UNIVERSITAT ROVIRA i VIRGILI
Departament d'Economia

UNIVERSITAT ROVIRA i VIRGILI

ECO SOS
CENTRE DE RECERCA EN ECONOMIA I SOSTENIBILITAT

WORKING PAPERS ECO & ECO-SOS

The society gendered equilibrium: in search for an economic rationale

António Osório

Document de treball n. **06 - 2021**

Edita:

Departament d'Economia
Universitat Rovira i Virgili
Facultat d'Economia i Empresa
Av. de la Universitat, 1
43204 Reus
Tel.: +34 977 759 811
Tel.: +34 977 759 812
Email: sde@urv.cat

ECO-SOS
www.eco-sos.urv.cat
Universitat Rovira i Virgili
Departament d'Economia
Av. de la Universitat, 1
43204 Reus
Tel.: +34 977 758 936
Email: eco-sos@urv.cat

Adreçar comentaris al Departament d'Economia / ECO-SOS

ISSN: 2696-5097

The society gendered equilibrium: in search for an economic rationale

António Osório[†]

[†] ***Universitat Rovira i Virgili (Dept. of Economics) and ECO-SOS (antonio.osoriodacosta@urv.cat).***

Abstract

Several occupations are male-dominated while others are women-dominated. This paper attempts to establish an economic rationale behind it. In this paper, women have greater difficulty to conciliate the labor market with the household and for that reason have a higher cost of effort. We found that when the marginal cost of effort is increasing, production is organized in competitive ways in which men have a lower cost of effort advantage, and economic forces push men towards those more competitive and higher paying occupations. On the other hand, when the marginal cost of effort is decreasing, production is organized in less competitive ways, and the economic forces push women towards those less competitive and lower paying occupations.

Keywords: Gender equality; Occupational segregation; Effort cost; Stereotypes; Economic incentives.
JEL classification: J16, J30, D63, C72.

1. Introduction

In most developed countries, the women's share on the labor force has been increasing since the 1950s (Toossi and Morisi, 2017), which has changed the traditional family structure from the breadwinner-homemaker to the dual-earner model. Women access to the labor market has been facilitated, several discrimination barriers have been removed, maternity and child-caring policies have been put in place, among other work-family reconciliation policies (Cortes and Tessada, 2011; Furtado and Hock, 2010; Gajendran and Harrison, 2007; Hegewisch and Gornick, 2011). Despite these improvements, there has been no great qualitative changes in the composition of the occupations performed by men and women. Most professions that were male-dominated in the 1950s are still male-dominated in the 2020s. The problem is that male-dominated occupations tend to pay better than female-dominated occupations, which has profound implications in the gender pay gap and in other aspects (Bertrand and Hallock, 2001; Blau and Kahn, 2016; Wolfers, 2006). In order to deal with this issue, researchers have been paying increasing attention to the STEM (Science, Technology, Engineering and Mathematics) occupations, which have been experiencing rapid growth, and because they pay relative higher wages (Kahn and Ginther, 2017; Wang and Degol, 2017). In 2015, the US average wage for STEM and non-STEM occupations was $87,570 and $45,700, respectively (Fayer et al., 2017). In this context, researchers have been searching for ways of creating greater women's involvement in male-dominated occupations, which is not happening as expected. In 2017, women were only 25.5% of computer and mathematical occupations and 16.2% of architecture and engineering occupations in US, which are some of the highest paying occupations (Bureau of Labor Statistics, Current Population Survey 2018).

In this context, the question is why there is an apparent resistance to a homogeneous gender distribution across all occupations? In addition, what is the fundamental reason behind occupational segregation based on gender?

The answer to these questions is crucial in order to fully understand the forces that push men and women to different occupations, and to eliminate gender based occupational and income inequality.

Several theories have attempted to explain the reasons behind the women's low representation in some highly paid male-dominated occupations like engineering, computer science, and other STEM occupations. One argument points that the women's low representation in those occupations is the result of ingrained stereotypes and socialization practices that start early in childhood (Gunderson et al., 2012). A second argument points for professional stereotypes about the personality traits and characteristics of the technology professionals like social awkwardness or introverted character, which are the opposite of the women's expected prototype (Cheryan et al., 2015). A third argument claims that individuals behave consistently with their "in group" sense and perception (Crosnoe et al., 2008). Altogether, these arguments lead to the idea of gender-constructed roles, which are institutionalized and continually reconstructed through cyclical routines, and determine the distribution of roles within and outside the household (Davis and Greenstein, 2009; Lorber, 1994), and may lead to occupational segregation and specialization within and outside the household (Becker, 1985; Benschop et al., 2001; Ely and Padavic, 2020; Lundberg and Pollak, 1996; Pollak, 2003).

This paper acknowledges the existing theories, but tries to address the questions posed above in a different way. Instead of offering an alternative theory, it goes one-step back to establish the economic rationale behind the stereotypes, socialization and gender constructed roles, which are determinant in the gender occupational choices and are always present in the gender literature.

This paper considers a theoretical model in which individuals of different genders provide effort to produce an output and their returns depend on their efforts.

The first challenge we encounter is how to model men and women in theoretical terms. This challenge is general to all theoretical approaches to gender.[1] The reason is that after correcting for physical differences, men and women are the same, which creates a technical difficulty. If we assume that men and women are the same, the results should be the same, but this is not what is happening in reality and what is showing the data. However, theoretical approaches are crucial to understand the past, predict the future and guide gender policy. Therefore, we must be able to establish some starting difference between men and women.

In this paper, We consider that women have a higher cost of effort than men do. This assumption is motivated by women's greater difficulty to conciliate the labor market with the household. Despite the fact that men are doing more housework than ever before, there is a clear recognition that the household labor is not equally split, even among dual-earner couples (Bianchi, 2000; Bianchi et al., 2000; Shelton and John, 1996). Presser (1994) and Bianchi et al. (2000) estimate that women perform 65-80 percent of all household labor. This aspect overwhelms women that consequently find it difficult to conciliate the labor market with the household and to compete with men in equal circumstances (Chiappori et al., 2018; Gajendran and Harrison, 2007; Gornick and Meyers, 2003; Osório, 2019; Shelton and John, 1996). According to Bielby and Bielby (1989), while women remain unequally responsible for the household labor, they are unable to establish a strong identity with their careers.

In this context, this paper studies how men and women's relative efforts and net returns are affected by different cost structures and degrees of complementarity in production, and how economic arguments like production efficiency and aggregate welfare push men or women towards one particular occupation or another.

We found that the way production is organized depends crucially on the cost

[1] Gender research is particularly asymmetric in this respect. On the one hand, there is a large body of empirical research on men and women differences across all dimensions of life because most data sets allow this distinction. On the other hand, there is no sufficient theoretical research (Fryer Jr and Loury, 2005).

structure. When the marginal cost of effort is increasing with effort, production tends to be organized in a competitive equilibrium in which individuals competitively provide effort, and more effort is associated with higher net returns, and potentially better career prospects. In this context, men are more competitive and provide more effort than women because they have a lower cost of effort.

These findings corroborate several empirical and experimental studies that show that women have lower willingness to compete than men, and tend to underperform men in competitive environments (Dohmen and Falk, 2011; Gneezy and Rustichini, 2004; Gneezy et al., 2003; Iriberri and Rey-Biel, 2019; Niederle and Vesterlund, 2007; Vandegrift and Yavas, 2009). Croson and Gneezy (2009) and Niederle and Vesterlund (2011) review this literature.[2]

However, when the marginal cost of effort is decreasing with effort, the competitive equilibrium fails to exist and production must be organized in non-competitive ways. In those cases, individuals provide an amount of effort compatible with a predetermined exogenous objective. In this context, women provide higher effort than men in order to compensate for their higher cost of effort and satisfy this predetermined objective.

In this context, we found that economic arguments like production efficiency and aggregate welfare push women towards these less competitive occupations, but which are also easier to conciliate in terms of effort costs (e.g., nursing and care, administrative support, school teachers, accountants, etc.). On the other hand, these same economic arguments push men towards more competitive occupations with increasing marginal cost of effort, which are more difficult to conciliate in terms of effort costs (e.g., software and media developers, financial analysts, engineers, etc.). These more competitive occupations are also the ones that deliver higher returns. Altogether, since women have a higher cost of effort, they are pushed towards lower paid occupations, while men are pushed towards higher paid occupations.

These results may help to explain the gender wage gap and show that gender

[2]Men's also show a stronger preference to compete with women than women preference to compete with men (Booth and Nolen, 2012; Datta Gupta et al., 2013; Ivanova-Stenzel and Kübler, 2011). Factors such as discrimination (Altonji and Blank, 1999; Goldin and Rouse, 2000), preferences (Croson and Gneezy, 2009), culture (Alesina et al., 2013; Gneezy et al., 2009), risk aversion (Vandegrift and Brown, 2005), strategic behavior (Cubel and Sánchez-Pagés, 2017), genes (Bateup et al., 2002), stakes (Azmat et al., 2016) or age (Flory et al., 2018) play an important role in this process. Affirmative action policies have been shown to improve women's participation and willingness to compete (Holzer and Neumark (2000, 2006); Niederle et al., 2013), but there are doubts on the adequacy of these policies in terms of economic incentives and efficiency (Altonji and Blank, 1999; Coate and Loury, 1993; Holzer and Neumark, 2000).

occupational segregation and specialization emerges naturally in the societal equilibrium when individuals have different costs. This is a striking result. Differences in terms of costs produce an enormous impact in the societal equilibrium.

The message is clear, if we want men and women to have the same opportunities and competitive capacity, the household labor must be distributed and shared equally. While women are still holding a larger share of the domestic labor, they are in a weaker position to compete. Cost differences immediately feedback into wage gaps, low representation of women in the STEM occupations, and other gendered dimensions of life.

In our context, production efficiency and aggregate welfare are the microeconomics fundamentals behind the existence of stereotypes, socialization practices and gender constructed roles that heavily penalize women in the labor market and lead to occupational segregation. These concepts explain each other in a circular way.

The obtained results are also found to be robust to the existence of complementarities in production. On the one hand, complementarities seem to benefit women more than proportionally in occupations organized under competitive principles. On the other hand, complementarities enlarge the spectrum of occupations organized under non-competitive principles, which are the occupations in which women are incentivized to work on, but also the ones that deliver lower returns. Altogether, complementarities seem to not lead to significant changes in the societal equilibrium and in the economic incentives.

Some related theoretical literature - Despite the large empirical body of literature on gender, only few studies have tried to address gender issues from a theoretical perspective. The present paper is an attempt in this direction.

The few exceptions in the theoretical literature tend to consider some cost differences between men and women. Albanesi and Olivetti (2009) assume that the marginal cost of effort is increasing in home hours to show that if firms believe that the allocation of home hours favors men over women, then the intra-household efficient allocation of home hours in going to favor men over women in a perpetual and cyclical self-fulfilling "gendered" equilibrium. Their analysis builds on the theory of statistical discrimination (Coate and Loury, 1993; Lundberg, 1991), and on the idea that the gender wage gap can be explained by a self-fulfilling equilibrium without asymmetries between men and women (Francois, 1998), and which are in line with the concepts of stereotypes and gender constructed roles. In the same vein, Athey et al. (2000) study how gender and ethnic diversity at the firm upper-levels affect gender and ethnicity at the firm entry-levels.

The decisions inside the household are also influenced by gender. For instance, in the Lundberg and Pollak (2003) model, women are likely to become the trailing spouse that incurs in larger career sacrifices. Their weaker bargaining position is strongly determined by their outside and within marriage alternatives, which depend on past investment decisions, fertility aspects, self-constructed roles, etc.

Several theoretical papers also study whether affirmative action policies result in more or less efficient outcomes in competitive and non-cooperative settings. For instance, Osório (2019) assumes that men and women differ in terms of share in the domestic labor cost to show that cost reducing policies are more effective than affirmative action policies in terms of granting the same opportunities and competitive capacity for both genders. Nonetheless, the theoretical literature on affirmative action shows a great diversity of results. For instance, Welch (1976) found that hiring and promoting less-qualified minorities through affirmative action is inefficient, while Franke (2012) considers a rent-seeking approach to show the opposite (see also Fain, 2009; Fu, 2006; Schotter et al., 1992).

The rest of the paper is organized as follows: Section 2 presents the theoretical framework, Section 3 studies the competitive equilibrium, Section 4 studies the non-competitive equilibrium construction, Sections 5 discussed the obtained results, and Section 6 concludes.

2. The description of the model

We consider an economy in which individuals of the same or different genders participate in the joint production of an output, which is obtained with labor effort e_m and e_w, for men and women, respectively. Alternatively, individuals can opt for a zero outside option, which is the payoff from staying out of the labor market.

The labor market effort is increasingly costly, because each additional unit becomes more difficult to deliver and conciliate with the household. In this context, women have a higher cost of effort than men, which is captured by the parameters $c_w \geqslant c_m$. This is a natural assumption because in aggregate terms women carry out the majority of the household and child-care labor, which increases their cost of effort relatively to men.

The output $Y = F(e_i, e_{-i})$ is given by a CES production function, as in Ray et al. (2007):

$$F(e_i, e_{-i}) = \gamma(e_i^{1-\sigma}/2 + e_{-i}^{1-\sigma}/2)^{\frac{1}{1-\sigma}}, \tag{1}$$

for $i = m, w$, where $\sigma \geqslant 0$ is the degree of complementarity between the individual efforts (the elasticity of substitution is the reciprocal $1/\sigma$), and γ is some constant.

For instance, if $\sigma = 0$, we have a linear production function with perfect substitutes, while if $\sigma \to \infty$, we have the Leontief production function with perfect complements. Moreover, in order to focus on the individual efforts for varying marginal cost of effort, the production function exhibits constant returns to scale and the input share is the same for each individual effort.

The two individuals involved in the production of the joint output split the output via a sharing rule, which depends on the effort contribution for the total output as follows $s_i = e_i/(e_i + e_{-i})$ for $i = m, w$.[3] In this case, higher the individual effort, higher the share in the total output.

In this context, each agent i chooses an effort level e_i that maximizes their own net return. Hence, the objective function of each agent i is given by:

$$u_i(e_i, e_{-i}) = F(e_i, e_{-i})s_i - c_i e_i^r, \tag{2}$$

for $i = m, w$, where $r \geqslant 0$ determines the associated cost structure. In other words, if $r < 1$ the marginal and the average cost of effort is decreasing with effort. If $r > 1$ the marginal and average cost of effort is increasing with effort. This aspect has important implications on the equilibrium structure and relative efforts.

In our model, different occupations are characterized by different values of $r \geqslant 0$, and occupations that feature increasing marginal costs tend to be associated with higher returns. These association are discussed in greater detail in Section 5.

Each individual participates in the labor market if the net return in expression (2) is higher than the utility derived from the outside option, i.e., $u_i \geqslant 0$, for $i = m, w$, and the opposite otherwise.

Production efficiency and aggregate welfare - Since our objective is to derive conclusions regarding economic incentives, we consider two approaches to measure the forces behind these mechanisms.

The first approach is based on *production efficiency*, which is measured by the total output in expression (1), i.e., $F(e_i, e_{-i})$. In this case, the higher the obtained total output the more efficient is the society or the economy. This approach ignores

[3]The "rent seeking" literature on sharing rules, often considers the general expression:

$$s_i = \alpha\frac{1}{2} + (1-\alpha)\frac{e_i}{e_m + e_w},$$

for $i = m, w$, where $\alpha \in [0, 1]$ determines the importance given to the egalitarian sharing rule relative to the sharing rule based on individual effort. We focus on the case $\alpha = 0$ because it is richer and more realistic.

the individual costs.

The CES production function is interesting because the most efficient output depends not only on the effort levels, but also on how close are the individual efforts from each other. Therefore, all the rest constant, when individuals do not provide the same amount of effort (e.g., in the different genders match), inefficiency increases with the degree of complementarity in efforts, i.e., with σ.

The second approach considers the *aggregate welfare*, which is measured by the sum of the net returns of the individuals involved in the production process, i.e.,

$$U(e_i, e_{-i}) = u_i(e_i, e_{-i}) + u_{-i}(e_i, e_{-i}) = F(e_i, e_{-i}) - c_i e_i^r - c_{-i} e_{-i}^r. \tag{3}$$

This utilitarian approach focuses on the individuals' wellbeing, which is captured by the aggregate net returns. Welfare is measured by the net returns. This approach subtracts from the total output the individuals' cost of effort.

Finally, this paper does not formalize the details about the individuals matching and occupational sorting processes. Instead, it focusses on the efficiency and welfare forces that tend to support a particular matching or occupational sorting over the other.

3. The competitive equilibrium

In this section, we consider that production is organized in a competitive context, in which self-interested individuals provide effort and compete to obtain the highest possible net returns. This is the probably most common structure in regarding the organization of work.

We are interested in the conditions that sustain these more efficient competitive structures, but we are also interested in understanding how men and women's efforts and net returns evolve in relative terms, for varying cost structures and degrees of complementarity in production, and how economic forces favor one particular gender match over the other.

For simplicity, we consider the cases $\sigma = 0$ and $\sigma = 2$. The case $\sigma = 0$ represents the situation of perfect substitution in the production, while $\sigma = 2$ represents the situation of complementarities in the production. These cases are chosen because they allow close form expressions. The intermediate cases can be analyzed numerically.

3.1. ***Perfect substitutes in production***

In the case $\sigma = 0$, there are no complementarities and efforts are perfect substitutes in the production. The production function becomes linear and each individual return depend only on the effort.

In this context, the gender i first order condition from the maximization of the net return in expression (2) is given by:

$$\gamma/2 - rc_i e_i^{r-1} = 0,$$

for $i = m, w$, and the second order condition is given by $-r(r-1)c_i e_i^{r-2}$, which is negative providing that $r \geqslant 1$.[4]

Consequently, for $r \geqslant 1$ we have a unique equilibrium with positive effort:

$$e_i = (\gamma/(2c_i r))^{\frac{1}{r-1}}, \tag{4}$$

and positive net returns $u_i \geqslant 0$ for gender $i = m, w$.[5]

In this case, the women/men effort and net returns ratios are given by:

$$\frac{e_w}{e_m} = \frac{u_w}{u_m} = (\frac{c_m}{c_w})^{\frac{1}{r-1}} \leqslant 1. \tag{5}$$

Since $c_m \leqslant c_w$, these ratios are lower than one, which means that women—the gender with higher cost of effort—provides less effort and obtains less net returns than men—the gender with higher cost of effort.

Consequently, we have the following result.

Proposition 1. *For $\sigma = 0$ and $r \geqslant 1$, in the competitive equilibrium, women effort and net returns are always lower than men effort and net returns. The women/men effort and net returns ratios improve in relative terms when r increases.*

In order to prove this result simply note that the ratio (5) is always smaller than one because $c_w \geqslant c_m$. Consequently, it increases when $r \geqslant 1$ increases.

Proposition 1 means than in occupations, in which individual efforts are perfect substitutes and the marginal costs of effort is increasing, women effort and net returns are lower than men effort and net returns. The higher cost of effort places women in a weaker position to compete with men in occupations with increasing marginal cost of effort. Consequently, women obtain a lower share of the output and their

[4]Consequently, the competitive approach fails to be an equilibrium with labor market participation for $r < 1$. In those cases, the economy must find an alternative way to incentivize effort and organize production (see Section 4).

[5]The net returns can be written as $u_i = \gamma e_i/2 - c_i e_i^r = \gamma(1 - 1/r)e_i/2$ for $i = m, w$.

net returns are lower. However, the difference between men and women improves in relative terms when r increases. For increasing and large marginal cost levels, both genders are affected independently of their cost differences, but women less in relative terms because they are already in a weaker position.

Note that in absolute terms, depending on the individual costs (i.e., the parameterization of the model), we may have different patterns of effort and net returns. For instance, when r increases, we may have men and women's effort and net returns simultaneously falling or increasing, or even moving in opposite directions.[6] Consequently, in order to avoid this diversity, we focus on the relative difference between men and women, which is robust across all parameterization of the model.

Under the CES production function, production efficiency is achieved when the highest effort pair of individuals are matched together. However, in this case, since men and women do not provide the same effort, this gender match fails to deliver the highest production efficiency and aggregate welfare. In this context, when the economy is not operating at the most efficient level, it will have an incentive to move towards that level.

Consequently, we have the following result.

Proposition 2. *For $\sigma = 0$, in the competitive equilibrium, the economy incentivizes men towards occupations with $r \geqslant 1$.*

The proof can be found in the Appendix.

Proposition 1 states than occupations in which individual efforts are perfect substitute, and the marginal cost of effort is increasing, the highest production efficiency and aggregate welfare are achieved when men perform these occupations. Consequently, the economic incentives, independently on whether we look at them from a production or an utilitarian perspective, will have a preference to employ men in occupations with $r \geqslant 1$. Therefore, men are pushed towards these more competitive occupations because this is the most efficient economic arrangement.

These societal biases and incentives give rise to gender constructed roles. This mechanism may operate through many different ways, but in our setting, it emerges endogenously from the fact that men and women do not have the same cost of effort. The message is robust and holds independently on whether we consider a production

[6] In absolute terms, gender $i = m, w$ effort and net returns increases with r if $1 > r(1+\ln(\gamma/2c_i r))$, and decreases otherwise.

efficiency or an utilitarian perspective. In the following section, we will see that this result is also robust to the existence of complementarities in the production.

3.2. ***Complementarities in production***

This section considers the case of complementarities in the production process. This aspect is important because occupations vary not only in terms of cost structure, which is captured by r, but also in terms of complementarities between individuals, which is captured by σ.

We consider complementarities of degree $\sigma = 2$.[7] In this case, the production function is non-linear, and the individual return also depends on the other individual effort through complementarity effects. This framework is richer in strategic terms.

In this context, the gender i first order condition from the maximization of the net return in expression (2) is the following:

$$4\gamma e_i e_{-i}^2/(e_i + e_{-i})^3 - rc_i e_i^{r-1} = 0,$$

for $i = m, w$.[8]

Therefore, we have the following unique equilibrium with positive effort:

$$e_i = \left[\frac{4\gamma(c_i/c_{-i})^{\frac{2}{r}}}{rc_i(1 + (c_i/c_{-i})^{\frac{1}{r}})^3} \right]^{\frac{1}{r-1}}, \tag{6}$$

for $i = m, w$.

In this context, we must also guarantee that net returns are positive. Otherwise, individuals would prefer the null outside option.[9] Consequently, $u_i \geqslant 0$ if the condition $r \geqslant (2 - r)(c_i/c_{-i})^{1/r}$ is satisfied for $i = m, w$. This condition is more restrictive than the second-order condition (see Footnote 8). Therefore, it becomes the relevant condition. Now, since $c_w \geqslant c_m$, the women's positive net returns condition is more

[7]The case $\sigma = 2$ allows analytical expressions and it is for that reason chosen. Otherwise, the analysis can be performed with the resource to numerical approximations.

[8]The second-order condition is given by:

$$-4\gamma e_{-i}^2(2e_i - e_{-i})/(e_i + e_{-i})^4 - (r-1)rc_i e_i^{r-2},$$

which, after some algebra, is negative if $(2 - r)(c_i/c_{-i})^{1/r} < 1 + r$ for $i = m, w$. The second-order condition for a maximum is satisfied in the relevant interval as it is explained below.

[9]The gender $i = m, w$ net returns can be written as $u_i = 2\gamma(1 - 2e_{-i}/[r(e_i + e_{-i})])e_i^2 e_{-i}/(e_i + e_{-i})^2$.

restrictive than the men's condition. Consequently, if women are obtaining positive net returns, so thus men, and both genders are maximizing. Therefore, for $\sigma = 2$, an interior equilibrium exists if:

$$r \geqslant (2-r)(c_w/c_m)^{1/r}. \tag{7}$$

Since $c_w \geqslant c_m$, for $r < 1$ the equilibrium always fails to exist, while for $r \geqslant 2$ the equilibrium always exists. Consequently, when $\sigma = 2$, the equilibrium existence frontier is less clear cut, but somewhere in the interval $[1, 2]$. Therefore, in comparison with Section 3.1, complementarities enlarge the interval of r values in which the competitive equilibrium fails to exist. In Section 4, we study the case in which condition (7) fails.

In this case, the women/men effort ratio is given by:

$$\frac{e_w}{e_m} = (\frac{c_m}{c_w})^{\frac{1}{r}} \leqslant 1, \tag{8}$$

while the women/men net return ratio is given by:

$$\frac{u_w}{u_m} = \frac{r(c_m/c_w)^{\frac{1}{r}} - (2-r)}{r(c_w/c_m)^{\frac{1}{r}} - (2-r)} \leqslant 1. \tag{9}$$

Since $c_m \leqslant c_w$, these two ratios are lower than one, which means that women—the gender with higher cost of effort—provides less effort and obtains less net returns than men—the gender with higher cost of effort.

Consequently, we have the following result.

Proposition 3. *For $\sigma = 2$ and $r \geqslant (2-r)(c_w/c_m)^{1/r}$, in the competitive equilibrium, women effort and net returns are always lower than men effort and net returns. The women/men effort and net returns ratios improve in relative terms when r increases.*

The proof can be found in the Appendix.

Essentially this result is not different from the one obtained in the perfect substitutes case of Proposition 1. The main difference is the existence of a new equilibrium existence cutoff. Therefore, complementarities seem to not change the competitive forces that place women in a weaker position than men in competitive labor markets. Nonetheless, Propositions 3 adds robustness to our findings.

Some particular differences between the results in Propositions 1 and 3 are discussed in Section 5 below.

Now, consider the effects of complementarities on the production efficiency and aggregate welfare, which are the driving forces of the economic incentives.

Consequently, we have the following result.

Proposition 4. *For $\sigma = 2$, in the competitive equilibrium, the economy incentivize men towards occupations with $r \geqslant (2-r)(c_w/c_m)^{1/r}$.*

The proof can be found in the Appendix.

Similarly, complementarities seem to not change the main observations made in Section 3.1 regarding the economic incentives in Proposition 2. In the competitive labor structure, the individuals with lower cost of effort have an advantage over the other individuals. In other words, men provide higher effort, obtain higher net returns, and are expected to deliver more efficient and welfare superior outcomes.

The main difference between complementarity and perfect substitution is that effort asymmetries induces even larger losses in terms of production efficiency. Therefore, the higher the complementarities, the higher the loss of efficiency associated with the men and women match.

4. The non-competitive equilibrium construction

In Section 3, we have seen that the competitive equilibrium with labor market participation fails to exist in the perfect substitutes case for $r < 1$, and in the complementarities case ($\sigma = 2$) for $r < (2-r)(c_w/c_m)^{1/r}$. Nonetheless, the economy is still be able to organize labor in ways that are different from the competitive equilibrium.

In this section, inspired by the observed reality, we considers alternative equilibrium constructions, which are motivated by arguments different from the competitive and non-cooperative maximization of the individual returns. We focus on the case in which both genders obtain the same net return, but their efforts may be different. Alternative constructions, like the aggregate welfare optimization or the case in which both genders provide the same effort, but with different net returns, are also discussed.

Intuitively, these constructions attempt to replicate the fact that in many occupations individuals are expected to provide a predetermined effort that achieves a predetermined output/objective. In exchange individuals receive an associated predetermined return. The effort level is not necessarily optimal, but determined by a third party according to some objective. This way of organizing labor and production, is common in industrial and public administration jobs in which the required efforts and objectives are in most cases determined ex-ante by the employer.

In this context, we are interested in studying how these alternative equilibrium constructions affect men and women efforts and net returns, and whether economic forces favor one particular gender match.

4.1. ***Equilibrium with equal net returns***

In this context, we consider an equilibrium construction in which both men and women obtain the same constant net return, but in which their efforts may differ to meet this requirement.

In this paper, since we are interested in the relative efforts, and not so much on the absolute effort levels, we normalize the net returns to zero, i.e., we let $u_i = 0$ for $i = m, w$, and search for the effort levels e_i that meet this homogeneous and predetermined objective.[10] This homogeneous requirement across genders is motivated by the fact that in most of those professions (e.g., public administration, manufacturing, teaching, accounting, among other professions) there are no quantitative differences between what is demanded to men and women in the workplace.

Consequently, the system of two equations made from expression (2) with zero normalized returns delivers a unique and positive level of effort given by:

$$e_i = \left[\frac{c_i(1 + (c_{-i}/c_i)^{\frac{1}{1-r}})}{\gamma(1/2 + (c_{-i}/c_i)^{\frac{1-\sigma}{1-r}}/2)^{\frac{1}{1-\sigma}}} \right]^{\frac{1}{1-r}}, \qquad (10)$$

for $i = m, w$. This result is valid for any $\sigma \geqslant 0$ and $r \geqslant 0$. However, since this equilibrium construction expresses a less efficient way to organize labor than the competitive equilibrium of Section 3, it is expected to prevail only when such equilibrium fails to exist.

In this context, the women/men return ratio equals one, i.e., $u_w/u_m = 1$, but the women/men effort ratio is given by:

$$\frac{e_w}{e_m} = (\frac{c_w}{c_m})^{\frac{1}{1-r}}. \qquad (11)$$

Since $c_m \leqslant c_w$, this ratio is larger than one for $r < 1$, but smaller than one for $r > 1$, which means that for $r < 1$ the women—the gender with higher cost of effort—provides more effort than men—the gender with higher cost of effort. Note also that the women/men effort ratio does not depend on σ.

[10] In this case, the employer extracts the entire workers surplus, which is a convenient and common assumption in many economic models. The results do not change if the net returns are normalized to some strictly positive amount.

Consequently, we have the following result.

Proposition 5. *In the non-competitive equilibrium, the women effort is always higher than the men effort for $r < 1$, but lower for $r > 1$. The women/men effort ratio improves in relative terms when r increases.*

In order to prove this result, simply note that since $c_w \geqslant c_m$ the ratio (11) is always larger than one if $1/(1-r)$ is positive, which is the case when $r < 1$, but smaller than one if $1/(1-r)$ is negative, which is the case when $r > 1$. Consequently, it increases with r.

The women effort is higher than men effort in occupations with $r < 1$, which suggests that in those occupations women may have better chances to compete with men and better career prospects.

Note that the nature of this result does not depend on the specificities of the equilibrium construction, but on the fact that the individuals' returns are exogenously determined and fixed. This type of exogenous equilibrium construction is often found in reality. The problem for women is that the $r < 1$ occupations tend to deliver lower net returns than the competitive occupations of Sections 3.1 and 3.2.

Another interesting aspect of the non-competitive equilibrium construction in this section is the fact that when $r > 1$, men—the gender with lower cost of effort—recover their competitive advantage, which is in line with the results obtained in Sections 3.1 and 3.2. This connection is a remarkable aspect of this equilibrium, which shows the robustness of the obtained results and the importance of costs in the determination of the effort levels and in establishing gender advantages.

In this context, we have the following result regarding the economic incentives behind this equilibrium.

Proposition 6. *In the non-competitive equilibrium, the economy incentivize women towards occupations with low r in the interval $r < 1$, incentivize both men and women towards occupations with high r in the interval $r < 1$, and incentivize men towards occupations with $r > 1$.*

The proof can be found in the Appendix.

Since the net returns are normalized to zero, the statement in Proposition 6 is based on production efficiency, which is the relevant measure from the employers perspective. In more detail, the result has implicit that in the perfect substitutes case, the non-competitive equilibrium tends to incentivize women towards occupations with $r < 1$, and men towards occupations with $r > 1$, because for those parameterization these are the optimal matches. The complementarities case opens an intermediate interval of occupations in which collaboration between individuals of different genders is optimal, which happens for sufficiently high r in the interval $(0,1)$. In this case, the highest total output is obtained when individuals with different costs of effort collaborate with each other.

Nonetheless, in line with the results obtained in Sections 3.1 and 3.2, the results in this section suggest the existence of economic incentives that favor gender specialization and push women towards occupations with $r < 1$, which are associated with lower net returns.

4.2. ***Other equilibrium constructions***

We conclude this section by briefly commenting on some alternative equilibrium constructions.

An alternative non-competitive equilibrium approach would be to consider a self-interested employer that would demand/choose from workers the effort levels that would minimize their aggregate welfare. Such approach would lead to a well-defined minimization problem for small r in the interval $(0,1)$, with equilibrium effort given by:

$$e_i = \left[\frac{2rc_i}{\gamma(1/2 + (c_{-i}/c_i)^{\frac{1-\sigma}{1-r-\sigma}}/2)^{\frac{\sigma}{1-\sigma}}} \right]^{\frac{1}{1-r}},$$

for $i = m, w$, and the women/men effort ratio given by:

$$\frac{e_w}{e_m} = (\frac{c_w}{c_m})^{\frac{1}{1-r-\sigma}}, \tag{12}$$

which would lead to similar results and conclusions as the ones obtained in Propositions 5 and 6. In other words, women would provide more effort than men for $r < 1-\sigma$, but less than men for $r > 1-\sigma$, with the dependence on σ already in the women/men effort ratio.

The first limitations of this approach is that it may no replicate the reality as well as the approach in Section 4.1. The second limitation is that the equilibrium would fail to be a minimum for sufficiently large r in the interval $(0,1)$. In such case, we would have to consider a benevolent social-planner would maximize aggregate welfare, which could contradict the original argument.

Another alternative non-competitive equilibrium approach would be to consider that individuals of both genders would provide the same level of effort. In this case, since men and women have different costs of effort, their net returns would be different. In this context, a production efficiency argument would require the common effort to be the highest of the men and women efforts. Consequently, the reference effort would be the women's effort that would satisfy the normalization $u_w = 0$, i.e.,:

$$e_w = e_m = (2c_w/\gamma)^{\frac{1}{1-r}}, \tag{13}$$

with positive returns for men, i.e., $u_m = \gamma(1 - c_m/c_w)e_m/2 \geqslant 0$.

The disadvantage of this approach is that the women/men effort ratio equals one and the women/men net returns ratio is zero because the women net return is normalized at zero. These aspects limit in a great extent the study and analysis of our problem.

To conclude and summarize this section, when the equilibrium fails to exist the equilibrium configuration may be some mixture of the equilibria found in expressions (10), (12), (13). Nonetheless, these constructions reveal the remarkable nature of the existent societal equilibrium and show that economic efficiency arguments push women towards lower r occupations (i.e., lower marginal cost of effort) and men toward higher r occupations (i.e., higher marginal cost of effort).

5. Joint consideration and discussion

In this section, we put together the main ideas and intuition behind the results obtained in Sections 3 and 4.

The first observation is regarding the fact that labor is not organized in the same way across all occupations. It depends on the structure of the effort costs associated with each occupation. This aspect emerges endogenously in the model.

On the one hand, for occupation with $r \geqslant 1$ sufficiently large (which includes most situations of increasing marginal cost of effort), we have a competitive equilibrium in which individuals competitively provide effort, and more effort is associated with higher net returns and potentially better career prospects. In this context, men are more competitive and provide more effort than women because they have a lower cost of effort.

On the other hand, for occupations with $r < 1$ or $r \geqslant 1$ sufficiently small, the competitive equilibrium fails to exist. In those cases, individuals provide an amount of effort compatible with a predetermined objective. In particular, for occupations with $r < 1$ women provide higher effort than men in order to compensate for their higher cost of effort and meet the predetermined objective.

What do these observations imply? Note that in order to function well, the economy requires all types of occupations, independently on whether they have decreasing or increasing marginal costs of effort (i.e., captured by the parameter r). And since women provide more effort than men in $r < 1$ occupations and men provide more effort than women in $r \geqslant 1$ occupations, economic efficiency and welfare objectives may push women towards occupations with low $r < 1$ and men towards occupations with $r \geqslant 1$. These economic forces may be the economic equivalent to the concept of gender constructed roles and these keywords may explain each other in a circular way.

Of course, reality is more complex and diverse, and not all women will necessarily end up having higher costs of effort than men, even when performing the majority of the household labor, because human beings are different and many aspects that are not captured in this model will play a role in this process. For that reason, we can find women in $r \geqslant 1$ occupations and men in $r < 1$ occupations. Nonetheless, the obtained results clearly point that we should expect more women than men in $r < 1$ occupations and more men than women in $r \geqslant 1$ occupations. These results also point towards the emergence of gender specialization, male-dominated and female-dominated occupations.

Another crucial implication is related with the fact that occupations with higher values of r are associated with higher net returns. Even though, we do not make absolute value comparisons of efforts and net returns, which depend crucially on the numerical values of the parameters, the differences in net returns is clear—net returns are higher in the competitive equilibrium than in the non-competitive construction. Therefore, our findings may help to explain the existing gender wage gap. For instance, most Science, Technology, Engineering and Mathematics (STEM) occupations are likely to be associated with higher values of r, in which women tend to have less chances to compete, as shown in our model. These observations may also explain in a great extent the men and women gap in STEM occupations.

What are the $r < 1$ and $r \geqslant 1$ occupations? Examples of $r < 1$ occupations are arguably and non-exhaustively most types of nursing and child/home/health care, office clerks/secretaries/administrative support, elementary/middle school teachers, cashiers and accountants, etc. Note that in most of these occupations women are more than two thirds of the labor force. These occupations also have in common lower wages and the fact that output is pretty much predetermined.

Examples of $r \geqslant 1$ occupations, in which women are underrepresented, are software developers, financial analysts, engineers, pilots and flight engineers, video and media operators, etc. (Bureau of Labor Statistics 2019, Women in the labor force:

a databook). In these occupations, the marginal cost of effort is increasingly costly. Every new additional unit of productive effort becomes more difficult to deliver and conciliate, for example with the household.

What is the role of complementarities? In the competitive equilibrium, complementarities seem to not change the main observations made in Sections 3.1 and 3.2 regarding the relative effort and net returns (see Propositions 1 and 3), and regarding economic incentives (see Proposition 2 and 4).

Nonetheless, women seem to slightly benefit from complementarities, because the ratio (8) is larger than the ratio (5), which implies that women are better in relative terms when there are complementarities in the production, as they benefit more than proportionally from the complementarity spillovers.[11]

In the non-competitive equilibrium construction, complementarities open an intermediate interval of occupations in which collaboration between individuals of different genders is optimal in terms of total output. In Proposition 6, the interval for sufficiently high $r < 1$, in which it is optimal to have both men and women performing occupations with $r < 1$ only exist (and expands) if there are complementarities. This result could conceptually be seen as a positive aspect of complementarities in production. However, that is not necessarily true for women, because if we assume that occupations with high r tend to be associated with higher returns, women lose some "protection" in the better $r < 1$ occupations. Therefore, complementarities are not necessarily better for women in non-competitive contexts.

6. Conclusion

This paper attempts to provide an economic rationale behind concepts like stereotypes, socialization practices and gender-constructed roles that seem to determine each gender occupational choices. In this context, we study how men and women's relative efforts, and net returns are affected by different cost structures and degrees of complementarity in production, and how economic arguments like production efficiency and aggregate welfare may push men or women towards some types of occupations.

[11]Note also that the competitive equilibrium with perfect substitutes ($\sigma = 0$) occurs when $r \geqslant 1$, while the competitive equilibrium with complementarities ($\sigma = 2$) occurs when $r \geqslant (2 - r)(c_w/c_m)^{1/r}$, which is more restrictive than $r \geqslant 1$. Consequently, complementarities enlarge the non-competitive equilibrium existence region, in which women are incentivized to participate and net returns are lower.

In this paper, women have greater difficulty to conciliate the labor market with the household and for that reason have a higher marginal cost of effort than men. We found that the way production is organized depends crucially on the cost structure. When the marginal cost of effort is increasing with effort (roughly speaking), production is organized in a competitive equilibrium, in which men are more competitive and provide more effort than women, because they have a lower cost of effort. Consequently, economic arguments like production efficiency and aggregate welfare push men towards these more competitive occupations, which are also the ones with higher returns (e.g., software and media developers, financial analysts, engineers, etc.).

On the other hand, when the marginal cost of effort is decreasing with effort (roughly speaking), production tends to be organized in less competitive ways in which women provide higher effort than men, in order to compensate for their higher cost of effort and satisfy the predetermined objective. In those cases, economic arguments like production efficiency and aggregate welfare push women towards those occupations, which are also the ones with lower returns (e.g., nursing and care, administrative support, schoolteachers, accountants, etc.). In terms of costs of effort, these occupations have the advantage of being easier to conciliate with the household responsibilities.

We have also considered the effect of complementarities in production. In this case, the results are less clear-cut but the fundamental idea remains unchanged. Complementarities may benefit women in the more competitive occupations, but limit the women opportunities in the less competitive occupations.

An important aspect is that complementarities add robustness to the obtained results. The results are also found to hold true independently on whether we consider a production efficiency or aggregate welfare argument.

Of course, reality is more complex than in our model, consequently not all women will necessarily have higher costs of effort than men, even when performing the majority of the household labor because human beings are different along many dimension like productivity, skills and so on. Many aspects play an important role in this process, consequently there will be women in highly competitive occupations and men in less competitive occupations. Therefore, our results should be interpreted in relative and expected terms, in the sense of more women than men in the less competitive occupations and more men than women in the more competitive occupations.

We have also made several simplifying assumptions in order to have an analytical model and focus on the societal and economic incentives without further considerations that could potentially bloat the analysis. For instance, physical and biological differences between men and women or other specific aspects that may explain gender segregation in some particular occupations. The consideration of those aspects may allow us more granular predictions and could be the subject of further research. Despite the complexity of the topic, the present paper is a step forward in those directions.

Finally, we hope that our findings will help researchers and decision-makers to better understand the economic mechanisms behind men and women occupational choices and careers. We believe that economic arguments like production efficiency and aggregate welfare are the microeconomics fundamentals that support concepts like stereotypes, socialization practices and gender constructed roles, which heavily penalize women and are always present in the gender literature.

The message is clear: even if we remove discrimination barriers and equate the men and women educational opportunities (Cortes and Tessada, 2011; Furtado and Hock, 2010; Gajendran and Harrison, 2007; Hegewisch and Gornick, 2011), we still encounter economic forces that push the society towards gender based occupational segregation and income inequality because men and women do not have the same competitive capacity. For instance, while women are still accountable for the largest share of the domestic labor (which in this paper is materialized by a higher cost of effort), they are in weaker position to compete with men, and the society will naturally end-up in an equilibrium with gender based occupational segregation and income inequality.

Acknowledgments: Financial support from the GRODE, Universitat Rovira i Virgili and Generalitat de Catalunya Project 2019PFR-URV-53, and the Spanish Ministry of Science and Innovation Project RTI2018-094733-B-I00 (AEI/FEDER, UE) and PID2019-105982GB-I00 is gratefully acknowledged. I would like to thank Juan Kai Konrad and Pablo Rincón-Zapatero, as well as several seminars and congress participants for helpful comments and discussions. I would also like to thank Justus Haucap and the Düsseldorf Institute for Competition Economics (DICE) for hosting me during the period of this research. The usual caveat applies.

Appendix A. Proofs of the Propositions

Proof of Proposition 2. Simply note that if individuals are of different genders, then $F(e_i, e_{-i}) = \gamma(e_i + e_{-i})/2$, which is expression (1) evaluated at $\sigma = 0$, and $U(e_i, e_{-i}) = \gamma(1 - 1/r)(e_i + e_{-i})/2$, which is expression (3) evaluated at $\sigma = 0$, while if individuals are of the same gender i, then $F(\overline{e}_i, \overline{e}_i) = \gamma\overline{e}_i$ and $U(\overline{e}_i, \overline{e}_i) = \gamma(1-1/r)\overline{e}_i$. Note also that the equilibrium effort in expression (4) does not depend on the costs asymmetry. Consequently, we have $\overline{e}_i = e_i$ for $i = m, w$. Therefore, since $e_m \geqslant e_w$, the algebraic comparison of these expressions delivers $F(\overline{e}_m, \overline{e}_m) \geqslant F(e_i, e_{-i})$ and $U(\overline{e}_m, \overline{e}_m) \geqslant U(e_i, e_{-i})$ for $i = m, w$. ■

Proof of Proposition 3. In order to show that the ratio $e_w/e_m = (c_m/c_w)^{1/r}$ improves with r, simply note that since $c_w \geqslant c_m$, this ratio increases monotonically with r and approaches the unit as r increases to infinite. In order to show that the ratio u_w/u_m improves with r, suppose the numerator and denominator in (9) are both positive. In order to avoid derivatives with exponents and logarithms, which the sign is difficult to determine, consider first an increase in expression $(c_m/c_w)^{1/r}$ alone, which could have also been caused by an increases in r. In this case, this movement increases the numerator, and decreases the inverse of this expression that is in the denominator, and consequently decreases the denominator. Therefore, this effect increases the ratio u_w/u_m. Subsequently, consider that the expression $(c_m/c_w)^{1/r}$ is constant, but let r vary. In this case, the derivative of the ratio u_w/u_m with respect to r with $(c_m/c_w)^{1/r}$ constant is $2(e_w/e_m)(1-(e_w/e_m)^2)/(r-(2-r)(e_w/e_m))^2$, which is always positive because $e_w/e_m = (c_m/c_w)^{1/r} \leqslant 1$. Together, these two effects imply that the ratio u_w/u_m must increase with r. ■

Proof of Proposition 4. We want to show that inequality $F(\overline{e}_m, \overline{e}_m) \geqslant F(e_m, e_w)$ holds, where $F(\overline{e}_m, \overline{e}_m) = \gamma\overline{e}_m$ and $F(e_m, e_w) = \gamma 2e_m e_w/(e_m + e_w)$ for $\sigma = 2$. This inequality reduces to show that $\overline{e}_m \geqslant 2e_m e_w/(e_m + e_w)$. Since $e_m/e_w = (c_w/c_m)^{\frac{1}{r}} \geqslant 1$, the inequality becomes:

$$\overline{e}_m \geqslant 2e_m/(1 + (c_w/c_m)^{1/r}).$$

Replace $\overline{e}_m = (\gamma/(2rc_m))^{1/(r-1)}$ and $e_m = (c_w/c_m)^{1/r}e_w$ where e_i is given by expression (6) to obtain after some algebra:

$$\left[\frac{1}{2}\right]^{\frac{1}{r-1}} \geqslant \frac{2}{1 + (c_w/c_m)^{\frac{1}{r}}}\left[\frac{4(c_w/c_m)^{\frac{1}{r}}}{((c_w/c_m)^{\frac{1}{r}} + 1)^3}\right]^{\frac{1}{r-1}}.$$

Note that since $(c_w/c_m)^{1/r} \geqslant 1$, then $1 + (c_w/c_m)^{1/r} \geqslant 2$. Subsequently, define $x \equiv 1 + (c_w/c_m)^{1/r}$, and replace it in the above inequality to obtain after some algebra the following polynomial expression $k^{r+2} \geqslant (2)^{r+2}(k-1)$. Since $k \geqslant 2$, the higher the value of r in the interval $r \geqslant 0$, the higher the left-hand side relative to the right-hand side. In this context, the case in which the inequality is more difficult to satisfy is at $r = 0$, but in this case, the polynomial inequality is always satisfied for any $k \geqslant 2$, which proves our result.

Now, we want to show that inequality $U(\overline{e}_m, \overline{e}_m) \geqslant U(e_m, e_w)$ holds for $\sigma = 2$. In order to avoid large and complex expressions, suppose that the minimum difference $U(\overline{e}_m, \overline{e}_m) - U(e_m, e_w)$ is at either of the extremes of the interval $r \geqslant (2-r)(c_w/c_m)^{1/r}$, which is indeed the case. In this context, at the upper extreme $r \to \infty$, we have that $e_w/e_m \to 1$, which imply that $e_m \to 1$ and $e_w \to 1$, and that $u_m \to \gamma/2$ and $u_w \to \gamma/2$. Therefore, $U(\overline{e}_m, \overline{e}_m) \to \gamma$ and $U(e_m, e_w) \to \gamma$. At the lower extreme of r, the inequality (7) must hold with equality. In this case, we have $e_w/e_m = (c_m/c_w)^{1/r} = (2-r)/r$, which implies that $u_w = 0$. Then, if individuals are of the same gender $i = m$:

$$U(\overline{e}_m, \overline{e}_m) = \gamma(1 - 1/r)\overline{e}_m,$$

where $\overline{e}_m$ is given above, while if individuals are of different genders:

$$\begin{aligned} U(e_m, e_w) &= u_m = 2\gamma(1 - 2e_w/[r(e_m + e_w)])e_m^2 e_w/(e_m + e_w)^2 \\ &= 2\gamma(1 - 2/[r(e_m/e_w + 1)])e_w/(1 + e_w/e_m)^2 = \gamma(1 - 1/r)r^2 e_w, \end{aligned}$$

where e_w is given by expression (6). The next step is to compare the aggregate net returns, i.e., verify the inequality $U(\overline{e}_m, \overline{e}_m) \geqslant U(e_m, e_w)$ at $e_w/e_m = (c_m/c_w)^{1/r} = (2-r)/r$. Consequently, we have:

$$\gamma(1 - \frac{1}{r}) \left[\frac{\gamma}{2rc_m}\right]^{\frac{1}{r-1}} \geqslant \gamma(1 - 1/r)r^2 \frac{(2-r)}{r} \left[\frac{4\gamma(\frac{2-r}{r})^2}{rc_m(1 + \frac{2-r}{r})^3}\right]^{\frac{1}{r-1}},$$

which after some algebra reduces to:

$$1 \geqslant r(2-r)\left[r(2-r)^2\right]^{\frac{1}{r-1}}.$$

The right-hand side of this inequality is maximal when r approach 1. In this case, the right-hand side takes the limit value $1/e$ and the inequality is satisfied because $e \geqslant 1$. Therefore, the inequality $U(\overline{e}_m, \overline{e}_m) \geqslant U(e_m, e_w)$ also holds at the lower bound and any $e_w/e_m = (c_m/c_w)^{1/r}$. ∎

Proof of Proposition 6. Recall that $F(\overline{e}_i, \overline{e}_i) = \gamma\overline{e}_i$ and that $F(e_i, e_{-i})$ is given by the CES production function (1), where e_i is given by expression (10) and $\overline{e}_i$ is given by that expression evaluated at $c_{-i}/c_i = 1$. Suppose that $r < 1$. In this case, women provide more effort than men by inequality (11), and $F(\overline{e}_w, \overline{e}_w) \geqslant F(\overline{e}_m, \overline{e}_m)$

because $\overline{e}_w \geqslant \overline{e}_m$. Therefore, for $r < 1$, we want to show when inequality $F(\overline{e}_w, \overline{e}_w) \geqslant F(e_m, e_w)$ holds true, i.e., $\gamma\overline{e}_w \geqslant \gamma(e_m^{1-\sigma}/2 + e_w^{1-\sigma}/2)^{\frac{1}{1-\sigma}}$, which after some algebra reduces to:

$$(1/2 + (c_m/c_w)^{\frac{1-\sigma}{1-r}}/2)^{\frac{r}{1-\sigma}} \geqslant (1/2 + (c_m/c_w)^{\frac{1}{1-r}}/2).$$

In order to obtain concrete results, suppose that $\sigma = 0$. In this case, the inequality simplifies and the right-hand side is always lower than the left-hand side because $c_m \leqslant c_w$. Subsequently, suppose that $\sigma = 2$, in this case, the inequality becomes:

$$1 \geqslant (1/2 + (c_m/c_w)^{\frac{1}{1-r}}/2)(1/2 + (c_w/c_m)^{\frac{1}{1-r}}/2)^r,$$

and the right-hand side is monotonically increasing in r. In this context, evaluate the inequality at $r = 0$ to obtain that it holds true because $c_m/c_w \leqslant 1$. Evaluate the inequality at the other extreme of the interval, i.e., at $r \to 1$, to obtain that the inequality fails because $(c_w/c_m)^{\frac{1}{1-r}} \to \infty$ while $(c_m/c_w)^{\frac{1}{1-r}} \to 0$. Therefore, there is some r in the interval $(0, 1)$ below which $F(\overline{e}_w, \overline{e}_w) \geqslant F(e_m, e_w)$ and above which $F(\overline{e}_w, \overline{e}_w) \leqslant F(e_m, e_w)$.

Now, suppose that $r > 1$. In this case, women provide less effort than men by inequality (11), and $F(\overline{e}_m, \overline{e}_m) \geqslant F(\overline{e}_w, \overline{e}_w)$ because $\overline{e}_m \geqslant \overline{e}_w$. Therefore, for $r > 1$, we want to show that inequality $F(\overline{e}_m, \overline{e}_m) \geqslant F(e_m, e_w)$ holds true, i.e., $\gamma\overline{e}_m \geqslant \gamma(e_m^{1-\sigma}/2 + e_w^{1-\sigma}/2)^{\frac{1}{1-\sigma}}$, which after some algebra reduces to:

$$(1/2 + (c_m/c_w)^{\frac{1}{r-1}}/2) \geqslant (1/2 + (c_m/c_w)^{\frac{1-\sigma}{r-1}}/2)^{\frac{r}{1-\sigma}}. \tag{A.1}$$

This inequality holds true for any $r > 1$ and $\sigma \geqslant 0$, because since $c_m \leqslant c_w$ we have that $(1/2 + (c_m/c_w)/2) \geqslant (1/2 + (c_m/c_w)^{1-\sigma}/2)^{\frac{1}{1-\sigma}}$, which is always true (it is a property of the CES functions), and because the $r > 1$ power on the right-hand side of inequality (A.1) is always higher than the unit power on the left-hand side. ■

References

Albanesi, S., Olivetti, C., 2009. Home production, market production and the gender wage gap: Incentives and expectations. Review of Economic Dynamics 12 (1), 80–107.

Alesina, A., Giuliano, P., Nunn, N., 2013. On the origins of gender roles: Women and the plough. The Quarterly Journal of Economics 128 (2), 469–530.

Altonji, J. G., Blank, R. M., 1999. Race and gender in the labor market. Handbook of Labor Economics 3, 3143–3259.

Athey, S., Avery, C., Zemsky, P., 2000. Mentoring and diversity. American Economic Review 90 (4), 765–786.

Azmat, G., Calsamiglia, C., Iriberri, N., 2016. Gender differences in response to big stakes. Journal of the European Economic Association 14 (6), 1372–1400.

Bateup, H. S., Booth, A., Shirtcliff, E. A., Granger, D. A., 2002. Testosterone, cortisol, and women's competition. Evolution and Human Behavior 23 (3), 181–192.

Becker, G. S., 1985. Human capital, effort, and the sexual division of labor. Journal of Labor Economics 3 (1), S33–S58.

Benschop, Y., Halsema, L., Schreurs, P., 2001. The division of labour and inequalities between the sexes: An ideological dilemma. Gender, Work & Organization 8 (1), 1–18.

Bertrand, M., Hallock, K. F., 2001. The gender gap in top corporate jobs. Industrial & Labor Relations Review 55 (1), 3–21.

Bianchi, S. M., 2000. Maternal employment and time with children: Dramatic change or surprising continuity? Demography 37 (4), 401–414.

Bianchi, S. M., Milkie, M. A., Sayer, L. C., Robinson, J. P., 2000. Is anyone doing the housework? trends in the gender division of household labor. Social Forces 79 (1), 191–228.

Bielby, W. T., Bielby, D. D., 1989. Family ties: Balancing commitments to work and family in dual earner households. American Sociological Review 54 (5), 776–789.

Blau, F. D., Kahn, L. M., 2016. The gender wage gap: Extent, trends, and explanations. Tech. rep., National Bureau of Economic Research.

Booth, A., Nolen, P., 2012. Choosing to compete: How different are girls and boys? Journal of Economic Behavior & Organization 81 (2), 542–555.

Cheryan, S., Master, A., Meltzoff, A. N., 2015. Cultural stereotypes as gatekeepers: Increasing girls interest in computer science and engineering by diversifying stereotypes. Frontiers in Psychology 6, 49.

Chiappori, P.-A., Dias, M. C., Meghir, C., 2018. The marriage market, labor supply, and education choice. Journal of Political Economy 126 (S1), S26–S72.

Coate, S., Loury, G. C., 1993. Will affirmative-action policies eliminate negative stereotypes? The American Economic Review 83 (5), 1220–1240.

Cortes, P., Tessada, J., 2011. Low-skilled immigration and the labor supply of highly skilled women. American Economic Journal: Applied Economics 3 (3), 88–123.

Crosnoe, R., Riegle-Crumb, C., Field, S., Frank, K., Muller, C., 2008. Peer group contexts of girls and boys academic experiences. Child Development 79 (1), 139–155.

Croson, R., Gneezy, U., 2009. Gender differences in preferences. Journal of Economic literature 47 (2), 448–474.

Cubel, M., Sánchez-Pagés, S., 2017. Gender differences and stereotypes in strategic reasoning. The Economic Journal 127 (601), 728–756.

Datta Gupta, N., Poulsen, A., Villeval, M. C., 2013. Gender matching and competitiveness: Experimental evidence. Economic Inquiry 51 (1), 816–835.

Davis, S. N., Greenstein, T. N., 2009. Gender ideology: Components, predictors, and consequences. Annual Review of Sociology 35 (1), 87–105.

Dohmen, T., Falk, A., 2011. Performance pay and multidimensional sorting: Productivity, preferences, and gender. The American Economic Review 101 (2), 556–590.

Ely, R., Padavic, I., 2020. What's really holding women back? it's not what most people think. Harvard Business Review 98 (2), 58–67.

Fain, J. R., 2009. Affirmative action can increase effort. Journal of Labor Research 30 (2), 168–175.

Fayer, S., Lacey, A., Watson, A., 2017. STEM occupations: Past, present, and future - Spotlight on Statistics. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics.

Flory, J. A., Gneezy, U., Leonard, K., List, J., et al., 2018. Gender, age, and competition: A disappearing gap? Journal of Economic Behavior and Organization 150, 256–276.

Francois, P., 1998. Gender discrimination without gender difference: theory and policy responses. Journal of Public Economics 68 (1), 1–32.

Franke, J., 2012. Affirmative action in contest games. European Journal of Political Economy 28 (1), 105–118.

Fryer Jr, R. G., Loury, G. C., 2005. Affirmative action and its mythology. Journal of Economic Perspectives 19 (3), 147–162.

Fu, Q., 2006. A theory of affirmative action in college admissions. Economic Inquiry 44 (3), 420–428.

Furtado, D., Hock, H., 2010. Low skilled immigration and work-fertility tradeoffs among high skilled us natives. American Economic Review 100 (2), 224–28.

Gajendran, R. S., Harrison, D. A., 2007. The good, the bad, and the unknown about telecommuting: Meta-analysis of psychological mediators and individual consequences. Journal of Applied Psychology 92 (6), 1524.

Gneezy, U., Leonard, K. L., List, J. A., 2009. Gender differences in competition: Evidence from a matrilineal and a patriarchal society. Econometrica 77 (5), 1637–1664.

Gneezy, U., Niederle, M., Rustichini, A., 2003. Performance in competitive environments: Gender differences. Quarterly Journal of Economics 118 (3), 1049–1074.

Gneezy, U., Rustichini, A., 2004. Gender and competition at a young age. The American Economic Review 94 (2), 377–381.

Goldin, C., Rouse, C., 2000. Orchestrating impartiality: The impact of" blind" auditions on female musicians. The American Economic Review 90 (4), 715–741.

Gornick, J. C., Meyers, M. K., 2003. Families that work: Policies for reconciling parenthood and employment. Russell Sage Foundation.

Gunderson, E. A., Ramirez, G., Levine, S. C., Beilock, S. L., 2012. The role of parents and teachers in the development of gender-related math attitudes. Sex Roles 66 (3-4), 153–166.

Hegewisch, A., Gornick, J. C., 2011. The impact of work-family policies on women's employment: a review of research from oecd countries. Community, Work & Family 14 (2), 119–138.

Holzer, H., Neumark, D., 2000. Assessing affirmative action. Journal of Economic Literature 38 (3), 483–568.

Holzer, H., Neumark, D., 2006. Affirmative action: What do we know? Journal of Policy Analysis and Management 25 (2), 463–490.

Iriberri, N., Rey-Biel, P., 2019. Competitive pressure widens the gender gap in performance: Evidence from a two-stage competition in mathematics. The Economic Journal 129 (620), 1863–1893.

Ivanova-Stenzel, R., Kübler, D., 2011. Gender differences in team work and team competition. Journal of Economic Psychology 32 (5), 797–808.

Kahn, S., Ginther, D., 2017. Women and stem. Tech. rep., National Bureau of Economic Research Working Paper No. 23525.

Lorber, J., 1994. Paradoxes of gender. Yale University Press.

Lundberg, S., Pollak, R. A., 1996. Bargaining and distribution in marriage. The Journal of Economic Perspectives 10 (4), 139–158.

Lundberg, S., Pollak, R. A., 2003. Efficiency in marriage. Review of Economics of the Household 1 (3), 153–167.

Lundberg, S. J., 1991. The enforcement of equal opportunity laws under imperfect information: affirmative action and alternatives. The Quarterly Journal of Economics 106 (1), 309–326.

Niederle, M., Segal, C., Vesterlund, L., 2013. How costly is diversity? affirmative action in light of gender differences in competitiveness. Management Science 59 (1), 1–16.

Niederle, M., Vesterlund, L., 2007. Do women shy away from competition? do men compete too much? The Quarterly Journal of Economics 122 (3), 1067–1101.

Niederle, M., Vesterlund, L., 2011. Gender and competition. Annual Review of Economics 3, 601–630.

Osório, A., 2019. Gender differences in competition: gender equality and cost reduction policies. Review of Economic Design 23 (1-2), 27–52.

Pollak, R. A., 2003. Gary becker's contributions to family and household economics. Review of Economics of the Household 1 (1-2), 111–141.

Presser, H. B., 1994. Employment schedules among dual-earner spouses and the division of household labor by gender. American Sociological Review 59 (3), 348–364.

Ray, D., Baland, J.-M., Dagnelie, O., 2007. Inequality and inefficiency in joint projects. The Economic Journal 117 (522), 922–935.

Schotter, A., Weigelt, K., et al., 1992. Asymmetric tournaments, equal opportunity laws, and affirmative action: Some experimental results. The Quarterly Journal of Economics 107 (2), 511–539.

Shelton, B. A., John, D., 1996. The division of household labor. Annual Review of Sociology 22 (1), 299–322.

Toossi, M., Morisi, T. L., 2017. Women in the workforce before, during, and after the Great Recession - Spotlight on Statistics. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics.

Vandegrift, D., Brown, P., 2005. Gender differences in the use of high-variance strategies in tournament competition. The Journal of Socio-Economics 34 (6), 834–849.

Vandegrift, D., Yavas, A., 2009. Men, women, and competition: An experimental test of behavior. Journal of Economic Behavior & Organization 72 (1), 554–570.

Wang, M.-T., Degol, J. L., 2017. Gender gap in science, technology, engineering, and mathematics (stem): Current knowledge, implications for practice, policy, and future directions. Educational Psychology Review 29 (1), 119–140.

Welch, F., 1976. Employment quotas for minorities. Journal of Political Economy 84 (4), S105–S141.

Wolfers, J., 2006. Diagnosing discrimination: Stock returns and ceo gender. Journal of the European Economic Association 4 (2-3), 531–541.