Men, women and capital
Estimating substitution patterns using a size and gender-dependent childcare policy in Chile [*]

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Abstract

We test whether men and women have the same degree of complementarity to capital using a policy that obliges firms to fund childcare for their female employees, if they hire more than 19 women. This policy generated bunching at the threshold, particularly since it has become more binding, in male-intensive industrial sectors and in larger firms. Firms that hire 19 women have a higher capital-to-men ratio than firms just above the threshold. Our theoretical framework suggests that the distortion in this ratio is consistent with women being less complementary with capital than men, despite being similar in skills. Our calibration shows that this differential degree of complementarity increased the policy's distortions, highlighting the relevance of differential degrees of substitutability between men-capital and women-capital to measure the impact of policies with gender components.

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1 Introduction

In most models of production, female and male workers are treated as perfect substitutes. However, there is a large debate in other literatures about the comparative advantage that each gender may enjoy in different activities. Acemoglu, Autor, and Lyle (2004) demonstrate that in the mid-20th century U.S., women were stronger substitutes of higher-skilled men than lower-skilled ones. However, if this is due to the fact that women lack the physical strength that men can display, we may also anticipate that other factors of production may also respond to a change in the workforce composition. To explore this question, this paper employs a policy in Chile that increases the cost of women but not of men workers for some firms and measure how these firms respond in terms of capital. This allows us to estimate whether capital has different degrees of complementarity or substitution with each gender. It focuses on the manufacturing sector because of data constraints but also because manufacturing is a sector where capital is highly relevant to the production and thus where its response may be stronger.

Our usual assumption is that, in today's economy, capital is particularly complementary to high-skill workers and less so with physical strength (see Lewis, 2013, for the modern manufacturing sector). Given that women are usually viewed to be endowed with more "brains" than "brawn", women could be anticipated to be more complementary to capital than men. Nevertheless, Lafortune, Lewis, and Tessada (2019) show that capital-skill complementarity only arose with the Second Industrial Revolution in the United States while capital and skill may have been substitutes previously, thus suggesting that the relationship between capital and workers of a given gender could also differ depending on contexts. Juhn, Ujhelyi, and Villegas-Sanchez (2014) uses NAFTA as a trade shock in Mexico to show that firms that faced a demand shock were incentivized to modernize their production and that this new technology led them to replace male blue-collar workers with female blue-collar workers. We wish to explore the relative complementarity of men, women, and capital for a given technology instead. Since a demand shock may involve other changes that would influence labor demand, we instead employ a difference in factor price ratios that firms can face. We believe to be the first to use such variation to estimate complementarity between workers of different genders and capital.

Understanding this relationship may be highly relevant in developing economies where formal female labor supply is still, in general, much below that of developed countries. Chile is no exception to this, with a female labor force participation of 57.9 percent in 2014, about the same rate as Italy and Mexico, and much lower than the OECD average. Our work is thus helpful in understanding how the expansion of the female labor force in these contexts may influence the demand for capital and vice-versa. It is also relevant when thinking of cross-country differences in female labor force attachment and its impact on capital intensity. The Euro area has been slowly catching up to the U.S. in terms of female labor force participation and our work suggests that this would have impacts on the choice of other factors like capital. It also informs us about the potential effect of differences in sector composition, across countries and/or regions, on the demand for female workers. Finally, since most family-friendly policies are often gender-biased, our work also provides important insights into whether these policies may not only affect hiring of women by firms but also capital use.

The policy we study is a policy that was, like many others, aimed at improving the way that women can combine their work and family lives. However, it has some particular characteristics that are very specific to this context. Since 1917, Chile has had a legislation where some firms are required to provide childcare for children of their female employees. The law has evolved over time in many ways and has become more binding as more and more women enter the labor force. Today, any firm that employs more than 19 *female* workers must either provide child care on-site or reimburse the expenses related to child care for any child below the age of 2 of any female employees. This is a mandated benefit like those studied by Gruber (1994) but with the added twist that firms can avoid it by limiting to 19 their hiring of women, thus potentially penalizing exactly the workers it wishes to benefit. In order to comply with the regulation, firms have three options. First, they can create and maintain child care centers on their premises. Alternatively, firms can build or habilitate common services with other establishments in the same geographic region. Finally, firms can also pay directly external day care centers. In practice, the latter is the most used way of offering the benefit. An estimate of the cost of providing such a service is about US$200 per month, almost equal to the minimum wage and around 1/4 of the average wage in our sample.

We first empirically test if firms try to avoid being subject to this unconventional policy. If the mandated benefit can easily be passed to workers through lower wages, we should not observe firms avoiding having more than 19 female workers since the benefit would be of no cost to them. However, if firms are unable to pass the additional cost to the workers themselves, then we would anticipate bunching around 19 women. We thus begin by empirically testing whether there is evidence of such bunching. Given that the number of women hired is a discrete and not a continuous variable, we use a variety of tests specific to discrete distributions. We conclude that there is strong evidence that, in the manufacturing sector, firms avoid being subject to the law by hiring just 18 or 19 women instead of 20 and more. This is particularly marked for the most recent period (where enforcement and rules have become tougher), for sectors that hire few women and in firms of more than 100 employees (where compliance is higher). We obtain similar results whether we use a polynomial to construct a counterfactual distribution as in Chetty et al. (2011) or if we use the most traditional test of McCrary (2008) for distributions.

This policy also offers a unique opportunity to explore production factors' complementarity by comparing firms with a different number of women above and below the cut-off generated by the law. In that sense, we employ the fact that there is bunching to estimate underlying elasticities as Kleven and Waseem (2013). If men and women were equally complementary to capital, firms should substitute women in a way that keeps the capital to men ratio constant. By contrasting the capital intensity of firms just subject to the law and those just avoiding it, we can estimate the relative degree of substitution and complementarity between this factor and men and women workers. This is akin to using exogenous shocks created by immigration on factor ratios to estimate their complementarity, as in Lewis (2013) and Lafortune, Lewis, and Tessada (2019). This analysis reveals that firms with fewer women have a larger capital stock per male worker than those just above the threshold. Thus, firms who abstain from hiring women to avoid the law substitute women workers more intensively with capital than with men. This is consistent with capital being more complementary to men than to women workers. This appears to be equally visible for machinery and equipment than for other types of capital and for capital using electricity but not fuel.

Our results are robust to changes driven by differences in production technologies between sectors, and we find no evidence that this substitution pattern is due to the fact that female workers have different skills (as measured by their occupation) than male workers. We also see no change in average labor productivity around the discontinuity in agreement with our model that firms would be indifferent in terms of profit around the threshold. Thus, we argue that our strategy can validly estimate the degree of complementarity between each type of labor and capital.

Finally, we calibrate our model and show that the instances where we see more bunching are linked to higher effective costs of the policy more than differences in technology. We also demonstrate that capital being more complementary with men than with women workers led to more factor misallocation than if it had been more similarly complementary both genders.

Our study is related to the papers by Prada, Rucci, and Urzúa (2015) and Rojas, Sánchez, and Villena (2016) that analyze the same policy as we do but using an administrative individual workers' database. They find no evidence of bunching and strong evidence of wage penalty for women when firms cross the threshold and also for men in the second case. The big difference between their results and ours may be driven by the fact that they use large firms in all sectors of the economy instead of only in manufacturing and mainly because they focus their attention on firms that switch over the span of their panels between having more than 19 women and less. It may very well be that firms that are likely to switch over time are exactly those where the cost can be easily passed to workers directly, while our sample includes firms that may be permanently selecting to be below or above the threshold. We show that we see much less evidence of bunching when we look at firms that have switched over the years from being subject to being exempt from the law. We thus see our paper as complementary rather than critical of their work, suggesting that some firms systematically avoided the legislation by maintaining themselves below the threshold and substituting female workers for capital. In contrast, some firms moved between being subject to the law and being exempt and those firms were able to pass most of the costs to the female employees themselves.

The impact of improving access to childcare has been studied in various settings. Most studies conclude that preschool education has positive impacts on future scholar performance (e.g. NICHD Early Child Care Research Network, 2005; Berlinski, Galiani, and Gertler, 2009). While most of the international evidence argues that increasing childcare access may increase labor force participation (see for example Baker, Gruber, and Milligan, 2008), the evidence in Chile has been more muted. For instance Encina and Martinez (2009), Aguirre (2011) and Manley and Vásquez (2013) show that plausibly exogenous increases in access to daycare had no effects on female labor participation. If firms are strongly incentivized not to hire women because of the existing mandate, then we could anticipate that granting subsidized childcare to women would not increase their employment.

We are not the first ones to study how legislations may distort firm size decisions. There are several studies related to firm size regulations which are known as *regulatory tiering*. Brock and Evans (1985) develop a model where regulators may use taxes to reduce externalities, but such taxes are costly to raise. The model also includes firm size heterogeneity produced by differences in access to managerial ability. In such context, the authors predict that firm size regulations may be Pareto-superior to unique norms. Regulatory tiering has been empirically treated in terms of the effect of differentiated tax rates and environmental and labor regulations. The latter is particularly relevant for this case since such rules are often applied based on the number of workers. Amirapu and Gechter (2015) show that Indian labor regulations, which apply only to firms with more than 10 employees, strongly distort the distribution of firm employment. They find evidence that the avoidance costs, however, may be more linked to an interest in avoiding corruption than the actual costs of the labor regulation. In this fashion, Becker and Henderson (2001) show that non-uniform environmental regulations tend to generate changes in firm dimension, altering industrial structure. Moreover, Gao, Wu, and Zimmerman (2009) indicates that firms respond to costly regulations applied to large firms by maintaining a small size. In particular, companies invest lower amounts and distribute more dividends in order to avoid growth. Almunia and Lopez-Rodriguez (2018) show that in Spain, firms bunch below the revenue cut-off over which they would face more careful auditing. However, we see this paper as the first to use this type of bunching to estimate the relative complementarity of production factors. We do so first in a reduced-form way and then use the size of the bunching to inform the model, as in Garicano, Lelarge, and Van Reenen (2016).

More generally, this paper contributes to the literature on mandated benefits. As Gruber (1994) points out, the public supply of child care would imply a deadweight loss because of the inefficiencies produced when collecting taxes. Hence, if the benefits received are valued by those who receive them, then the deadweight loss produced by mandated benefits would be lower than the one produced by taxation. Furthermore, if there is full valuation of the benefits by employees, then wages will diminish to compensate the mandated cost. Therefore, in the absence of rigidities that prevent wages from adjusting, no bunching would be produced if valuation is complete (this is because in practice the total cost of hiring women would not raise as a result of this law). Nevertheless, Gruber (1994) also suggests that the previous argument may not hold because of elements such as the minimum wage, firm internal rules, union agreements or equality laws that prevent wages from adjusting.[1] Moreover, in cases where it is not possible to adjust relative wages, mandated benefits would introduce inefficiencies even when there is full valuation. Consequently, rigidities could provoke higher amounts of bunching independently of benefit valuation by women, since it would not adapt to reflect real valuation and hiring costs. This is the first paper that looks at the role of capital in adjustments to mandated benefits on labor.

The rest of the paper is organized as followed. Section 2 describes in more detail the legal background of the legislation we use and presents a framework that will be the basis for our empirical analysis. The following section describes our data and empirical strategy while Section 4 presents the results of our analysis. Finally, Section 5 compares firms at the threshold to derive conclusions regarding the substitutability or complementarity of factors within the production function while Section 6 performs a calibration of our model. Finally, the last section concludes.

2 Legal and Theoretical Framework

2.1 Legal background

The first law regulating child care payment by firms in Chile was promulgated in 1917, called *Ley de Salas Cuna*, and forced every factory, workshop or industrial establishment that hired fifty or more women over eighteen years old to offer a child care facility, especially conditioned to receive female employees' children under 1 year old during working hours.[2] Since then, the law has been modified in several opportunities, first diminishing the required amount of female

[1] The Law 20.348 of wage equality between men and women was promulgated in 2009 in Chile, so it does not affect the period being studied. Moreover, even today when it is currently in place, its compliance is seriously questioned. Consequently, it would not affect the salary adjustment in the period we study.

[2] Law 3,186, (1917), Chile.

workers from 50 to 20 in 1931[3] and, in 1966, raising the coverage period from 1 to 2 years[4].

A series of modifications has also been introduced since 1990, as can be seen in Table 1. Among these modifications the most relevant related to manufacturing are those implemented in 1998 and 2002. The first one expanded the coverage of the regulation, extending the unit over which number of workers is counted from "establishment" to "firm" [5] (this is relevant when a firm has more than one productive establishments because "establishment" refers uniquely to the physical place where each one of the firm's plants is located). The modification made in 2002 obligated industrial and service establishments administered under a common legal entity to finance day care even when the number of women they hired was below the threshold at the plant level as long as it was above the threshold at the firm level.

The two changes mentioned above point in the direction of increasing the number of firms susceptible to be forced to provide childcare. Therefore, there are firms that previously to the reforms were not affected by the regulation that became obligated to pay day care after 1998 and 2002. Consequently, there was an increase in the number of firms that may have incentives to reduce women hiring. Additionally, it is possible that the supervision was enhanced during the period next to the reform, as is usually occurring after legal modifications (at least temporarily).

As a result, the Chilean labor code in its article 203 currently says that all firms that hire 20 or more women must have annexed rooms where female workers can have their children taken care of as long as they are below 2 years old. The code also indicates that the same obligation applies to commercial, industrial or services centers or complexes administered under a common legal entity which establishments hire in total 20 or more women. In order to fulfill their legal obligations, firms have 3 options. First, they can create and maintain child care centers annexed to the work place. Alternatively, firms can share child care facilities with other establishments in the same geographic region. Finally, firms can also pay directly to external day care centers.

In practice, external childcare are the main way firms comply with the law, and this mode has increased over time, as can be seen in Table 2. What can also be seen from this table is that a large fraction of firms simply pay a bonus to the mother, which is not sufficient to comply with the law. The table also evidences the increasing share of firms that are complying with the law over the years.[6] These patterns are less clear when focusing on data reported by employees. However, they are not necessarily informed about the policy or its enforcement –men respond as well as women–, as reflected by the high share of people in 2006 who reported that their firm

[3]DFL 178, (1931), Chile.

[4]Law 16,511, (1966), Chile.

[5]According to Chilean labor laws, a firm is "every organization of personal medias, material and immaterial, ordered under a direction for the achievement of economic, social, cultural or benefic goals, endowed with a legal individuality".

[6]Data for year 1995 does not fully satisfy this, however it is constructed using a different data source than following years because the National Labor Survey was implemented for the first time in 1998, so it is not fully comparable.

did not have to offer the benefit despite having more than 20 women (that survey answer was not included in other years). The table also shows that compliance with the law is much higher among large firms in both employers and employees' surveys, while manufacturing appears to have a compliance rate similar to other sectors.

The cost of providing childcare for two years is relatively important for a firm. According to Aedo (2007), the monthly average cost of registering a child in a daycare was CLP$100,000 per month (in 2002), around US$200 at the time. This is only slightly lower than the legislated minimum wage of CLP$111,200 that same year. As a comparison, the average wage (for men and women) in the manufacturing sector in that same year was about CLP$218,000 per month. In our sample of firms above 10 workers, the wages are above that level but the childcare cost would still correspond to at least 20 percent of wages. This suggests that this cost is relatively high compared to wage levels. A similar value is obtained by Rau (2010) who measures the cost of daycare for 2008 by calling 30 establishments and obtains an average value of CLP$137.438 for a full-day daycare. Data from the National Labor Survey (*ENCLA*) also confirms these numbers. In years 1998, 2002, and 2004, where the question was included, on average firms reported an annual cost of CLP$1,190,404, which is roughly US$200 per month.

It is worth mentioning that there is no distinction in terms of the type of contract for women to be counted towards the threshold of 20. Therefore, it is irrelevant if women are hired permanently or for fixed term. Moreover, female workers count the same toward the quota whether they are working full or part time. Most probably this is one of the reasons why firms might prefer to avoid hiring part-time female workers, imposing an obstacle to labor flexibility. This element is particularly relevant considering that women are arguably the most benefited group from that kind of work arrangement. Moreover, as Rau (2010) points out, a second reason why firms may avoid contracting part time female employees is that day care centers charge, on average, more than proportionally for the amount of time that children are in child care (taking as reference the full time price). Lastly, it should be noted that firms are not directly forced to pay day care to the children of their subcontracted workers, although they are considered when counting total employees. The obligation then lays on the subcontractor company, which in turn probably transfer the cost to the principal firm.

2.2 Theoretical framework

Having described the legal framework in place, we now model the expected behavioral response of firms to that regulation. This will allow us to explain how comparing firms above and below the threshold set by the legislation provides a way to identify the relative degree of complementarity between each type of worker and capital.

A firm i can produce an output Y_i using a production function

$$Y_i = \alpha_i \, F(W, M, K)^{\sigma}$$

where W represents the number of women, M represents the number of men and K, the capital. As is common in the literature, we may think of $\alpha_i > 0$ as the managerial ability of the entrepreneur. F is assumed to be increasing in each of its argument and displays constant returns to scale in the three factors of production. Finally, $\sigma \in (0, 1)$ represents the returns to scale of the firm and it is assumed to be common for all firms

For ease of exposition, we will further assume that $F(\cdot)$ is a CES production function such that,

$$F(W, M, K) = \left(\left(K^{\theta} + W^{\theta} \right)^{\frac{\rho}{\theta}} + M^{\rho} \right)^{\frac{1}{\rho}}$$

where $\rho, \theta < 1$. This assumption is not very restrictive since we include the Leontief (as $\theta, \rho \to -\infty$), perfect substitutes (as $\theta, \rho \to 1$) and Cobb-Douglas (as $\theta, \rho \to 0$). Under our assumption we will have capital neutrality when $\theta = \rho$ and capital will be more complementary to men's than women's labor when $\theta > \rho$.

The firm sells Y in a competitive market where the price is p. Denote the unit cost of each factor as w_W, w_M and r respectively. However, the costs differ depending on whether $W \leq 19$ or $W > 19$. In the latter case, the firm faces an additional cost that it must pay for all women it hires, that we denote by τ. This should be considered the *expected* cost faced by the firm since not all female workers will have a child below the age of 2 at any point in time.

Given that the production function is homothetic, factor ratios will be entirely determined by factor prices, as long as firms do not distort their decisions to avoid becoming subject to the policy (i.e., the choose to remain exactly at or below the threshold for the extra cost).[7]

Proposition 1 *The childcare policy which increases the wage of women by τ will distort factor choices, except if factors are perfect complements. M/W and K/W will be higher in firms subject to the policy than for those that are not. K/M will be increasing in w_W if $\theta \geq \rho$ and decreasing otherwise.*

Proof. From the first order conditions:

$$K/W = \left(\frac{w_W}{r} \right)^{\frac{1}{1-\theta}}$$

[7] The full model is derived in Appendix section B.

and

$$M/W = \frac{w_W^{\frac{1}{1-\theta}} \left(r^{\frac{\theta}{\theta-1}} + w_W^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-\rho}{\theta(1-\rho)}}}{w_M^{\frac{1}{1-\rho}}}$$

which are increasing in w_W. Finally, we have that

$$K/M = \frac{w_M^{\frac{1}{1-\rho}}}{r^{\frac{1}{1-\theta}} \left(r^{\frac{\theta}{\theta-1}} + w_W^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-\rho}{\theta(1-\rho)}}}$$

which is increasing in w_W when $\rho < \theta$, namely when capital is more complementary to men than women's labor. ■

Thus, the policy would decrease the relative use of women's work compared to that of men and capital if it was applied to all firms. When capital is more complementary to men than women's labor, it would also increase the capital to male workers ratio.

However, the policy also has an additional distortion in that some firms may find it optimal to remain artificially small in terms of women employees to avoid being subject to the policy.

For this, we need to consider how firms select the level of inputs. Let us denote the profits of a firm with productivity α_i that selects their input level according to the factor choices presented above,

$$\begin{aligned} \pi(\alpha_i) =& \alpha_i * p * F(W(\alpha_i,\tau), M(\alpha_i,\tau), K(\alpha_i,\tau))^\sigma \\ & - w_M M(\alpha_i,\tau) - rK(\alpha_i,\tau) - (w_W + \tau * \mathbb{1}(W > 19))W(\alpha_i,\tau) \end{aligned}$$

where $\mathbb{1}(W > 19)$ is an indicator function that takes the value of 1 if $W > 19$.

Profit maximization with respect to each factor then determines firm size. By the envelope theorem, we can show that profits are increasing in α_i such that the derivative is pF^σ. More productive entrepreneurs will have larger firms, all factor uses will be multiplied by $\alpha_i^{\frac{1}{1-\sigma}}$. There will be a lower bound below which all entrepreneurs will choose not to open a business since their profits will be negative. Let us define as $\underline{\alpha}$ the level of productivity where $W(\underline{\alpha}) = 19$. Thus, all firms with $\alpha_i < \underline{\alpha}$ will not be subject to the policy. For α_i above $\underline{\alpha}$, firms will continue to set $W = 19$ if their profits from restricting their hiring of female workers are higher than that of becoming subject to the law. Formally, let us define the profits for a firm that elects to restrict their hiring at 19 women as

$$\widetilde{\pi(\alpha_i)} = \alpha_i * p * F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)})^\sigma - w_M \widetilde{M(\alpha_i)} - r\widetilde{K(\alpha_i)} - w_W * 19$$

These profits continue to be increasing in α_i. By the envelope theorem, the rate of growth for firms that are avoiding the policy will be smaller if $F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)}) < F(W(\alpha_i), M(\alpha_i), K(\alpha_i))$ which will be guaranteed since W cannot be increased to the optimal level in response to the higher productivity. It is also clear that profits are decreasing in τ and thus that firms very close to $\underline{\alpha}$ will prefer to keep their hiring at $W = 19$ and not pay the cost of τ. Firms will continue to do so until their profits are equal under this setting than being subject to the law. Given that profits that are subject to the law grow faster in α_i than those that avoid it, we will have a point in which both levels of profits will be equal. We can thus define a threshold $\bar{\alpha}$ where the firm will be indifferent between restricting its hiring to 19 female workers and becoming subject to the law, that is

$$\begin{aligned}
&\bar{\alpha} * p * F(W(\bar{\alpha},\tau), M(\bar{\alpha},\tau), K(\bar{\alpha},\tau))^{\sigma} - w_M M(\bar{\alpha},\tau) - rK(\bar{\alpha},\tau) - (w_W + \tau)W(\bar{\alpha},\tau) \\
&\quad = \bar{\alpha} * p * F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)}) - w_M \widetilde{M(\bar{\alpha})} - r\widetilde{K(\bar{\alpha})} - w_W * 19
\end{aligned}$$

Figure 1 shows this graphically. At $\underline{\alpha}$, costs for firms that decide to cross the threshold and hire 19 women would increase discontinuously. Firms can instead continue to hire 19 women but this comes at a higher and higher cost as α increases until at $\alpha = \bar{\alpha}$, where firms jump at hiring a larger number of women and pay for childcare.

What is useful for our empirical strategy is that we can further discuss what happens to factor use around the threshold, as indicated in the following proposition.

Proposition 2 *Over the range $\alpha_i \in [\underline{\alpha}, \bar{\alpha}]$, K/W and M/W are increasing such that there is a discontinuity at $\bar{\alpha}$ where firms with $\alpha_i < \bar{\alpha}$ have substantially higher K/W and M/W ratios than those with $\alpha_i > \bar{\alpha}$. K/M will be increasing over that range as well if $\theta > \rho$ and be decreasing when $\theta < \rho$. K/M will also jump discontinuously at $\bar{\alpha}$ with firms with $\alpha_i < \bar{\alpha}$ having a larger (smaller) K/M ratio than those with $\alpha_i > \bar{\alpha}$ when $\theta > \rho$ ($\theta < \rho$).*

We present a more detailed proof of this proposition in Appendix B. Intuitively, within the range $[\underline{\alpha}, \bar{\alpha}]$ the firms expand production using only M and K while keeping female hiring fixed. This explains why M/W and K/W are increasing over the range. Within this range, the relative use of K and M depends on whether K is more or less complementary to M than to W, as determined by θ and ρ. Firms at or above the threshold $\bar{\alpha}$ will hire more W, and the ratios M/W and K/W will be discontinuous at $\bar{\alpha}$ and lower than for firms below that level of α. The ratio K/M is also discontinuous, and the direction of the change depends on the level of complementarity with both types of labor. Intuitively, if K is more complementary to W, as firms in the range $[\underline{\alpha}, \bar{\alpha}]$ keep W constant, higher α firms will use relatively more M than K to produce more output. At $\alpha = \bar{\alpha}$ more women are hired and there will be a larger downward adjustment for M than for K, thus explaining the change in the ratio (and the reverse argument holds when K is more complementary to M).

A graphical representation of the effect on factors' ratios is provided in Figures 2 and 3. These show that if there is bunching, the sign of the jump is K/W and M/W will always be the same but the direction of the jump for K/M will depend on the relative complementarity or substitution between capital and each type of workers.

Finally, we can also derive conclusions regarding the extent of "bunching" around $W = 19$ and how it depends on the elasticities of substitutions of factors.

Proposition 3 *The range of $\alpha_i \in [\underline{\alpha}, \bar{\alpha}]$ will be increasing in θ and τ.*

Proof. See Appendix B ■

The degree of bunching will be reflected in how different will be $K/19$ and $M/19$ below the discontinuity and K/W and M/W above it. In the two extreme cases, perfect substitutes and perfect complements, we will have an infinitely large difference and no difference at all for the Leontief production function. Thus, when it is least costly for the firm to change the factor ratios is when we will have the most amount of bunching. The returns to having different factor ratios increases with θ: in the Leontief case, where $\theta = -\infty$, they are nonexistent. Thus, bunching will be increasing in θ. On the other hand, as τ increases, the range over which the firm benefits from avoiding the penalty increases, thus leading to more bunching.

This will direct the rest of our empirical analysis. We will try to focus on sectors, firm sizes and periods where firms may have been either facing a higher τ, thus making the restriction more stringent, or on firms where the elasticities of substitutions may be higher. Given the low level of female participation in the manufacturing sector in Chile, this implies focusing on groups of firms where women are hired in smaller numbers.

3 Empirical strategy and data

We now use the context generated by this law and our theoretical framework to explain the empirical strategy that will be used to test for bunching just below the legal cut-off and to estimate how factor ratios differ around the cut-off. We then present the data employed in our analysis.

3.1 Empirical strategy

We first used the method suggested by Chetty et al. (2011), which estimates a counterfactual density using a polynomial approximation. This method has been used by Kleven and Waseem (2013) and by Ito and Sallee (2018) to study the distribution of tax payers and the weight of cars in response to regulations.

This method involves estimating a counterfactual distribution that ignores the bunching to then compare the predicted values with the ones observed in the data. For this, we first estimate the distribution excluding the point in which we anticipate bunching. Following Ito and Sallee (2018), we denote C_j the quantity of firms that hire j female workers. To estimate the counterfactual distribution, we run the following regression

$$C_j = \sum_{s=0}^{S} \beta_s \cdot j^s + \gamma^0 \sum_{j=18}^{21} D_j^0 + \epsilon_j \tag{1}$$

where D_j^0 a dummy that takes, initially, the value of 1 for each point where we suspect bunching. Using the estimates of that regression, we can compute the counterfactual distribution as $\hat{C}_j^0 = \sum_{s=0}^{S} \hat{\beta}_s \cdot j^s$. Then, the excess of firms that hire k female workers with respect to the counterfactual distribution is given by $\hat{B}^0 = C_k - \hat{C}_k^0 = \hat{\gamma}_k^0$. However, this measure is inappropriate because it does not take into account that the bunching comes from lower density in other parts of the distribution, in our case, for firms with more than 19 workers. We adopt the methodology of Kleven and Waseem (2013) and recursively include firms with one more woman worker in our value of D. We can then calculate, in addition to the extra bunching $\hat{B}$, the area missing to the right of the cutoff $\hat{M}$. In their example, they continue to expand the range of D until $\hat{B} = \hat{M}$ since their running variable is continuous. However, since in our case, our running variable is discrete, we must stop at the point where $\hat{B}$ is closest to $\hat{M}$. We explored this and, almost always, $\hat{B}$ is smaller than $\hat{M}$ when we include up to 21 workers and becomes larger when we include 22 workers. We will thus often present both sets of results since they are not equivalent. Also, since in our case $\hat{B} \neq \hat{M}$, we will present both estimates. One measures the excess bunching at values slightly below the discontinuity while the second measures the lack of firms above the threshold. We think that in this context both estimates may be relevant. Following Kleven and Waseem (2013), we use residual bootstrap to obtain a distribution for the parameters β_s and then construct an empirical distribution for $\hat{B}$ and $\hat{M}$.

As an alternative, we use the method of McCrary (2008) based on a regression discontinuity design. However, we need to make adjustments to McCrary's methodology since the use of local linear regression may not be best here given that our running variable (number of female employees) is discrete. Instead, in that case, it is usually recommended to use a polynomial approximation, see for example Card and Shore-Sheppard (2004), Kane (2003) and DiNardo and Lee (2004).[8] We thus regress the density of firms with j women workers on a polynomial of j interacted with a dummy for being above the threshold.

Following Lee and Lemieux (2010), we use the following specification:

$$\ln f = \alpha + \beta D + \gamma f(j^S - 20) + \delta D * f(j^S - 20) + \epsilon \quad (2)$$

where we use a window of 15 above and below the threshold and a polynomial of degree 2 in the baseline specification. We check this specification using graphical analyses and robustness checks such as altering the degree of the polynomial and the size of the window.

3.2 Data

The data employed to conduct these empirical specifications are from the *Encuesta Nacional Industrial Anual* (ENIA) which is a panel of manufacturing firms. We use years 1995 through 2007, which includes the years in which the legal obligations to the firms have become more binding. The survey includes all manufacturing firms with 10 or more workers which operate in the manufacturing sector of Chile.[9]

The survey includes, at the level of an establishment, key variables regarding sales, employment, costs, etc. We will focus in particular on the number of men and women workers, total earnings and various measures of capital and output. These variables are all self-reported. We think this is potentially better than administrative data since we may see more bunching in administrative data since firms would be unwilling to report a twentieth woman to their payroll to labor regulators but may be very willing to report that they have 20 women in their firm to the survey (similar to Blank, Charles, and Salle, 2009). Thus, the bunching we find could be seen as a conservative estimate, including "hidden" workers that would not be captured in administrative data. Furthermore, if firms round their responses, answering mostly multiples of 5 or 10, we may underestimate the bunching we faced since many firms will round 18 or 19 female workers to 20.

The sample includes more than 70,000 firm-year observations. From that sample, 50 percent have less than 5 women hired and 85 percent of the sample has less than 20 women hired. By restricting our sample to those within a window of 10 or 15 women around the threshold, we

[8] Frandsen (2017) develops a different methodology to analyze bunching, which in our example, proxies the observed distribution to a binomial with probability 1/3 for each of the 3 points around the discontinuity. However, this method does not work well in distributions that are decreasing (instead of "flat") like the one we have.

[9] The survey also includes establishments with less than 10 workers because they are part of a multi-unit firm with more than 10 workers. However, these are not included in our sample since we cannot determine the total number of workers in that firm using the survey.

focus on 17 and 35 percent of the sample respectively. Since a large part of firms are surveyed multiple times, we find that many firms remain within the sample each time they are surveyed while a majority are sometimes within our sample and sometimes outside. About a third of the firms subject to the law because they hire more than 20 women have always been so in the sample while the remaining has been some years below and some years above.

Table 3 compares firms above and below the threshold within a window of 15. It also separates the sample according to the years, firm size and by sector. We denote as female-intensive the seven sectors with the highest ratio of men per women workers for firms outside our main estimation window (i.e. excluding firms that hire between 10 and 30 women), comprising 48 percent of the firms in our sample.[10] Specifically, this corresponds to the manufacturing of food products and beverages, textiles, wearing apparel, dressing and dyeing of fur, tanning and dressing of leather, manufacture of luggage, handbags, saddlery, harness and footwear, chemical products, medical, precision and optical instruments, and recycling. Low female-intensive sectors, on the other hand, includes the remaining sectors. While one may be worried because we used our own data to classify industries into female and less female-intensive sector, the United States' manufacturing sector, for example, shares 5 out of the 7 sectors we use here as their most female intensive when using 2000-2017 Census and American Community Survey answers. This suggests that our results are unlikely to be driven by the fact that we selected these sectors within the Chilean manufacturing sector.

We also observe that the number of women hired in each type of firm appears to have been stagnant over the years while men employment, in particular in firms that hire more than 20 women, has been increasing. The fast economic growth experienced by Chile is visible in the increase in average salaries and labor productivity over the period of the study. The most female intensive sectors are not hiring much more women than other sectors but they are hiring much fewer men. They are also sectors where wages and labor productivity are lower. Finally, firms with less than 100 employees hire slightly fewer women but they hire much fewer men. This suggests that large firms are the ones where female workers are particularly scarce. Small firms are also paying lower wages and tend to have lower labor productivity. It is worth noting that only in small firms do we see firms with fewer than 20 women having higher labor productivity than those who are above the threshold.

We must recognize that a major disadvantage of this database is the fact that we have extremely limited information regarding the characteristics of the employees except their gender. We will explore the little disaggregation there is by occupation later on in the paper.

[10]This corresponds to sectors 15, 17, 18, 19, 24, 33 and 37 of the ISIC classification Rev. 3

4 Empirical results

Having described our empirical strategy and the data we will employ, we now turn to empirically testing whether there is evidence of bunching in response to the law, both in aggregate and in some subgroups as guided by our theoretical framework.

4.1 Graphical evidence

We first present graphical representation of the number of women in the firms in our sample. Figure 4 shows a histogram where we display the number of firms who hire a given number of women, within 8 women of the policy threshold, for the full sample of year-firm observations from the ENIA. We find some weak evidence that firms appear to be more numerous just below 20 firms than at 21 and 22 firms, but in the overall sample bunching is weak.

Our next figure shows the same histogram but this time divided into three time periods. We see that as the legal framework became more and more binding, the bunching becomes clearer and clearer. Already, in 1999-2002, there seemed to be a much smaller number of firms hiring more than 20 female workers than in the previous years and some additional mass between 15 and 19 employees. However, there were also a large number of firms at exactly 20 female employees, suggesting either rounding bias or simply a fair number of firms who do not avoid altogether the legislation despite their best efforts. By 2003, the histogram seems to visually indicate much more bunching below 20 women.

We then present histograms by the industrial sector where the firm is operating. Female-intensive sectors correspond to sectors where female to male employment ratio is the highest in aggregate, and thus where limiting the number of women may be more difficult. The rest of the firms are in sectors where women workers are, in general, much less numerous and thus where a firm may be able to restrict the number of women it hires more easily. The histograms presented in Figure 6 suggest exactly that. While the histogram of firms in female-intensive sectors shows little difference in the number of firms with 19 and 20 female workers, the one of male-intensive sectors shows very striking change in the number of firms above and below 20 female employees. There are about 33 percent fewer firms with 20 female workers than firms with 19 women workers. In this case, firms clearly seem to avoid the threshold of 20. This is even more marked if we only look at firms in male-intensive sectors in the later period, where the pattern is more marked.[11]

We then separate our sample by firm size in terms of employment. Large firms are much more likely to have a number of women workers close to the threshold given that they have

[11] Available upon request.

more overall employees. In small firms, avoiding the 20 female worker threshold is relatively easy since only 10 percent of the firms in that sample hire more than 15 women. Crossing the threshold may also be much less costly for small firms since monitoring by the Labor Directorate is much less intense in small firms than in large and that small firms may be able to offer their female employees alternative benefits to compensate the absence of child care. Figure 7 show that there is no evidence of bunching in firms of less than 100 employees. However, in firms with more than 100 employees, the impact of the law is really striking. There are 20 percent fewer firms with 20 female workers than with 19. And the graph shows that large firms are relatively successful at avoiding hiring any number of women above 20 since the number of firms above 20 remains equally stunted.[12]

We finally separate our sample according to the exercise performed by Prada, Rucci, and Urzúa (2015). In their study, they use firm fixed effects, which is equivalent to using only firms that switched over time between being subject and not to the law. It is clear that these firms may be different than firms that purposefully avoid the cut-off. We thus split our sample of years-firms into those that include firms that switched from being subject to not subject to the law and those that have always been on one side of the threshold. It is a matter of statistics that the graph of switching firms would have a hump-shape while the graph of those who never switched would be hollowest exactly at the cut-off. However, it is telling that while in both cases, we find evidence that firms seem to dislike having more than 20 female workers, it is only within non-switching firms that a jump can be observed exactly at 20. This seems to indicate that firms that pass the threshold from time to time appear to pass it mostly at 20 or 21 while firms that have managed to avoid being subject to the law have carefully bunched below the threshold. This may explain why the aforementioned paper cannot reject the hypothesis that there is no strategic positioning on each side of the discontinuity but we find evidence of it in various sub-samples.

4.2 Polynomial approximation method

We now turn to our formal tests to quantify the magnitude of the bunching. We start with the polynomial approximation of the distribution as suggested by Chetty et al. (2011). These results are presented in Table 4. For each column, we present the "excess bunching", which is the mass at 18 and 19 workers that is above what the polynomial would have predicted and the "missing mass" at 20, 21 and 22 (only in Panel B) workers which is below what the polynomial would have predicted. As we indicated before, we present both measures since, given that we are in a discrete setting, they are not equal to each other. We include in brackets the standard deviation of the distribution of bootstrapped parameters. The "randomness" in the parameter comes from the fact that our polynomial is estimated and not exact.

[12] Using a different cut-off for large and small firms does not strongly affect the results.

Our results suggest that there is strong evidence of missing mass above 20 female workers. A large number of estimates are statistically significantly different from 0. However, the evidence of excess bunching at 18 or 19 female workers is much weaker. We only find statistically significant evidence of excess bunching for the 2003-2007 period and for large firms. We find that, in general, the patterns we identified graphically are confirmed by this methodology such that the largest bunching is found for recent periods, sectors with few female workers and large firms. The magnitudes are relatively striking. We find that in total, some 100 firms may be "missing" compared to what the counterfactual polynomial would predict. We find excess bunching in 18-19 female workers of about 20-40 firms. When we include all years, sectors and firm sizes, we have about 1100 firms with 18-19 female workers and 900 (1300) firms with 20-21 (20-22) female workers, which suggest that this corresponds to about 10 percent of missing mass and about 3 percent of excess bunching. However, the results also indicate that this method is relatively fragile in predicting whether the graphical evidence we presented before is indicative of bunching and this may be because the distribution of firms is far from being smooth.

4.3 Test of McCrary

We thus turn to an alternative test which is the test of McCrary (2008) which we altered given the discreteness of our data as discussed above. This test allows for the distribution of firms below and above to have a different pattern, which would then potentially provide us with a different result than the ones with the polynomial approximation. It also directly measures whether there is a discrete jump at the point of the threshold instead of comparing the masses to a counterfactual distribution. The results of the test are presented in Table 5 using the same divisions as the previous table.

The results suggest that we observe a discrete jump in the log number of firms around the legal threshold. The magnitudes are relatively large. For our larger window, on average, we find 23 percent fewer firms above 20 than below that threshold. For our smaller window, we find an even bigger estimate (26 percent). However, exactly as before, we also find heterogenous patterns in these results. Before 1998, the law barely appears to have affected the hiring decisions of firms. However, by 2003, when the law becomes even more strict, we observe a very large and significant different in the log number of firms above and below the threshold. Similarly, we find strong evidence of an effect for more male-intensive sectors than those more intensive in women workers. Finally, we find evidence that only large firms alter their hiring decisions around the threshold.

Appendix Table C.1 shows that we do not find the same discontinuity at 15, 18 or 22 female workers. We also show that there is no evidence of a discontinuity in the number of male workers at 19.

Appendix Figure C.1 shows that our results are robust to different definitions of male-intensive sectors, as long as we consider sectors that are above the median in terms of male intensity. Appendix Figure C.2 shows that our results are robust to different definitions of what is a "large" firm, as long as we consider firms above 50 employees.

Although not reported, the test of McCrary shrinks but remain significant if we measure the log number of years a given firm has a given number of female worker as our dependent variable and include firm fixed effects, that is to say, we ask instead if there is a discontinuity in the number of years in our sample where a firm reports a given number of female worker. This suggests that even within switchers, we continue to find evidence of a discrete jump around 20 female workers.

5 Adjustment mechanisms

We then turn to studying in particular how firms on each side of the threshold differ in other input choices than only women to try to derive some conclusions regarding the relative complementarity of capital and women/men labor. To do this requires the additional assumption that after the controls we include in the regression, including sector fixed effects, firms are using the same production function on each side of the threshold. Our model predicts that this would be the case since what determines labor demand is the productivity parameter α_i. We can also allow for firms to be sorting above or below the threshold for factors that are uncorrelated with their production function (for example, owners' taste for discriminating against women). We include sector fixed effects on all regression to avoid distortions arising from comparing firms in different sectors with different production technologies, as well as year fixed effects. What we cannot assume is that, within a given manufacturing sector, firms that avoid the law combine men, women and capital using a different production function than those who hire more than 20 women. We will argue that the fact that our model predictions are upheld is suggestive that we may not face this problem. If this is true, then we can use the framework we presented above to derive how each type of labor may be substitute or complementary to capital. Moreover, our results are not sensitive to including different aggregations of sectors fixed effects, suggesting that differences in production technology are not related to firms crossing the threshold of 19 women employees. We conduct all analyses in log terms.

We first demonstrate that comparing firms below and above the threshold, we observe a substantial change in the ratio of male to female in their workforce. Table 6 shows that firms that have just above 20 female workers have, on average, 7-8 percent fewer men per women workers than firms just below that threshold. When computed in levels, this implies about 0.4 fewer male per women workers at the threshold. Once we split our sample into sub-groups as we have done earlier, we find that the same subgroups where we noticed irregular bunching are the points where we are able to find also evidence of a jump in the male-to-female ratio within workers, although the evidence is stronger for our smaller window than the larger one. For the most recent period, for example, we observe that there were 20 percent fewer men per women workers for firms above the threshold than those below. For firms in low female-intensive sectors, the fall is 17 percent. This suggests that firms that elect to hire more than 20 female workers in part replace male with female workers. This is consistent with our theoretical framework which indicates that we should observe a discontinuous jump in the number of men per woman in the firm's workforce but only where bunching is most salient because of the cost of the policy or the capacity to substitute to other factors.

We now turn to evaluating how measures of capital-ratios differ above and below the threshold. For this, we use 5 different measures, each presented in a different panel of the following tables. One is the value of capital, as this is the most comprehensive measure we have access to. We are able to decompose it between machinery and equipment and other forms of capital, which we do to explore the importance of each category. We then use two alternative measures which involve complementary inputs to machinery and equipment capital, namely expenditures on electricity and expenditures on fuel. We think that their combination should provide us with a more complete picture than any of them separately, allowing us to judge whether there are differences in complementarity between types of capital.

Table 7 shows the difference we observe in capital per women workers between firms that are above and below the threshold. We show the results for our smaller window of firms between 10 and 30 workers. Results when using a larger window are weaker in that case for value of capital but similar for the other measures. Table 7 shows that in the case where capital is measured by the value of the capital stock, we observe very marked decreases in that ratio as firms become subject to the policy. On average, the results suggest a fall of about 33 percent in the capital per female worker ratio. This increases when we focus only on the most recent period. It is also more marked again for sectors where we observed bunching, mainly those less intensive in female workers and the largest firms (although only significantly so for the first one). The results for electricity and fuel expenditure are also relatively consistent with our hypothesis, showing, in the cases of the sub-sample where we observed bunching and shifts in male/female ratios, some negative and significant coefficient for many cases. In the case where we do not observe bunching, we have some positive coefficients, which is again what we would expect since the cost of female workers would be higher above the threshold and thus would lead to a higher capital-per-women ratio above the threshold than below if firms do not strategically behave to avoid the law.

We then present, in Table 8, the difference in terms of capital per male worker for firms just above and below the threshold. Our framework suggested that if we observe a decrease in the capital per male worker around the threshold, this would be indicative that capital is more strongly complementary to men's labor than women's labor. We find in Table 8 large, negative and statistically significant jumps in the log of capital per male worker when comparing firms just above the threshold to firms just below it. Interestingly, we find again that these are much stronger (only statistically significant) in sub-samples where we saw a significant decrease in male per female worker, namely more recent and more male-intensive sectors. This suggests that as firms above the threshold hire more women, they substitute away from capital more strongly than they do so with male workers. This is thus an indication that capital complement more strongly men than women's work. Our alternative measures of capital do not indicate necessarily the same pattern. We find a positive and significant increase in the expenditures on electricity or fuel per male worker in a few instances but only in sub-samples where we had not observed robust evidence of bunching. This is again what we expected given our model namely that in groups where firms do not distort size very strongly, K/M would be higher when the firms have to pay a larger wage to women as long as capital particularly complements men's work. We thus see this as evidence that in this particular setting, capital complements much more strongly the work of men than that of women.

We present in Figure 9 the graphical depiction of our results. It shows a clear jump in the capital ratio around 20 women. While the fall in capital per women is more marked, the change is also visible for the capital per men, which leads us to believe that men are more complimentary to capital than women. This confirms what the formal estimates measured above indicated.

This could be because male and female workers are fundamentally different or because female have different skill levels than men and capital responds to skill levels. We unfortunately do not have information regarding the educational level of workers in the ENIA but we do have access to their occupation. We classify as high-skill workers the following categories provided by the database: owners, directors, specialized workers and administrative personnel. The corresponding categories for low-skill are: commission workers, unskilled direct workers, unskilled indirect workers and personal service workers. While clearly not ideal divisions, they should help us identify if the avoidance of women was done in a way to favor a type of skill or another. Table 9 presents the test of discontinuity in the log of the high per low skill worker for all workers (in Panel A), and for men and women in the subsequent panels. They use the smaller window but results are extremely similar when using firms between 5 and 35 workers. These results indicate no statistically significant change in the skill ratio around the cut-off of the law. This suggests that the avoidance of female workers did not, at least based on our coarse definition of skills, lead to a change in skill composition that could explain the response in capital we previously documented. We also redid this exercise using 3 skills group instead of 2 to try to approach more the "automatizing tasks" but found limited evidence of a change in this case as well.

We confirm that capital is key to the puzzle we display by also dividing sectors between those intensive in capital and those less intensive in capital. To obtain a definition that is as far as possible from the Chilean context, we use definitions from either the US capital share by manufacturing industries (from the Bureau of Labor Statistics Multifactor Productivity Tables) or from Manova (2013)'s physical capital intensity measure.[13] While not reported here, we find that the difference between firms above and below the threshold are most marked when we remove sectors with a physical capital intensity of less than 0.05 (compared to an industry average of 0.07) in the case of Manova and sectors with capital shares below 10 percent (in the case of the BLS). This suggests that sectors that are more intensive in physical capital were more likely to experience bunching and much more likely to show the pattern of higher complementarity between men and capital than women, which we presented above.

As we explained above, our strategy is valid if firms do not have a difference in their production function above and below the threshold. While we cannot test this directly, we use other outcomes to evaluate whether this is likely to hold. The results using other outcomes are presented in Table 10. We first estimate whether there is a discontinuity in the log total number of workers around the cut-off in Panel A. This would be expected to be 0 if firms were simply replacing female workers with male workers when they wished to avoid the legislation. We find some evidence of this in aggregate but not in the sub-groups where bunching was most visible, since in this case we have a clear decrease in the number of workers when firms hire more than 20 female workers. This is normal since it is in this context that we found the most evidence of substitution with capital. In Panel B, we explore the only variable we have available regarding wages which we will use as a measure of labor productivity and find some weak evidence that firms that hire 20 female workers pay lower average wages than those who hire just 19 in sub-samples where we observed evidence of bunching. However, since we do not have wages by gender, it is very difficult to make any inferences from this result. It could be, for example, that by hiring more women, if women have lower wages than men, that this would lower the average wage paid to workers. Finally, our framework suggest that if we are truly capturing firms that are indifferent between the two levels of hiring, we should observe that firms that hire more than 20 women and those that hire less should have similar profits since they must be indifferent. We use value added per worker as a measure of profits and find no evidence that this changed discontinuously around the cut-off of 20 women. The substitution for capital is thus made in a way that does not increase value added per worker.

[13] We obtain similar results if we rank, within our data, the industries by K/L and drop the least capital intensive sectors from the analysis.

6 Calibration

Having shown patterns consistent with differential degrees of complementarity between capital and workers of both genders, we now use our stylized model to calculate whether differences in sub-samples are linked to production function differences or in the effective cost of the policy for firms. We then compute counterfactuals to estimate the impact of this difference in complementarities on the impact of the policy.

To calibrate our model, we need to obtain credible estimates of the parameters of the production function. We focus on firms that hire less than 18 women to try to avoid the zone of bunching. First, we use the Chilean household surveys, *Encuesta de Caracterización Socioeconómica Nacional* (CASEN), from 1996 to 2006 to obtain wages by gender. This requires us to make a few approximations in terms of time periods (the first period includes the 1996 and 1998 survey, the second the 2000 survey and the last period includes the 2003 and 2006 surveys), industries (CASEN uses ISIC rev2 instead of rev3) and firm sizes (we classify firms above 50 as large) but we obtain similar results when using different approximations. We restrict our attention to workers reporting working in the manufacturing sector and in firms above 10 workers since this is the sample for the ENIA. We find that in the overall sample, women earn about 85 percent of the wage of men. This is more than what has been found in the overall economy: women with less than high school earned about 80 percent of their male counterparts over this period, while for those with more than high school this was about 65 percent (Instituto Nacional de Estadisticas, 2015). We see that the gap was significantly larger in the first period than in the other two. Women in large firms only earned around 75 percent of the wage of their male counterpart while in small firms, that number jumped to 92. Similarly, while women in female intensive sectors had hourly wages within 10 percent of that of men, the gap increased to more than 20 percent for those in male-intensive sectors.

We then use the estimate of r computed in Caselli and Feyrer (2007), equal to 0.26.[14] We use our equations on factor ratios and the average factor ratios observed in firms with less than 20 women to obtain the parameters ρ and θ. Finally, we set the firms returns to scale parameter, σ, by matching the firms reported value added with the production level given our estimates of the parameters and the average amount of each factor reported by firms in the data. The values for each parameter and subsample are displayed in Table 11. We observe that ρ is always larger than θ but that is particularly the case for the most recent period, the sectors that are the least female intensive and in large firms.

Following our theoretical model, we then need to calibrate the managerial ability or produc-

[14] This corresponds to their "naive" estimate of marginal product of capital. We were unable to estimate industry-specific or time-specific measures of return to capital.

tivity factor, α_i. We perform this by matching total number of workers of the firms hiring between thirty and two hundred employees.[15] To do this we assume that the distribution of α_i follows a Pareto distribution, which is a common assumption in the literature and reduces the problem to finding the scale and shape parameters to match the workers' distribution observed in the data.[16] Once we estimate the underlying parameters of the Pareto distribution, we use it to obtain the distribution of the optimal hiring of capital, men and women.

Our calibration then allows us to obtain bunching estimates under alternative scenarios, assuming different costs of the policy to the firms. We compute our baseline cost measure using data from the 2006 CASEN to obtain the proportion of women who have children under the age of 2 who are employed, which is 6.3 percent. We then use data of the childcare cost per children and average wages for women in the ENIA to calculate that the average cost of the policy is equivalent to 1.7 percent of the wage of women hired in unconstrained firms.[17]

Using this cost estimate, Panel A of Table 12 shows the estimates obtained in our calibration assuming that firms bear the full cost of the policy. The estimated bunching in the model is around 40.5 percent for the full sample, and it is stable over periods. The largest differences arise when comparing small and large firms, where the estimated bunching is 36.2 and 45.4 percent, respectively. In contrast, bunching in sectors with high and low female participation is almost identical, respectively at 41.4 and 39.4 percent. This implies that the difference we observed previously appears to stem not from differences in technology parameters between the sectors but from something different.

Another plausible explanation for the difference between sub groups in our empirical analysis is that the effective cost of the policy may not be constant over time or across sectors. This is consistent with the evidence of increased compliance in the later periods, which went up from a bottom of 69 percent in 1998 (including cases of partial compliance such as bonuses) to 88 percent in 2006 according to the self reported National Labor Survey employers survey. Similarly, compliance in larger firms was considerably higher than smaller ones: firms with 100 or more workers reported a compliance of 81 percent in the period 1998-2004, while firms smaller than 100 total workers and more than 20 women reported a compliance of 57 percent. Moreover, as Gruber (1994) points out, part of the cost of this kind of policies can be transmitted to the benefited population through lower wages. Unfortunately, we do not have wages information

[15] In the case of small firms we match the total number of workers of firms hiring between thirty and one hundred employees, and for large firms we match the proportion of firms between one hundred and two hundred workers.

[16] Since our production function has increasing differences in the productivity parameter and the marginal productivity of each factor, the amount of workers will be increasing in the productivity parameter α. We can then map the values of α that induce a given number of workers by obtaining the largest and smallest α that map into each bin, greatly simplifying the problem and improving the accuracy of the solution.

[17] This computation assumes that women cannot sort into larger or smaller firms around the threshold. In particular, if women with children under two years old could sort into larger firms then the cost would be larger and our estimate would represent a lower bound.

at the worker level to directly measure this outcome. Despite this, our calibration permits us to contrast the bunching level observed in the actual data with the bunching we observe under alternative costs of the policy. Thus, we use this to estimate the effective cost of the policy for firms so that the observed level of bunching matches that in the model.

Panel B of Table 12 shows the estimated bunching for each of the calibrated periods. We compare this results with our bunching estimates from the McCrary estimations and find that for the whole sample the results are consistent with a context where firms bear 61.3 percent of the policy cost. Our results also suggest that an important mechanism leading to the increase in bunching in the more recent period was a higher effective cost of the policy. In specific, our calibration shows that the proportion of the cost faced by the firms increases from 18.1 percent in the period 95-98, to 65.8 percent in the period 99-02, and it further increases to 94.6 percent in the latter period. This is consistent with the evidence of increased supervision and compliance with the policy in the more recent periods. Similarly, we find results consistent with a scenario where firms in female-intensive sectors, where it is easier to substitute women, transfer a larger proportion of the cost to women, while firms in male-intensive sectors bear a higher proportion of the cost of the policy. Analogously, large firms bunching estimates are consistent with them absorbing the whole cost of the policy, while small firms bear a limited proportion of the cost. This could be due to larger firms having more difficulty in lowering female wages (anti-discrimination law is more strongly enforced in larger firms) or to larger firms facing more scrutiny in their compliance for this policy.

Thus, our calibration results suggest that not only did change in elasticities between the different samples made the bunching more likely. There are also other factors that appear to have been at play, more likely how much of the impact of the policy translated into higher costs of hiring women. However, in Panel C, we show that technology also had significant role in how the policy distorted factor choices. In the first row of Panel C, we reestimate the bunching that should be observed in a case where men and women had the same level of complementarity with capital than the one estimated for men. We see that in that scenario, the policy would have led to much less distortion of firms' decisions in terms of hiring of female workers. This suggests that firms were particularly able to avoid hiring women because of their particular relationship to capital. The next row shows the opposite case, that is, what would have happened if both genders had been similarly substitute to degree we estimated for women. We observe that, in this case, the bunching would have been even more marked since capital would have been used to replace labor of both genders. This thus suggests that the relative complementarity of men and women with capital is key to understand the impact of this "childcare mandate" and of gender-specific policies in general.

7 Conclusions

This paper documents the existence of marked concentration of firms below the threshold of 19 women in the Chilean manufacturing sector that appears to be a way for firms to avoid becoming subject to the mandated childcare policy in place. This is more evident in more recent periods (where enforcement appears to have increase) and in firms with higher substitution capacities (those in industries with low numbers of women workers and larger firms). We also document that this bunching has translated into distorted factor ratio use that favor capital and men over women around the threshold. The patterns suggest that in this context, capital is more complementary to men than women's labor. Our calibration finally suggests that this difference in complementarity has significant consequences for the impact that such policies may have on factor distortions.

This is the evidence from one given sector, namely manufacturing. We elected this dataset because it was one of the only available dataset that would give us measures of capital. However, our framework also suggests that the substitutability of factors is key for this type of policy to distort firm choices. In agreement with this, we have found limited evidence of bunching in sectors other than manufacturing or primary sectors, using a firm survey in Chile (ELE, Encuesta Longitudinal de Empresas). This would reinforce our point that the existence of capital as a valid substitutes for women workers is key in the pattern we document. We think that this has been mostly ignored in other studies of size-dependent labor policies and would be worth more analysis.

The evidence we suggest also implies that while this policy may benefit mothers who have an employment in Chile, it may do so at the cost of limiting female employment. Given that Chile has a very low level of female participation, this type of policy should thus be reevaluated to remove the disincentives of the law in the hiring of women. We explore this in a companion paper (Escobar et al., 2020).

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8 Tables and Figures

Table 1. Legal changes between 1900 and 2010

Year	Law	Summary
1993	19.250	Allows, during vacation periods, the use of schools to function as daycare centers
1995	19.408	Alters article 203, extending the daycare benefit to commercial centers or buildings administered under a single legal name or entity.
1998	19.591	Alters article 203, changing the term "establishments" for "firms".
2002	19.824	Extends the daycare benefit to industrial and service establishments administered under a single legal name or entity.
2007	20.166	Extends the right of working mothers to breastfeed their children during their work day even when there does not exist a daycare.
2009	20.399	Extends the right to daycare benefits to workers who are the legal guardian of children of less than 2 years old, to fathers if the mother has died and to working fathers who are the legal guardian of their children.

[1] *Source: Dirección del Trabajo, Ministerio del Trabajo, Chile.*

Table 2. Compliance with daycare law

	All	Year						Size		Sector	
	Years	1995	1998	1999	2002	2004	2006	Small	Large	Manuf.	Others
Employer Survey											
Own childcare	0.09	0.09	0.17	0.07	0.04	0.04	0.05	0.05	0.12	0.12	0.08
External childcare	0.47	0.58	0.42	0.42	0.52	0.57	0.69	0.38	0.53	0.51	0.46
Bonus to mother	0.15	0.17	0.09	0.20	0.19	0.17	0.15	0.14	0.16	0.12	0.17
No benefits	0.23	0.17	0.31	0.28	0.17	0.11	0.10	0.37	0.14	0.20	0.24
Other answer	0.05		0.00	0.04	0.09	0.11	0.02	0.06	0.05	0.04	0.06
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Employees Survey											
Own childcare	0.07		0.12	0.07	0.02	0.02	0.03	0.04	0.10	0.09	0.07
External childcare	0.34		0.32	0.33	0.32	0.37	0.15	0.25	0.41	0.33	0.34
Bonus to mother	0.17		0.16	0.24	0.15	0.12	0.06	0.16	0.19	0.19	0.17
No benefits	0.34		0.40	0.35	0.35	0.41	0.04	0.43	0.26	0.35	0.34
Other answer	0.08		0.00	0.00	0.15	0.08	0.13	0.12	0.04	0.03	0.09
Not needed							0.60				
Total	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Observations	1171	151	262	188	170	174	377	597	572	293	878

[1] *Source: info for year 1995 comes from Labor Inspection annual reports. Values for years 1998-2006 generated using National Labor Survey. Sample include only firms that employ 20 or more women. than 2 years old. Categories homogeneized across years. Comparisons beside 2006 excludes those who answer "Not needed" due to years compatiblity, since that option was not included in other versions of the survey. Comparisons by sector and size only cover years 1998 to 2004 due to availability.*

Table 3. Description of firms above and below the threshold

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
Observations								
Below	24,193	8,095	7,195	8,903	14,716	9,477	20,243	3,950
Above	4,329	1,617	1,131	1,581	2,953	1,376	2,736	1,593
Female Workers								
Below	9.461	9.591	9.368	9.418	9.596	9.252	9.106	11.281
Above	25.973	25.934	25.912	26.056	26.069	25.767	25.809	26.254
Male Workers								
Below	53.567	55.910	50.568	53.862	32.713	85.950	24.019	204.996
Above	109.573	101.514	104.242	121.628	60.573	214.729	25.404	254.133
Wage per Worker								
Below	8.207	8.062	8.180	8.360	8.008	8.515	8.098	8.763
Above	8.365	8.188	8.352	8.555	8.211	8.695	8.089	8.837
Capital per Worker								
Below	1.628	1.609	1.655	1.623	1.251	2.207	1.370	2.984
Above	2.026	1.944	2.046	2.094	1.600	2.938	1.339	3.215
Electricity Consumption per Worker								
Below	-5.518	-5.475	-5.729	-5.388	-5.741	-5.174	-5.752	-4.323
Above	-5.319	-5.416	-5.549	-5.056	-5.699	-4.508	-5.919	-4.292
Fuel Consumption per Worker								
Below	-1.731	-1.979	-1.794	-1.487	-1.672	-1.819	-1.900	-0.991
Above	-1.856	-2.245	-1.962	-1.458	-2.088	-1.421	-2.391	-1.088
Production per Worker								
Below	296.019	194.915	262.629	414.859	145.405	529.904	85.485	1,374.918
Above	308.751	179.745	239.298	490.381	152.375	644.348	30.099	787.342

[1] *High female intensity sectors are the top 50 percent of sectors by female to male ratio for firms outside our main estimation window of 10 to 30 women. Sectors are weighted by number of firms in the sample. All monetary units in millions of Chilean pesos of 2007.* Sample includes all firms in the manufacturing sector with 10 or more workers.

Table 4. Results of Counterfactual Polynomial

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Using up to 21 workers				
"Excess bunching"	40.234	-13.808	13.400	40.642***	15.841	24.392	0.120	40.113***
	(33.872)	(13.149)	(17.884)	(14.396)	(36.518)	(22.642)	(29.005)	(10.058)
"Missing mass"	99.180***	23.501*	28.636	47.043***	2.115	97.064***	48.274*	50.906***
	(34.474)	(13.935)	(17.438)	(15.536)	(36.398)	(23.806)	(29.363)	(10.991)
				Panel B: Using up to 22 workers				
"Excess bunching"	17.520	-19.208	6.125	30.602**	9.339	8.181	-13.260	30.779***
	(33.674)	(12.892)	(17.926)	(14.199)	(33.769)	(23.900)	(32.284)	(9.666)
"Missing mass"	200.529***	47.594***	61.095***	91.839***	31.128	169.401***	107.975***	92.554***
	(56.928)	(22.23)	(27.823)	(24.506)	(54.381)	(37.087)	(52.284)	(16.509)

Standard deviation of the bootstrapped distribution presented in parentheses. The regression included a 5th order polynomial in number of women workers and a dummy for firms with 18-21 workers in Panel A and with 18-22 workers in Panel B. The number of stars specify how much of the bootstrapped distribution is below 0. *: less than 5 %; **: less than 1%; ***: less than 0,1%.

Table 5. Results of McCrary's test

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
				Panel A: Using firms with 5 to 35 female workers (N=31)				
$W \geq 20$	-0.223***	-0.063	-0.263*	-0.360***	-0.065	-0.490***	-0.150	-0.346***
	(0.078)	(0.074)	(0.146)	(0.107)	(0.080)	(0.117)	(0.105)	(0.095)
				Panel B: Using firms with 10 to 30 female workers (N=21)				
$W \geq 20$	-0.253**	-0.099	-0.267	-0.402***	-0.067	-0.587***	-0.166	-0.422***
	(0.100)	(0.082)	(0.171)	(0.130)	(0.093)	(0.141)	(0.124)	(0.104)

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold and the dependent variable is the log of the number of firms in each bin. *: significant at 10 %; **: at 5%; ***: at 1%.

Table 6. Discontinuity in the log of men per women workers

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
	Panel A: Using firms with 5 to 35 female workers							
$W \geq 20$	-0.076*	-0.131*	-0.036	-0.077	-0.060	-0.128*	-0.032	-0.081*
	(0.043)	(0.078)	(0.078)	(0.069)	(0.053)	(0.076)	(0.044)	(0.042)
N	28,302	9,658	8,254	10,390	17,461	10,841	22,759	5,543
	Panel B: Using firms with 10 to 30 female workers							
$W \geq 20$	-0.072	-0.109	0.117	-0.194**	-0.029	-0.167*	-0.051	-0.083*
	(0.053)	(0.098)	(0.094)	(0.086)	(0.065)	(0.093)	(0.054)	(0.050)
N	13,223	4,675	3,766	4,782	8,477	4,746	9,599	3,624

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold, as well as year and sector fixed effects (ISIC four-digit). The dependent variable is the log number of male/female workers. *: significant at 10 %; **: at 5%; ***: at 1%.

Table 7. Discontinuity in the log of capital per female workers

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
				Panel A: Value of capital stock				
$W \geq 20$	-0.048	-0.014	-0.023	-0.137*	-0.076	-0.032	-0.032	-0.065**
	(0.046)	(0.085)	(0.085)	(0.074)	(0.060)	(0.068)	(0.064)	(0.030)
N	12,016	4,248	3,406	4,362	7,459	4,557	8,552	3,464
				Panel B: Value of capital stock (machinery and equipment)				
$W \geq 20$	-0.126	-0.217	0.056	-0.275*	0.019	-0.408**	0.037	-0.400***
	(0.102)	(0.174)	(0.209)	(0.164)	(0.109)	(0.152)	(0.125)	(0.177)
N	12,938	4,574	3,683	4,681	8,316	4,622	9,468	3,470
				Panel C: Value of capital stock (other)				
$W \geq 20$	-0.275**	-0.131	-0.052	-0.620***	-0.226	-0.395**	-0.217	-0.329**
	(0.112)	(0.184)	(0.215)	(0.198)	(0.141)	(0.184)	(0.132)	(0.167)
N	11,585	4,063	3,297	4,225	7,205	4,380	8,220	3,365
				Panel D: Expenses in electricity				
$W \geq 20$	-0.089	-0.146	0.121	-0.242*	0.065	-0.377**	0.029	-0.301**
	(0.083)	(0.137)	(0.156)	(0.144)	(0.098)	(0.148)	(0.082)	(0.137)
N	13,302	4,696	3,789	4,817	8,558	4,744	9,683	3,619
				Panel E: Expenses in fuel				
$W \geq 20$	0.115	0.026	0.113	0.174	0.132	0.092	0.276**	-0.220
	(0.100)	(0.174)	(0.184)	(0.169)	(0.130)	(0.156)	(0.107)	(0.157)
N	10,800	3,491	3,040	4,269	6,656	4,144	7,450	3,350

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold, as well as year and sector fixed effects (ISIC four-digit). Dependent variables are the log of the proxy for capital per female worker. *: significant at 10 %; **: at 5%; ***: at 1%.

Table 8. Discontinuity in the log of capital per male workers

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
				Panel A: Value of capital stock				
$W \geq 20$	-0.125	-0.137	-0.082	-0.236*	-0.075	-0.241**	-0.038	-0.291**
	(0.077)	(0.124)	(0.164)	(0.123)	(0.102)	(0.117)	(0.097)	(0.122)
N	12,873	4,548	3,656	4,669	8,246	4,627	9,400	3,473
				Panel B: Value of capital stock (machinery and equipment)				
$W \geq 20$	-0.044	-0.084	-0.053	-0.087	0.040	-0.200	0.085	-0.301**
	(0.081)	(0.131)	(0.174)	(0.128)	(0.104)	(0.130)	(0.098)	(0.136)
N	12,820	4,531	3,641	4,648	8,203	4,617	9,350	3,470
				Panel C: Value of capital stock (other)				
$W \geq 20$	-0.226**	-0.065	-0.203	-0.432**	-0.224*	-0.241	-0.204	-0.226
	(0.098)	(0.151)	(0.193)	(0.176)	(0.128)	(0.151)	(0.127)	(0.151)
N	11,510	4,041	3,267	4,202	7,132	4,378	8,145	3,365
				Panel D: Expenses in electricity				
$W \geq 20$	-0.002	-0.017	0.025	-0.044	0.122	-0.214**	0.102	-0.214*
	(0.063)	(0.101)	(0.127)	(0.108)	(0.079)	(0.105)	(0.073)	(0.118)
N	13,180	4,651	3,747	4,782	8,441	4,739	9,561	3,619
				Panel E: Expenses in fuel				
$W \geq 20$	0.196**	0.103	0.085	0.371***	0.163	0.264**	0.320***	-0.096
	(0.080)	(0.138)	(0.145)	(0.136)	(0.104)	(0.126)	(0.096)	(0.143)
N	10,735	3,471	3,018	4,246	6,593	4,142	7,385	3,350

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold, as well as year and sector fixed effects (ISIC four-digit). Dependent variables are the log of the proxy for capital per male worker. *: significant at 10 %; **: at 5%; ***: at 1%.

Table 9. Discontinuity in the log of high per low skill workers

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
				Panel A: All workers				
$W \geq 20$	0.141*	0.122	0.390**	0.020	0.283**	-0.091	0.217**	0.032
	(0.085)	(0.124)	(0.174)	(0.149)	(0.113)	(0.123)	(0.108)	(0.132)
N	12,634	4,469	3,609	4,556	8,006	4,628	9,043	3,591
				Panel B: Male				
$W \geq 20$	0.100	-0.017	0.206	0.214	0.178	-0.079	0.170*	0.004
	(0.079)	(0.119)	(0.162)	(0.136)	(0.110)	(0.130)	(0.095)	(0.140)
N	11,645	4,099	3,308	4,238	6,087	4,530	8,060	3,585
				Panel C: Female				
$W \geq 20$	0.141	0.106	0.467**	-0.000	0.203	0.089	0.203	0.057
	(0.099)	(0.155)	(0.200)	(0.168)	(0.159)	(0.116)	(0.139)	(0.126)
N	9,704	3,146	2,777	3,781	5,103	4,601	6,776	2,928

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold, as well as year and sector fixed effects (ISIC four-digit). Dependent variables are the log of the ratio for high and low skills workers by gender. *: significant at 10 %; **: at 5%; ***: at 1%.

Table 10. Discontinuity in other variables

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
				Panel A: Log average wages				
$W \geq 20$	-0.002	-0.033	0.021	0.003	0.055	-0.112**	0.041	-0.098**
	(0.030)	(0.046)	(0.055)	(0.055)	(0.037)	(0.049)	(0.035)	(0.046)
N	13,350	4,723	3,810	4,817	8,599	4,751	9,726	3,624
				Panel B: Value added per worker				
$W \geq 20$	-1248.428	4218.215	-9678.074	1576.650	-606.392	-3926.881	-1087.691	-4262.886
	(3852.190)	(2701.441)	(7727.923)	(7977.821)	(4171.022)	(8313.849)	(2186.427)	(12611.766)
N	13,345	4,718	3,810	4,817	8,595	4,750	9,722	3,623
				Panel C: Revenues per Worker (log)				
$W \geq 20$	-0.049	-0.052	0.000	-0.078	-0.007	-0.148*	-0.039	-0.067
	(0.046)	(0.073)	(0.090)	(0.081)	(0.057)	(0.078)	(0.053)	(0.077)
N	13,350	4,723	3,810	4,817	8,599	4,751	9,726	3,624
				Panel D: Costs Materials and External Services per Worker (log)				
$W \geq 20$	-0.040	-0.099	0.057	-0.058	-0.010	-0.128	-0.029	-0.062
	(0.058)	(0.088)	(0.109)	(0.106)	(0.074)	(0.092)	(0.069)	(0.086)
N	13,349	4,723	3,809	4,817	8,598	4,751	9,725	3,624

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold, as well as year and sector fixed effects (ISIC four-digit). Dependent variables are the log of the variable indicated in the panel, except for value added per worker that can take negative values. *: significant at 10 %; **: at 5%; ***: at 1%.

Table 11. Production Function Parameters

	All Years (1)	Years 95-98 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
W_m	6,093	4,920	5,911	7,540	5,089	7,387	5,933	6,849
W_w	5,227	3,720	5,349	6,553	4,744	5,835	5,482	5,116
θ	0.219	0.242	0.220	0.201	0.186	0.238	0.153	0.301
ρ	0.056	0.065	0.066	0.041	0.070	0.040	0.024	0.073
σ	0.645	0.667	0.688	0.554	0.698	0.534	0.352	0.762

Table 12. Model Estimated Bunching Comparison and Effective costs

	All Years (1)	Years 95-98 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
	Panel A: Main Bunching Estimates							
Bunching Assuming No Cost-Transfer	0.405	0.418	0.408	0.394	0.394	0.414	0.362	0.454
	Panel B: Effective Cost (Proportion of Total Cost)							
Estimated cost paid by firms	0.613	0.181	0.658	0.946	0.364	0.886	0.148	1.06
	Panel C: Bunching under Alternative Elasticies of Substitution							
Equal Capital Substitution (using K/M ratio)	0.282	0.290	0.292	0.264	0.293	0.265	0.236	0.311
Equal Capital Substitution (using K/W ratio)	0.482	0.430	0.453	0.587	0.436	0.508	0.399	0.556

Figure 1. Firms' cost functions and optimal response

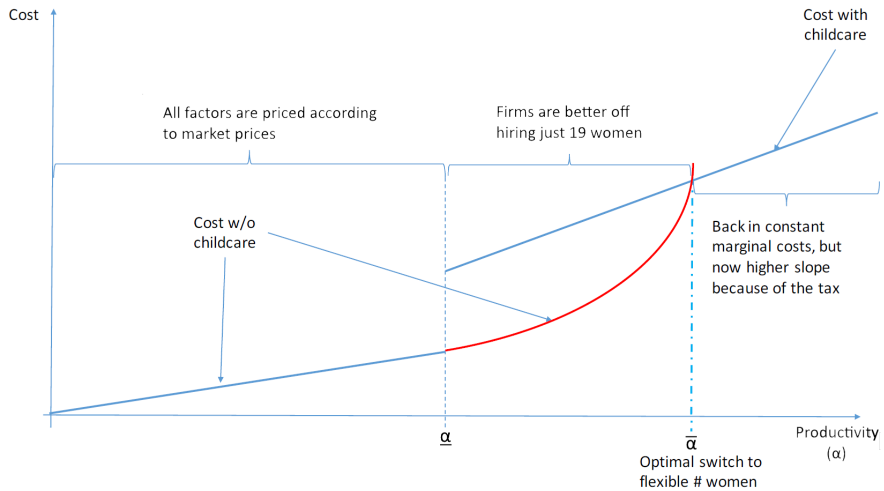


Figure 2. Impact of bunching on capital-women and men-women factor ratios

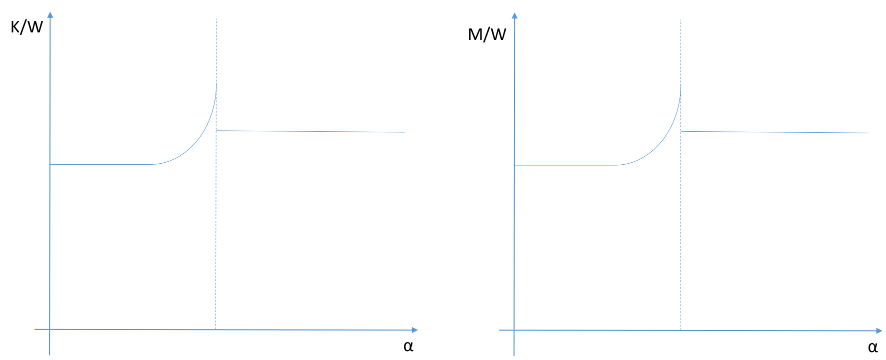


Figure 3. Impact of bunching on capital-men factor ratio

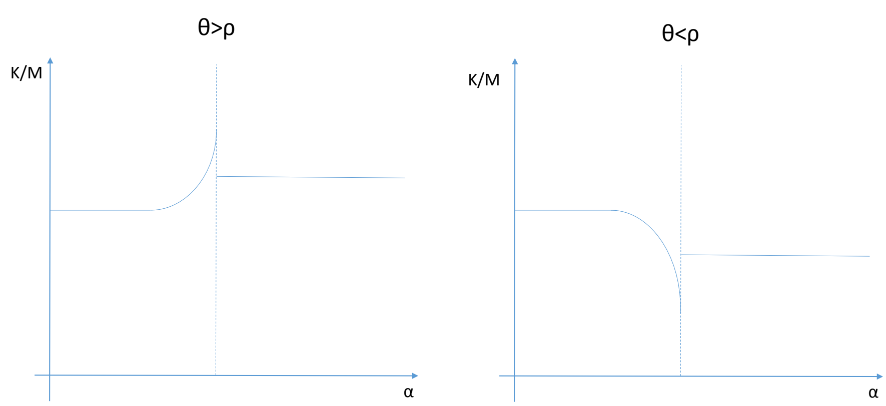


Figure 4. Histogram of the number of female workers per firm.

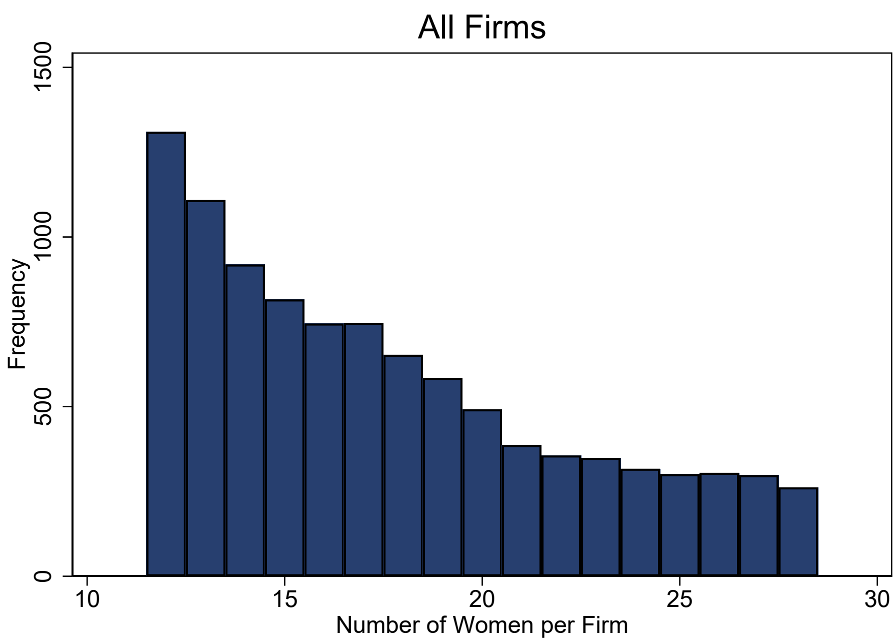


Figure 5. Histogram of the number of female workers per firm-by time period.

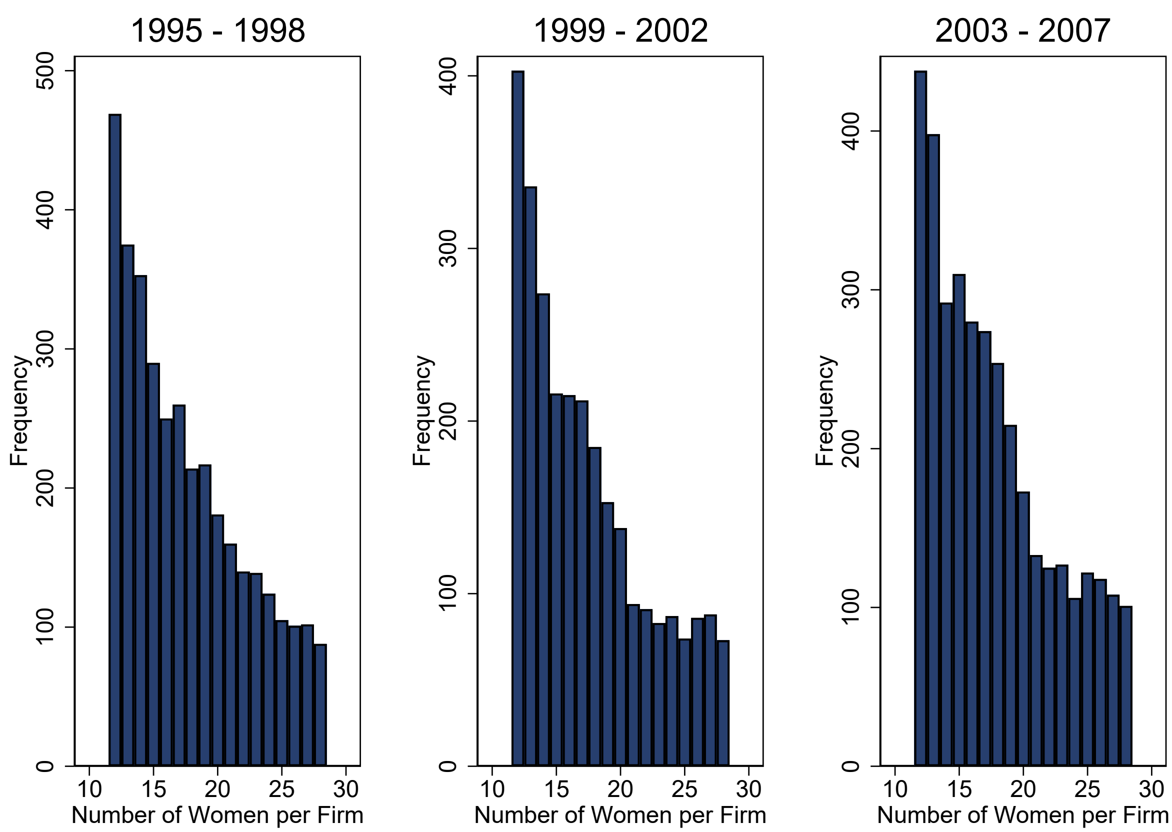


Figure 6. Histogram of the number of female workers per firm-by sector.

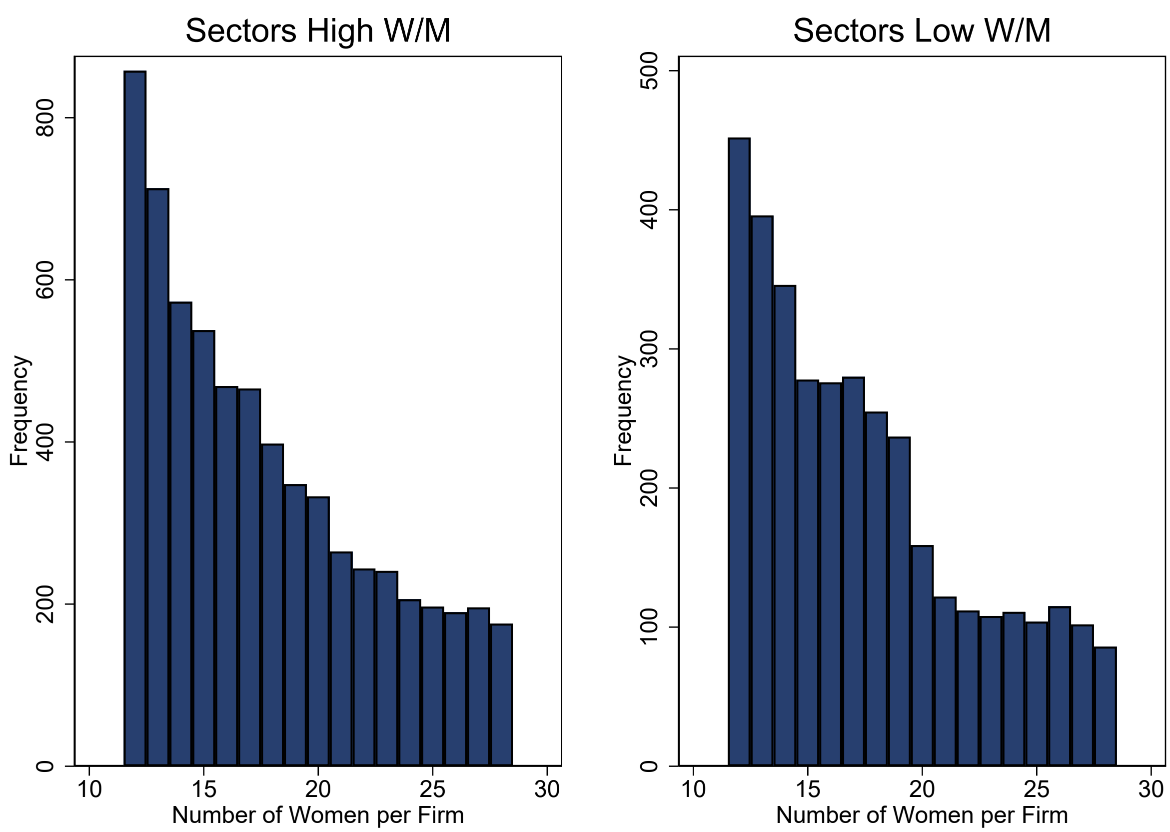


Figure 7. Histogram of the number of female workers per firm-by size.

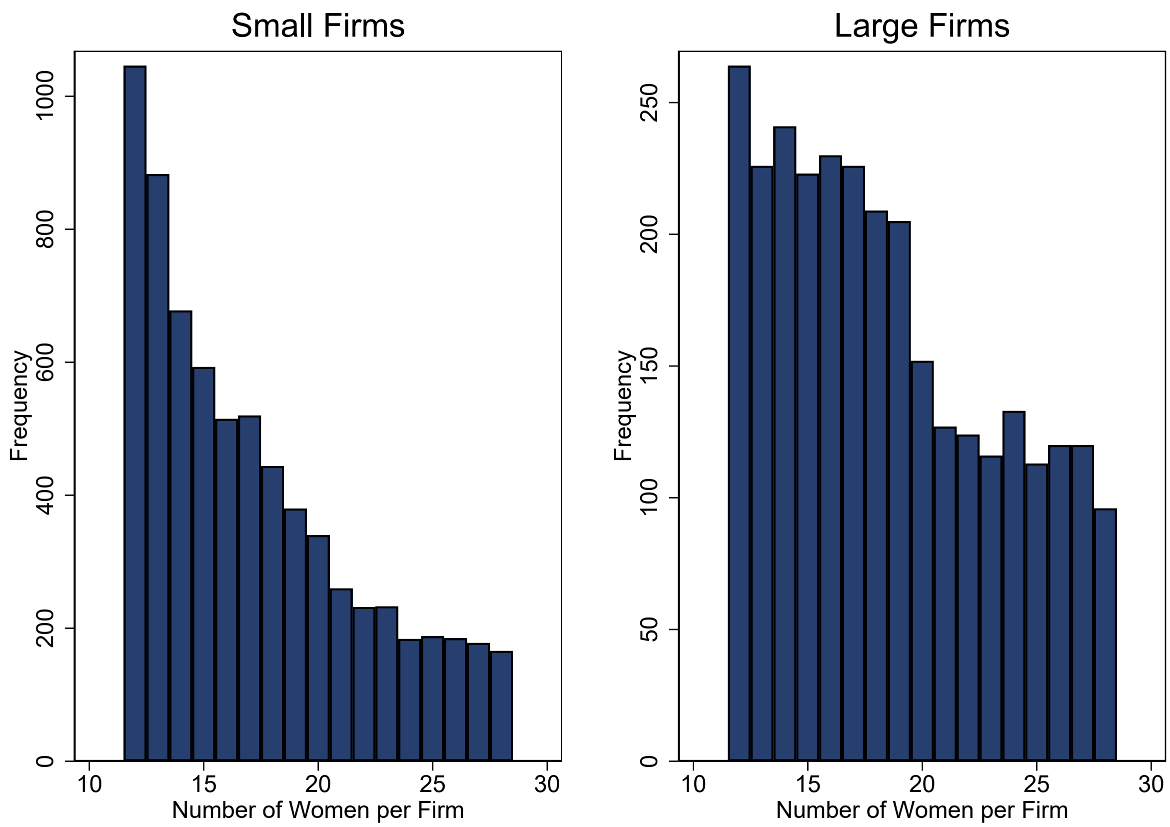


Figure 8. Histogram of the number of female workers per firm-by threshold-crossing status.

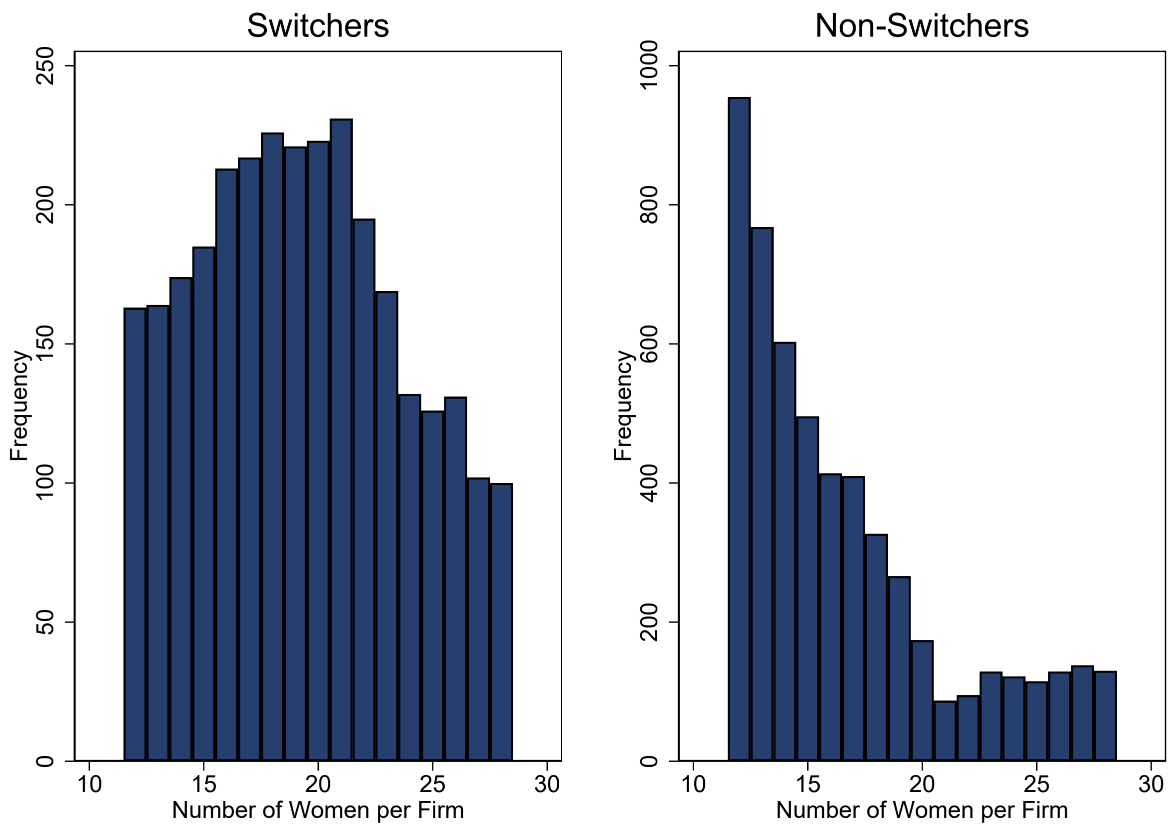
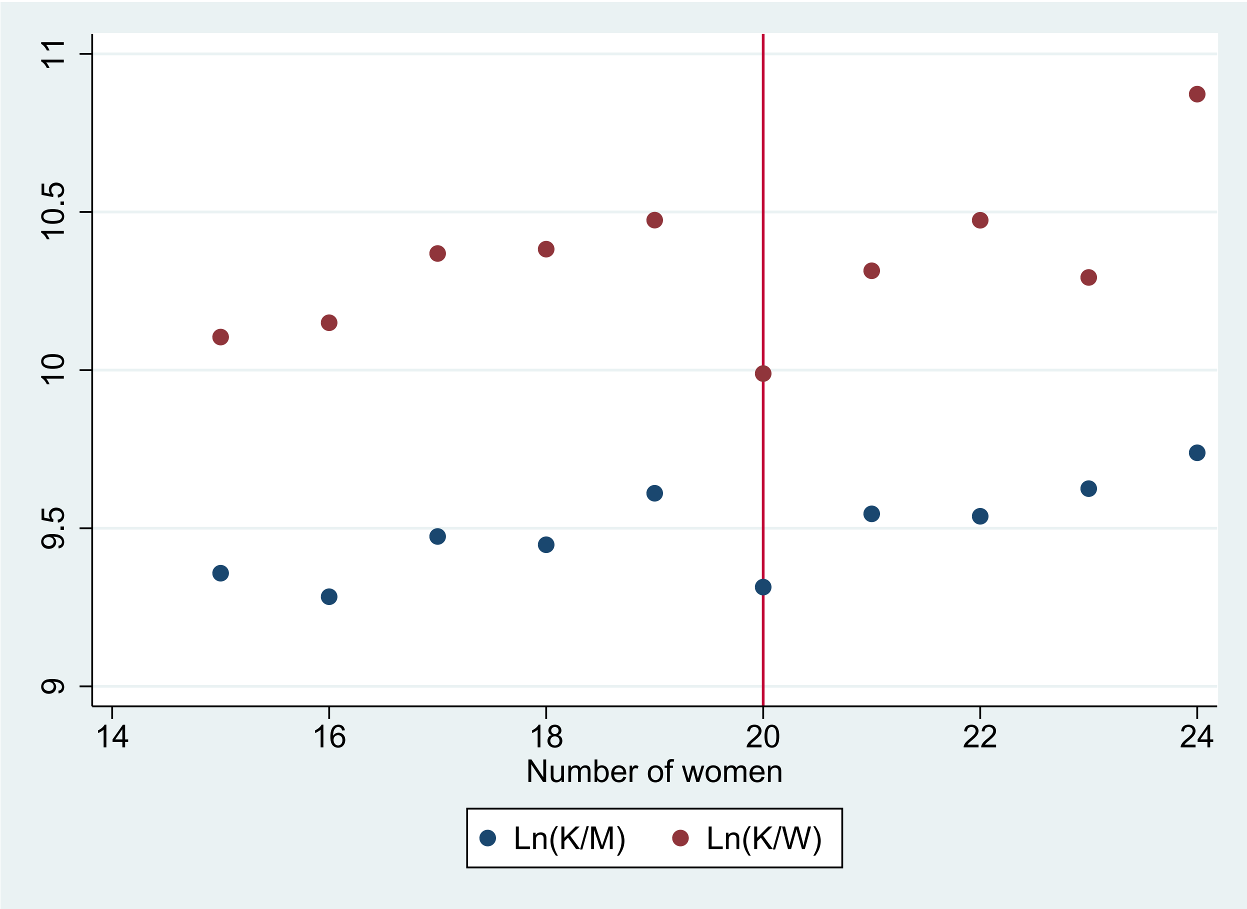


Figure 9. Discontinuity in capital ratios around 20 women



A Appendix

B Model derivations

B.1 Maximization problem without the policy

A firm without the policy will want to maximize its profits given by

$$p\alpha_i\left(\left(K^\theta + W^\theta\right)^{\frac{\rho}{\theta}} + M^\rho\right)^{\frac{\sigma}{\rho}} - w_W W - w_M M - rK$$

The first order conditions of this maximization are given by:

$$p\alpha_i\sigma F^{\sigma-1}(K^\theta + W^\theta)^{\frac{\rho-\theta}{\theta}} W^{\theta-1} = w_W$$

$$p\alpha_i\sigma F^{\sigma-1}(K^\theta + W^\theta)^{\frac{\rho-\theta}{\theta}} K^{\theta-1} = r$$

$$p\alpha_i\sigma F^{\sigma-1} M^{\rho-1} = w_M$$

Combining the first two, we obtain that

$$\frac{W^{\theta-1}}{K^{\theta-1}} = \frac{w_W}{r}$$

which, reordering, gives us

$$K/W = \left(\frac{w_W}{r}\right)^{\frac{1}{1-\theta}}$$

When combining the first and the third, we obtain:

$$\frac{(K^\theta + W^\theta)^{\frac{\rho-\theta}{\theta}} W^{\theta-1}}{M^{\rho-1}} = \frac{w_W}{w_M}$$

Replacing K/W for its above value, we can rewrite this expression as:

$$\frac{(W^\theta \frac{w_W}{r}^{\frac{\theta}{1-\theta}} + W^\theta)^{\frac{\rho-\theta}{\theta}} W^{\theta-1}}{M^{\rho-1}} = \frac{w_W}{w_M}$$

which becomes

$$\frac{W^{\rho-1}\left(\frac{w_W^{\frac{\theta}{1-\theta}}+r^{\frac{\theta}{1-\theta}}}{r^{\frac{\theta}{1-\theta}}}\right)^{\frac{\rho-\theta}{\theta}}}{M^{\rho-1}}=\frac{w_W}{w_M}$$

which then allows us to write the women to men ratio as

$$M/W=\frac{w_W^{\frac{1}{1-\theta}}\left(r^{\frac{\theta}{\theta-1}}+w_W^{\frac{\theta}{\theta-1}}\right)^{\frac{\theta-\rho}{\theta(1-\rho)}}}{w_M^{\frac{1}{1-\rho}}}$$

The capital to men ratio is then simply the division of these two.

We can rewrite the output of the firm as a function of only one of the input through these factor ratios. This gives us:

$$\alpha_i W^{\sigma} G(w_W, w_M, r, \rho, \theta)^{\sigma}$$

where $G(w_W, w_M, r, \rho, \theta)$ is a complicated non-linear function of factor prices and of the two CES parameters.

We can also write the costs of the firm as a function of only one of the input through the factor ratio which gives us

$$W * c(w_W, w_M, r, \rho, \theta)$$

where $c(w_W, w_M, r, \rho, \theta)$ is another non-linear function of factor prices and of the two CES parameters.

Combining this, the firm will pick W such that it maximizes:

$$p\alpha_i W^{\sigma} G(w_W, w_M, r, \rho, \theta)^{\sigma} - W * c(w_W, w_M, r, \rho, \theta)$$

This implies that the optimal input will be given by

$$W^*(\alpha_i)=\left(\frac{p\alpha_i\sigma G}{c}\right)^{\frac{1}{1-\sigma}}$$

This will be increasing in α_i.

Define α_0 as

$$\begin{aligned}0 =&\alpha_0 * p * F(W(\alpha_0), M(\alpha_0), K(\alpha_0))^{\sigma}\\ &- w_M M(\alpha_0) - rK(\alpha_0) - (w_W + \tau * \mathbb{1}(W > 19))W(\alpha_0)\end{aligned}$$

By the envelope theorem, we know that the derivative of the maximized function with respect to a parameter is the direct effect of that parameter, without considering the change in optimal factor input choices. Thus,

$$\frac{\partial \pi}{\partial \alpha_i} = p * F(W(\alpha_i), M(\alpha_i), K(\alpha_i))^{\sigma}$$

and profits will be increasing in α_i.

This implies that for all $\alpha_i < \alpha_0$, profits will be negative and firms will choose not to operate.

B.2 Introducing the policy

A firm that is subject to the policy will face the same problem but with an added cost for female workers such that the maximization problem is now given by

$$\alpha_i \left(\left(K^{\theta} + W^{\theta} \right)^{\frac{\rho}{\theta}} + M^{\rho} \right)^{\frac{\sigma}{\rho}} - (w_W + \tau)W - w_M M - rK$$

Define the optimal factor inputs in this case as $W(\alpha_i, \tau)$.

The maximized profit function can then be rewritten as:

$$\begin{aligned} \pi(\alpha_i, \tau) = & \alpha_i * p * F(W(\alpha_i, \tau), M(\alpha_i, \tau), K(\alpha_i, \tau))^{\sigma} \\ & - w_M M(\alpha_i, \tau) - rK(\alpha_i, \tau) - (w_W + \tau * \mathbb{1}(W > 19))W(\alpha_i, \tau) \end{aligned}$$

where $\mathbb{1}(W > 19)$ is an indicator function that takes the value of 1 if $W > 19$.

We can then define $\underline{\alpha}$ as $W(\underline{\alpha}, 0) = 19$, that is the level of α_i where a firm that is not subject to the law would exactly elect to hire 19 women. All firms with $\alpha_i < \underline{\alpha}$ will thus not be subject to the law since factor inputs are increasing in α.

B.3 Policy avoidance

A firm can decide to avoid the policy by restricting their choice to $W = 19$ and selecting the other inputs in a way that would maximize its profits. This implies that the maximization problem of the firm becomes:

$$p\alpha_i \left(\left(K^{\theta} + 19^{\theta} \right)^{\frac{\rho}{\theta}} + M^{\rho} \right)^{\frac{\sigma}{\rho}} - 19 w_W - w_M M - rK$$

The first order conditions of this problem are given by

$$p\alpha_i \sigma F^{\sigma-1}(K^\theta + 19^\theta)^{\frac{\rho-\theta}{\theta}} K^{\theta-1} = r$$

$$p\alpha_i \sigma F^{\sigma-1} M^{\rho-1} = w_M$$

combining both, we obtain

$$\frac{(K^\theta + 19^\theta)^{\frac{\rho-\theta}{\theta}} K^{\theta-1}}{M^{\rho-1}} = \frac{r}{w_M}$$

The factor ratios will no longer be constant and we will have that

$$K/M = \frac{w_M^{\frac{1}{1-\rho}} (1 + (19/K)^\theta)^{\frac{\rho-\theta}{\theta(1-\rho)}}}{r^{\frac{1}{1-\rho}}}$$

Let us define the optimal factor choice for a given level of α_i as $\widetilde{M(\alpha_i)}$ and $\widetilde{K(\alpha_i)}$. Factor choices continue to be increasing in α_i.

We can then define the profits under this constrained choice as

$$\widetilde{\pi(\alpha_i)} = \alpha_i * p * F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)})^\sigma - r\widetilde{K(\alpha_i)} - w_M \widetilde{M(\alpha_i)} - w_W * 19$$

By the envelope theorem,

$$\frac{\partial \widetilde{\pi(\alpha_i)}}{\partial \alpha_i} = p * F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)})^\sigma$$

which will be smaller than in the unconstrained case as long as $F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)}) < F(W(\alpha_i), M(\alpha_i), K(\alpha_i))$ which will hold since a constant returns to scale production function is always maximized when all factors can be optimally be selected.

Again using the envelope theorem, we can show that profits when being subject to the policy are decreasing in τ. For α_i very close to $\underline{\alpha}$, $\widetilde{\pi(\alpha_i)} > \pi(\alpha_i, \tau)$. We have also previously shown that profits increase more rapidly in α_i when being subject to the law than when avoiding it. This implies that there will be a level of α_i where profits being subject to the policy and profits when avoiding them will be equal. We can thus define a threshold $\bar{\alpha}$ where the firm will be indifferent between restricting its hiring to 19 female workers and becoming subject to the law, that is

$$\begin{aligned} \bar{\alpha} * p * F(W(\bar{\alpha}, \tau), M(\bar{\alpha}, \tau), K(\bar{\alpha}, \tau))^\sigma - w_M M(\bar{\alpha}, \tau) - rK(\bar{\alpha}, \tau) - (w_W + \tau) W(\bar{\alpha}, \tau) \\ = \bar{\alpha} * p * F(19, \widetilde{M(\alpha_i)}, \widetilde{K(\alpha_i)}) - w_M \widetilde{M(\bar{\alpha})} - r\widetilde{K(\bar{\alpha})} - w_W * 19 \end{aligned}$$

By our same argument as above, all firms with $\alpha_i > \bar{\alpha}$ will be subject to the law and will select their factor ratios in an unconstrained fashion.

B.4 Proof of proposition 2

Proof. It is easy to show that as α_i increases, marginal products of firms who restrict their hiring of women must decrease for the equalities to remain valid and as such $M/19$ and $K/19$ must rise. We can show that the ratio of capital to men labor will increase in α when

$$\frac{\partial K/M}{\partial \alpha_i} = \frac{\partial K/M}{\partial K/19} = \left(\frac{w_m}{r}\right)^{\frac{1}{1-\rho}} \frac{\rho-\theta}{\theta(1-\rho)} \left(1 + \frac{19^\theta}{K}\right)^{\frac{\rho-2\theta+\theta\rho}{\theta(1-\rho)}} (-\theta)(19/K)^{\theta+1} > 0$$

which will occur when $\theta > \rho$

In all cases, for values very close to $\bar{\alpha}$, we will have discontinuity in factor ratios. To ease the exposition, let us assume, without loss of generality that before the policy, $w_M = w_W = r = 1$. Then, it can be shown that for $\alpha_i < \underline{\alpha}$, $K = W$ and for $\alpha_i > \bar{\alpha}$, $K/W = (1+\tau)^{\frac{1}{1-\theta}}$. It can be shown that factor choices (K, M) would be the same for α_i approaching $\bar{\alpha}$ from the left as for α_i approaching $\bar{\alpha}$ from the right if $19/K = (1+\tau)^{\frac{1}{\theta-1}}$. But if that was the case, then it can be shown that the profits of a firm that restricts itself to 19 women would be higher than those of a firm that chooses $W > 19$ in this range of α_i,

$$\frac{\pi_{W>19}}{\pi_{W=19}} = \left(\frac{\frac{1+(1+\tau)^{\frac{1}{\theta-1}}}{1+(1+\tau)^{\frac{\theta}{\theta-1}}} + \left(1 + (1+\tau)^{\frac{\theta}{\theta-1}}\right)^{\frac{\rho(\theta-1)}{\theta(1-\rho)}}}{1 + \left(1 + (1+\tau)^{\frac{\theta}{\theta-1}}\right)^{\frac{\rho(\theta-1)}{\theta(1-\rho)}}} \right)^{\frac{\sigma}{1-\sigma}}$$

This is less than 1 since $(1+\tau)^{\frac{\theta}{\theta-1}} > (1+\tau)^{\frac{1}{\theta-1}}$. Intuitively, this happens because both firms have the same output but one of the firms must pay a higher cost for female workers. Thus, if firms not subject to the policy were to chose identical factor ratios to those who would be subject to the policy, they would not be indifferent between the two options, which means that we would not be at the point $\alpha_i = \bar{\alpha}$. Given that profits for the firms below the threshold are decreasing in $19/K$, firms will continue to increase their use of capital beyond the point where $K/W = (1+\tau)^{\frac{1}{1-\theta}}$ until their profits are equalized. This will imply that we will have discontinuous jumps in factor ratios around the threshold. Finally, since for $\alpha_i < \bar{\alpha}$, $K/M = (1 + (19/K)^\theta)^{\frac{\rho-\theta}{\theta(1-\rho)}}$ while it is equal to $(1 + (1+\tau)^{\frac{\theta}{\theta-1}})^{\frac{\rho-\theta}{\theta(1-\rho)}}$ when $\alpha_i > \bar{\alpha}$, by the same argument, we must know that K/M will have a discontinuous jump around $\bar{\alpha}$ and that the direction will depend on whether θ is larger or smaller than ρ. ■

B.5 Proof of proposition 3

Proof. The incentives to avoid becoming subject to the law will be greatest when the firm will be able to adjust the other factors more while maintaining the number of female workers fixed. If we combine the first order condition for K and the optimal K/M ratio when W is fixed at 19, we obtain the following:

$$p\alpha_i\sigma K^{\sigma-1}\left(1+\frac{19^{\theta}}{K}\right)^{\frac{\sigma-\theta}{\theta}}\left(1+\left(1+\frac{19^{\theta}}{K}\right)^{\frac{\rho(\theta-1)}{\theta(1-\rho)}}\right)^{\frac{\sigma-\rho}{\rho}}=r$$

This defines K implicitly. We can thus obtain from this the derivative of K with respect to θ. We obtain

$$\begin{aligned}\frac{\partial K}{\partial\theta} &\propto \left(1+\tfrac{19^{\theta}}{K}\right)^{\frac{\sigma-\theta}{\theta}}\left(1+\left(1+\tfrac{19^{\theta}}{K}\right)^{\frac{\rho(\theta-1)}{\theta(1-\rho)}}\right)^{\frac{\sigma-2\rho}{\rho}}\tfrac{19^{\theta}}{K}\ln\tfrac{19}{K}\ln\left(1+\tfrac{19^{\theta}}{K}\right)\\ &\left(\tfrac{-\sigma}{\theta^2}\left(1+\left(1+\tfrac{19^{\theta}}{K}\right)^{\frac{\rho(\theta-1)}{\theta(1-\rho)}}\right)+\tfrac{\rho-\sigma}{\theta^2(1-\rho)}\left(1+\tfrac{19^{\theta}}{K}\right)^{\frac{\rho(1-\theta)}{\theta(1-\rho)}}\right)>0\end{aligned}$$

This is positive since $K/19>1$. Since K will be able to increase more when θ is larger, this will allow the firm to continue to increase output more easily while maintaining the number of women hired at 19. This will imply that for a larger range of α firms will select to avoid the legislation.

Finally, the profits when avoiding the law are independent of τ but decreasing in τ when being subject to it. This implies that $\bar{\alpha}$ will be increasing in τ since it corresponds to the value of α where both profits are equal. ■

C Additional tables and figures

Table C.1. McCrary's test for different cut-offs

	All Years (1)	Years 95-07 (2)	Years 99-02 (3)	Years 03-07 (4)	High W/M Sectors (5)	Low W/M Sectors (6)	Small Firms (7)	Large Firms (8)
				Panel A: Cutoff at 15 women				
above	0.020	-0.143*	-0.051	0.244*	0.039	0.003	-0.009	0.116
	(0.088)	(0.069)	(0.136)	(0.127)	(0.076)	(0.168)	(0.091)	(0.133)
				Panel B: Cutoff at 18 women				
above	0.004	0.030	0.022	-0.037	0.001	0.002	0.045	-0.085
	(0.073)	(0.078)	(0.128)	(0.108)	(0.071)	(0.141)	(0.081)	(0.122)
				Panel C: Cutoff at 22 women				
above	-0.027	-0.068	-0.027	0.016	-0.048	0.010	-0.062	0.077
	(0.099)	(0.093)	(0.211)	(0.124)	(0.085)	(0.159)	(0.124)	(0.103)
				Panel D: Cutoff at 19 men				
above	-0.020	0.065	-0.116	-0.017	0.049	-0.085	-0.019	-0.062
	(0.059)	(0.067)	(0.102)	(0.076)	(0.077)	(0.049)	(0.062)	(0.545)

Robust standard errors in parentheses. The regression includes a 2nd order polynomial above and below the threshold, as well as year and sector fixed effects (ISIC four-digit). The dependent variable is the log of the number of firms in each bin. Sample for each panel includes all firms within a window of 10 women around the cutoff (e.g. firms with 5 to 25 women in Panel A). Panel D includes an equivalent window but counting men instead. *: significant at 10 %; **: at 5%; ***: at 1%.

Figure C.1. McCrary's test result for different definitions of sectors by average female intensity.

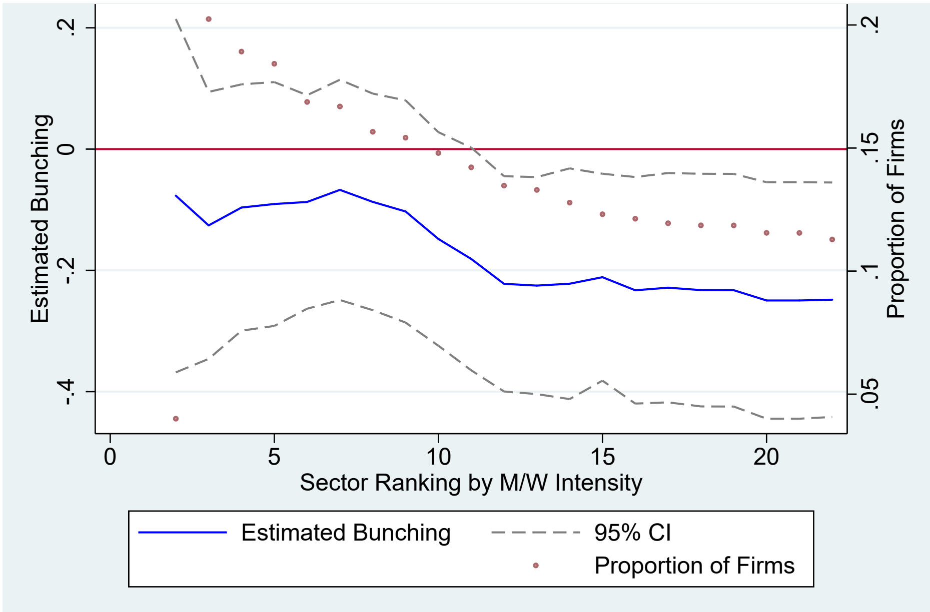


Figure C.2. McCrary's test result for different definitions of large firm.