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Gender Gaps in STEM Occupations in Costa Rica, El Salvador, and Mexico

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Gender Gaps in STEM Occupations in Costa Rica, El Salvador and Mexico*

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November 2022

Abstract

This paper documents the existence of significant gender gaps in STEM occupations in Costa Rica, El Salvador, and Mexico and estimates the aggregate costs associated with these gaps in Mexico. For Mexico we calibrate and simulate a version of the general equilibrium occupational choice model of Hsieh et al. (2019) to estimate the output losses associated with these differences since 1992. We find that if barriers in STEM occupations were eliminated aggregate output would have been between 1% and 10% larger, depending on the year. If female-specific social norms were also eliminated, the rise in aggregate output would be between 1.4% and 14%. For comparison purposes, we also compute the gains of eliminating all the distortions in high-skilled occupations as well as in all occupations. We find that aggregate output would rise between 16.5% and 3.6% in the first case and between 36.7% and 12% in the latter.

Keywords: talent misallocation, STEM occupations, aggregate productivity.

JEL Codes: E2, J21, J24, O40

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1 Introduction

Inequalities between men and women are widespread around the world, especially in developing countries. Significant gaps between men and women are present in the labor market as well as in political representation or bargaining power in the household, among others. While it is true that some of these gaps are closing fast in recent decades and they are doing so faster in today's developing countries than they did in industrialized ones in the past, the prevalence of gender inequality is still high, especially in the former group.

In this paper we focus on a specific gender gap, namely the gap in STEM (Science, Technology, Engineering, Math) occupations. We believe this is an important group of occupations because of their contribution to a country's stock of human capital. In particular, the generation of new technologies and the knowledge spillovers that come with them are often associated with occupations in the STEM field. We use the definition of the Bureau of Labor Statistics and refer to STEM jobs as *those in which workers use their knowledge of science, technology, engineering, or math to try to understand how the world works and to solve problems.* As argued in Bustelo et al. (2019), early biases in career choices reinforce the inequalities observed in the labor market. This is likely to be the case in particular for STEM occupations since they tend to have high wages and because women are often underrepresented in these jobs. Our dataset contains information on individual's occupations, not their field of study, so the implicit assumption throughout the analysis is that working in a STEM occupation is highly correlated with having specialized in a STEM field during the schooling years.

The article is organized as follows. In the next section we describe the related literature. In Section 3 we report the fraction of men and women in all occupations in different years, breaking down the men-women gap in terms of participation and gender wage gaps in different STEM occupations. Section 4 briefly describes the theoretical framework and presents our quantitative results for the barriers faced by women in their occupation choices as well as the income losses associated with the STEM gaps. The results are discussed in Section 5 together with the policy implications, with a section devoted to the effects of women with young children. Finally, Section 6 concludes the paper.

2 Literature Review

To the best of our knowledge, the literature on gender gaps in STEM fields is still quite limited. A few studies show that gender gaps in STEM are present in many countries even though, as Castillo et al. (2014) show, there have been initiatives towards more inclusive educational programs, especially in high-income countries.[1] These gaps exist not just in the labor force in general but also in companies' boards. For example, Adams and Kirchmaier (2016) use data from firms in twenty countries over the period 2001-2010 and show that women are underrepresented on boards and especially so in firms' boards in STEM sectors.

In Latin American and the Caribbean, somewhat surprisingly, according to Busso and Messina (2020) gender gaps in STEM increase with national income, especially for degrees in engineering, manufacturing and construction, and in information and communication technologies. Their study uses data from the 2018 PISA results and find that, by age fifteen, gendered differences in mathematics and science performance are modest in this region. However, in tertiary education, women tend to avoid traditionally male-dominated fields, including STEM sectors (Schleicher, 2019).

We contribute to this literature by providing model-based quantitative results of the effects of eliminating barriers in the STEM sector in Mexico between 1992 and 2018. To do that we use the theoretical framework of Hsieh et al. (2019). To the best of our knowledge, we are the first ones to do so for a Latin American country.[2]

3 Empirics

3.1 Data

This section describes the data we used for Mexico. In Section 5 we briefly discuss the sources of data for Costa Rica and El Salvador.

In order to identify STEM occupations, we faced two main difficulties. First, countries use different occupation coding systems and some of these systems

[1]See for instance the Athena project in the United Kingdom, the Advance program in the United States, or Belgium's Great Experiment.

[2]Indeed to our knowledge this model has only been applied to the U.S.

change over time. Identifying the sources of these occupational codes and matching them with actual occupation names has been a daunting task and we have tackled this challenge to the best of our possibilities. Second, the decision to classify an occupation as a STEM occupation is not trivial. We follow the criteria of the Bureau of Labor Statistics (BLS) and our own judgement, but in some cases, this involves a considerable degree of arbitrariness. In any case, we are quite confident that our comparisons of STEM gender gaps in Mexico over time are reasonable and meaningful. Table 1 shows the percentage of adult men and women working in STEM occupations in Mexico. The table reveals two very clear patterns: first, in all years, the percentage of men in STEM is larger than that of women. For example, in the year 2000, about 5% of adult men in our sample worked in STEM fields, while only around 3% of women did so. Second, over time, these percentages increase for both men and women in all years.

We use the classification of occupations from IPUMS in 2000.[3] For the years 1992 and 2008, this classification matched more than 97% of the occupations in our databases. We therefore use the same 2000 classification in the three years.

In order to select STEM occupations we used the STEM occupation list published by The Occupational Information Network (O*NET) for the U.S.[4] Since O*NET uses different occupational codes than ours, we had to manually select the occupations that matched their STEM list.

Table 1: Percentage of men and women in STEM occupations in Mexico

Years	Men	Women	All
1992	4.78	1.81	3.17
2000	5.02	1.98	3.40
2008	5.14	2.87	3.91
2018	6.23	3.31	4.66

[3] https://international.ipums.org/international-action/variables/MX2000A$_0$439$codes_section$

[4] See the list at https://www.onetcenter.org/overview.html

3.2 Gender Wage Gaps and Occupational Gaps in STEM occupations over time in Mexico

In order to study gender differences in the Mexican labor market we consider two variables, namely the wage and the occupational gaps between men and women. Figure 1 shows the relationship between the wage gap (defined as one minus the ratio of the women's average wage and the men's average wage) and the relative propensity to work in the occupation for the two groups (defined as the number of women working in a given occupation relative to the number of men) for 1992, the first year in our sample. Every dot in the figure represents one of the 17 occupation groups we clustered and the red dots represent STEM occupations. Focusing first on the horizontal axis, dots to the right of one represent occupations where the presence of women in that occupation is higher than that of men (i.e., women are overrepresented in those occupations), while the opposite occurs for dots to the left of one. This shows that occupations such as *Secretaries, Teachers, Social Scientists, Food and Cleaning Services* are strongly female-dominated in Mexico in 1992. For example, women were six times more likely to work in *Natural and Social Sciences* and eighteen times less likely to work as an *Architect, Engineer, Mathematician* or *Computer Science*.

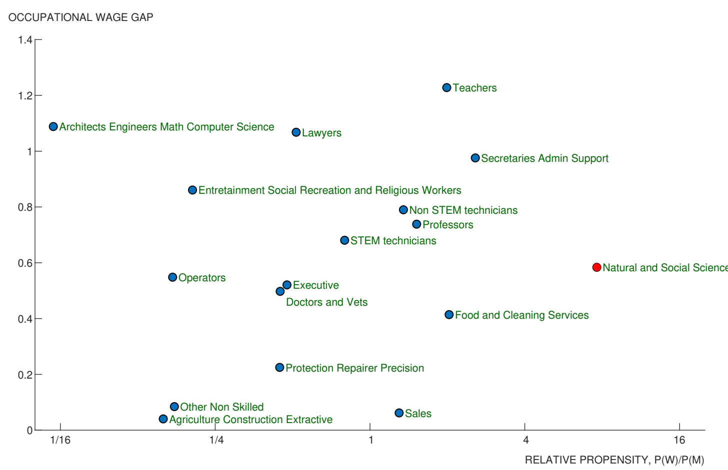
The vertical axis of Figure 1 represents wage differences between men and women in the different occupations. Dots located above zero on this axis represent occupations where men have higher wages than women on average, while those below zero represent occupations where women have higher average wages than men. As it is apparent from the figure, all the dots are located above zero, indicating that for every cluster of occupations, men had higher salaries than women in Mexico in 1992.

It is interesting to notice that these two variables display a very low correlation. For example, although women in *Natural and Social Sciences* and *Doctors and Vets* or *Executives* appear far away on the horizontal axis, they are very close on the vertical axis, which means they have similar wage gaps. This is consistent with the prediction of the model presented in the Appendix. In the model, if women face higher barriers in a given occupation, only the most talented ones will enter that occupation and this selection effect may offset the direct negative effect on their earnings.

When focusing on STEM occupations, we can see that occupation and wage gaps were very high for women working as an *Architect, Engineer, Mathematician* or *Computer Scientist*. However, our STEM definition is broader and includes other science-related occupations such as *Health Related Professionals*, *Natural and Social Scientists* and also *All Technicians Working in STEM Occupations*.[5]

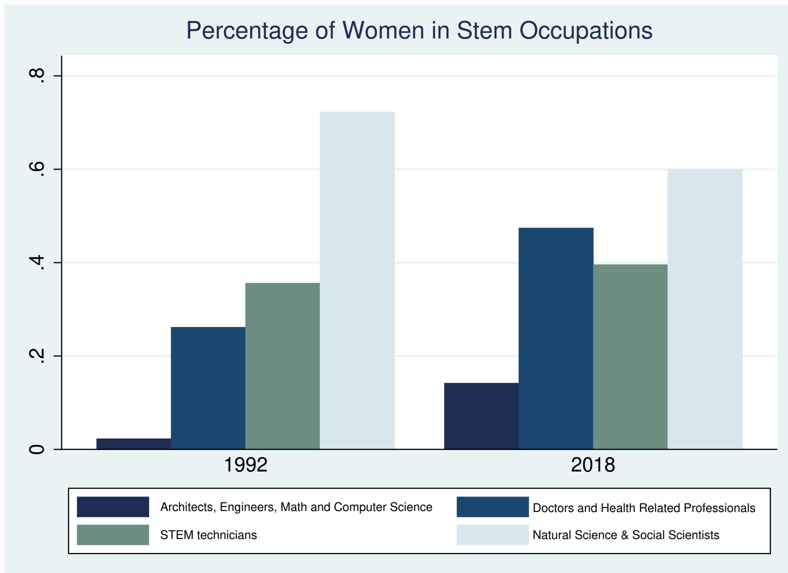
Out of the four occupation-clusters that we consider STEM, the percentage of women is above 50% in only one of them (Natural and Social Scientists). As we observe in Figure 2, in Mexico in 1992, 2% of Architects, Engineers, Mathematicians and Computer Scientists, 26% of Doctors and Vets, and 36% of STEM technicians were women. However, when we look at those percentages in 2018, we can see they significantly increased to 14%, 47% and 40%, respectively. It is also the case that in the Natural and Social Scientists cluster the percentage of women has fallen from 72% to 60%.

Figure 1: Wage Gaps Versus Propensities Across Occupations in 1992 in Mexico



[5] We define technicians as those performing technical and related tasks who do not hold a university degree.

Figure 2: Percentage Of Women in STEM Occupations in 1992 and 2018 in Mexico



4 Quantitative Results

4.1 Theoretical framework description

In this section we follow the framework by Hsieh et al. (2019) to study the aggregate effects of differences in labor market outcomes between groups (men and women). Their calculations are based on a version of the Roy (1951) model of occupational choice. The details of the model are presented in the Appendix.

Within the model, an individual is born with a range of talents across all occupations, and these talents are independent of their gender. As in McFadden (1974) and Eaton and Kortum (2002), the worker's idiosyncratic talent follows a multivariate Fréchet distribution. Individuals then choose their human capital investment and their occupation in an initial "pre-period" to maximize their intertemporal utility, given their talent and their group preferences or social norms towards a given occupation. As we show below, the model allows for differences in preferences or social norms to drive occupation differences across men and women. For example, there might have been stronger social norms against women working in STEM occupations in the 1990s than today.

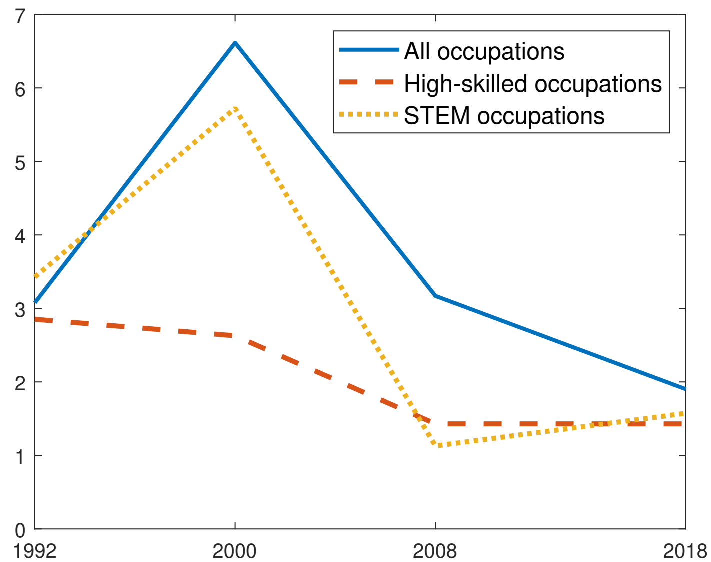
Individuals work in their chosen market occupation or in the home sector for three working life-cycle periods (young, middle, and old). Their intertemporal utility depends positively on the consumption level at each period and negatively on their schooling time. Consumption in each period equals after-tax earnings net of expenditures on education, which in turn depend on the innate talent and the acquired human capital. The barriers faced by women (τ) are modeled as taxes affecting all individuals in the group: labor market discrimination (τ^w) represents a tax on earnings, while barriers to human capital attainment (τ^h) are modeled as an additional cost associated with human capital accumulation expenditures. Aggregate output in the economy is produced by a representative firm, which hires workers in each occupation to maximize profits net of the utility cost of discrimination.

This setup implies that if an individual faces higher barriers in a given occupation, only the most talented ones will enter that occupation. On the other hand, if the barriers faced are lower, this results in "lower-quality" workers entering these jobs and, hence, lower earnings.

4.2 Estimated Barriers

As we can see in Figure 3, the simulation of our theoretical framework gives that women in Mexico faced important barriers in their labor market choices for the entire sample period, since the value of the composite occupational frictions (τ) is above one in all years. We can also see that the value of τ is significantly higher initially, and that most of the decline took place before the year 2008. Finally, we also observe that, in most years, barriers were significantly higher for STEM occupations than for high skilled occupations (defined as occupations that require a university degree) in general since the value of τ is significantly higher for STEM occupations in most years.

Figure 3: Earnings – Weighted Mean of Composite Frictions (τ) for Different Occupation Groups



4.3 Gains of Eliminating Barriers

The main goal of our quantitative exercise is to calculate the output gain associated with reducing talent misallocation between men and women in STEM occupations in Mexico in the period 1992-2018. Using the calculated differences in labor market outcomes by gender at the occupational level, we quantify the effects that these differences have on the country's aggregate output.

Intuitively, if all groups of individuals have the same innate talent distribution and the same preferences, we should observe the same proportion of workers and the same average earnings in all occupations. Differences across gender groups can then be interpreted as the result of barriers and restrictions that prevent workers in some groups from choosing the occupation where they have a comparative advantage. These restrictions distort the efficient allocation of talent and reduce aggregate output because, *ceteris paribus*, when one individual is not working in his/her best occupation, another one with less talent will take the job.

Table 2 shows the increases in output associated with eliminating τ^w and τ^h in STEM occupations. Columns (1) and (2) show the gains in Total Output which includes the home sector and Market Output.[6] In column (2) we add the effect of also eliminating social norms against women ($\tilde{z}$), which could be interpreted as making women have the same preferences as men towards STEM occupations.

We find important output gains when focusing on STEM occupations. When considering Total Output, eliminating τ^w and τ^h in STEM occupations results in an output gain of 2.0% in 1992, 12.8% in 2000, and 2.0% in 2018. Adding the effect of eliminating differences in social norms ($\tilde{z} = 0$) increases the output gains to 2.6% in 1992, 18.7% in 2000, and 3.3% in 2018. What is more, we observe higher gains in the year 2000, probably responding to a more important and developed STEM sector.

Furthermore, when considering market output (columns (3) and (4)), eliminating the barriers faced by women in STEM occupations results in even larger gains, given that the loss in market sector output is not taken into account.

Table 2: GDP gains of decreasing gender barriers in STEM Occupations in Mexico (%)

	Total Output		Market Output	
	$\tau = 0$	$\tau=0$, $\tilde{z}=0$	$\tau = 0$	$\tau=0$, $\tilde{z}=0$
Year	(1)	(2)	(3)	(4)
1992	2.0	2.6	2.5	4.0
2000	12.8	18.7	15.4	23.2
2008	2.1	2.8	2.8	4.7
2018	2.0	3.3	3.0	5.6

[6] Since there is no wage data for the home occupation, we assume that average earnings per person in the home sector for young men are equal to the weighted average of the earnings in two other clusters: Secretaries and Admin. Support, and Food and Cleaning Services.

Table 3: GDP gains of decreasing gender barriers in All Occupations in Mexico (%)

	All Occupations				High Skilled Occupations			
	Total Output		Market Output		Total Output		Market Output	
	$\tau = 0$	$\substack{\tau=0 \\ \tilde{z}=0}$	$\tau = 0$	$\substack{\tau=0 \\ \tilde{z}=0}$	$\tau = 0$	$\substack{\tau=0 \\ \tilde{z}=0}$	$\tau = 0$	$\substack{\tau=0 \\ \tilde{z}=0}$
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1992	26.5	30.5	33.2	40.7	8.3	13.5	10.0	17.3
2000	25.7	32.3	35.8	45.3	15.6	23.3	18.9	29.5
2008	10.8	21.1	21.9	36.0	5.0	8.3	6.6	12.6
2018	3.4	14.3	15.4	29.8	3.5	7.0	4.9	11.6

For comparison purposes, Table 3 shows the increases in output associated with eliminating τ^w and τ^h in "All Occupations" and in "High Skilled Occupations". Columns (1), (2), (5) and (6) show the gains in Total Output which includes the home sector, and columns (3), (4), (7) and (8) show the gains in the Market Output. In columns (2), (4), (6) and (8) we add the effect of eliminating also female-specific social norms $\tilde{z}$.

We find very important output gains both when contemplating "All Occupations" and only the "High Skilled Occupations". When considering Total Output, eliminating τ^w and τ^h results in an output gain of 26.5% in 1992, 25.7% in 2000, and of 3.4% in 2018. Adding the effect of eliminating social norms ($\tilde{z} = 0$) increases the output gains to 30.5% in 1992, 32.3% in 2000, and 14.3% in 2018. When analyzing the gains in Market Output we can see higher gains but with a similar behavior than for total output.

Since "High Skilled Occupations" are a subgroup of "All Occupations", they show lower gains in total and market output, but still significantly higher than in STEM Occupations (which are a much smaller subgroup). In all cases we observe larger gains when we eliminate the social norms captured by $\tilde{z}$.

5 Comparison with other Countries

The next two tables show the percentage of men and women working in STEM occupations for two years in Costa Rica and El Salvador. Unfortunately, due to data availability it's not possible at this point to show the figures for more years.

Table 4: Percentage of men and women in STEM occupations in Costa Rica

Years	Men	Women	All
2001	6.67	2.78	4.64
2010	8.28	2.93	5.54

Table 5: Percentage of men and women in STEM occupations in El Salvador

Years	Men	Women	All
1992	3.42	1.69	2.37
2015	3.68	2.84	3.21

For both countries we observe similar qualitative patterns as the one observed in Mexico, namely, that in every year the percentage of men working in STEM is clearly larger than the percentage of women in that field. for example, in Costa Rica, in 2001, 6.7% of adult men worked in STEM whereas only 2.8% of adult women did so. In El Salvador, for example, in 2015, the percentage of adult men in STEM was 3.7% while the figure was only 2.8% for adult women.

Moreover, as it was also the case in Mexico, the percentages of both men and women in STEM increased over time in both Costa Rica and El Salvador. For women in particular, the increase in Costa Rica was from 2.8% in 2001 to 2.9% in 2010. In El Salvador this percentage went from 2.4% in 1992 to 3.2% in 2015.

6 Result discussion and policy implications

6.1 Gender gaps in STEM for individuals with and without children

To understand better the origins of the gender differences observed, in this section we explore whether women with children are less likely to work in a STEM occupation. To do that we first need to identify individuals with children. This is not an immediate task in our datasets since the variable that indicates whether an individual is the son/daughter of another individual of the household does not tell us who the mother is. In order to find the mothers of young children

(17 or less) we then carry out the following procedure. First, we identify individuals younger than 18. Second, in households with a unique adult woman, we infer that these women are the mothers. Third, we consider households with more than one adult woman but eliminate anyone who is not being reported as "wife". This allows us to identify the remaining adult women as mothers of young children. This methodology gives as the percentage of adult men and women (ages between 25 and 54) with young children.

We next use our classification of STEM occupations to calculate the percentage (out of the entire sample) of men and women that work in STEM occupations and that also have young children. The results for our three countries are presented in Tables 6-8.

Table 6: Percentage of men and women in STEM with and without young children in Mexico

Years	Men in STEM with young children	Men in STEM without young children	Women in STEM with young children	Women in STEM without young children
1992	4.75	4.94	1.53	3.63
2000	4.79	5.96	1.88	2.43
2008	4.35	7.71	2.51	4.27
2018	5.22	8.46	2.61	5.37

For example, in the year 1992 in Mexico, 4.8% of the observations in our sample are men in a STEM occupation who also have young children, and 4.9% are men in a STEM occupation who do not have young children. While this difference is rather small among men, it becomes more relevant when we look at women: the percentage of women with children in a STEM occupation in our sample is 1.3% and 3.6% are women in a STEM occupation who do not have young children. Nevertheless, the difference between men in STEM with and without children increases over time while it remains relevant for women in STEM across years.

Tables 7 and 8 show the same calculations for Costa Rica and El Salvador, respectively. In both cases the patterns are qualitatively the same as those we observe in Mexico: both men and women without children are more likely to work in STEM occupations than those with young children. And across the board we still observe much lower figures for women than for men.

Table 7: Percentage of men and women in STEM with and without young children in Costa Rica

Years	Men in STEM with young children	Men in STEM without young children	Women in STEM with young children	Women in STEM without young children
2001	5.71	9.57	2.28	4.92
2010	6.58	11.46	2.13	5.10

Table 8: Percentage of men and women in STEM with and without young children in El Salvador

Years	Men in STEM with young children	Men in STEM without young children	Women in STEM with young children	Women in STEM without young children
1992	3.00	5.56	1.53	2.84
2015	3.32	4.70	2.13	5.35

Tables 6-8 illustrate several points. First, in all years the percentage of men in STEM and with young children is larger than the percentage of women in STEM and with young children. This suggests that young children represent a bigger barrier to enter STEM occupations for women than for men. One interpretation of this finding may be that STEM occupations are very demanding and time consuming and, given that women tend to be in charge of most household chores, very few of them can afford to work in these occupations when they have young children at home. Second, these percentages tend increase over time for women in all countries.

One caveat with the role played by young children in the household is that, in our sample, there are many types of households in terms of their family structure. For example, some of them have only one parent at home while others have elderly individuals living there. One may hypothesize that, for instance, single moms with young children are less likely to work in STEM occupations than non-single moms with young children. Similarly, it is likely that having a grandfather or grandmother at home may help taking care of young children and this may increase the likelihood that a woman ends up working in a STEM occupation. We have abstracted here from this detailed analysis of the composition of households, but we believe this is an area of potential interest in future research.[7]

6.2 Policy Implications

While the situation of women in the Mexican labor market has substantially improved since 1990 (López Marmolejo et al., 2020), we have shown above that gender gaps in STEM occupations are still substantial. López Marmolejo et al. (2020) also show marked improvements in the education gap between men and women in this period, but our results point out to substantial barriers in the accumulation of human capital of women in the STEM sector. These barriers are consistent with their Figure 2.5 that shows a pronounced gender bias in tertiary STEM graduates (see p. 29). As stated there, *"Given that STEM occupations tend to pay higher salaries and have a higher concentration of men, these early biases in career choice reinforce gender inequalities in the labor market, both with respect to occupation type and expected earnings (Bustelo et al., 2019). It is striking how many women with STEM degrees do not work in related professions, while those who are involved in research are concentrated in universities and government institutions, though underrepresented in the private sector (López-Bassols et al., 2018)*".

In this section we discuss several potential policy implications from our study. The first one has to do with the costs associated with the barriers that women face to enter STEM occupations and the second one is related to the differences in these costs between families with and without young children. Recall that the theoretical model used here identifies three types of barriers that a woman can face: a "tax" on her earnings, a "tax" on her education expenditures, and the social or cultural barriers/norms against women. Individuals choose their human capital investment and their occupation in an initial "pre-period" to maximize their intertemporal utility, given their talent and their group preferences or social norms towards who "should" work in a given occupation.

6.2.1 Barriers vs. Social Norms

Our results show that the costs associated with barriers to women's access to STEM occupations in Mexico during the period 1992-2018. The first type of

[7]Another strategy would be to estimate regressions for the likelihood that men and women work in STEM occupations as a function of the presence of young children at home and other factors. We leave this for future research.

explicit barriers faced by women in a given occupation appear once they have decided to work in that occupation. The most natural example of such a barrier is that a woman with the same occupation than a man receives a lower wage. It is also possible that a woman with the same education as a man has a lower probability of working in a given occupation. Social norms against women reflect the fact that a society's views of women create implicit barriers to the occupation that women end up choosing. For example, it may be socially unacceptable or undesirable for women to work in STEM occupations. We find that if barriers in STEM occupations were eliminated aggregate output would have been between 1% and 10% larger, depending on the year. If female-specific social norms were also eliminated, the rise in aggregate output would be between 1.4% and 14%.

These results suggest that, while both are important, the barriers faced by women in STEM occupations are more important than the social norms against women. For example, considering the lower bound of the estimates from the previous paragraph, the weight of these barriers is 71% (dividing 1 by 1.4).[8] One obvious implication of this calculation is that policies towards reducing these barriers are more urgent than those aiming to reduce social norms against women.

A naïf way to reduce these barriers would be to penalize firms that overtly discriminate against women in the STEM sector. This discrimination could potentially be identified by finding firms that pay lower wages to equally qualified women or that are less likely to hire a woman than a man that have the same qualifications for a given job. Naturally, since policymakers can only observe individuals who are hired and do not have information on the hiring process the latter is clearly unfeasible. Finding discrimination in wages is also complicated since, in practice, it is hard to find candidates with different gender and with the exact same qualifications. A more pragmatic and effective "carrot policy" would be to reward STEM firms that hiring women via subsidies.

Regarding policies to reduce social norms against women, policymakers could create programs that directly target young girls/women to receive education in STEM fields. A more indirect policy could be to educate the population about

[8] The upper bound of our estimates gives us the same weight, which is the result of dividing 10 by 14).

gender equality issues, with an emphasis on denying the myth that men are better fit for the STEM field than women.

6.2.2 Additional barriers for households with young children

As stated in López Marmolejo et al (2022), upon becoming mothers, many women often interrupt their education and careers to take maternity leave and subsequently look after the child. This often requires spending more time on unpaid activities.

In Section 5.1 of the paper we collect information on families with and without young children (ages below 18) and provide some statistics on their access to STEM occupations. Although the data on the number of children presents several challenges - discussed above- our general conclusion is that women in families with young children are significantly less likely to work in STEM fields.

A possible policy to alleviate this is to promote family-friendly legislation that expands maternity leave and/or allows for men to benefit from paternity leave programs. As shown in Bustelo et al. (2019), childcare policies that increase women's labor force participation could result in a permanent increase in GDP per capita of 6% as a result of such policies. Our results suggest that such policies could result in a much higher participation of women with young children in STEM jobs.

7 Conclusions

In spite of the substantial improvements for Mexican women in the labor market in the last two decades, gaps in STEM occupations are still large. In this paper we use the model of Hsieh et al. (2019) to interpret these gaps as reflecting barriers to women and social norms against them. We then calculate the aggregate costs associated with these barriers and norms.

Using data on occupations by gender for Costa Rica, El Salvador, and Mexico in recent years we observe significant gender gaps in STEM occupations. For Mexico, we simulate the theoretical model and find that if these barriers in STEM occupations were eliminated, aggregate output would have been between 1% and 10% larger, depending on the year. If female-specific social norms were also eliminated, the rise in aggregate output would be between 1.4% and 14%.

Additionally, we present results that suggest that both men and women with young children at home are less likely to work in STEM in all three countries, although women seem to be more penalized by this factor.

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8 Appendix

8.1 Theoretical framework

In this section we present a theoretical framework that will allow us to quantify the importance of the different constraints women face to achieve their comparative advantage and the impact that these constraints have at the aggregate level. Our main goal is to answer the question: How much productivity growth in these Central American countries is due to the improvement in the allocation of talent in specific occupations? We will calibrate the model for Costa Rica, El Salvador, and Mexico.

The model we use is based on Hsieh et. al. (2018), a general equilibrium model of occupational choice that allows them to study the aggregate effects of barriers in the labor market across different race and gender groups. Within the model, every person is born with a range of talents across all occupations, independently of their race or gender. As in McFadden (1974) and Eaton and Kortum (2002) the worker´s idiosyncratic talent follows a multivariate Fréchet distribution. If the labor market works efficiently, every worker would be able to choose the occupation where they get the highest utility given their talents.

In the model we allow for barriers such as discrimination, barriers to accumulation of human capital and social norms. The discrimination barrier will be modeled as a tax on the earnings of those workers who are discriminated, and barriers to the accumulation of human capital will be modeled as an extra cost on education. Our emphasis would be on barriers to working in STEM fields.

We also allow for social norms to drive occupational choice differences across groups. We understand social norms as those which lead women´s occupation choices towards home duties in a greater extent than men. Under the assumption that the distribution of innate talent for high skilled occupations is identical for whites, blacks, men and women, the previous figures shown suggest that there is substantial talent misallocation in STEM occupations. In other words, a substantial pool of innately talented women in these countries were not allowed to work in STEM occupations.

In what follows we briefly summarize the model from Hsieh et al. (2019), HHJK henceforth. We refer the reader to the original paper for more details.

8.2 Workers

The economy consists of a continuum of workers, each in one of M discrete sectors, one of which is the home sector. Workers are indexed by occupation i, group g (such as race and gender), and cohort c. A worker possesses heterogeneous abilities i or preferences $_i$ over occupations. Workers' innate talent is drawn from the same distribution for all gender and ethnic groups. this talent ϵ is assumed to follow a Fréchet Distribution.

Individuals invest in human capital and choose an occupation in an initial "pre-period." They then work in their chosen market occupation or in the home sector for three working life-cycle periods ("young," "middle," and "old"). We assume that human capital investments and the choice of occupation are fixed after the pre-period. A worker from group g and cohort c has a lifetime utility given by

$$logU = \beta \left[\sum_{t=c}^{c+2} logC(c,t) \right] + log[1 - s(c)] + logz_{i,g}(c) + log\mu$$

where $C(c,t)$ denotes consumption of cohort c in year t, s is time spent accumulating human capital is, $z_i g$ is the common utility benefit of all members of group g from working in occupation i, and μ represents the idiosyncratic utility benefit of the individual from the occupation. The parameter β measures the trade-off between lifetime consumption and time spent accumulating human capital.

$$C(t) = [1 - \tau^w_{i,g}(t)]w_i(t)\epsilon h_{i,g}(t) - e_{i,g}(c,t)[1 + \tau^h_{i,g}]$$

where

$$h_{i,g}(c,t) = \overline{h}_{i,g}\gamma(t-c)s_i(c)^{\Phi_i}e_{i,g}(c)^{\eta}$$

The previous equation shows that individuals acquire human capital in the initial period, and this human capital remains fixed over their lifetime. Individuals use time s and goods e to produce h, where $\bar{h}_{ig}$ captures permanent differences in human capital endowments and γ parameterizes the return to experience. We assume that γ is only a function of $age = t - c$ and that $\bar{h}_{ig}$ is fixed for a given group-occupation. $\bar{h}_{ig}$ reflects any differences in talent common to a group in a given occupation. Φ_i is the occupation-specific return to time investments in human capital, while η is the elasticity of human capital with respect to human capital expenditures. Each individual chooses the occupation where he/she obtains the highest utility given her talents and preferences.

8.3 Firms

A representative firm produces final output Y from workers in M occupations.

$$Y = \left[\sum_{i=1}^{M} (A_i H_i)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where $H_i = q_g p_{ig} \mathbb{E}[\epsilon_i]$ denotes the total efficiency units of labor in occupation i.

The representative firm hires H_{ig} in each occupation to maximize profits net of the utility cost of discrimination:

$$max\ U_{owner} = \left[\sum_{i=1}^{M} (A_i H_i)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} - \sum_i \sum_g (1 - \tau_{ig}^{w}) w_i H_i - \sum_i \sum_g d_{ig} H_{ig}$$

where d_{ig} is the employer's utility loss for employing workers from group g in occupation i.

8.4 Composite Occupational Frictions τ

In equilibrium, the fraction of women working in occupation i relative to men is given by

$$\frac{p_{ig}(c)}{p_{i,M}(c)} = \Big(\frac{\tau_{ig}(c)}{\tau_{i,M}(c)}\Big)^{\frac{-\theta}{1-\delta}} \Big(\frac{\overline{h}_{ig}}{\overline{h}_{i,M}}\Big)^{\frac{\theta}{1-\delta}} \Big(\frac{\overline{wage}_{ig}(c)}{\overline{wage}_{i,M}(c)}\Big)^{\frac{-\theta(1-\eta)}{1-\delta}} \tag{1}$$

On the other hand, the share of women in the home sector relative to men is

$$\frac{1 - LFP_g(c)}{1 - LFP_M(c)} = \Big(\frac{\overline{wage}_{ig}(c)}{\overline{wage}_{i,M}(c)}\Big)^{-\theta(1-\eta)} \Big(\frac{\tilde{z}_{ig}(c)}{\tilde{z}_{i,M}(c)}\Big)^{-\theta} \frac{p_{ig}(c)}{p_{i,M}(c)}^{\delta} \tag{2}$$

From (1) we can recover the parameter τ (given a relative $\overline{h}_{ig}$), while we can obtain z_{ig} from (2). Using this we are able to display in Figure 2 the evolution of composite occupational frictions τ over time. The main takeaway from the figure is that these frictions have significantly decreased over between 1992 and 2018.