any positions or did not receive any acceptances do not posses a credible threat to re-bargain. Nevertheless, all workers in the economy, including those categorized as independents and the new ones that enter the labor force, can apply and compete for the positions that arise, even if they already have a job.

There is no limit to the number of applications that a worker can send, but each worker will apply specifically to those that: i) have the same occupation as the worker has; ii) offer wages greater or equal to the current ones (incorporating firms' reaction); iii) are located in the same province-canton in which the worker currently works; the variable province-canton of the current job is used as a proxy of where the workers are willing to go work; for fired workers, the wage to compare to is the previous one and for new workers is the one they would have had according to the data information

[5] Since this parameter is not endogenous to the model, it is calibrated according to Alfaro et al. (2019), who estimated the labor demand elasticity for the comprehensive period 2005-2017, resulting in a -0.358% impact on labor demand by a 1% increment in wages. The previous elasticity is algebraically transformed to calculate σ_0.

of the final period of analysis. The application of each worker contains: gender, wage decile in their firm, and experience.

Each occupation within a firm receives all applications and applies an initial filter according to the gender they wanted to put in the position. Then, each department assigns a priority number to each remaining application according to the following criteria: experience and wage decile (a proxy of worker importance and position in the old or current firm). Each department simultaneously offers each available position to the highest priority application until it is filled.

Workers receive all job offers at the same time, but they don't decide immediately; they have some space to wait for other offers that might be rejected by other candidates; if there are several positions offered, the one with the highest wage is chosen. If a position is rejected, then the department sends the offer to the next priority application in line. If no wage is enough to fill the position, then it is filled from an unobservable pool of unemployed and informal workers. These last positions cannot be declared as deserted since it would imply that the firms can function without them and were not really necessary in the first place. When the matching ends, all departments will be able to see how much the pressure in the labor market and other conditions deviated their initial strategy to meet the restriction. At this point, if the deviation prevented the departments from achieving an R type 0, then they move the lowest gender average wage upward and adjust, using deviations from the mean, all associated wages to that gender in order to finish complying with the restriction.

After this process is complete, all departments end up with an updated wage structure in $t+1$ that complies with the intra-occupational restriction; then, the respective computations on decomposition components and gender wage gaps in the economy's occupations can be recalculated in order to proceed with the analysis on the impacts of the restriction.

4.5. Calibration of parameters

The computation of the decomposition's components and the quantitative exercise solution is done using a monthly frequency of the available data for the years of 2008, 2013, and 2018. I'm interested in the possible effects of such gender wage gap restrictions in the short term; therefore, for each of the available years in the dataset, I will use the information for February and November as the initial and final periods in the model; I don't consider January and December since the model is interested in each firm's stable jobs, not in the seasonal ones.

The parameter $a_{\vartheta,f}(s, L_{f,t}, h_{\vartheta,f})$ refers to each firm's hiring costs for each worker as a percentage of the wage. Its calibration follows Blatter et al. (2012) results, which pertain to how many weeks of wage payment hiring cost represent for each sector, $a(s)$, and the same for each size of firm $a(L_{f,t})$. Following Blatter et al. (2012), the calibration of the hiring cost parameter also takes into account the hiring amount, so that there is an additional effect for more or less hires than the average; only positive $h_{\vartheta,f,t+1}$ are considered in the previous average. The parameter definition is presented in Table 2. Then, the parameters μ_s and ϕ_s refer to a markup over cost and output elasticity, respectively; these were calibrated using Alfaro et al. (2021) results, which use an expanded version of my administrative data that allows the computation of these specific parameters. Table 2 presents the explanation and values of all parameters discussed in previous sections.

Table 2: Calibration of Model parameters

Parameter	Value	Description
t	February	Initial period in which the restriction is announced
$t+1$	November	Final period in which all firm departments must comply with the restriction
η	$1/12$	Monthly portion of annual bonus
ι	1	Fraction annual bonus paid during laid off
$SV(\omega_{i,\vartheta,f,t})$	$\frac{1}{30}\omega_{i,\vartheta,f,t}[7 \cdot \mathbb{1}_{[3<m\leq 6]} + 14 \cdot \mathbb{1}_{[6<m\leq 12]}$ $+20\frac{m}{12} \cdot \mathbb{1}_{[12<m\leq 96]} + 20 \cdot 8 \cdot \mathbb{1}_{[96<m]}]$	Severance pay; m months worked in firm (Source: Ministry of Labor)
$a_{\vartheta,f}(s, L_{f,t}, h_{\vartheta,f})$	$\max\{a(s), a(L_{f,t})\} \cdot \frac{1}{4} \cdot \sqrt{h_{\vartheta,f,t+1}/\overline{h}_{\vartheta,f,t+1}}$	Hiring cost as percentage of wage
α	$\{1, 1.5, 2, 2.5, 3\}$	Restriction on intra-occupational gender wage gap
ϵ	$\mathbb{1}[R \in \{3,4\}]$	Department's hiring margin over their initial expectations ($h^*_{\vartheta,f,t+1}$)
Experience	$\max\{\text{social dues, months worked in } f\}$	Worker experience (Source: Administrative data computation)
ϕ_s	mean: 0.84, sd: 0.00	Output Elasticity by sector (Source: Alfaro et al. (2021))
μ_s	mean: 1.25, sd: 0.00	Markup over cost by sector (Source: Alfaro et al. (2021))
$\sigma_{\vartheta,G}$	$2.79 \cdot \overline{\omega}_{\vartheta,G}/L_{\vartheta,G}$	Impact wage decrease by an increase of demanded labor (Alfaro et al., 2019)
$\theta_{S,\vartheta,G}$	mean: 817.6, sd: 3116.8 (unit: colones)	Slope of the labor supply (Source: Administrative data computation)
$\theta_{D,\vartheta,G}$	mean: 1.996.094, sd: 1.492.859 (unit: colones)	Labor demand y-axis intercept (Source: Administrative data computation)

Note: Table 2 presents the explanation and values of all parameters discussed in Section 4.

Algorithm 1: Intra-occupational gender wage gap restriction impact

In t: every firm f is notified of the gender wage gap restriction (α)
Analysis of the situation:
if *Department* (ϑ, f) *meets restriction* (α) **then**
    $R = 0$
else
    $R \in \{1, 2, 3, 4\}$
end
Deciding number of positions to be opened or closed (h**):**
for h=h^* **to** *0* **to** –L **do**
    while $R \neq 0$ **do**
        Generate payroll modifications to achieve $R = 0$ using h
    end
    Compute $\mathbb{C}$
    Verify compliance of:
    if $IMW + IMH + \mathbb{C} \leq \mathbb{C}^* + ISR + ISF$ **then**
        break (inside and outside loop)
    else
        next h value
    end
end
Using h, Department (ϑ, f) executes: pay modifications, firing and job posting.
Workers' reaction:
Worker i (fired, employed, new labor force, independent) decides which jobs to apply to.
    Applying factors: wage, occupation, location
Labor market:
Wage pressure on each occupational-gender labor market
Firms' decisions:
Department (ϑ, f) receives all applications
    Decision factors: gender, experience
Workers' decisions:
Worker i receives acceptances and takes the highest paid job.
Final checks:
if *Department* (ϑ, f) *meets restriction* (α) **then**
    Computes final labor cost $\mathbb{C}$
else
    Final adjustments:
        $\uparrow$ lowest gender avg wage $\rightarrow$ R=0 (wages readjust based on deviation to gender avg)
        Computes final labor cost $\mathbb{C}$
end

Note: This algorithm presents the decisions that firms and workers face and the clearing of the labor market after the gender wage gap restriction is announced. First, firms' departments find the optimal number of job positions to open or close based on: sales expectations, labor costs and gender wage gap restriction compliance. Then, workers (with or without jobs) decide which new job positions to apply to, based on: occupation, location and wages. Available job positions in the market suffer wage changes due to pressure in labor supply and demand. Finally, firms decide on job candidates using the variables gender and experience, and workers decide on job offers based on the wage offered.

5. Results

5.1. Wage inequality decomposition by gender

Table 3: Wage inequality ($\mathbb{T}$) decomposition by gender for 2008, 2013 and 2018.

Component	Contribution to $\mathbb{T}$			Contribution to $\Delta\mathbb{T}$		
	08	**13**	**18**	**08-13** ($\Delta\mathbb{T}$: 45.56%)	**13-18** ($\Delta\mathbb{T}$: 14.49%)	**08-18** ($\Delta\mathbb{T}$: 66.65%)
$\mathbb{T}$	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
$\mathbb{W}_{\text{gender}}$	0.9999	0.9986	0.9984	0.9959	0.9966	0.9961
$\mathbb{B}_{\text{gender}}$	0.0001	0.0014	0.0016	0.0041	0.0034	0.0039
$\mathbb{W}(\vartheta, f, T, s)$	0.3923	0.4079	0.4246	0.4422	0.5400	0.4732
$\mathbb{B}(s)$	0.1028	0.1316	0.1058	0.1948	-0.0721	0.1104
$\mathbb{B}(T, s)$	0.0126	0.0244	0.0159	0.0502	-0.0426	0.0208
$\mathbb{B}(f, T, s)$	0.2352	0.1849	0.1990	0.0744	0.2969	0.1448
$\mathbb{B}(\vartheta, f, T, s)$	0.2571	0.2513	0.2546	0.2384	0.2779	0.2509
$\mathbb{W}_M$	0.2734	0.2674	0.2676	0.2543	0.2687	0.2589
$\mathbb{W}_F$	0.0956	0.1186	0.1323	0.1692	0.2263	0.1873
$\mathbb{P}_M$	0.1171	0.1311	0.1381	0.1619	0.1862	0.1696
$\mathbb{P}_F$	0.1074	0.1099	0.1145	0.1154	0.1460	0.1250
$\mathbb{G}_M$	-0.1077	-0.1216	-0.1272	-0.1521	-0.1656	-0.1564
$\mathbb{G}_F$	-0.0936	-0.0976	-0.1006	-0.1064	-0.1216	-0.1112
$\mathbb{B}(s)_M$	0.0333	0.0305	0.0223	0.0244	-0.0348	0.0057
$\mathbb{B}(s)_I$	0.0155	0.0392	0.0211	0.0912	-0.1042	0.0294
$\mathbb{B}(s)_F$	0.0540	0.0619	0.0625	0.0792	0.0669	0.0753
$\mathbb{B}(T, s)_M$	0.0056	0.0079	0.0041	0.0130	-0.0225	0.0018
$\mathbb{B}(T, s)_I$	0.0041	0.0103	0.0068	0.0240	-0.0170	0.0110
$\mathbb{B}(T, s)_F$	0.0029	0.0061	0.0050	0.0132	-0.0031	0.0080
$\mathbb{B}(f, T, s)_M$	0.1614	0.1143	0.1123	0.0111	0.0984	0.0387
$\mathbb{B}(f, T, s)_I$	0.0402	0.0358	0.0462	0.0263	0.1182	0.0554
$\mathbb{B}(f, T, s)_F$	0.0336	0.0347	0.0405	0.0371	0.0804	0.0508
$\mathbb{B}(\vartheta, f, T, s)_M$	0.1978	0.1760	0.1725	0.1281	0.1483	0.1345
$\mathbb{B}(\vartheta, f, T, s)_I$	0.0028	0.0166	0.0212	0.0468	0.0530	0.0488
$\mathbb{B}(\vartheta, f, T, s)_F$	0.0565	0.0587	0.0610	0.0635	0.0765	0.0676

Note: Table 3 presents three sections, each representing a wage inequality (variance) decomposition. The first section is a basic within-between decomposition by gender. The second section presents the first phase of the decomposition of Section 3; that is, a decomposition by sector, type of firm (public or private), firm and occupation. The third section presents the second phase of the decomposition of Section 3; that is, a decomposition of the first phase by gender. Table 3 presents each component's contribution to total inequality and contribution to inequality growth. A positive sign in the contribution to $\Delta\mathbb{T}$ column indicates that the component's growth is in the same direction as the inequality growth. See Section 3 for details on each component's intuition.

Table 3 presents the calculation of each of the components of the inequality decomposition by gender, as a percentage of total inequality, both for the first and second phase of the decomposition. Besides, it presents how much each component contributes to the growth of inequality; specifically, between 2008 and 2013, the total inequality measure increases 46%, between 2013 and 2018 a 15%, and between 2008 and 2018 a total of 67%. The increase in wage inequality after 2008 coincides with the post-crisis period, in which the 2008 Gini coefficient experienced a rise of 3.9%, going from 48.7 to 50.6 according to World Bank estimates (Gini Index). Between 2008 and 2018, the Gini coefficient does not show a positive growth but falls to 48. However, this measure is calculated through a survey and is on household income, not wage income. Using the employer-employee administrative dataset, I find that the comparable Gini coefficient is 38.9 for 2008, 41.6 for 2013, and 40.9 in 2018; this shows that the inequality in real wage distribution for formal workers grew 5.1% between 2008 and 2018. It is important to note that the wage variance and the Gini coefficient on workers' wages do not measure precisely the same aspect; the first focuses on the closeness between wages, and the second on proportions of distribution (concentration). This is the reason why their growth magnitudes don't match.

Finally, the table also presents the basic version of the decomposition according to gender. The latter shows that almost all of the growth in total inequality can be attributed to salary differences within each gender (99.6% due to $\Delta\mathbb{W}_{gender}$) and the remaining almost insignificant to salary differences between genders. (0.4% due to $\Delta\mathbb{B}_{gender}$). However, such a distinction between components, and more specifically, the vagueness in the definition of the dominant component, does not allow a deep understanding of the nature of the problem shown with the salary differences within each gender group.

The analysis of wage inequality based on the first phase of the decomposition reflects that the inequality in each year of study depends mainly on the wage differences within workers of the same occupation in each firm (around 41% due to $\mathbb{W}(\vartheta, f, T, s)$), followed by salary differences between occupations of the same firm (25% due to $\mathbb{B}(\vartheta, f, T, s)$). Likewise, much of the growth in wage inequality can be explained by an increase in the wage differences within occupations in each firm (47% of the growth in inequality occurs by $\Delta\mathbb{W}(\vartheta, f, T, s)$) and through an increase in the salary differences between occupations of the same firm (around 25% of the growth in inequality occurs by $\Delta\mathbb{B}(\vartheta, f, T, s)$).

The previous analysis, now carried out for the second phase of decomposition, shows the importance of the following components in total inequality ($\mathbb{T}$): i) the differences within men of the same occupation in each firm (27% due to $\mathbb{W}_M$), ii) the penalty for occupational segregation in each firm (24% of $\mathbb{T}$ comes from $\mathbb{P}_M + \mathbb{P}_F$), and iii) the award for the fact that a certain number of occupations in each firm do not initially breach the restriction (around -22% arises from $\mathbb{G}_M + \mathbb{G}_F$). It is important to note that the previous award depends on how many departments were initially complying with the restriction and the weights that magnify the award or penalty, for example, the number of workers in each firm's occupation. Finally, in this more precise decomposition, the growth in inequality is mainly explained by an increase in the segregation penalty (30% of the total increase occurs by $\Delta(\mathbb{P}_M + \mathbb{P}_F)$), and by the rise in the salary differences within men of the same occupation of each firm (26% occurs due to $\Delta\mathbb{W}_M$) and the same for women (around 19% due to $\Delta\mathbb{W}_F$). Also, it is important to note that the growth in total inequality is slowed (around -27% from $\Delta(\mathbb{G}_M + \mathbb{G}_F)$) by a decrease of the gender wage gaps (see Table 5), which presents an example of the role that gender wage gaps play in reducing inequality (also seen in Piketty et al. (2018)).

A question that naturally arises when looking at which components explain the inequality measure and its growth is why do I impose a restriction on an element like $\mathbb{G}_M + \mathbb{G}_F$ if it seems to be that the differences within men of the same occupation in each firm are more important? Such a question must be answered in two parts. First, the restriction is not only for the gaps between the gender average wages that characterize $\mathbb{G}_M + \mathbb{G}_F$, but also applies to the gender segregation and dominance issue in each department that manifests in $\mathbb{P}_M + \mathbb{P}_F$; the latter represents an important component in inequality and its growth, and the former could become more negative (decrease in inequality measure) if remaining violations of the restriction were eliminated. Second, it is not necessary to implement an additional constraint to $\mathbb{W}_M$ and remove the one on gender wage gaps; this occurs because although each component measures something different, an interdependence is inherently created between them when an impulse such as the restriction in question is introduced, mainly between the differences within each gender, $\mathbb{W}_M$,$\mathbb{W}_F$, and the gender wage gaps, $\mathbb{G}_M + \mathbb{G}_F$. Specifically, this interdependence, which will allow the impact of the restriction to manifest itself in the differences within each gender, occurs when firms try to adapt gender wage averages to the restriction, since they are inevitably modifying wages within each gender, allowing the constraint to flow to these other components. Such insight will be taken up later in the quantitative exercise results.

5.2. Impact of the restriction on economy's occupational gender wage gaps

Figure 1 shows that the impacts on gender wage gaps of each occupation in the economy are particularly important for occupations with low participation of either gender. Moreover, those with low male participation (left) tend to present a deterioration in the gaps in favor of women (move away from $\frac{\overline{\omega}_M}{\overline{\omega}_F} = 1$ line, see Figure 2), and occupations with low female participation (right) present a deterioration of the gaps in favor of men.

Figure 1: Impact on gender wage gap for each occupation, $\frac{\overline{\omega}_{M,t+1}}{\overline{\omega}_{F,t+1}} - \frac{\overline{\omega}_{M,t}}{\overline{\omega}_{F,t}}$: Feb2013-Nov2013.

Note: Figure 1 presents the change in gender wage gap using different restriction's magnitudes (α); the calculation is done using the model's output on wages as the final period data after implementing the intra-occupation gender wage gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

Figure 2: Gender wage gap for each occupation in the initial and final period: Feb2013-Nov2013, alpha 2.

Note: Figure 2 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 2$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

Figures 1, 3 and 4 show that with a more stringent restriction ($\alpha = 1$), the previous effect of deterioration in the gaps in favor of some gender ceases, because the restriction imposes that these salary averages must be equalized in each department, so, the counterfactuals approach $\frac{\overline{\omega}_M}{\overline{\omega}_F} = 1$. Subsequently, with greater flexibility ($\alpha = 3$) the effect is contrary to the previous one, since a greater margin is allowed in the differences between averages.

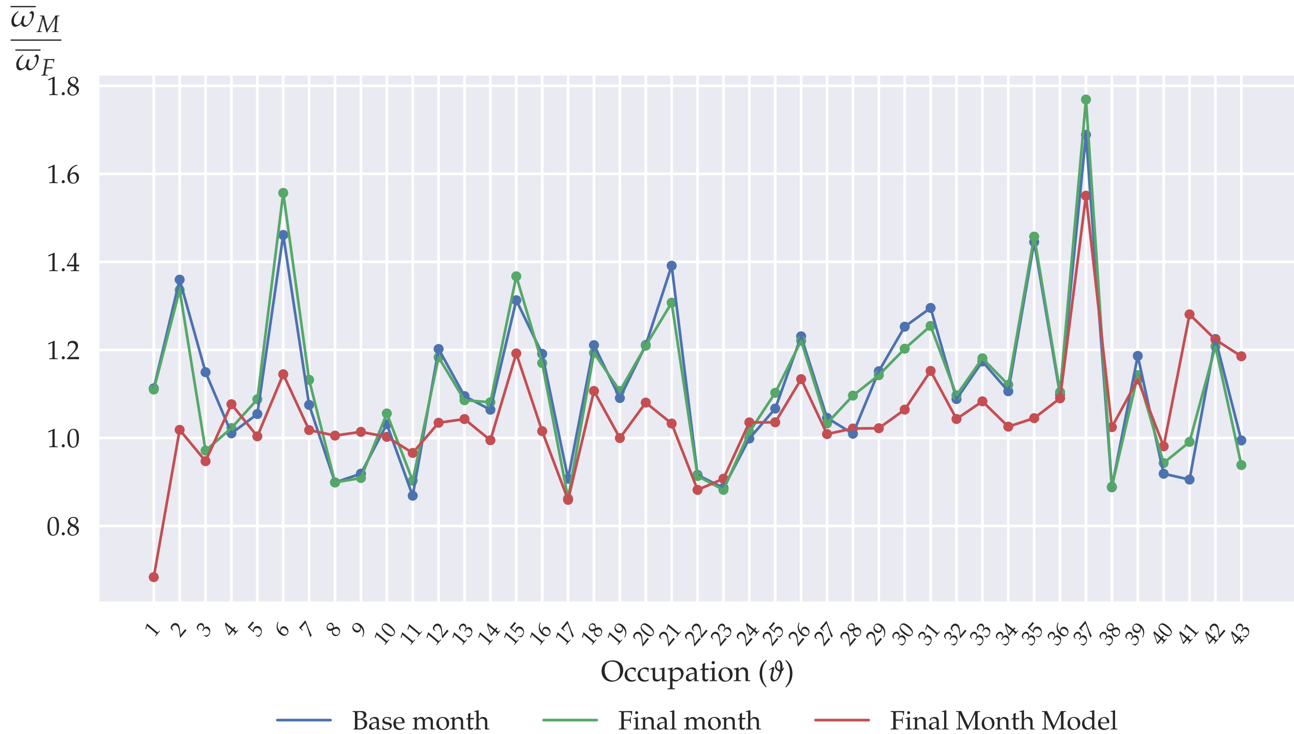

Figure 3: Gender wage gap for each occupation in the initial and final period: Feb2013-Nov2013, alpha 1.

Note: Figure 3 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 1$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

Figure 4: Gender wage gap for each occupation in the initial and final period: Feb2013-Nov2013, alpha 3.

Note: Figure 4 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 3$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

Figures 7 to 14 in Appendix C present the previous effects for the Feb2008-Nov2008 and Feb2018-Nov2018 periods. Initially, it could have been speculated that for a certain occupation ϑ, if the value that the gaps can take is reduced or limited, a movement towards the line of equal averages ($\frac{\overline{\omega}_M}{\overline{\omega}_F} = 1$) should be observed, or at least some stability compared to initial gaps, as with occupations in the center of the graph. However, despite the fact that the previous argument reflects the restriction's intuition, there is an important opposite effect in occupations with significant segregation.

First, it is important to note that the fact that the gender wage gaps in each occupation of each firm cannot be greater than α does not imply a transmission of this property to the occupations in the economy.[6] Now, one reason that explains the effect observed in occupations with a high concentration of one gender is that these occupations of the economy accumulate many departments with an R type 3 and 4. Since these occupations in firms must comply with the restriction, but they consist entirely of one gender, they are forced by the same restriction to hire at least one member of the opposite gender, either by opening new positions or using those they expected to open due to growth. For example, for the set of departments without women, an entry of this gender will be observed, but the entry wage may be low relative to the few women who were already in that occupation of the

[6]The following example shows how two single-occupational firms can comply with the restriction without necessarily transferring that property to the occupation in the economy. Firm 1 has a woman with salary 1 and a man with salary 2, and firm 2 has a woman with salary 2 and a man with salary 4. Both comply with the restriction, and the global gender wage gap is equal to 2. However, this possible final scenario could have culminated with three women with salary 1 in firm 1. In the same way, firms comply with the restriction, but the gap of this occupation in the economy is now 2.4.

economy. This causes the average salary of the few women in the economy's occupation to decrease and the gap to deteriorate in favor of men. The same would occur for occupations with low male participation. However, the effect is much greater in the case of female segregation (occupations to the right of the graph) because the data shows that this problem of occupational segregation occurs mainly for women (more R type 3 departments than type 4). Finally, this effect is consistent through the other simulations.

5.3. Impact of the restriction on wage inequality

Table 4: Wage inequality ($\mathbb{T}$) decomposition by gender: Feb2013-Nov2013 exercise.

Component	$\alpha = 1$ Contribution to ΔT: 25.18%	$\alpha = 2$ Contribution to ΔT: -11.19%	$\alpha = 3$ Contribution to ΔT: -8.38%
$\mathbb{T}$	1.0000	1.0000	1.0000
$\mathbb{W}_{\text{gender}}$	0.9945	0.9968	0.9951
$\mathbb{B}_{\text{gender}}$	0.0055	0.0032	0.0049
$\mathbb{W}(\vartheta, f, T, s)$	0.5709	0.9158	0.9352
$\mathbb{B}(s)$	0.0529	-0.0112	-0.0208
$\mathbb{B}(T, s)$	0.0123	-0.0115	-0.0188
$\mathbb{B}(f, T, s)$	0.1309	0.0872	0.0308
$\mathbb{B}(\vartheta, f, T, s)$	0.2331	0.0196	0.0735
$\mathbb{W}_M$	0.1631	0.6451	0.6612
$\mathbb{W}_F$	0.5517	0.1055	0.1441
$\mathbb{P}_M$	-0.0011	0.0811	0.1109
$\mathbb{P}_F$	0.1884	-0.0632	-0.0683
$\mathbb{G}_M$	-0.0591	-0.0071	-0.0446
$\mathbb{G}_F$	-0.2720	0.1544	0.1319
$\mathbb{B}(s)_M$	0.0090	-0.0038	-0.0052
$\mathbb{B}(s)_I$	0.0254	-0.0161	-0.0217
$\mathbb{B}(s)_F$	0.0185	0.0088	0.0062
$\mathbb{B}(T, s)_M$	0.0035	-0.0039	-0.0060
$\mathbb{B}(T, s)_I$	0.0044	-0.0048	-0.0084
$\mathbb{B}(T, s)_F$	0.0043	-0.0028	-0.0043
$\mathbb{B}(f, T, s)_M$	-0.0144	0.1378	0.0893
$\mathbb{B}(f, T, s)_I$	0.0992	-0.0526	-0.0672
$\mathbb{B}(f, T, s)_F$	0.0460	0.0021	0.0087
$\mathbb{B}(\vartheta, f, T, s)_M$	0.0201	0.0828	0.0877
$\mathbb{B}(\vartheta, f, T, s)_I$	0.1652	-0.1070	-0.0795
$\mathbb{B}(\vartheta, f, T, s)_F$	0.0477	0.0438	0.0653

Note: Table 4 presents three sections, each representing a wage inequality (variance) decomposition. The first section is a basic within-between decomposition by gender. The second section presents the first phase of the decomposition of Section 3; that is, a decomposition by sector, type of firm (public or private), firm and occupation. The third section presents the second phase of the decomposition of Section 3; that is, a decomposition of the first phase by gender. Table 4 presents each component's contribution to inequality growth after the implementation of the gender gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. A positive sign in the contribution to $\Delta\mathbb{T}$ column indicates that the component's growth is in the same direction as the inequality growth. See Section 3 for details on each component's intuition.

Table 4 presents the effects of the short-term restriction on the inequality components. Specifically, for $\alpha = 2$, a reduction in total wage inequality is observed with a decrease of 11.2%. The reduction is mainly driven by a decrease in wage differences within men of the same occupation in each firm (65% of $\Delta\mathbb{T}$ due to $\Delta\mathbb{W}_M$), as well as in differences within women (11% due to $\Delta\mathbb{W}_F$). The model suggests that when firms (more specifically, occupations within firms) are more vigilant of gender average wages, because of the restriction they must fulfill, wages within each gender tend to be relatively closer as a mechanism to maintain a better control of the respective average wage. Also, there is a decrease in the effect of segregation (penalization for not dominating, $\mathbb{P}_M + \mathbb{P}_F$) that contributes 2% to the reduction of inequality; however, the effect almost goes unnoticed because it is lowered by an increase in the female segregation effect ($\mathbb{P}_F$). This increment's cause does not lie in an increasing male dominance in each department, but in the fact that the restriction allowed the extreme female segregation to come to the surface; if you turn your attention to equation (11), you will see the final penalization is dependent on how many women are affected and their wage, which were both 0 at the beginning for R type 3 cases.

Now, the initial objective of the intra-occupational gender wage gap restriction in each firm was to counter the penalties that arose from $\mathbb{G}_M$ or $\mathbb{G}_F$, for having gender average wages above the allowed limit. However, despite the fact that the departments no longer present penalties for this reason, only reward for complying with the restriction, column (2) of Table 4 shows that the sum of these components doesn't contribute as much as other components to the reduction of inequality; specifically, $\mathbb{G}_F$ contributes 15% and $\mathbb{G}_M$ zero. The latter occurs because the penalties for not complying with the restriction had a dual character (the benefit of one gender group was a disadvantage for the other), so, by reducing the penalties of one group we are taking away the benefit of the opposite gender.[7] An extension of this point is shown in the $\alpha = 1$ case, in which the restriction requires gender wage gaps to be below the penalization threshold of 2. In this case, all departments receive a benefit for having gender wage gaps below the penalization threshold; furthermore, $\mathbb{G}_F$ contributes more to the inequality reduction since the female gender not only got rid of its wage domination penalties (reached the threshold of 2), but is now receiving benefits because of the gender wage gap elimination (also reached a more difficult threshold of 1); on the other hand, $\mathbb{G}_M$ doesn't contribute much because on one side lost the benefits of being the wage dominating gender and on the other receives some new benefits because of the gender wage gap elimination.

Table 4 also shows that the decrease in total inequality is also observed when the constraint is relaxed ($\alpha = 3$), with a decrease of 8.4% and when the constraint is tightened ($\alpha = 1.5$), with a decrease of 11.4% (see Figure 5). However, it can be seen that a very tight gender wage gap restriction ($\alpha = 1$) dissipates the wage inequality reduction, with an increase of inequality by 25.2%. The model's results suggest two main drivers for this effect, which can be seen in the same Table 4. The first reason pertains to the differences within gender, which may experience an increase of dispersion when more drastic changes in wages are needed in order to abide by the $\alpha = 1$ restriction; this occurs mainly for the gender with the lowest average wage, which in this case refers to $\mathbb{W}_F$. Second, since the $\alpha = 1$ constraint requires the equalization of both genders' average wage, differences between occupations, firms, type, and sector (based on wage averages) tend to increase; that is, the equalization of both genders' average wage within each occupation for each firm makes more evident the average wage differences between those occupations within firms ($\mathbb{B}(\vartheta, f, T, s)$). The past effects are also present,

[7] Suppose there is a single-occupation firm in which there is a man with a salary of 4 and a woman with a salary of 1. This generates a benefit for the man of $-7 = (1 - 2 \cdot 4)$, a penalty for the woman of $2 = (4 - 2 \cdot 1)$ and a global benefit of -5. For simplicity, I will ignore the gap weights in this example. Now, suppose that by abiding by the restriction, the man's salary falls to 2 (remember that it is actually a group of men whose average can drop through the use of scheduled job layoffs and new low-wage jobs) and the woman's wage remains at 1. This generates an impact of $0 = (2 - 2 \cdot 1)$ to the woman (punishment ceases because of the restriction), and for men the impact is of $-3 = (1 - 2 \cdot 2)$ (they still draw a benefit, although smaller, for being above the woman's salary). In this situation, the aggregate prize has dropped to -3.

with variations in magnitudes, in the other simulations (see Appendix C).
Figure 5 shows the impact of the restriction on total wage inequality for all simulations. It shows how a more severe restriction is counterproductive, even reversing the potential benefit of inequality reduction.

Figure 5: Restriction's impact on total wage inequality growth (%): Feb2008-Nov2008, Feb2013-Nov2013 and Feb2018-Nov2018 simulations.

Note: Figure 5 presents the growth of wage inequality (variance) using the model's output on wages as the final period data after implementing the intra-occupation gender wage gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other.

A last important aspect that must be emphasized is that the quantitative exercise results are especially interesting to analyze with respect to the initial situation and not with respect to the not modeled (real) final results. This is because the simulations, despite considering agent reactions, only focus their attention on a single event of interest, the restriction, and not on other events that may have occurred in that period of time. For this reason, they should not be compared directly with the final results that would have happened without the restriction on the intra-occupational gender wage gaps.
This precaution is of vital importance to avoid falling into excessive optimism or unfounded accusations. Specifically, there are going to be scenarios where from one period to another the measure of total inequality will increase or decrease; if it decreases, and the restriction produces a labor scenario where inequality also decreases, but not as much as if the restriction had not been applied, voices will arise against state intervention, claiming that this is proof that the involvement of the Government not only consumes resources but also increases distortion in the economy. On the other hand, if the inequality measure rises from one period to another, and the simulation produces a scenario where it decreases, other voices could praise the successful government intervention. In reality, what the simulations argue is that the restriction on the intra-occupational gender wage gaps in each firm can produce, by themselves (ignoring other events), a decrease in wage inequality, which is materialized through an interrelation of the components: occupational segregation, gender wage gaps, and inequality within the same gender.

5.4. Discussion

The previous results' sections have shown that the $\alpha = 2$ restriction that arose from the gender wage gap component in the inequality decomposition could have promising results. The model suggests that it not only limits the magnitude of the gender wage gap within each occupation in each firm, but it reduces wage inequality by about 10%, and causes little disruption in most of the economy's occupational gender wage gaps. However, the model's results also show that in the end, the restriction would produce additional labor costs, as defined in equation (15), for approximately 50% of all departments.

Even though an $\alpha = 2$ is suggested by the wage inequality decomposition, one could think that the restriction's rigor should be set according to its benefits and downsides. The model's results suggest that toughen the restriction too much can backfire and increase overall inequality. The positive effect associated with an $\alpha = 1$ is that it causes the economy's occupational gender wage gaps to near themselves to the equality line ($\frac{\overline{\omega}_M}{\overline{\omega}_F} = 1$). On the other hand, a more flexible restriction still limits the departments' gender wage gaps within a range, and does it with a similar wage inequality reduction. As it was already seen, this $\alpha = 3$ has the downside that produces a gender wage gap deterioration in highly segregated occupations; however, this issue could be solved with a differentiated α restriction, according to gender concentration within each occupation in the economy. Moreover, those occupations with a high percentage of men or women, or entirely without one of the genders, specifically the occupations that show volatility in Section 5.2, could be given the most rigorous restriction of $\alpha = 1$, while the others an $\alpha = 2$.

It is relevant to keep in mind that the past results are computed based on a model that makes two essential assumptions. First, I assume a short time between announcement and compliance of restriction (approximately 1 year). This is important for the exercise, since giving more time would engender further assumptions and speculation about how firms would choose to behave regarding when to begin the process to comply, which subsequently would affect the wage pressures in the labor market; the short-time assumption allows us to think of all firms moving to comply about at the same time. Furthermore, this feature is why the model is based on two periods only and a decision process in between, instead of several periods of adjustment. Second, I assume firms maintain their sales expectations (prior restriction) once they are informed of the intra-occupational gender wage gap restriction, arguing they do not hold enough information to estimate how this novel policy would impact their demand. In general, the model centers on how firms introduce changes into their payroll and make decisions about hiring and firing based on intra-occupational gender wage gap requirements; furthermore, it takes into account the unofficial gender discrimination that may occur based on the firms' interest on filling positions with a specific gender to strategically meet the restriction. The model captures the labor market's pressure on specific occupations' wages based on firms' needs for specific professions and genders to comply with the restriction. Also, it captures the fact that cost may increase in such a way that some firms will fire all workers and cease operation; similarly, it also captures firms that are able to offset new costs associated with the gender gap restriction through wage reductions during the labor market's pressure on specific occupations and genders. On the other hand, the model is unable to capture the fact that firms may renegotiate wages once a worker has received an acceptance for another better-paid job. Finally, the model does not incorporate workers' decision between employment and leisure.

Finally, even though it must be made clear that the previous results may vary in other countries, the circumstances which motivated the restriction and were key in how the restriction ultimately transmitted its effect on overall wage inequality through certain components may also be present in other countries. First, the presence of gender wage gaps (intra-occupational within each firm), so that there is space to increase their contribution in reducing or slowing inequality as seen in Table 4. Second, wage inequality within men (or women) of the same specific occupation in each firm (non zero contribution of $\mathbb{W}_M$ or $\mathbb{W}_F$). Third, the presence of gender segregation (occupations within each firm that are composed of more than one worker but only one gender). Then, another important point is that even though the decomposition presents a clear way to decrease overall inequality through the gender gap component (via a restriction on the gap), there could be cases in which a gender gap restriction can end up having the opposite effect to the one intended; this is the case of limiting the wage gender gap with an $\alpha = 2$ versus forcing an elimination of the gender gap with an $\alpha = 1$ in the case of Costa Rica.

6. Concluding Remarks

This article evaluates the impact of a mandatory restriction on intra-occupational gender wage gaps within each firm. To do so, a novel wage inequality decomposition is developed in order to relate gender-specific components, like differences within gender, gender wage gaps, and occupational segregation, to the overall measure of inequality. This decomposition is then used to set the basis of a labor market that models the firms' and workers' reactions to the restriction. This allows quantifying the impact of the restriction on wage inequality and on occupational gender wage gaps in the economy.

First, the wage inequality decomposition shows there has been a 67% growth in the inequality measure between 2008 and 2018; most of it is explained by an increment in the gender segregation and dominance component (30% of inequality growth) and higher wage differences within men of the same occupation in each firm (26%). Additionally, for the study years, around 40% of the departments in the economy (occupations in each firm) violate the standard intra-occupational gender wage gap restriction of $\alpha = 2$ by having a gender average wage over two times the other gender average; and, 94% of these departments initially violate the restriction because of occupational segregation (departments with more than one worker and only one type of gender present).

Then, the quantitative exercise shows that the effect of the restriction on gender wage gaps in the economy's occupations is particularly important for those with a high concentration of one gender; in general, these gaps tend to deteriorate (move away from the equalization of averages) in favor of men for those occupations with little female participation, and tend to deteriorate in favor of women if the occupation has low male participation. This deterioration of the gap is exacerbated when the restriction is relaxed, and it is lessened with a more severe restriction (gender salary averages must be the same in each firm's occupation). The model also shows that the constraint of $\alpha = 2$ produces a decrease in total inequality of about 10%. This reduction is mainly achieved through lesser wage differences among workers of the same gender within the same department. However, this overall inequality reduction dissipates and reverts into an increment if the restriction is tightened too much ($\alpha = 1$).

Finally, although this article highlights the potential benefits and disadvantages of imposing limits to the intra-occupational gender wage gaps within each firm, it also raises two interesting points that should be embraced in future research. First, the quantitative exercise for the restriction centered its attention on the firms' labor decisions, but an extension of the model and data regarding each firm's production could provide further insides into the effects on their performance after the gender wage gap regulation. Second, it was shown that forcing (by mandate) wage gender equality with an $\alpha = 1$ restriction (gender wage averages equal) increases overall wage inequality; however, it would be useful to study if that also occurs (or not) when the wage gender gap is eliminated through a less disruptive and forceful event. For instance, Roussille (2021) presents that changing the way candidates give the ask wage before hiring (change from empty box to pre-filled based on similar candidates) drove the bid gap (wage offered by firm) to zero, without penalty on the number of bids received after the change.

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Appendices

A. Employer-employee administrative dataset cleaning

The database records monthly labor aspects of workers insured in the Costa Rican Social Security or *Caja Costarricense del Seguro Social* (henceforth, CCSS); this insurance is compulsory for all formal jobs. The base that the Institute for Research in Economic Sciences (IICE) obtained from the CCSS contains, for 2008, 2013, and 2018, the following variables: month, firm identifier, firm name (only for public firms or institutions), type of firm (public or private), economic sector of the firm, location of the firm (province, canton, and district), number of workers per firm, worker identifier, gender, date of birth, age, occupation, working time, monthly salary, type of worker (salaried or independent), work start date in the firm and number of contributions to CCSS.

In general, the base underwent a series of transformations to obtain the necessary conditions to implement the methodology. For example, given that the interest is in the gender wage gaps, and since these can be affected or formed by considerable salary differences, I did not eliminate the outliers that could be the cause for those differences, but only those that may be associated with typing errors. Specifically, the observations with monthly wages greater than 100 million colones (182 000 dollars) and lower than 100 thousand colones (182 dollars) were eliminated; the upper limit was set based on local research and news that identified the existence of people in the private sector with wages around the mentioned amount; the lower limit was established based on the minimum wage of the period and the number of observations lost due to this filter. For government employees there is no need for the past upper limit; nevertheless, I imposed a different upper limit of 15 million colones to offset a common event in this sector regarding accumulated wages due to delayed payment. Furthermore, I kept only workers between the ages of 17 and 85; some dates were corrected due to evident errors in the year of birth. All occupations and locations that do not have a valid value were re-coded into an additional category in each variable. The economic sectors that are not detailed for a few firms in the base were approximated through their workers' occupations.

Subsequently, part-time workers were discarded because they are not of interest for this research and because their wages are not comparable with full-time ones. Independent workers were kept during the manipulation of the base because they are an input for the labor supply in the quantitative exercise; however, they were eventually discarded because the measures of inequality and gender wage gaps are analyzed for firms and therefore only for direct employees. Then, workers without an assigned gender were eliminated; this modifies to a certain extent the exact composition of specific firms; however, not only are they relatively few (from 0.03 to 1.8% of total observations, depending on the period), but this step is unavoidable because gender is the central variable in the research. For workers with more than one job in the same month, only the job with the highest salary was considered, because the second one is probably a part-time job.

In order to calculate some statistics for each year, a transformation was applied to the dataset to obtain a yearly frequency. To do so, the yearly average wage was computed for each worker; workers who worked only one month in the year were eliminated due to the intuition of an annual labor force for each firm; also, if an individual had more than one employer in the year, it was taken as a worker of the firm where he earned the most in those 12 months. Finally, only the firms that after the modifications have a number greater or equal to 4 workers are kept; this is partly because of the volatility associated with small-sized firms, but also because the restriction in the gender wage gap that is going to be introduced makes little sense in firms with one person or very extreme cases such as 2 or 3 people. Finally, Table 5 shows statistics of the final observations used, specifically, the gender average wage, the labor force gender composition and gender wage gaps by sector.

Table 5: Descriptive statistics by economic sectors: gender composition of labor force (δ), average wage ($\overline{\omega}$) and gender wage gaps ($\overline{\omega}_M$ / $\overline{\omega}_F$) for years 2008, 2013 and 2018.

Sector		δ_M			δ_F			$\overline{\omega}_M$			$\overline{\omega}_M$ / $\overline{\omega}_F$	
	08	13	18	08	13	18	08	13	18	08	13	18
Agriculture	0.82	0.84	0.83	0.18	0.16	0.17	234.06	246.87	271.10	1.17	1.09	1.07
Mining	0.89	0.89	0.91	0.11	0.11	0.09	288.58	296.26	328.30	1.28	1.18	1.06
Manufacturing	0.71	0.71	0.69	0.29	0.29	0.31	367.31	411.94	438.55	1.34	1.23	1.17
Energy supply	0.79	0.79	0.79	0.21	0.21	0.21	546.29	675.83	698.38	1.17	0.94	0.96
Construction	0.94	0.93	0.92	0.06	0.07	0.08	241.53	262.49	286.62	0.82	0.70	0.73
Retail	0.65	0.64	0.64	0.35	0.36	0.36	300.80	328.61	367.93	1.17	1.13	1.09
Hotels and restaurants	0.56	0.54	0.53	0.44	0.46	0.47	240.28	256.40	281.54	1.16	1.14	1.12
Transportation	0.82	0.81	0.80	0.18	0.19	0.20	289.52	322.43	350.03	0.93	0.90	0.88
Information and communication	0.65	0.63	0.62	0.35	0.37	0.38	444.75	465.58	524.04	1.28	1.27	1.25
Finance	0.65	0.64	0.58	0.35	0.36	0.42	623.94	697.25	753.38	1.15	1.10	1.13
Real state	0.76	0.75	0.72	0.24	0.25	0.28	326.01	327.96	386.45	0.98	1.04	1.01
Public administration	0.65	0.64	0.65	0.35	0.36	0.35	437.49	568.73	588.67	0.83	0.81	0.79
Education	0.31	0.32	0.30	0.69	0.68	0.70	451.38	620.97	679.54	1.11	1.12	1.10
Social and health	0.43	0.43	0.40	0.57	0.57	0.60	709.89	929.86	902.22	1.20	1.20	1.23
Cultural and association	0.55	0.56	0.55	0.45	0.44	0.45	327.31	391.12	461.68	1.08	1.10	1.15
International activities	0.38	0.37	0.43	0.62	0.63	0.57	780.18	989.28	954.56	1.19	1.31	1.28
Water and waste management	0.68	0.73	0.74	0.32	0.27	0.26	366.86	458.46	432.66	1.31	0.97	0.88
Professional and scientific	0.64	0.63	0.61	0.36	0.37	0.39	465.44	494.34	598.79	1.19	1.19	1.16
Other services	0.75	0.74	0.72	0.25	0.26	0.28	224.89	256.46	288.18	1.11	1.08	1.05
Other	0.57	0.57	0.60	0.43	0.43	0.40	301.46	345.83	493.54	1.17	1.18	1.18

Note: Table 5 presents the gender composition, average wages and gender wage gaps by sector. Average wages are read in thousands of real January 2008 colones. The agricultural sector includes agriculture, livestock, fishing and forestry. Retail includes wholesale and retail sales, as well as other sales that do not conform to other sectors. The transport sector includes not only aspects of transport services, but storage and trips abroad. The information sector groups information manipulation and presentation, including surveys. The water and waste management sector includes environmental protection.

Table 6: List of occupations.

Code	Occupation	Code	Occupation
1	Preschool and Special Education	23	Others
2	Domestic Employees	24	Entertainment and Culture
3	Beauty	25	Medical equipment operator
4	Caregiver	26	Seller
5	Primary and secondary education	27	Chemistry
6	Dentist	28	Politician
7	Social scientist	29	Agriculture
8	Nursing	30	Executive
9	Nutritionist	31	Operator (production line)
10	Pharmaceutical and other health sciences	32	Production Supervisor
11	Professional in language	33	Computer scientist
12	Clerk	34	Engineer and Mathematics
13	Public Attention	35	Religious and thinker
14	Lawyer	36	Printing and Design
15	Cleaning and maintenance	37	Electrician
16	Administration and Business	38	Logistical and customs support
17	Biologist and geologist	39	Pawn
18	Food professional	40	Security
19	University Education	41	Builder
20	Economy and Finance	42	Mechanic
21	Medicine	43	Transporter
22	Communicator		

Note: The occupations' codes in the original employer-employee dataset are based on the Costa Rican Occupation Classification, COCR, 2011 version. These codes have a 4-digit precision and in the case of this dataset give 482 different occupations; this amount is slightly overestimate given that it differentiates by a few academic and non-academic degrees. These codes were aggregated into 43 categories according to their description similarity and using a 2-digit precision.

B. Wage inequality decomposition

I take the variance of wages as the total wage inequality ($\mathbb{T}$) in the economy. The first phase of the decomposition will part the total inequality into between and within inequality components according to the following aspects of the economy: sector (s), type of firm (T), firm (f), occupation (ϑ) and worker (i):

$$\mathbb{T}(\omega) \equiv \frac{1}{N}\sum_{i=1}^{N}(\omega_i - \overline{\omega})^2 = \frac{1}{N}\underbrace{\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\sum_{i\in\vartheta}}_{\sum_{s,T,f,\vartheta,i}}\underbrace{(\omega_i - \overline{\omega})^2}_{(\omega_i-\overline{\omega}_s+\overline{\omega}_s-\overline{\omega})^2}$$

I start the decomposition by summing and subtracting $\overline{\omega}_s$ within the factor. Take $x = \omega_i - \overline{\omega}_s$ and $y = \overline{\omega}_s - \overline{\omega}$. I apply this technique to all other aspects of the economy until equation (31) is obtained.

$$\begin{aligned}
\mathbb{T}(\omega) =& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_s)^2 + \frac{2}{N}\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\sum_{i\in\vartheta}(\omega_i - \overline{\omega}_s)(\overline{\omega}_s - \overline{\omega}) + \frac{1}{N}\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\sum_{i\in\vartheta}(\overline{\omega}_s - \overline{\omega})^2 \\
\iff& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_s)^2 + \frac{2}{N}\sum_{s\in S}[(\overline{\omega}_s - \overline{\omega})\underbrace{\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\sum_{i\in\vartheta}(\omega_i - \overline{\omega}_s)]}_{0} + \underbrace{\frac{1}{N}\sum_{s\in S}N_s(\overline{\omega}_s - \overline{\omega})^2}_{\mathbb{B}(s)}
\end{aligned}$$

Note that because of the aggregation over the workers, all intermediate terms by the form of $2xy$ disappear.

$$\begin{aligned}
\iff& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_{T,s})^2 + \frac{2}{N}\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\sum_{i\in\vartheta}(\omega_i - \overline{\omega}_{T,s})(\overline{\omega}_{T,s} - \overline{\omega}_s) + \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\overline{\omega}_{T,s} - \overline{\omega}_s)^2 + \mathbb{B}(s) \\
\iff& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_{T,s})^2 + \frac{2}{N}\sum_{s\in S}\sum_{T\in s}[(\overline{\omega}_{T,s} - \overline{\omega})\underbrace{\sum_{f\in T}\sum_{\vartheta\in f}\sum_{i\in\vartheta}(\omega_i - \overline{\omega}_{T,s})]}_{0} + \underbrace{\frac{1}{N}\sum_{s\in S}\sum_{T\in s}N_{T,s}(\overline{\omega}_{T,s} - \overline{\omega}_s)^2}_{\mathbb{B}(T,s)} + \mathbb{B}(s) \\
\iff& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_{f,T,s} + \overline{\omega}_{f,T,s} - \overline{\omega}_{T,s})^2 + \mathbb{B}(T,s) + \mathbb{B}(s) \\
\iff& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_{f,T,s})^2 + \mathbb{B}(f,T,s) + \mathbb{B}(T,s) + \mathbb{B}(s) \\
\iff& \frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_{\vartheta,f,T,s} + \overline{\omega}_{\vartheta,f,T,s} - \overline{\omega}_{f,T,s})^2 + \mathbb{B}(f,T,s) + \mathbb{B}(T,s) + \mathbb{B}(s) \\
\iff& \underbrace{\frac{1}{N}\sum_{s,T,f,\vartheta,i}(\omega_i - \overline{\omega}_{\vartheta,f,T,s})^2}_{\mathbb{W}(i,\vartheta,f,T,s)} + \mathbb{B}(\vartheta,f,T,s) + \mathbb{B}(f,T,s) + \mathbb{B}(T,s) + \mathbb{B}(s)
\end{aligned}$$

$$\boxed{\mathbb{T}(\omega) = \mathbb{W}(i,\vartheta,f,T,s) + \mathbb{B}(\vartheta,f,T,s) + \mathbb{B}(f,T,s) + \mathbb{B}(T,s) + \mathbb{B}(s)} \tag{31}$$

This completes the first phase of the decomposition. Now, I'm interested in separating workers into categories according to a specific characteristic of their own, in this case, gender ($\mathrm{G} \in \{M, F\}$). The second phase begins as follows.

Taking the within component in equation (31):

$$\mathbb{W}(i,\vartheta,f,T,s) = \frac{1}{N}\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\underbrace{\sum_{i\in\vartheta}}_{\sum_{G\in\vartheta}\sum_{i\in G}}(\omega_i - \overline{\omega}_{\vartheta})^2$$

$$\iff \frac{1}{N}\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}[\underbrace{\sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\overline{\omega}_\vartheta)^2}_{\zeta}+\underbrace{\sum_{F\in\vartheta}\sum_{i\in F}(\omega_i-\overline{\omega}_\vartheta)^2}_{\varphi}]$$

Define $\delta_{\vartheta,M}$ y $\delta_{\vartheta,F}$ as the proportions of each gender in occupation ϑ in firm f. Then, $\delta_{\vartheta,M}+\delta_{\vartheta,F}=1$ y note that $\overline{\omega}_\vartheta=\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M}+\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}$. Now, expanding ζ and φ of occupation ϑ in firm f:

$$\begin{aligned}
\zeta &= \sum_{M\in\vartheta}\sum_{i\in M}(\omega_i^2-2\omega_i\overline{\omega}_\vartheta+\overline{\omega}_\vartheta^2)\\
\iff & \sum_{M\in\vartheta}\sum_{i\in M}(\omega_i^2-2\omega_i\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M}-2\omega_i\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}+\delta_{\vartheta,M}^2\overline{\omega}_{\vartheta,M}^2+2\delta_{\vartheta,F}\delta_{\vartheta,M}\overline{\omega}_{\vartheta,F}\overline{\omega}_{\vartheta,M}+\delta_{\vartheta,F}^2\overline{\omega}_{\vartheta,F}^2)\\
\iff & \sum_{M\in\vartheta}\sum_{i\in M}[(\omega_i-\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M})^2+(\delta_{\vartheta,F}^2\overline{\omega}_{\vartheta,F}^2+2\delta_{\vartheta,F}\delta_{\vartheta,M}\overline{\omega}_{\vartheta,F}\overline{\omega}_{\vartheta,M}-2\omega_i\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F})]\\
\iff & \sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M})^2+\sum_{M\in\vartheta}\sum_{i\in M}(\delta_{\vartheta,F}^2\overline{\omega}_{\vartheta,F}^2+2\delta_{\vartheta,F}\delta_{\vartheta,M}\overline{\omega}_{\vartheta,F}\overline{\omega}_{\vartheta,M}-2\omega_i\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F})\\
\iff & N_{\vartheta,M}\delta_{\vartheta,F}^2\overline{\omega}_{\vartheta,F}^2+2N_{\vartheta,M}\delta_{\vartheta,F}\delta_{\vartheta,M}\overline{\omega}_{\vartheta,F}\overline{\omega}_{\vartheta,M}-2\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}\underbrace{\sum_{M\in\vartheta}\sum_{i\in M}\omega_i}_{N_{\vartheta,M}\overline{\omega}_{\vartheta,M}}+\sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M})^2\\
\iff & N_{\vartheta,M}\delta_{\vartheta,F}^2\overline{\omega}_{\vartheta,F}^2+2N_{\vartheta,M}\delta_{\vartheta,F}\delta_{\vartheta,M}\overline{\omega}_{\vartheta,F}\overline{\omega}_{\vartheta,M}-2\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}N_{\vartheta,M}\overline{\omega}_{\vartheta,M}+\sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\overline{\omega}_{\vartheta,M}+\overline{\omega}_{\vartheta,M}-\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M})^2\\
\iff & N_{\vartheta,M}\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}(\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}+2\delta_{\vartheta,M}\overline{\omega}_{\vartheta,M}-2\overline{\omega}_{\vartheta,M})+\sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\overline{\omega}_{\vartheta,M})^2+N_{\vartheta,M}[\overline{\omega}_{\vartheta,M}\underbrace{(1-\delta_{\vartheta,M})}_{\delta_{\vartheta,F}}]^2\\
\iff & N_{\vartheta,M}\delta_{\vartheta,F}\overline{\omega}_{\vartheta,F}(\delta_{\vartheta,F}\overline{\omega}_F-2\overline{\omega}_{\vartheta,M}\underbrace{(1-\delta_{\vartheta,M})}_{\delta_{\vartheta,F}})+\sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\overline{\omega}_{\vartheta,M})^2+N_{\vartheta,M}\overline{\omega}_{\vartheta,M}^2\delta_{\vartheta,F}^2\\
\iff & \underbrace{N_{\vartheta,M}\delta_{\vartheta,F}^2\overline{\omega}_{\vartheta,F}(\overline{\omega}_{\vartheta,F}-2\overline{\omega}_{\vartheta,M})}_{\mathbb{G}_{\vartheta,M}}+\underbrace{\sum_{M\in\vartheta}\sum_{i\in M}(\omega_i-\overline{\omega}_{\vartheta,M})^2}_{\mathbb{W}_{\vartheta,M}}+\underbrace{N_{\vartheta,M}\overline{\omega}_{\vartheta,M}^2\delta_{\vartheta,F}^2}_{\mathbb{P}_{\vartheta,M}}
\end{aligned}$$

Analogously for φ:

$$\varphi=\underbrace{N_{\vartheta,F}\delta_{\vartheta,M}^2\overline{\omega}_{\vartheta,M}(\overline{\omega}_{\vartheta,M}-2\overline{\omega}_{\vartheta,F})}_{\mathbb{G}_{\vartheta,F}}+\underbrace{\sum_{F\in\vartheta}\sum_{i\in F}(\omega_i-\overline{\omega}_{\vartheta,F})^2}_{\mathbb{W}_{\vartheta,F}}+\underbrace{N_{\vartheta,F}\overline{\omega}_{\vartheta,F}^2\delta_{\vartheta,M}^2}_{\mathbb{P}_{\vartheta,F}}$$

Substituting ζ y φ in $\mathbb{W}$:

$$\mathbb{W}(i,\vartheta,f,T,s)=\frac{1}{N}\sum_{s\in S}\sum_{T\in s}\sum_{f\in T}\sum_{\vartheta\in f}\sum_{G\in\vartheta}(\mathbb{G}_{\vartheta,G}+\mathbb{W}_{\vartheta,G}+\mathbb{P}_{\vartheta,G})$$

Therefore, I obtain a gender decomposition for $\mathbb{W}(i,\vartheta,f,T,s)$:

$$\mathbb{W}(i,\vartheta,f,T,s)=\mathbb{G}_M+\mathbb{G}_F+\mathbb{W}_M+\mathbb{W}_F+\mathbb{P}_M+\mathbb{P}_F \tag{32}$$

Now, taking the between sector component from equation (31), I substitute the average wages with their gender average wages by using the previously defined δs as weights.

$$\begin{aligned}
\mathbb{B}(s) =& \frac{1}{N}\sum_{s\in S}N_s(\overline{\omega}_s-\overline{\omega})^2\\
\iff & \sum_{s\in S}\frac{N_s}{N}[(\delta_{s,M}\overline{\omega}_{s,M}+\delta_{s,F}\overline{\omega}_{s,F})-(\delta_M\overline{\omega}_M+\delta_F\overline{\omega}_F)]^2
\end{aligned}$$

$$\iff \sum_{s\in S}\frac{N_s}{N}[\underbrace{(\delta_{s,M}\overline{\omega}_{s,M}-\delta_M\overline{\omega}_M)}_{M}+\underbrace{(\delta_{s,F}\overline{\omega}_{s,F}-\delta_F\overline{\omega}_F)}_{F}]^2$$
$$\iff \underbrace{\sum_{s\in S}\frac{N_s}{N}M^2}_{\mathbb{B}(s)_M}+\underbrace{\sum_{s\in S}\frac{N_s}{N}2MF}_{\mathbb{B}(s)_I}+\underbrace{\sum_{s\in S}\frac{N_s}{N}F^2}_{\mathbb{B}(s)_F}$$

Analogously, I obtain:

$$\mathbb{B}(s) = \mathbb{B}(s)_M + \mathbb{B}(s)_I + \mathbb{B}(s)_F$$
$$\mathbb{B}(T,s) = \mathbb{B}(T,s)_M + \mathbb{B}(T,s)_I + \mathbb{B}(T,s)_F$$
$$\mathbb{B}(f,T,s) = \mathbb{B}(f,T,s)_M + \mathbb{B}(f,T,s)_I + \mathbb{B}(f,T,s)_F$$
$$\mathbb{B}(\vartheta,f,T,s) = \mathbb{B}(\vartheta,f,T,s)_M + \mathbb{B}(\vartheta,f,T,s)_I + \mathbb{B}(\vartheta,f,T,s)_F$$

By incorporating the gender within and between decomposition I finally obtain:

$$\boxed{\begin{gathered}\mathbb{T}(\omega) = \mathbb{G}_M + \mathbb{G}_F + \mathbb{W}_M + \mathbb{W}_F + \mathbb{P}_M + \mathbb{P}_F + \mathbb{B}(s)_M + \mathbb{B}(s)_I + \mathbb{B}(s)_F + \mathbb{B}(T,s)_M + \mathbb{B}(T,s)_I + \mathbb{B}(T,s)_F + \\ \mathbb{B}(f,T,s)_M + \mathbb{B}(f,T,s)_I + \mathbb{B}(f,T,s)_F + \mathbb{B}(\vartheta,f,T,s)_M + \mathbb{B}(\vartheta,f,T,s)_I + \mathbb{B}(\vartheta,f,T,s)_F\end{gathered}} \tag{33}$$

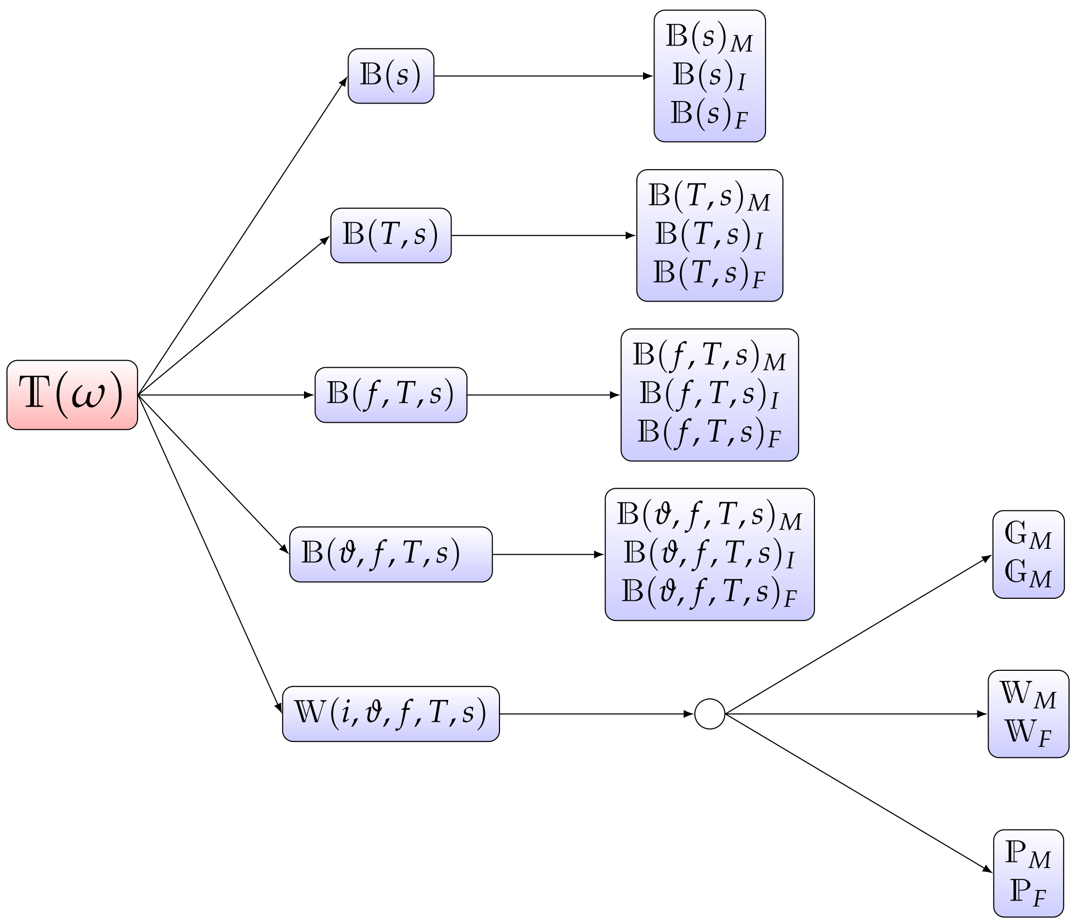

Figure 6: Wage inequality decomposition by gender in graph tree

C. Additional Results

Table 7: Wage inequality ($\mathbb{T}$) decomposition by gender: Feb2008-Nov2008 exercise.

Component	$\alpha = 1$ Contribution to ΔT: 1.24%	$\alpha = 2$ Contribution to ΔT: -9.85%	$\alpha = 3$ Contribution to ΔT: -10.02%
$\mathbb{T}$	1.0000	1.0000	1.0000
$\mathbb{W}_{\text{gender}}$	0.9763	1.0019	1.0034
$\mathbb{B}_{\text{gender}}$	0.0237	-0.0019	-0.0034
$\mathbb{W}(\vartheta, f, T, s)$	-6.5814	0.8477	0.7303
$\mathbb{B}(s)$	-0.0027	0.1096	0.1054
$\mathbb{B}(T, s)$	0.1557	-0.0269	-0.0281
$\mathbb{B}(f, T, s)$	3.7600	0.0524	0.1174
$\mathbb{B}(\vartheta, f, T, s)$	3.6684	0.0172	0.0750
$\mathbb{W}_M$	-5.4584	0.5917	0.5614
$\mathbb{W}_F$	0.7689	0.2354	0.2430
$\mathbb{P}_M$	0.0722	0.0672	0.0746
$\mathbb{P}_F$	4.0006	-0.0828	-0.0480
$\mathbb{G}_M$	-0.8673	-0.0480	-0.0901
$\mathbb{G}_F$	-5.0973	0.0842	-0.0107
$\mathbb{B}(s)_M$	0.2468	-0.0277	-0.0247
$\mathbb{B}(s)_I$	0.3248	0.0047	0.0057
$\mathbb{B}(s)_F$	-0.5743	0.1327	0.1243
$\mathbb{B}(T, s)_M$	0.1291	-0.0283	-0.0281
$\mathbb{B}(T, s)_I$	0.0358	-0.0060	-0.0069
$\mathbb{B}(T, s)_F$	-0.0091	0.0074	0.0069
$\mathbb{B}(f, T, s)_M$	-1.0591	0.2408	0.2324
$\mathbb{B}(f, T, s)_I$	3.7090	-0.1793	-0.1150
$\mathbb{B}(f, T, s)_F$	1.1100	-0.0091	0.0000
$\mathbb{B}(\vartheta, f, T, s)_M$	-0.6427	0.1463	0.1430
$\mathbb{B}(\vartheta, f, T, s)_I$	3.4278	-0.1617	-0.1015
$\mathbb{B}(\vartheta, f, T, s)_F$	0.8833	0.0326	0.0335

Note: Table 7 presents three sections, each representing a wage inequality (variance) decomposition. The first section is a basic within-between decomposition by gender. The second section presents the first phase of the decomposition of Section 3; that is, a decomposition by sector, type of firm (public or private), firm and occupation. The third section presents the second phase of the decomposition of Section 3; that is, a decomposition of the first phase by gender. Table 7 presents each component's contribution to inequality growth after the implementation of the gender wage gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. A positive sign in the contribution to $\Delta\mathbb{T}$ column indicates that the component's growth is in the same direction as the inequality growth. Note that some magnitudes in column (1) of $\alpha = 1$ are bigger than respective values in Tables 4 and 8 because the inequality growth magnitude in this column is quite small. See Section 3 for details on each component's intuition.

Table 8: Wage inequality ($\mathbb{T}$) decomposition by gender: Feb2018-Nov2018 exercise.

Component	$\alpha = 1$ Contribution to ΔT: 11.70%	$\alpha = 2$ Contribution to ΔT: -9.40%	$\alpha = 3$ Contribution to ΔT: -9.54%
$\mathbb{T}$	1.0000	1.0000	1.0000
$\mathbb{W}_{\text{gender}}$	0.9930	0.9941	0.9933
$\mathbb{B}_{\text{gender}}$	0.0070	0.0059	0.0067
$\mathbb{W}(\vartheta, f, T, s)$	0.2351	0.7352	0.6349
$\mathbb{B}(s)$	-0.0270	-0.0102	-0.0159
$\mathbb{B}(T, s)$	-0.0243	-0.0099	-0.0125
$\mathbb{B}(f, T, s)$	0.3649	0.2411	0.3030
$\mathbb{B}(\vartheta, f, T, s)$	0.4514	0.0438	0.0904
$\mathbb{W}_M$	-0.3340	0.5489	0.5275
$\mathbb{W}_F$	0.7835	0.1232	0.1255
$\mathbb{P}_M$	-0.0055	0.0145	0.0171
$\mathbb{P}_F$	0.3070	-0.0459	-0.0189
$\mathbb{G}_M$	-0.0805	0.0132	-0.0188
$\mathbb{G}_F$	-0.4353	0.0812	0.0025
$\mathbb{B}(s)_M$	0.0214	-0.0139	-0.0142
$\mathbb{B}(s)_I$	-0.0268	-0.0085	-0.0089
$\mathbb{B}(s)_F$	-0.0216	0.0123	0.0072
$\mathbb{B}(T, s)_M$	-0.0043	-0.0042	-0.0046
$\mathbb{B}(T, s)_I$	-0.0146	-0.0037	-0.0053
$\mathbb{B}(T, s)_F$	-0.0054	-0.0021	-0.0026
$\mathbb{B}(f, T, s)_M$	-0.0134	0.2731	0.2875
$\mathbb{B}(f, T, s)_I$	0.2733	-0.0449	-0.0049
$\mathbb{B}(f, T, s)_F$	0.1050	0.0129	0.0204
$\mathbb{B}(\vartheta, f, T, s)_M$	0.0590	0.1604	0.1511
$\mathbb{B}(\vartheta, f, T, s)_I$	0.2978	-0.1527	-0.0998
$\mathbb{B}(\vartheta, f, T, s)_F$	0.0946	0.0360	0.0391

Note: Table 8 presents three sections, each representing a wage inequality (variance) decomposition. The first section is a basic within-between decomposition by gender. The second section presents the first phase of the decomposition of Section 3; that is, a decomposition by sector, type of firm (public or private), firm and occupation. The third section presents the second phase of the decomposition of Section 3; that is, a decomposition of the first phase by gender. Table 8 presents each component's contribution to inequality growth after the implementation of the gender wage gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. A positive sign in the contribution to $\Delta\mathbb{T}$ column indicates that the component's growth is in the same direction as the inequality growth. See Section 3 for details on each component's intuition.

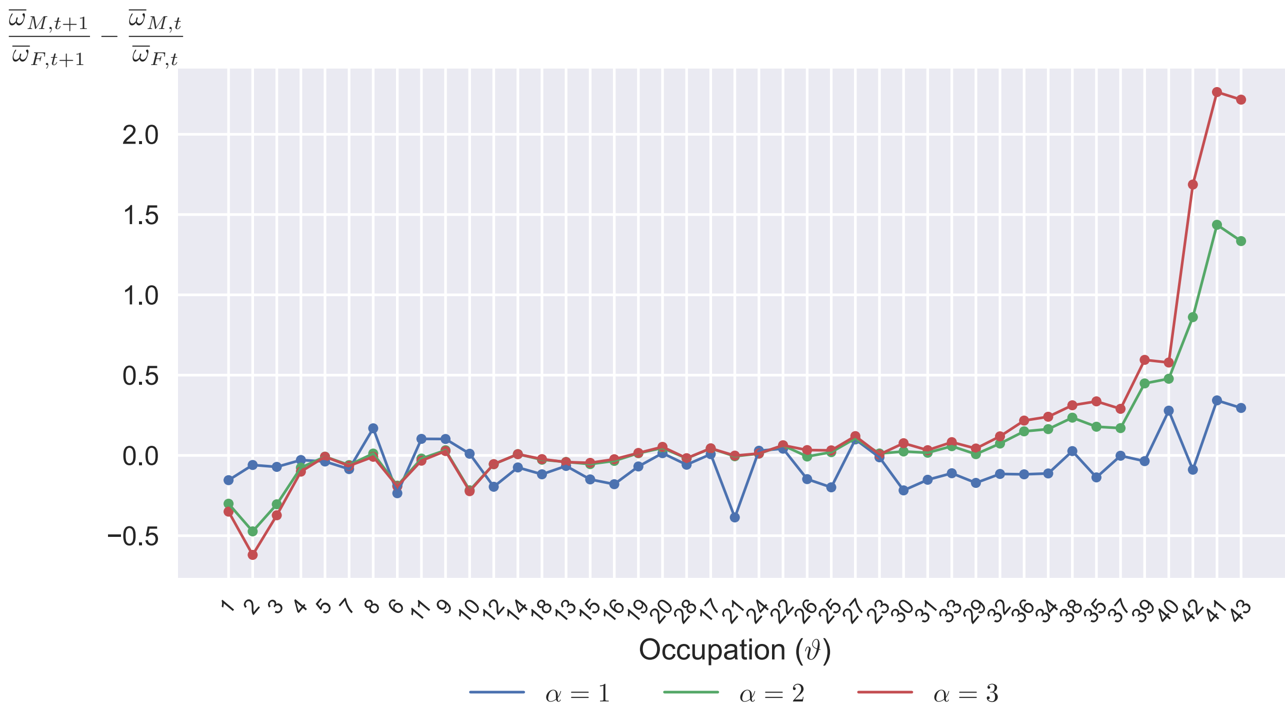

Figure 7: Impact on gender wage gap for each occupation, $\frac{\overline{\omega}_{M,t+1}}{\overline{\omega}_{F,t+1}} - \frac{\overline{\omega}_{M,t}}{\overline{\omega}_{F,t}}$: Feb2008-Nov2008.

Note: Figure 7 presents the change in gender wage gap using different restriction's magnitudes (α); the calculation is done using the model's output on wages as the final period data after implementing the intra-occupation gender wage gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

Figure 8: Gender wage gap for each occupation in the initial and final period: Feb2008-Nov2008, alpha 2.

Note: Figure 8 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 2$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

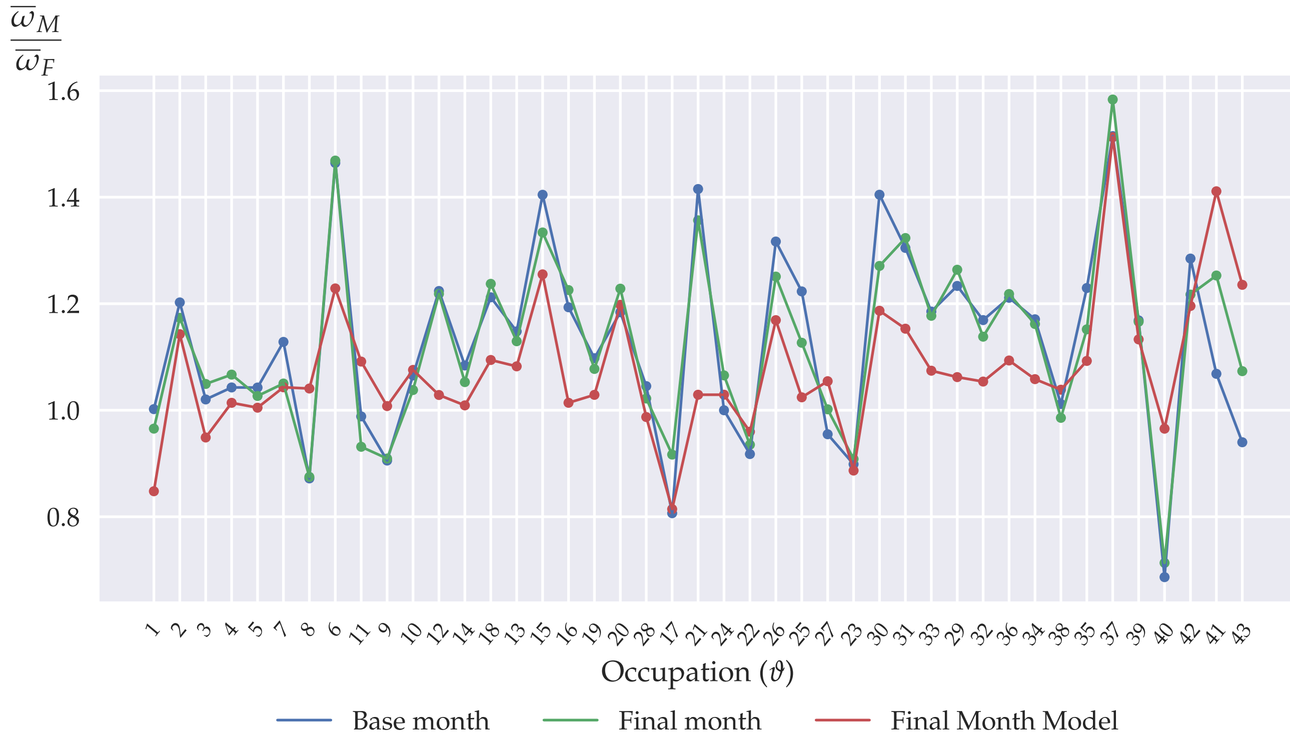

Figure 9: Gender wage gap for each occupation in the initial and final period: Feb2008-Nov2008, alpha 1.

Note: Figure 9 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 1$*; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than* α *times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.*

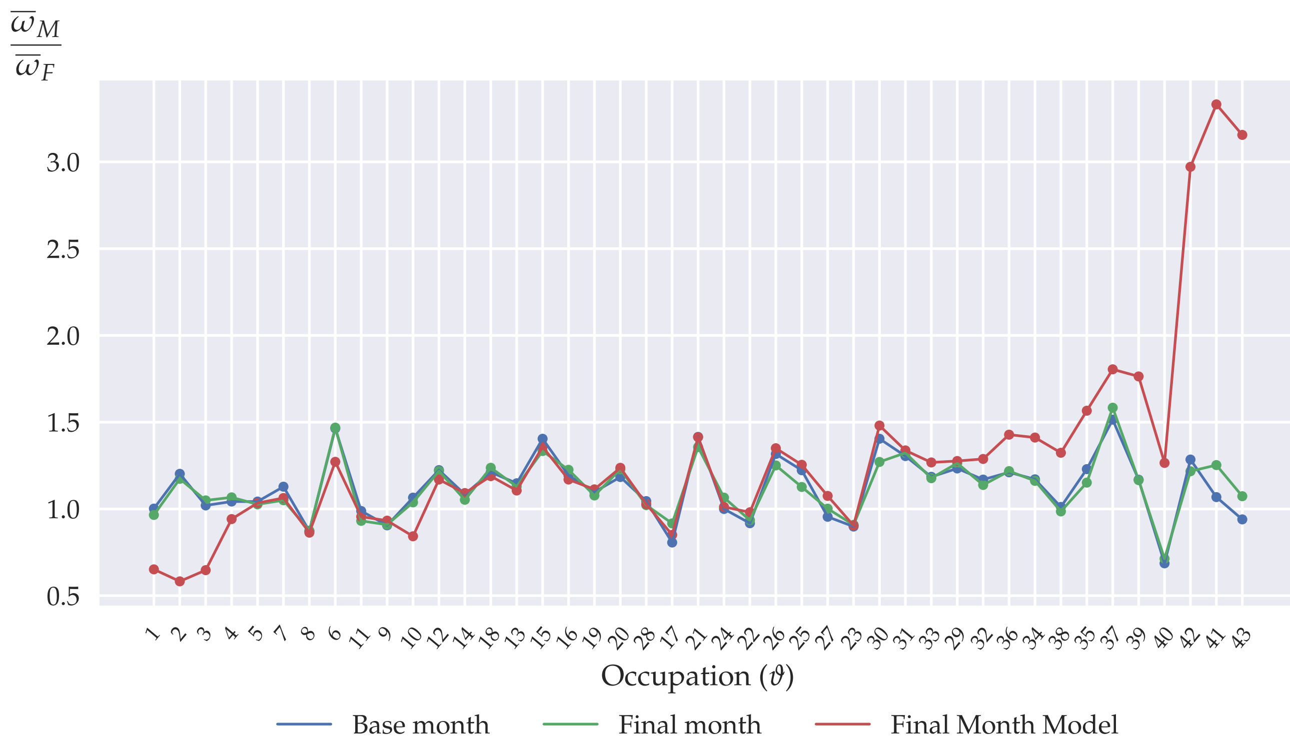

Figure 10: Gender wage gap for each occupation in the initial and final period: Feb2008-Nov2008, alpha 3.

Note: Figure 10 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 3$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 3 (beauty). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

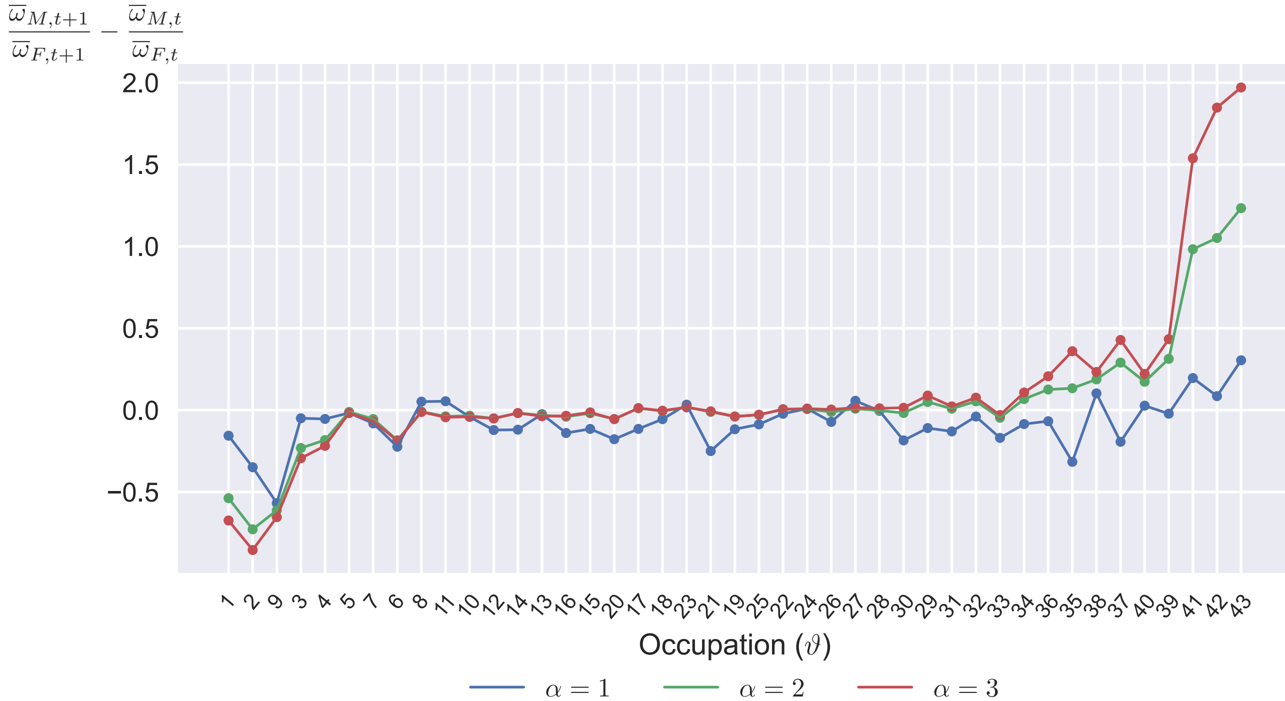

Figure 11: Impact on gender wage gap for each occupation, $\frac{\overline{\omega}_{M,t+1}}{\overline{\omega}_{F,t+1}} - \frac{\overline{\omega}_{M,t}}{\overline{\omega}_{F,t}}$: Feb2018-Nov2018.

Note: Figure 11 presents the change in gender wage gap using different restriction's magnitudes (α); the calculation is done using the model's output on wages as the final period data after implementing the intra-occupation gender wage gap restriction; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 9 (nutritionist). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

Figure 12: Gender wage gap for each occupation in the initial and final period: Feb2018-Nov2018, alpha 2.

Note: Figure 12 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 2$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 9 (nutritionist). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

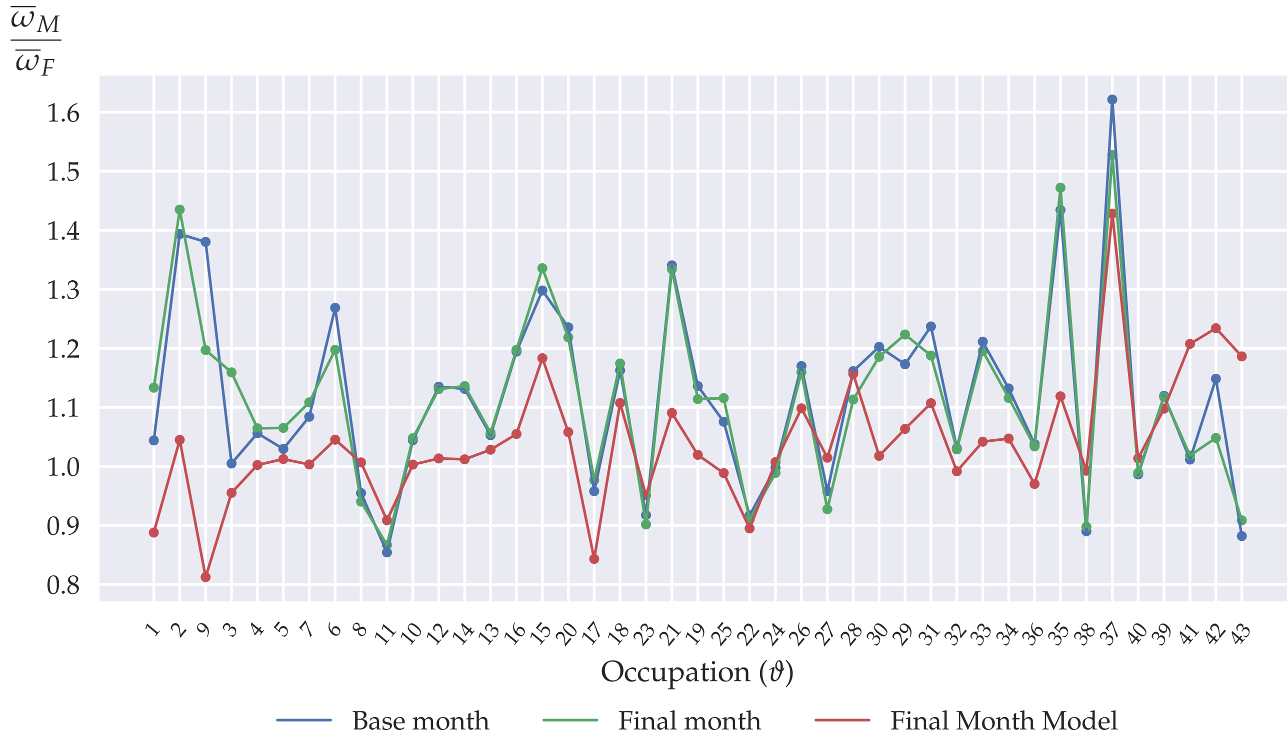

Figure 13: Gender wage gap for each occupation in the initial and final period: Feb2018-Nov2018, alpha 1.

Note: Figure 13 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 1$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 9 (nutritionist). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.

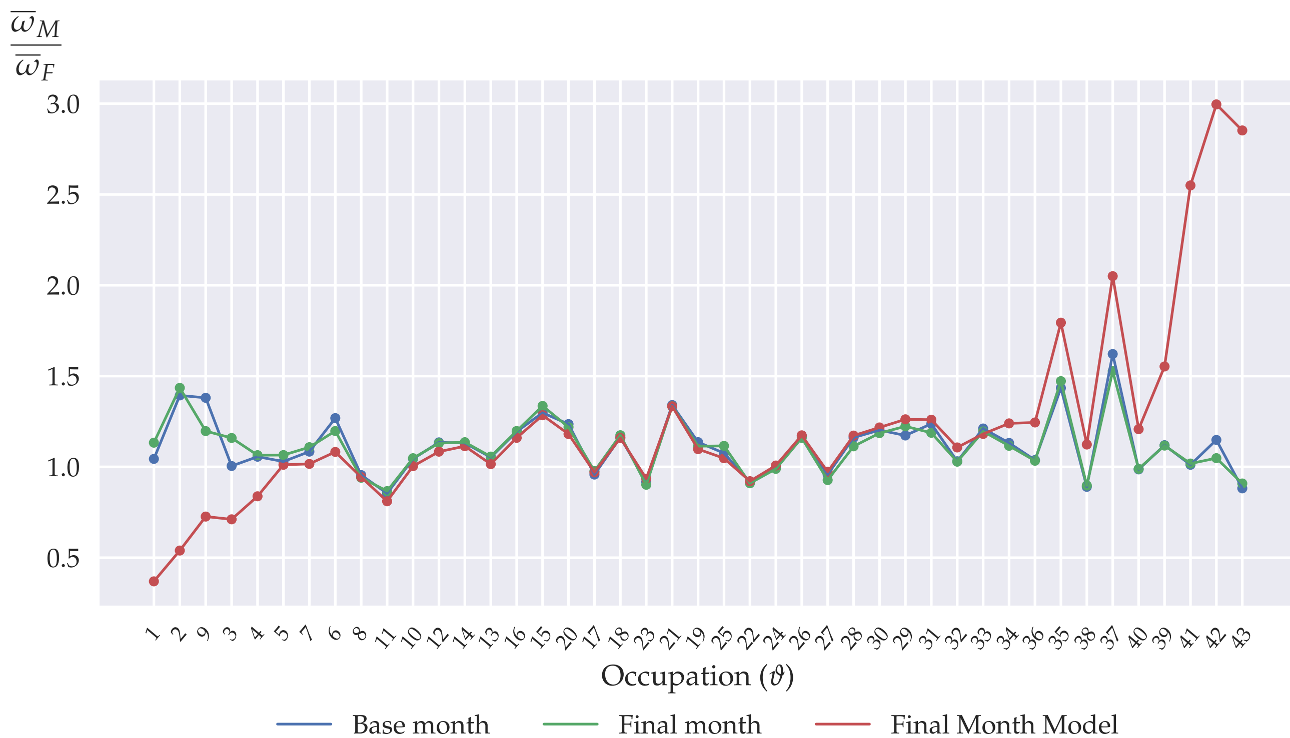

Figure 14: Gender wage gap for each occupation in the initial and final period: Feb2018-Nov2018, alpha 3.

Note: Figure 14 presents the gender wage gap in the final period using the observable data and the model's output on wages after implementing the gender wage gap restriction with an $\alpha = 3$; the restriction establishes that for each occupation within a firm, each gender average wage cannot be greater than α times the other. The occupations are ordered from highest to lowest proportion of women in the composition. The first three are: 1 (preschool and special education), 2 (domestic workers) and 9 (nutritionist). The last three are: 41 (builder), 42 (mechanic) and 43 (transporter). The list of all occupations is in Appendix A, Table 6.