Immigration and Gender Differences in the Labor Market

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This paper analyzes the effect of immigration on gender gaps in the labor market. Using an equilibrium structural model for the U.S. economy, I simulate the importance of two mechanisms: the differential labor market competition induced by immigration on male and female workers, and the availability of cheaper child care services. Consistent with the literature, aggregate effects on gender and participation gaps are negligible. However, female are more negatively affected by labor market competition, even though these effects are compensated from the cheaper-childcare effect. This generates heterogeneity in the effects along the skill distribution: gender gaps are increased at the bottom of the distribution and reduced at the top. Human capital adjustments are also heterogeneous.

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JEL Codes: *J16, J2, J31, J61.*

I. Introduction

Over the last half of century, most developed countries observed a surge in large scale immigration. At the same time, these economies experienced an increasing convergence of female wages and labor force participation towards the levels observed for males. Yet, gender gaps still remain large, and many governments undertake policies with the aim of closing them. Understanding the extent and mechanisms by which immigration can affect gender gaps in the labor market is, therefore, relevant in order to make governments' efforts effective.

There are two confronting forces by which immigrants can affect gender gaps. The first one is the differential increase in labor market competition experienced by males and females as a consequence of immigration. Given that male and fe-

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male workers have comparative advantage in different occupations, immigration can have different effects on them depending on who the most direct competitors of immigrants are. The second mechanism is through the impact of immigration on the prices of household services such as child care, which (in traditional societies) reduces the opportunity cost of female labor supply. Importantly, these two mechanisms not only influence labor supply decisions and wages contemporaneously, but they also influence career prospects and incentives to invest in human capital.

In this paper, I investigate the importance of the two mechanisms using a structural model for the U.S. labor market that can account for them. The structural model also allows for labor supply and human capital adjustments by natives and established immigrants. The model allows me to simulate the effect of immigration on gender gaps over the last half century, quantifying the importance of each channel. The main findings suggest that while the labor market competition effects increase gender wage and participation gaps substantially, the availability of cheaper child care compensates this initially negative effect on average, making overall aggregate effects negligible. However, there is an important degree of heterogeneity in these effects, and while gender gaps are reduced at some points of the skill distribution, they are substantially increased in others.

Building on the structural framework presented in Llull (2018a), the model consists of heterogeneous males and females that make yearly discrete decisions of labor supply and human capital accumulation. Every year, individuals decide to work in a blue collar or a white collar occupation, to attend school, or to stay home. These decisions affect the evolution of human capital: attending school increases education, and working increases occupation-specific experience. Labor force participation does not only depend on labor market prospects as there are also heterogeneous preferences for the different alternatives. On top of permanent and random idiosyncratic differences in preferences, the model takes into account the effect of preschool children on participation decisions, and accounts for gender-specific secular trends in preferences for home production.

Workers supply their labor to the market, and an aggregate firm combines blue collar and white collar skill units with capital equipment and structures to produce a single output. As noted by Llull (2018a), a relatively simple production function with these four inputs (two labor inputs and two capital inputs) together with the endogenous occupation decisions, generates a degree of "imperfect substitutability" between natives and immigrants comparable to estimates in the literature,

such as those in Ottaviano and Peri (2012).[1] Importantly, for the same reasons, the model also endogenously accounts for imperfect substitutability between male and female workers. Correctly allowing for the imperfect substitutabilities between male and female and between immigrants and natives is fundamental to correctly quantify the differential effects of immigration on male and female labor market prospects.

In equilibrium immigrants change the relative supplies of skills (and hence skill prices) and are assumed to affect female utility of staying home with preschool children in an amount that is consistent with other estimates in the literature. Different scenarios of capital adjustment are considered. As in Llull (2018a), I start by simulating the two extreme scenarios: no capital reaction (Borjas, 2003), and no interest rate adjustment (Ottaviano and Peri, 2012). These two extreme scenarios delimit the bands within which the *true* effects must lie. However, these bands are somewhat unsatisfactory, because they are too wide to be informative. For this reason, in my preferred scenarios I simulate an arguably realistic intermediate case in which I assume a unitary capital supply elasticity, consistent with perfect-foresight capitalists with log-consumption preferences.

Armed with aggregate data for the period 1967-2018, and parameter estimates from Llull (2018a), I simulate the counterfactual U.S. economy keeping the share of immigrants constant to 1967. In particular, I present two types of counterfactuals. First, I simulate a set of counterfactuals in which I assume that immigration does not influence childcare costs. These counterfactual scenarios describe the competition effect. They account for the different competition of immigrants on male and female workers, affecting relative skill prices and hence labor supply and human capital decisions. Then, I simulate a second set of counterfactuals in which I additionally let immigration affect childcare costs. Specifically, in this second set of counterfactuals I reduce the female home-utility parameter associated to preschool children (lower opportunity cost of working after childbearing) by an amount consistent with the estimated effect of immigration in reducing childcare costs provided by the estimates in Cortés (2008).

Comparing counterfactual simulations with baseline results, I quantify the effect of immigration on wages and human capital/labor supply decisions for both

[1] The estimates from the literature are based on different production functions that explicitly model natives and immigrants as imperfect substitutes. My model endogenously generates this result because natives and immigrants with the same education and age endogenously sort into different occupations. Specialization in different occupations is precisely the argument used in Peri and Sparber (2009) and Ottaviano and Peri (2012) to justify the need of allowing for imperfect substitutability between natives and immigrants. In my model, imperfect substitutability is generated endogenously, without the need of parameterizing it through a "black box" parameter.

males and females, and both at the aggregate level and along the native skill distribution. When only competition effects are accounted for, aggregate female wages and participation are more negatively affected than male counterparts. On average, female wages are reduced by around 1.4%, whereas male wages are only reduced by 0.4%. Participation rates are reduced by 1.6 and 0.6 percentage points respectively. However, when the effects on childcare costs are accounted for, wage effects are around 0.8–0.9% for both, and participation effects are around 0.6–0.8 percentage points. Therefore, when both mechanisms are taken into account, the aggregate effect on gender gaps is negligible.

Analyzing the effects on labor force participation along the native skill distribution, the overall effect is positive for the top 60% of the distribution, closing the gap in around one percentage point. However, the effect is very negative at the bottom quartile of the skill distribution, and especially at the bottom decile, where the participation gap is increased by more than 10 percentage points. This heterogeneity is also important to analyze the effect on wages. While the gender gaps on *observed* wages are negligible throughout the distribution, the gaps in *offered* wages are very large. This is so because the strong detachment of women at the bottom of the distribution reduces their human capital substantially, which would map into much lower wages had they decided to work.

The differential effects on wages along the native distribution reflect differential labor supply and human capital adjustments by male and female. The effects on higher educated male and female are not very different, and, if anything, they lead to higher participation of females relative to males when the effects of immigration on childcare costs are accounted for. At lower education levels, a larger fraction of female reduce their education as a consequence of their (expected) detachment from the labor market compared to low educated male. At the same time, however, also a larger fraction of them decide to increase their investment in education as a result of the lower childcare costs, and hence become both more likely to follow a white collar career and to become more active in the labor market.

This paper contributes to the growing literature that links gender differences in the labor market and immigration. Cortés (2008) shows that immigration affects prices of immigrant-intensive non-traded goods such as household related services. Using spatial variation and the standard shift-share instrument used in the immigration literature (e.g., see Card, 2001), she finds that a 10 percent increase in the share of low-skilled immigrants in the labor force reduces these prices by 2 percent. This estimate, combined with some estimates of childcare costs, is the basis for the computation of counterfactual home utility for females

in the simulations presented below.

Building on that paper, and using a similar source of variation, Cortés and Tessada (2011) analyze the effect of low-skilled immigration on average hours supplied by female in the labor market and on the probability that these women work long hours. These authors find that high skilled women (at the top quartile and, especially, top decile of the wage distribution) are more likely increase the number of hours they supply conditional on working, and they are more likely to work more than 50 hours per week. These effects are smaller and/or insignificant at the bottom of the distribution. They are also smaller/insignificant for the extensive margin because labor force participation in this skill segment is already large. Perhaps the most relevant difference with respect to the current paper is that, by focusing on the effect of low-skilled immigration, Cortés and Tessada (2011) abstract, to some extent, from the competition effect. They also abstract from the human capital adjustments, difficult to capture using spatial variation.

Cortés and Pan (2019) update the results in Cortés and Tessada (2011) and explore the mechanisms. Their results suggest an important role for job-switching behavior (within and across occupations, especially for young high-skilled women) and heterogeneity of effects depending on spousal propensity to work longer hours. The results below include the occupation adjustment mechanism to the extent that it is captured by broad occupation groups, but abstracts from within-occupation job switches and spousal labor supply behavior. Results below suggest that, for women, these occupation adjustments are particularly important for women who, in the absence of the observed increase in immigration, would be low educated. With immigration, these women become more likely to increase their white collar experience, and also to undertake further education. An important part of these effects are driven by the higher likelihood of keeping active in the labor market after childbearing.

Several papers have found similar results for other countries. Using data for Spain, Farré, González and Ortega (2011) find that female immigration increases the labor supply of high skilled women, allowing them to return from their maternity leave earlier after childbirth, and to continue working while caring for elderly dependents. Barone and Mocetti (2011) analyze the case of Italy, for which they find important effects at the intensive margin for high skilled women but negligible effects on the labor force participation decision. Cortés and Pan (2013) analyze the effect of the availability of foreign domestic workers in Hong Kong on female labor force participation. Exploiting a policy change in 1970s, they find that the inflow of such domestic helpers increased labor supply of women with

young children by 10 to 14 percentage points. Forlani, Lodigiani and Mendolicchio (2015) corroborate the results at the intensive margin for high skilled women using a cross-country harmonized dataset, and find positive effects at the extensive margin for low-skilled.

In a series of papers, Furtado and Hock (2010) and Furtado (2015a,b, 2016) go a step further and analyze whether the availability of cheaper child care increases fertility. In the different papers, they find that immigrant inflows are associated with a higher probability of having a child, especially for married and high skilled women. This rise in childbearing, however, was coupled with an increase in exits from the labor force. Despite that, it increased the joint probability of having a child and participating in the labor market, weakening the link between childbearing and labor force participation. Using German data, Forlani, Lodigiani and Mendolicchio (2020) find that higher immigration is associated to an increase in the probability of having a child, increases the number of hours worked by female, especially for high skilled women. Posing endogenous growth models, Ehrlich and Kim (2015) and Ehrlich and Pei (2020) show how fertility and human capital evolve in origin and destination countries under different immigration policies. The mechanisms in these models stem from the balanced growth paths in origin and destination countries under the different policies, and not necessarily from a direct effect on the availability of childcare. My paper abstracts from endogenous effects on fertility. If one were to model endogenous childbearing decisions, the model would be able to embed the mechanisms in Furtado and Hock (2010) and Furtado (2015a,b, 2016): a potential increase in fertility driven by the reduction in the expected cost of having children, an increase in exits from the labor force driven by the competition effects, and an increase in the joint likelihood of having children and working because the reduction in childcare costs is only materialized when women work. The model would also generate an adjustment in the human capital decisions as a result of the changes in fertility. Further extensions would be needed for the model to account for the mechanisms in Ehrlich and Kim (2015) and Ehrlich and Pei (2020) because it would require endogenously modeling origin country decisions of fertility, human capital formation, and migration.

Fewer papers have analyzed the labor market competition channel. Using data for Spain, Amuedo-Dorantes and de la Rica (2011) find that immigration reduces the relative supply of manual intensive tasks of female by twice as much as it reduces it for males. These authors argue that this could be the result of stronger competition on females and/or of females in a given occupation having less job-specific human capital and more education than men. This result is in

line with the predictions of my model when only the competition effect is taken into account. Focusing on the nursing sector, Cortés and Pan (2014, 2015) provide evidence of large displacement effects on native nurses. Edo and Toubal (2017) show that, in France, a 10% increase in the relative supply of immigrant female workers lowers relative wages of female workers by 4%. The latter is driven by the imperfect substitutability between male and female labor in production, which is also present in my model. These authors model this imperfect substitutability explicitly through a parameter in the production function. My model endogenously generates it through occupational choice because (native and immigrant) males and females specialize in different occupations. Overall, these four papers abstract from both human capital adjustments by natives and abstract from the potential effects through the availability of cheaper household services. Moreover, they focus on the direct competition by female immigrants, abstracting from the effects from male immigration.

Finally, this paper is also related to the literature on general labor market impacts of immigration (see Dustmann, Schönberg and Stuhler, 2016; Peri, 2016; The National Academy of Sciences, 2017; Fasani, Llull and Tealdi, 2020 for recent surveys). This literature has generally either focused exclusively on men (Borjas, 2003; Manacorda, Manning and Wadsworth, 2012; Llull, 2018b) or it has provided results for male and female together (Ottaviano and Peri, 2012; Dustmann, Frattini and Preston, 2013; Dustmann, Schönberg and Stuhler, 2017; Monràs, 2020). One exception is Llull (2018a), who provides results for male and female. However, unlike the current paper, these results do not take into account the potential effect through the prices of childcare. Overall, this literature is uninformative on the effects on gender gaps.

Over and above analyzing the effects on gender gaps, the current paper also provides an additional contribution to this strand of the literature. In particular, it provides simulations for an arguably reasonable intermediate case for capital adjustment when simulating counterfactuals. The micro literature has focused on the two extreme assumptions presented in Borjas (2003) —capital does not adjust— and Ottaviano and Peri (2012) —interest rate does not adjust.[2] Borjas (2013) and Dustmann, Schönberg and Stuhler (2016) formally show the importance of these assumptions in determining the simulated effects of immigration. The unit elasticity of capital supply is theoretically appealing because it is in line with a log-consumption utility for the representative capitalist (often used

[2] Some papers in the macro literature have treated physical capital as endogenous (e.g., see Ehrlich and Pei, 2020)

in heterogeneous agents macro models, such as Busch, Krueger, Ludwig, Popova and Iftikhar, 2020), and empirically plausible as it is in the same ballpark as the back-of-the-envelope value implied by the estimates in Llull (2020b).

The remainder of the paper is organized as follows. Section II provides some descriptive evidence that correlates immigration and gender wage and participation gaps. Section III provides an overview of the model, which is mostly based on Llull (2018a). Section IV discusses the parameterization of the model and its goodness of fit in and out of sample. Finally Section V presents the results of counterfactual simulations before concluding in Section VI.

II. Motivating Evidence

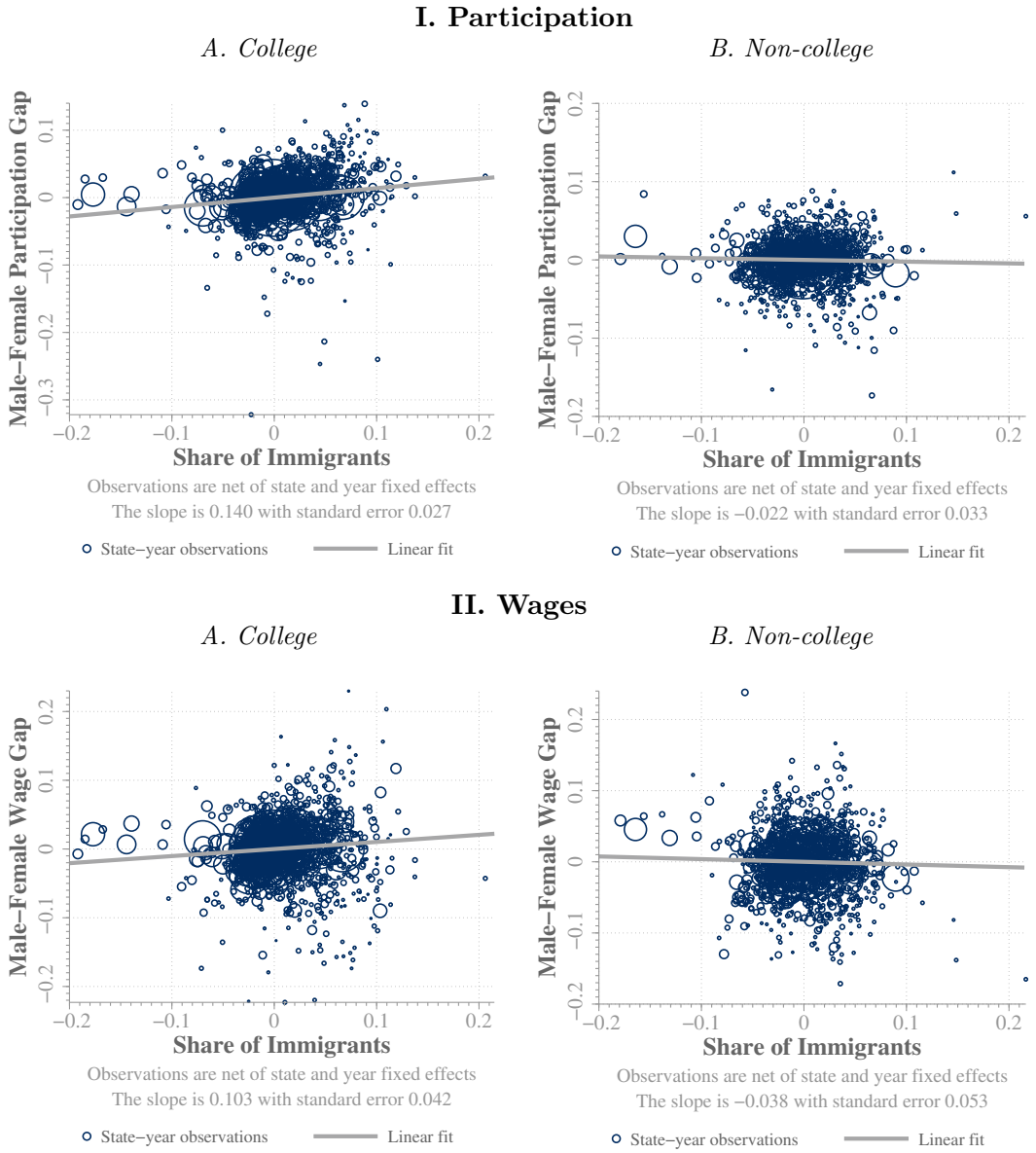
Using variation across metropolitan areas, this section illustrates the link between immigration and gender gaps. Using data from the U.S. Census and American Community Survey (Ruggles et al., 2020) for the years 1960, 1970, 1980, 1990, 2000, 2005-2010, and 2013-2018, I present cross-metro area correlations between immigration and male-female gaps in wages and labor force participation.[3]

Figure 1 shows the correlation between native gender gaps and overall immigration controlling for metropolitan area and year fixed effects. Circles indicate metro area-period observations, and the gray line is the regression line. This correlation, potentially contaminated by the endogeneity of immigrant decisions, captures the combination of the competition effect and the cheaper-childcare effect. For non-college workers, the figure shows no significant slope for both wage gaps (the regression coefficient is -0.038, and the standard error is 0.053) and participation gaps (-0.022, s.e. 0.033). For college workers, it shows a positive and significant slope both for wage (0.103, s.e. 0.042) and participation (0.14, s.e. 0.027) gaps, which suggests that gender gaps are larger in metro area-periods where there are more immigrants. As I discuss below, these differences capture a different set of effects that are difficult to disentangle from spatial correlations.

A small step in this direction is to divide immigrants by education group, which indirectly can be more related to the competition and childcare-cost-reduction effects. Controlling for immigration from the cross-groups, own-group correlations (that is, non-college immigration for non-college natives and college immigration for college natives) is informative of the competition effect, whereas cross-group correlations shed light on relative complementarities and, in the case of the correlations of non-college immigration with college native outcomes, the effect through

[3] The patterns using state instead of metropolitan area variation are essentially unchanged.

FIGURE 1. SPATIAL CORRELATION: GENDER GAPS AND IMMIGRATION

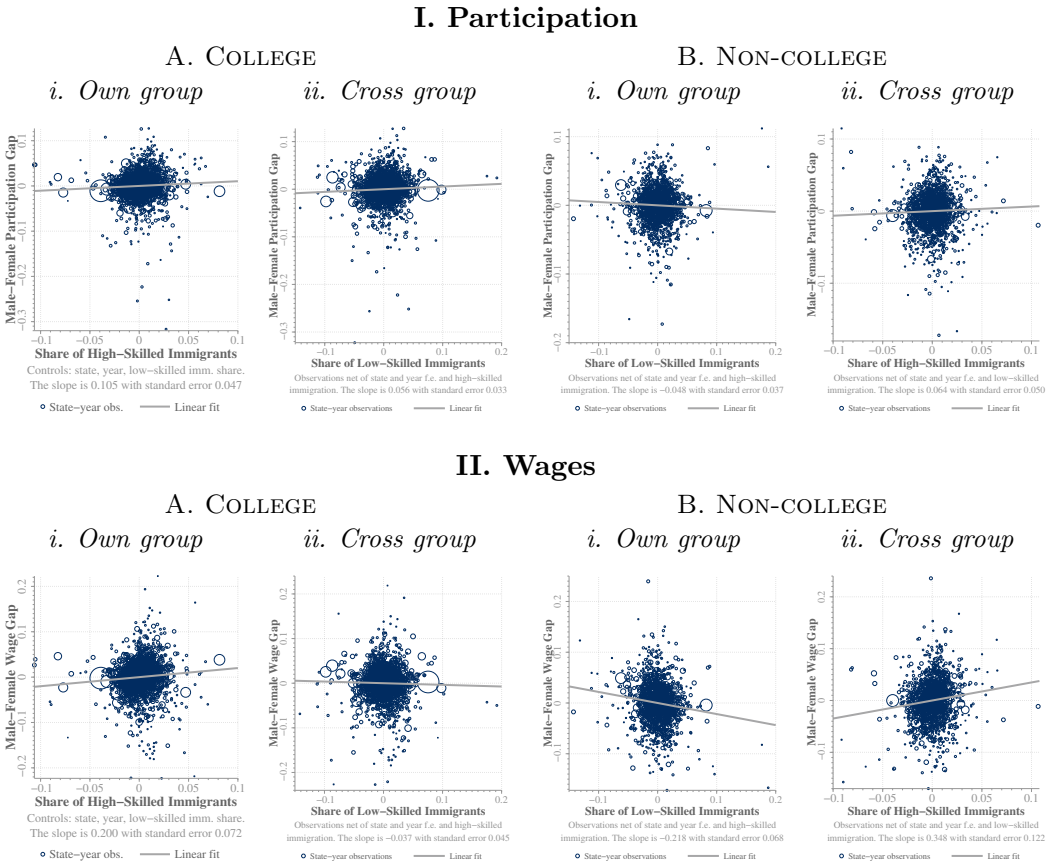


Note: Circles represent state-year observations. Periods include 1960, 1970, 1980, 1990, 2000, 2005-2010, and 2013-2018. All observations are net of state and year fixed effects and use the number of observations in the cell as weights (circle size indicates weight). Immigrant shares include all immigrants (college and non-college). Represented gaps are male-female gaps, that is, a larger value indicates that the value for male is larger than the value for female. These gaps are computed for native workers only. The observation for Alaska-1960 is excluded from the scatters for wages (outlier), but included in the fitted regression.

the cheaper provision of childcare services.

Figure 2 presents these correlations. Each plot represents the partial correlation implied by a regression of the corresponding gender gap (participation or wage gaps) and the shares of low-skilled (non-college) and high-skilled (college) immigration in the metro area-year, controlling for metro area and year fixed effects. For college workers, immigration of college individuals, controlling for non-college

FIGURE 2. GENDER GAPS AND SKILLED VS UNSKILLED IMMIGRATION



Note: Circles represent state-year observations. Periods include 1960, 1970, 1980, 1990, 2000, 2005-2010, and 2013-2018. All observations are net of state and year fixed effects, and control for the share of immigrants in the non-represented group. They use the number of observations in the cell as weights (circle size indicates weight). Represented gaps are male-female gaps, that is, a larger value indicates that the value for male is larger than the value for female. These gaps are computed for native workers only. The observation for Alaska-1960 is excluded from the scatters for wages (outlier), but included in the fitted regression.

immigration, is associated to larger participation (0.105, s.e. 0.047) and wage (0.2, s.e. 0.072) gaps. This result suggests that labor market competition induced by high skilled immigrants is stronger for women than for men, which leads to a lower labor force participation and lower wages. On the contrary, immigration of low-skilled workers does not seem to be associated with either of the two gaps (0.056, s.e. 0.033, and −0.037, s.e. 0.045). This result is not in contradiction with, for example, Cortés and Tessada (2011), who find that most of the cheaper-childcare effect occurs through hours worked (as opposed to the extensive margin), because labor force participation of high skilled women is already large.

Results for non-college workers are also interesting. The correlation of own and cross immigration with gender participation gaps are insignificant (−0.048, s.e. 0.037, and 0.064, s.e. 0.05). This does not mean that immigration is not correlated with labor force participation, but rather that the correlation is the same for male

and female participation. The correlations with wage gaps are significant. A larger share of immigrants in the low-skilled group is associated with lower gender wage gaps (-0.218, s.e. 0.068), suggesting that low skilled immigrants pose more competition on native males than on native females (plausible since low-skilled immigrants tend to work in blue collar occupations). The cross-correlation is positive and large (0.348, s.e. 0.122), which suggests a role for complementarities.

Overall, these correlations are informative for the discussion below.[4] The differential competition effects on males and females are ambiguous, and hard to disentangle, and while the indirect evidence of the childcare cost channel seems to suggest this effect is positive but small, it is complicated to extract general conclusions from these correlations. Moreover, as noted above, these spatial correlations are potentially contaminated by endogeneity of immigrant inflows. The structural model presented below allows me to overcome these problems.

III. A Labor Market Equilibrium Model for the U.S. Economy

The model economy in this paper closely follows Llull (2018a). In the following lines, I provide a brief description, and readers can refer to Llull (2018a) for a more detailed discussion about the justification for the different modeling choices. The economy consists of a labor market, characterized by cohorts of hand-to-mouth finitely-lived workers that make yearly decisions on education, occupation, and participation; a capital market, specified outside of the model (and for which I make different assumptions for different counterfactuals); and an aggregate firm that combines the different capital and labor inputs to produce a single output. Economy-wide aggregate shocks allow for Hicks neutral technological progress and business cycle fluctuations. Skill-biased technical change is generated by the evolution of the relative price of equipment in the presence of capital-skill complementarity (embedded in the observed accumulation of capital equipment and structures), as in Krusell, Ohanian, Ríos-Rull and Violante (2000). Agents are rational and forward-looking, and they make optimal decisions maximizing their lifetime discounted utility subject to the information available to them at each point in time. In equilibrium, skill prices clear the labor market, and interest rates are assumed to clear the capital market. The immigration process is specified outside of the model, but it is allowed to endogenously react to the aggregate conditions in the United States. The design of the different simulations determines

[4] In additional specifications, available from the author upon request, I control for the male-female ratio among immigrants. This ratio is uncorrelated with gender and participation gaps at all levels, and do not change any of the results presented above.

the counterfactual size of migration flows, and composition is assumed to be policy invariant, which is consistent with the evidence provided in Llull (2018a).[5]

A. Labor supply and human capital decisions

Let $a \in \{16, ..., 65\}$ denote age, and let t denote calendar time.[6] Every year, workers decide on education, occupation, and participation. Immigrants enter the United states at age $\tilde{a}$ and start making decisions upon arrival, solving maximization problem analogous to that of natives. Individuals are forward-looking and discount the future by β, the subjective discount factor. They are rational, but they face uncertainty about future aggregate and idiosyncratic shocks. At time t, they all share the same information about aggregate conditions, denoted by ϖ_t. Workers are hand-to-mouth, so they consume all their income every period. Their utility is assumed to be linear in consumption (and additive in other amenities). The utility parameters associated to the non-working utilities embed an implicit level of consumption associated to each of these alternatives.

Every year, individuals decide whether to attend school (S), to stay home (H), or to work in the blue collar (B) or white collar (W) occupations. Let d_{ja} denote an indicator variable that equals one if the individual chooses j, for $j \in \mathcal{J} \equiv \{B, W, S, H\}$. These choices are mutually exclusive, so that $\sum_{\mathcal{J}} d_{ja} = 1$. The state variables include a vector of idiosyncratic observable variables, x_a, a vector of idiosyncratic taste and productivity shocks, $\varepsilon_a \equiv (\varepsilon_{Ba}, \varepsilon_{Wa}, \varepsilon_{Sa}, \varepsilon_{Ha})'$, the vector of aggregate skill prices r_t, and the aggregate information ϖ_t. The vector of observable variables includes gender, indexed by g, immigrant/native status, indexed by i, the number of years of education E_a, the number of years of experience in blue-collar and white-collar (U.S.-based) occupations, X_{Ba} and X_{Wa}, the number of preschool children n_a, and, for immigrants, age at entry, $\tilde{a}$, and region of origin ℓ. The set of regions of origin includes Western Countries, Latin America, and Asia/Africa. Age evolves trivially, increasing in one year every period. Education and experience in each occupation increase by one year every time education or working in the corresponding occupation is respectively selected. The number of children evolves stochastically, with a process that depends on gender, age, education, calendar time, and the current number of children.[7] The vector

[5] In particular, Llull (2018a, Figure 3, p. 1879) shows that while the size of immigrant inflows correlates with the realizations of the aggregate shock (over the period 1993 to 2007), the composition follows an aggregate trend that is invariant to these shocks.

[6] For a given individual, a and t are colinear. Therefore, in what follows, I use the subscript a for idiosyncratic variables, whereas t is used to index aggregates.

[7] This assumption allows for fertility to adjust to immigration indirectly through the changes

ε_a is independently and identically joint-normally distributed with zero mean and gender-specific variance Σ_g, given by:

$$\Sigma_g \equiv \begin{pmatrix} \sigma^2_{Bg} & \rho_{BW}\sigma_{Bg}\sigma_{Wg} & 0 & 0 \\ \rho_{BW}\sigma_{Bg}\sigma_{Wg} & \sigma^2_{Wg} & 0 & 0 \\ 0 & 0 & \sigma^2_{Sg} & 0 \\ 0 & 0 & 0 & \sigma^2_{Hg} \end{pmatrix}. \tag{1}$$

All other idiosyncratic variables are fixed over time.

When workers decide to supply their labor to occupation j, they are paid a market price r_{jt} for each unit of skills they supply. Skill units, denoted by $s_{ja}(x_a, \varepsilon_a)$, are specified in a log-linear way, as in Mincer (1974):

$$\begin{aligned} &\ln s_{ja}(x_a, \varepsilon_{ja}) \equiv \\ &\quad \omega_{0j}(g,\ell) + \omega_{1j}(i)E_a + \omega_{2j}X_{Ba} + \omega_{3j}X^2_{Ba} + \omega_{4j}X_{Wa} + \omega_{5j}X^2_{Wa}\omega_{6j}(\tilde{a} - E_a) + \varepsilon_{ja}, \end{aligned} \tag{2}$$

where I define $\ell \equiv 0$ for natives, and I noramlize $\omega_{0j}(g,0) \equiv 0$ for male.

Workers make optimal decisions to maximize lifetime discounted utility. Let $u_j(x_a, \varepsilon_{ja}, r_t)$ denote the per-period flow utility. Appealing to Bellman's principle, the maximization problem solved by workers in the United States can be recursively expressed with the following equation:

$$\begin{aligned} &V_a(x_a,\varepsilon_a, r_t, \varpi_t) = \\ &\qquad \max_{\{d_{ja}\}_{j\in\mathcal{J}}} d_{ja}\{u_j(x_a, \varepsilon_{ja}, r_{jt}) + \beta\, \mathbb{E}[V_{a+1}(x_{a+1}, \varepsilon_{a+1}, r_{t+1}, \varpi_{t+1})|d_{ja}, a, x_a, \varpi_t]\}, \end{aligned} \tag{3}$$

where $\mathbb{E}[\cdot]$ denotes expectation. In the expected continuation value, only children, idiosyncratic shocks, and future skill prices are unknown, as the other elements of x_{a+1} are completely determined by the choice made by the individual. Future idiosyncratic shocks are unpredictable, x_a and d_{ja} are sufficient statistics for the number of children, and ϖ_t is, by definition, a sufficient statistic for future aggregate conditions, including r_{t+1} and ϖ_{t+1}. The alternative-specific flow utilities are defined as:

$$u_j(x_a, \varepsilon_{ja}, r_{jt}) \equiv \begin{cases} r_{jt}s_{ja}(x_a, \varepsilon_{ja}) + \vartheta_{BW}(g)d_{Ha-1}, & \text{if } j \in \{B, W\}, \\ \vartheta_{0S}(g,\ell) + \vartheta_{1S}(g)d_{Sa-1} - \tau(E_a) + \varepsilon_{Sa}, & \text{if } j = S, \\ \vartheta_{0H}(g,\ell) + \vartheta_{1H}(g)n_a + \vartheta_{2H}(g)t + \varepsilon_{Ha}, & \text{if } j = H, \end{cases} \tag{4}$$

where the tuition function $\tau(\cdot)$ is given by $\tau(E_a) \equiv \tau_1\, \mathbb{1}\{E_a \geq 12\} + \tau_2\, \mathbb{1}\{E_a \geq 16\}$.

in education. However, the fertility process is kept policy invariant in the counterfactuals and, hence, fertility is not allowed to adjust to immigration once we condition on education. In particular, once education is fixed, fertility is invariant to changes in skill prices or childcare costs.

This modeling approach includes the most important features to analyze the effects of immigration on wages taking into account human capital and labor supply adjustments, as discussed in Llull (2018a). For example, it accounts for downgrading at arrival, in line with Dustmann, Frattini and Preston (2013), because the returns to domestic and foreign education and experience differ. It also generates immigrant assimilation as immigrants accumulate domestic experience, in the spirit of LaLonde and Topel (1992) but subject to equilibrium competition as in Albert, Glitz and Llull (2020). All these elements, together with the dependence of some parameters on the region of origin, determine comparative advantage of natives and immigrants in different occupations which, as discussed in Llull (2018a), which ultimately determines the degree of imperfect substitutability between natives and immigrants.[8]

The model includes important features that are relevant for the question addressed in this paper. First, the comparative advantage of males and females in different occupations endogenously generate imperfect substitutability between males and females, which ultimately can generate different effects on their labor market outcomes. It is this imperfect substitutability what generates differential competition effects on males and females. Furthermore, the home utility parameters $\vartheta_{1H}(g)$ and $\vartheta_{2H}(g)$ embed two important drivers of gender differences. The first one determines the increase in utility of staying home by males and females when preschool children are present. This parameter is changed in one set of counterfactual exercises to capture the effect of immigration on the prices of childcare services. The second one captures secular changes in social norms, capturing the gradual process of moving away from a society with "traditional" gender roles.

In order to keep the model tractable, I make three simplifications that are worth mentioning. First, I abstract from endogenously modeling fertility decisions. As I discuss in the introduction, different papers suggest that immigration has a positive effect on fertility. While I discuss the implications for the results in more detail below, broadly speaking an increase in fertility would tend to mitigate the cheaper-childcare effect. Second, there could be a feedback effect on the skill composition on immigrant flows. The availability of cheaper childcare could make migration of high skilled workers more attractive, which could strengthen the competition effect. Allowing for such adjustments would require modeling migration decisions, which would make the model unfeasible.[9] Finally, I abstract

[8] Llull (2020a) allows for knowledge spillovers from immigrant and native high skilled workers on the different occupations. I abstract from this channel here.

[9] See Kennan and Walker (2011) and Lessem (2018) for two dynamic discrete choice mi-

from modeling the childcare services sector to endogenously generate the childcare-cost effect within the structure of the model. While this simplification takes out some internal consistency in the counterfactual simulations in terms of the model, it is less problematic than the other two because, as I discuss below, the design of the counterfactual experiments is designed to capture the equilibrium effects on childcare costs based on empirical estimates in the literature.

B. Aggregate firm problem

The production structure is determined by an aggregate firm that combines blue collar and white collar labor with equipment capital and structures to produce a single output. The aggregate firm determines input demands by solving a fairly standard static profit maximization problem. Let S_{Bt} and S_{Wt} denote the total amount of aggregate skill units supplied by workers in blue collar and white collar occupations. Let K_{Et} and K_{St} respectively denote equipment capital and structures. Let z_t denote a Hicks-neutral productivity shock. The aggregate firm produces output Y_t using the following production technology:

$$Y_t = z_t K_{St}^{\psi} \left\{ \alpha S_{Bt}^{\rho} + (1-\alpha) \left[\theta S_{Wt}^{\gamma} + (1-\theta) K_{Et}^{\gamma} \right]^{\frac{\rho}{\gamma}} \right\}^{\frac{1-\psi}{\rho}}. \tag{5}$$

The aggregate shock process is given by:

$$\Delta \ln z_{t+1} = \phi_0 + \phi_1 \Delta \ln z_t + \zeta_t, \qquad \zeta_t \sim i.i.d.\ \mathcal{N}(0, \sigma_z^2). \tag{6}$$

This production function allows for imperfect substitutability between males and females (and between natives and immigrants), which is crucial to correctly identify the competition effect. This imperfect substitutability is endogenously generated by the imperfect substitutability between the blue collar and white collar labor inputs and the different (endogenous) propensity of males and females (and natives and immigrants) to work in the different occupations.[10] Furthermore, the production function accounts for skill-biased technical change embedded in the exogenous fall in the relative prices of equipment capital together with capital-skill complementarity, as in Krusell, Ohanian, Ríos-Rull and Violante (2000).

The cost function for the aggregate firm consists of the aggregate wage bill, $r_{Bt}S_{Bt} + r_{Wt}S_{Wt}$, and the aggregate return to capital, $r_{Et}K_{Et} + r_{St}K_{St}$. The input

croeconometric models of migration decisions, and Ehrlich and Kim (2015) and Ehrlich and Pei (2020) for (macro) endogenous growth models with human capital formation, and endogenous fertility and migration decisions.

[10] Llull (2018a) shows this production function endogenously generates imperfect substitutability levels between natives and immigrants similar to those encountered in the literature (e.g. Ottaviano and Peri, 2012) as a result of the endogenous propensity of natives and immigrants to work in different occupations.

demands are given by the first order conditions on the maximization problem, and equalize rental prices $(r_{Bt}, r_{Wt}, r_{Et}, r_{St})'$ to the vector of marginal productivities for each of the inputs.

C. *Expectations about future aggregate variables*

Given the presence of idiosyncratic and aggregate shocks, solving for the rational expectations equilibrium is unfeasible because it requires incorporating the entire distribution of idiosyncratic variables in the state (e.g., see Krusell and Smith, 1998; Lee and Wolpin, 2006; Llull, 2018a, 2020a). Alternatively, I assume that there are quasi-sufficient statistics that summarize most of the relevant information to predict them without the need. In particular, following Lee and Wolpin (2006) and especially Llull (2018a), I assume that skill and capital prices in the United States are well approximated by:

$$\Delta \ln r_{jt+1} = \eta_{0j} + \eta_{1j} \Delta \ln r_{jt} + \eta_{2j} \Delta \ln z_{t+1}, \quad \text{for } j \in \{B, W\}. \tag{7}$$

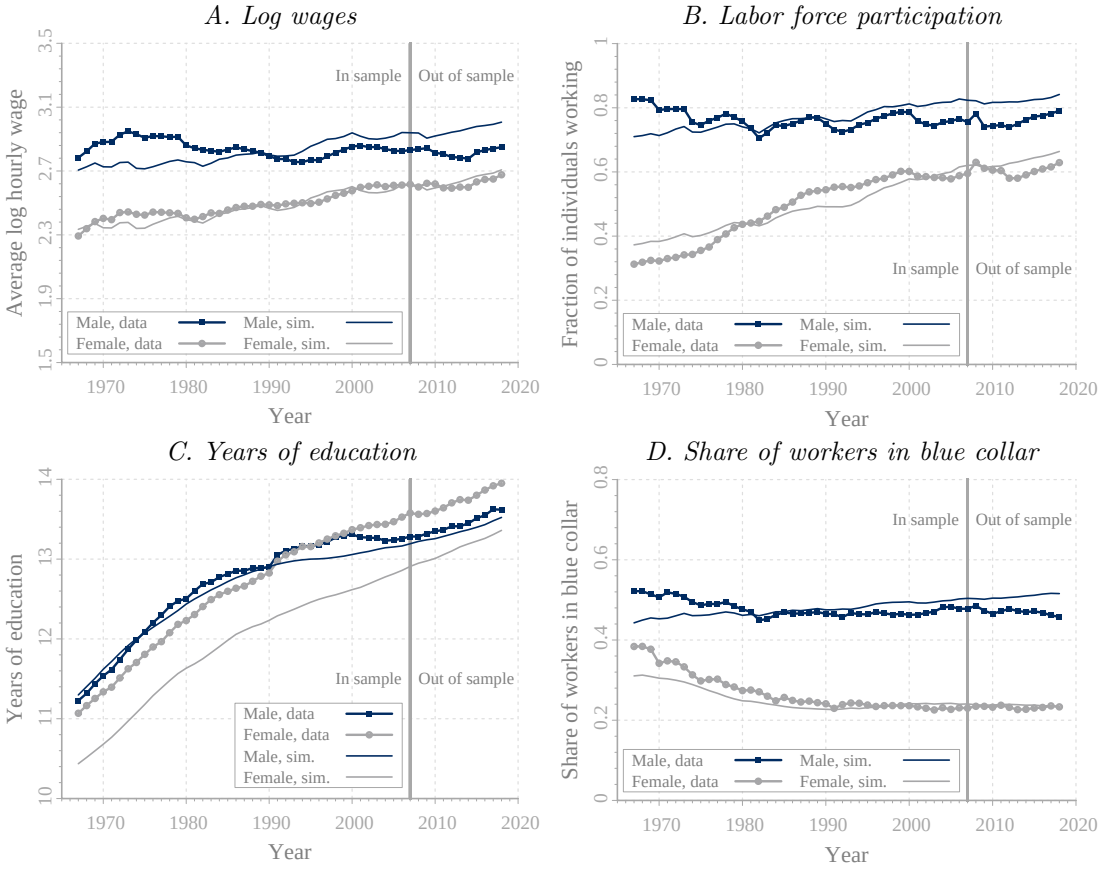
This approximation implies that ϖ_t only includes the relevant skill prices and the current realization of the aggregate shock. The coefficients $\{\eta_{0j}, \eta_{1j}, \eta_{2j}\}_{j \in \{B,W\}}$ are not fundamental parameters of the model. Instead, they are part of the model solution. As such, they are implicit functions of the fundamental parameters.

Llull (2018a) shows that, for blue collar and white collar wages, this process can explain 99.9% of the variation in skill prices. This result, however, does not imply perfect foresight, as z_{t+1} is unknown at time t. Indeed, Llull (2018a) obtains that, with the information available at t, individuals are only estimated to predict around 22% of the $t+1$ variation in skill prices.

D. *Equilibrium*

The market structure of this economy is as follows. The labor supply is given by the optimal solution to the worker's problem in each period and by the optimal migration decisions (specified outside of the model). The supply of assets is determined by the unspecified optimal decisions of capitalists. Factor demands are determined by the first order conditions of the firm's problem, which equalize prices to marginal products. The labor market clears, providing a job to all workers willing to work at the offered skill price. The equilibrium is given by the skill prices and capital prices that equalize supply and demand. Individuals form expectations about future skill and asset prices using the vectors $\{\eta_{0j}, \eta_{1j}\}_{j \in \{B,W\}}$ such that they make prediction errors equal to zero in expectation given (7).

FIGURE 3. GOODNESS OF FIT: AGGREGATES



Note: Lines in the top two plots represent aggregate data and predicted counterparts from the model. The data are obtained from the Bureau of Economic Analysis. Lines in the remaining plots represent averages of individual outcomes. Data averages are obtained from the the March Supplements of the CPS. These averages are computed for individuals aged 25 to 54 years.

IV. Parameterization and Model Fit

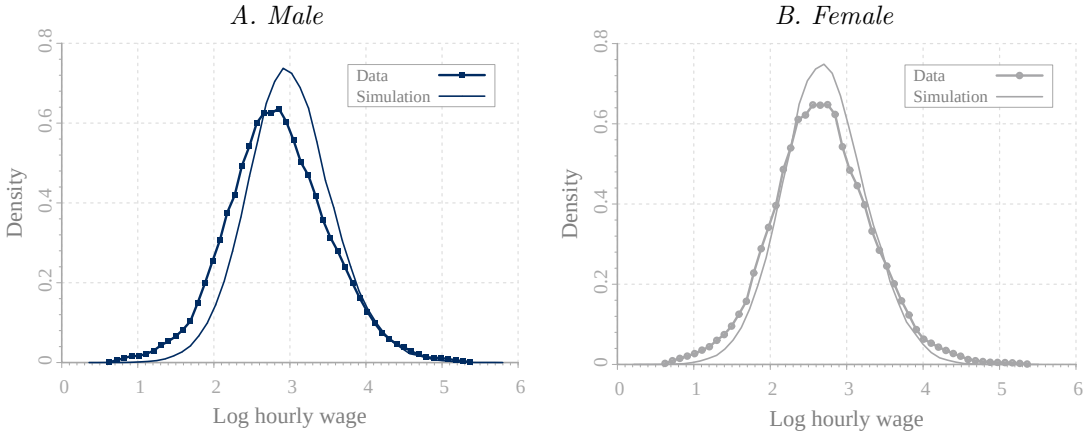
Given that the model is equivalent to Llull (2018a), I borrow parameter values from that paper. Those parameters are obtained for an estimation period of 1967-2007. In the current paper, I use data until 2018. Even though Llull (2018a) provides a battery of checks for in- and out-of-sample fit, and further validation exercises for the model, in this section I provide additional evidence in the same line, showing the goodness of the model in fitting different outcomes after 2007. In all the simulations, including the baseline, the expectation parameters are "re-estimated" as a part of the solution of the problem.[11]

Figure 3 shows the goodness of the model in fitting a set of relevant aggregates.[12] In particular, the figure shows the model fit of average log hourly wages, labor force participation rate, years of education, and the share of workers in blue collar

[11] The parameters of the aggregate shock process, however, are fundamental parameters of the model and, hence, are not re-estimated.

[12] All results presented in this paper are obtained for individuals aged 25-54 years.

FIGURE 4. GOODNESS OF FIT: WAGE DISTRIBUTIONS



Note: The figure represents observed wage distributions for male and female aged 16 to 64 years. Data are obtained from the March Supplements of the CPS. Data distribution is computed using sampling weights, and the simulated distribution weighs individual simulations by cohort sizes.

jobs, separately for male and female. As shown in the figure, the model does a good job in predicting in- and out-of-sample in several dimensions. Wages, occupation choices, and participation rates are very well fit for women. For these three aggregates, the model also correctly fits the levels for males, even though it predicts slightly growing trends for the three variables, while in reality, they are stable or, if anything, slightly decreasing. Years of education for male are also well predicted by the model. In the case of female, the trend is also accurately predicted (including the differential trend between male and female), but the level is off by half a year. As discussed in Llull (2018a), this is likely the result of the simplicity in the modeling of family and fertility decisions (Llull, 2018a, Footnote 25, p. 1875). While this might be a caveat for the research question addressed in this paper, the good fit of the (absolute and relative) trends suggests that counterfactuals are unlikely to be contaminated by this level effect. Out-of-sample, the model does a similar job in predicting the different aggregates, except, maybe, that wages start to grow a few years earlier in the model compared to the data after the Great Recession (2010 instead of 2014).

Given that a set of the results presented below analyze the effects along the native wage distribution (as of 2018), it is also useful to check whether the model can fit the wage distributions observed in the data. Figure 4 shows the goodness of the model in fitting them. The figure plots the estimated densities (in the data and in the simulations) of log hourly wages for male and female in year 2018. As apparent from the figure, the model does a reasonable job in predicting them. For females, the distribution is very well fit, with a slight under-prediction at both tails. For males, the top tail is well fit, but wages are, to some extent, over-estimated at the bottom tail. As a result, as shown in Figure 3, average wages are

also slightly over-estimated for males at the end of the sample. Overall, however, the ballpark of wage inequality is well captured by the model for both genders.

V. Counterfactual Simulations

This section provides the main results from the paper, obtained from counterfactual simulations produced by the estimated model. I start by describing the nature of the counterfactual exercises. Following Llull (2018a), in all simulations I evaluate an economy in which, after 1967, immigration is only allowed to replenish immigrant cohorts in order to keep the share of immigrants in the population of working-age constant to 1967 levels. The competition effect is evaluated through a set of counterfactual simulations that allow for different adjustments for capital. Then, I evaluate the overall effect adjusting women's utility of staying at home when they have preschool children, ϑ_{1H}, to match the effect of immigration on the cost of childcare.

A. Description of the counterfactual scenarios

All counterfactual scenarios keep the share of immigrants constant to the level of 1967, which is 5.1%. As in Llull (2018a), the distribution of characteristics of immigrants is assumed to be policy invariant, consistent with the evidence presented there (see Footnote 5 above for more details). All results presented below are for the population of individuals aged 25 to 54 years. All other elements of the model are kept as in the baseline, except in the fourth counterfactual, in which I also adjust the parameter ϑ_{1H} for female.

The first three scenarios make alternative assumptions about the counterfactual evolution of capital. The first scenario is the extreme case of no capital reaction, as in Borjas (2003). In this scenario, the stocks of both structures and equipment capital are assumed to be as in the data. The second counterfactual makes the other extreme assumption: no reaction reaction of the return to capital, consistent with an open small economy with capital adjusting immediately, as in Ottaviano and Peri (2012). In this second extreme scenario, the implied returns to structures and equipment capital are kept as in the baseline, and the stocks of the two types of capital adjust accordingly. Because, in reality, the United States is a large economy that is likely to have a key influence on world interest rates, I simulate a third scenario, which is an intermediate one.

Suppose that the returns to structures, r_{St}, correspond to the risk-free interest rate (net of depreciation), and that difference between this interest rate and the gross return to equipment capital, $r_{Et} - r_{St}$, captures differential depreciation

plus the (exogenous) relative price of equipment capital. Following Borjas (2013), and Dustmann, Schönberg and Stuhler (2016), suppose that capital is supplied according to the following (reduced form) inverse supply function:

$$r_{St} = \kappa_t (K_{St} + K_{Et})^{\lambda}, \tag{8}$$

where λ is the inverse elasticity of capital supply, and κ_t is a period-specific demand shifter. The relative supply of structures versus equipment is determined by a no-arbitrage condition. The two extreme scenarios correspond to $\lambda = \infty$ (no capital reaction) and $\lambda = 0$ (no interest rate reaction).

In the intermediate scenario, I assume $\lambda = 1$, which is consistent with the macro literature and in the ballpark of the back-of-the-envelope calculations based on the estimates in Llull (2020b). This choice is motivated by the following simplistic argument. Suppose capital is supplied domestically by a representative capitalist that solves a fairly standard consumption and savings decision problem. Suppose that the flow utility of this capitalist is represented by log consumption, often assumed in macro models such as Busch, Krueger, Ludwig, Popova and Iftikhar (2020). Such utility implies an intertemporal elasticity of substitution equal one. By definition, the intertemporal elasticity of substitution indicates the percent variation in next period's consumption when interest rates are changed by one percentage point. To make the back-of-the envelope calculation simple, suppose that the individual expects the interest rates to be constant. In this context, the individual would have constant consumption growth rate equal given by $C_{t+1}/C_t = \beta(1 + r)$, where C denotes consumption and r denotes the interest rate. Implementing standard transversality conditions, the solution to this problem also involves $K_{t+1}/K_t = \beta(1 + r)$, where K denotes the stock of capital. By observation, the elasticity of capital supply in this expression (i.e. the elasticity of K_{t+1} with respect to r) equals one, as in (8) when $\lambda = 1$.

In order to implement this counterfactual, I do the following exercise. First, I recover κ_t in the baseline economy as the ratio $\kappa_t = r_{St}/(K_{St} + K_{Et})$. Second, I recover the baseline difference between structures and equipment capital $\delta_t \equiv r_{Et} - r_{St}$. Armed with these two sequences of nuisance parameters, I substitute the capital supply into the capital demands to obtain the capital stocks for every given value of the skill prices. Given the functional form for the production function, this last step needs to be done numerically.

These three scenarios quantify the competition effect. For the fourth counterfactual, which analyzes the cheaper-childcare effect, I take the intermediate scenario for capital as a benchmark. Then, I adjust ϑ_{1H} for female to account

for the effect of immigration on the prices of childcare. Cortés (2008) finds that a 10% increase in immigration reduces the price of household services (including childcare) in about 2%. Assuming a baseline annual full-time daycare cost of 12,000US$, I compute how much female "gain" by staying at home and saving the childcare cost when they have preschool children in baseline and counterfactual scenarios.[13] More specifically, in the fourth counterfactual, I increase ϑ_{1H} for female by $0.002 \times 12,000 \times \%\Delta immigration$. In other words, in the absence of the observed increase in immigration, child care would be more costly, and hence, the utility of staying home when having young children, relative to working, would be larger. Thus, this counterfactual simulates how more attractive it would become for women with preschool children to stay home (or how less attractive it would be to work full-time) since the childcare cost would be more expensive relative to the baseline.

There are a few additional aspects that one could take into account. First, explicitly modeling the childcare sector would provide an internally consistent effect of immigration on childcare services. However, this extension of the model would be computationally unfeasible without simplifying other aspects of the model. Moreover, while the estimates in Cortés (2008) exploit spatial variation, such extension would only exploit time series variation at the U.S. level, and unless all relevant aspects that can affect the evolution of prices in this market were accounted for, it is unclear that this extension would provide a more accurate measurement of the effect of immigration on childcare prices. Second, as gender roles change, one could expect that a progressive part of the burden of childcare is absorbed by men. At the extensive margin, though, there is little evidence of adjustments of male participation to paternity. Since I focus on extensive margin labor supply decisions, this counterfactual only changes the utility of women, holding constant the parameters for male. In a model of the intensive margin of participation, however, it would be very important to internalize the progressive effect of the childcare mechanism on males' participation as well. Third, as discussed above, it would be interesting to model the effects of immigration on fertility decisions, but once again, that would be unfeasible without simplifying other important aspects of the model. Finally, another interesting analysis that one could perform is a set of simulations allowing only high-skilled (or only low-skilled) immigration. The current framework would have two caveats in order to undertake such analysis. First, the literature does not provide elasticities of childcare services to the im-

[13] Different estimates of average rates for different childcare options in different states are available at `http://www.care.com` and `http://www.childcareaware.org`.

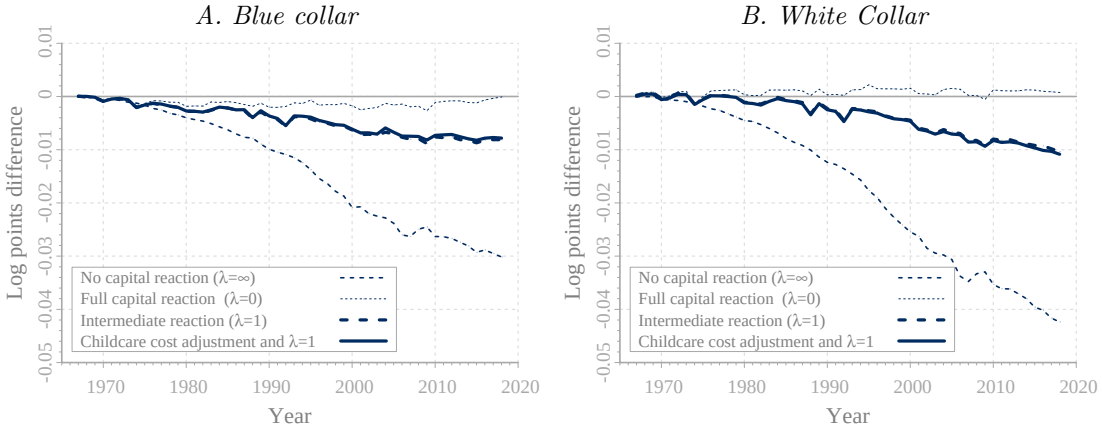
migration of high skilled. One could assume they are zero, but that would be too extreme: qualified teachers can enhance the provision of formal child care, and, additionally, high skilled immigrants often downgrade at entry, supplying labor in sectors for which they are overqualified, such as babysitting. Second, the current model abstracts from knowledge spillovers from high skilled immigrants, which is an important mechanism in order to fully understand the consequences of skill-biased immigration policies, as discussed in Llull (2020a).

B. Wages, skill prices, and labor force participation

The direct effect of immigration on wages occurs through the changes in skill prices. Figure 5 shows the effect of immigration on blue collar and white collar skill prices under the four counterfactual scenarios. The returns to the two types of skills is nearly unaffected if counterfactual interest rates are assumed to stay as in the baseline. As noted by Borjas (2013), this result is built into the assumption of a constant returns to scale production function. Likewise, the effect is much larger under the no-capital reaction, a scenario that is equally unrealistic given that we are reducing the labor supply by over a 10 percent. In the more realistic intermediate scenario, as expected, the effect lies between the two extreme cases. Interestingly, blue and white collar skill prices are reduced by a similar amount as immigrants enter the United States, reaching a maximum of about one percent by 2018, whether or not the childcare cost is allowed to adjust.

The effects on skill prices only tell us a part of the story regarding the effects of immigration on native wages and gender wage gaps. The overall effect is the combination of these effects on skill prices with labor supply and human capital adjustments by native workers. The two plots at the top panel of Figure 6 show the wage effects on native male and female workers respectively. Focusing on the intermediate adjustment counterfactuals (without childcare cost adjustment), the figure shows that competition effects are stronger for females than they are for males. In particular, in equilibrium, native male wages are barely affected, whereas the effect is stronger for females (about 1.4%). As I discuss below, this stronger effect on females is partly the result of a reduction in labor force participation, which maps into a slower accumulation of experience (even though it also makes self-selection into work more positive). Once child care costs are allowed to adjust, however, these gender differences are arbitraged out, and the overall effect on wages is roughly one percent both for males and females. The similar results for male and female workers suggest that the effects of immigration on gender wage

FIGURE 5. THE EFFECT OF IMMIGRATION ON SKILL PRICES



Note: The figure represents the difference between baseline and counterfactual skill prices under the four counterfactual scenarios explained in the text and indicated by the legend.

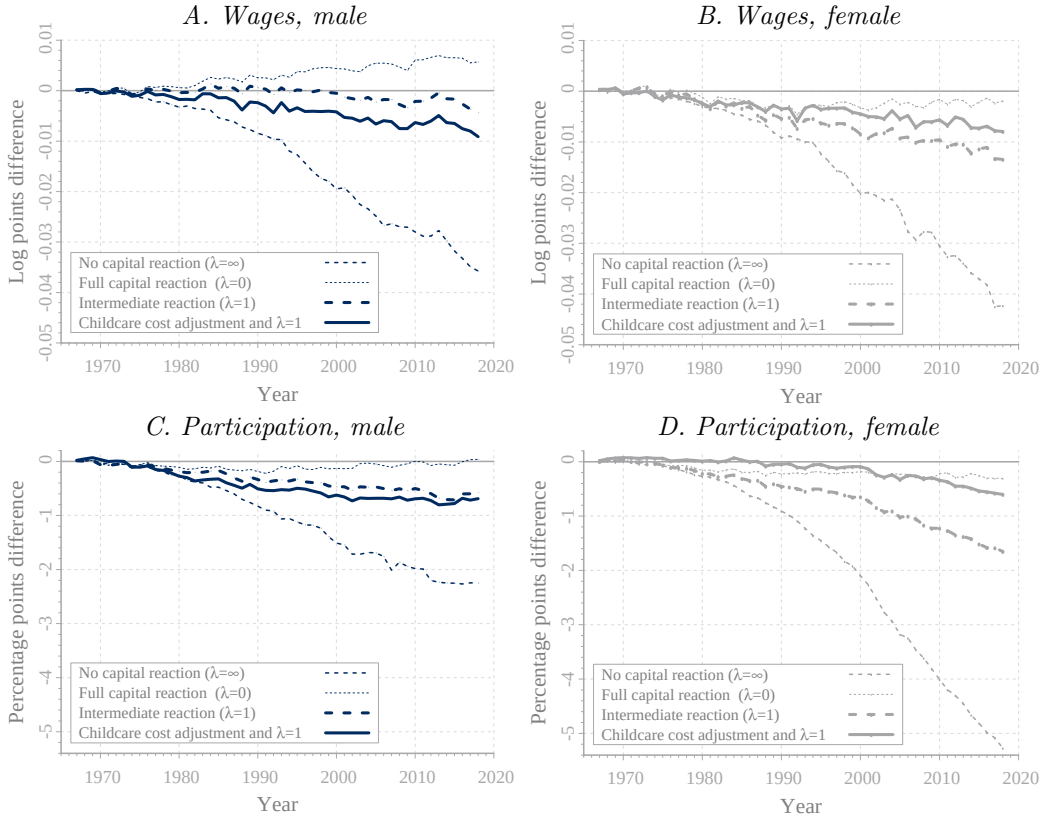
gaps are negligible on average.[14]

The two plots in the bottom panel of Figure 6 show the effects on labor force participation (extensive margin) under the different scenarios for native male and female respectively. The left panel shows that, for males, participation rates are reduced in about one percentage point, mostly driven by competition (i.e. this effect is not changed when childcare costs are allowed to adjust, which is to a large extent mechanical, since the home utility of males is not adjusted in the childcare cost counterfactual). For females, the competition effect reduces participation by almost two percentage points (twice as much as for males), but this is to a large extent compensated by the reduction in childcare costs. Overall, the average participation rates of male and female are reduced by a similar amount, slightly below one percentage point, which, as in the case of wages, seems to imply that the effect of immigration on gender gaps is negligible.

Different papers in the literature, discussed above, find that the most prevalent effects of immigration on labor force participation are on the intensive margin for high skilled women, and they only find small and often insignificant effects on the extensive margin, even for high skilled. These papers, however, do not allow to distinguish between competition effects and the effects through cheaper childcare services. The results from Figure 6 indicate that the average effects at the extensive margin are negligible mainly because the stronger competition effects suffered by female are compensated by the positive effect through the availability

[14] Figure 6 also shows the results for the more extreme scenarios, which provide wide bands for the effects. In the remaining figures, I focus on the third and fourth counterfactuals, which assume an intermediate capital reaction respectively without and with childcare costs adjustments due to immigration. Results from the extreme counterfactuals are available from the author upon request.

FIGURE 6. EFFECTS OF IMMIGRATION ON NATIVE WAGES AND PARTICIPATION



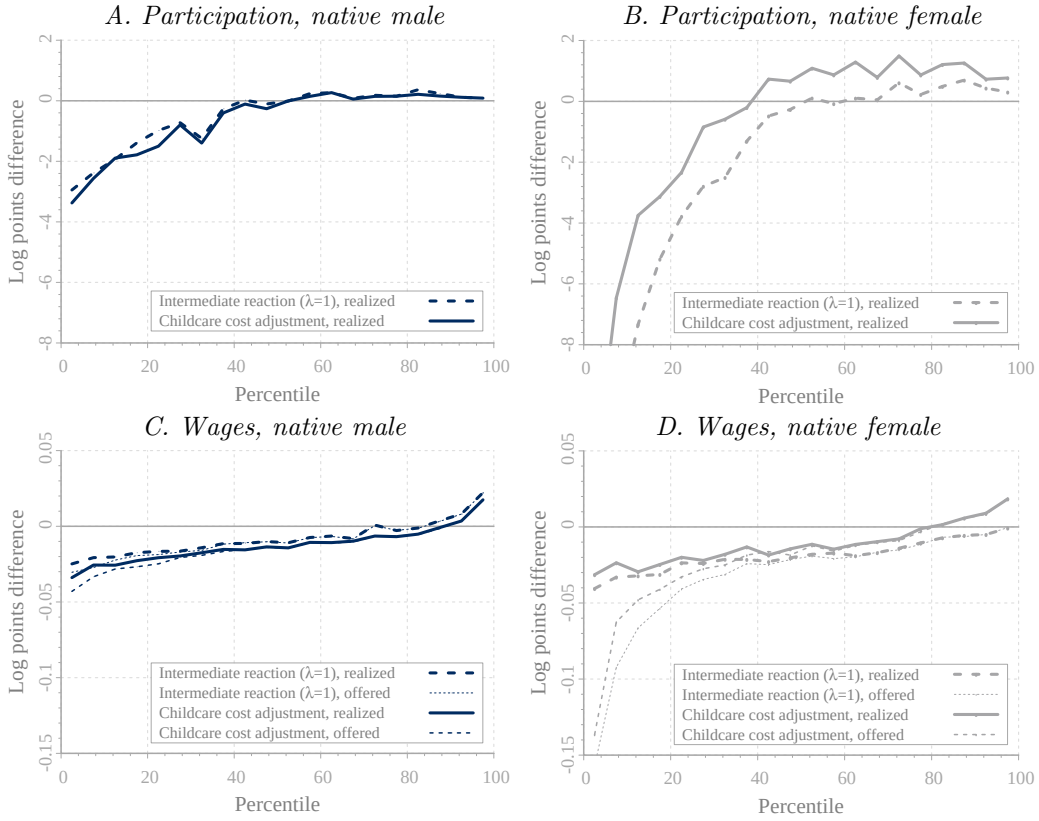
Note: The figure represents the difference between baseline and counterfactual average wages and labor force participation rates for native males and females under the four counterfactual scenarios explained in the text and indicated by the legend. Plotted lines represent average effects for natives aged 25–54.

of cheaper childcare services.

Even though Figure 6 suggests no effects on gender gaps on average, these effects might be heterogeneous across different workers. To investigate this potential heterogeneity, Figure 7 presents the results along the native skill distribution. In particular, the figure takes all simulated native males and females in 2018 (of ages 25–54) who work in at least one of the counterfactual scenarios. For them, it computes the offered wage distributions by gender in the baseline simulation as the distribution of either the observed wages, for those who work, or the largest of the two offered wages if they do not work. This offered wage distribution provides a measurement of the skill distribution. Dividing the sample of simulated individuals in 20 quantiles, the figure plots, for each of them, the average change in labor force participation decisions and offered wages (for all the relevant workers), and in realized wages (for those who work in both baseline and counterfactual scenarios).

As apparent from the top panel, labor force participation adjustments to not occur uniformly along the skill distribution. In the absence of childcare cost adjustments, participation of both males and females above the median is essentially unaffected. On the other hand, it is progressively reduced at the bottom of

FIGURE 7. EFFECTS ON WAGES AND PARTICIPATION ALONG THE SKILL DISTRIBUTION



Note: The figure represents the difference between baseline and counterfactual average labor force participation rates for males and females under the two counterfactual scenarios explained in the text and indicated by the legend. For each percentile, average wages and participation rates in counterfactuals are compared to baseline counterparts. The plotted lines represent effects for individuals aged 25–54.

the distribution, especially below the bottom 20th percentile, and especially for women. On this part of the female skill distribution it reaches a decrease of about 17 percentage points at the bottom 5 percent of the distribution.[15] Then, the childcare cost adjustment effect, which is largely homogeneous along the native female skill distribution, shifts the curve up by about one percentage point. As a result, immigration reduces gender participation gaps at the top of the skill distribution and increases them substantially at the bottom, even though on average we do not observe a significant effect. Hence, the availability of cheaper childcare reduces participation gender gaps at the top, but the competition effect, which is stronger for female, dominates at the bottom of the distribution, increasing gender participation gaps substantially.

These effects on participation have important consequences for wages. The bottom panel of Figure 7 shows wage effects along the skill distribution, on both realized and offered wages. Looking at realized wages, the differences between males and females along the skill distributions are not substantial. This is in line

[15] The scale of the graph is cut at 8 percentage points for a better visualization.

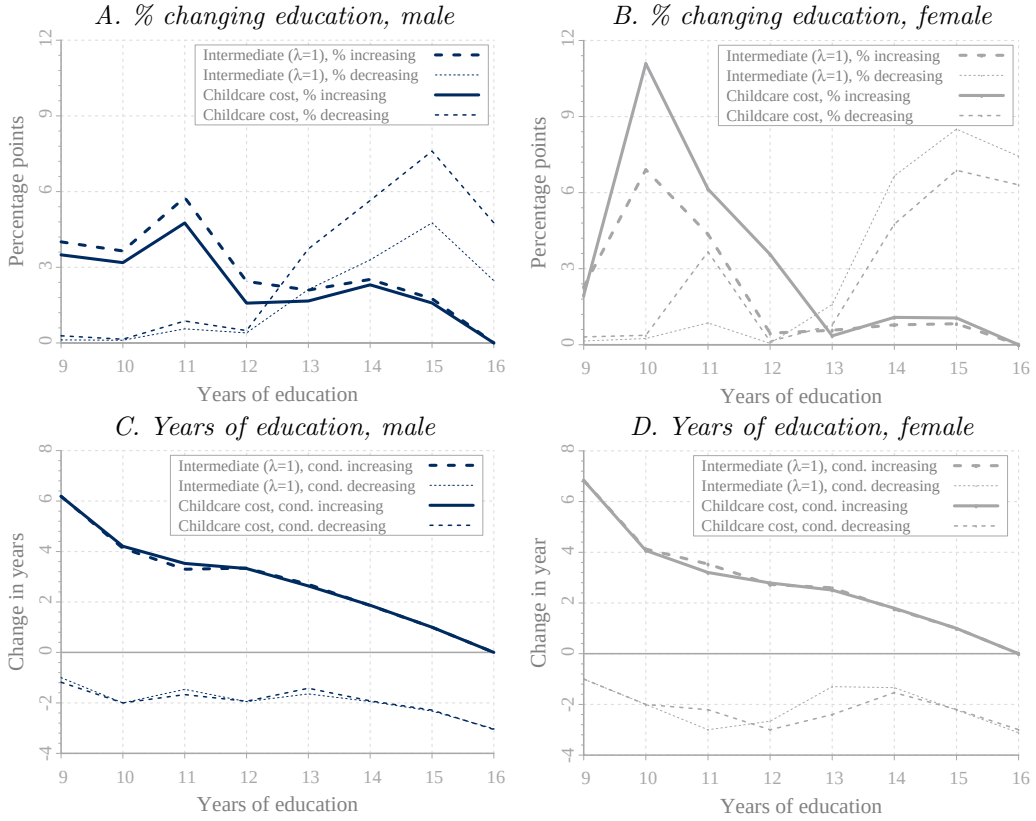
with the descriptive evidence in Section II. However, as noted in Llull (2018a), a comparison of realized wages in different scenarios leads to a biased picture of the effects on wages because of self-selection into work. If immigration has stronger effects on participation at the bottom of the female skill distribution, it is natural that the biases are larger there. This is what the simulated effects on wage offers show: the effect on female wages at the bottom of the distribution are much stronger, mainly as a result of the lack of accumulation of human capital. At the bottom fifth percentile, the effect reaches 0.14 log points, which compare to 0.04 log points on males. Therefore, as it occurred with participation, immigration increases gender wage gaps among the lowest skilled, especially through its effect on participation. On the contrary, at the very top of the skill distribution, the wage gains of female are marginally larger than those for male, marginally reducing wage gaps at the top.

C. Human capital adjustments

Given that skill prices of both occupations are affected by a similar extent, the effects on wage and participation gender gaps are mainly driven by differences in the accumulation of human capital. This section analyzes how male and female natives differently adjusted their education, experience, and occupation choices.

I first focus on education. As noted in Llull (2018a), while some natives increase their education in response to the specialization of immigrants in blue collar occupations, other individuals reduce their education as a result of the lower expected return (because of lower expected wages and labor market detachment). Given the results for labor force participation presented above, it is natural to anticipate that male and female adjust differently along these margins. Figure 8 shows these differences. The top panel shows how male and female of different (before-immigration, that is, counterfactual) education levels adjust their education. In particular, it shows the proportion of individuals increasing education, and the proportion that reduces it. As evident from the figure, individuals who already obtain some college education in the absence the observed increase in immigration often reduce their education. This is so because these individuals expect to work with a very high probability, and therefore, the main dominating effect is competition (i.e. lower wages, which maps into lower returns to education relative to the policy invariant costs). Individuals with high school education, on the contrary, increase their education more frequently. For these individuals, the larger probability of switching to a white collar career dominates. Looking at the bottom panel, which indicates the number of years that they adjust in each case,

FIGURE 8. EFFECTS ON EDUCATION

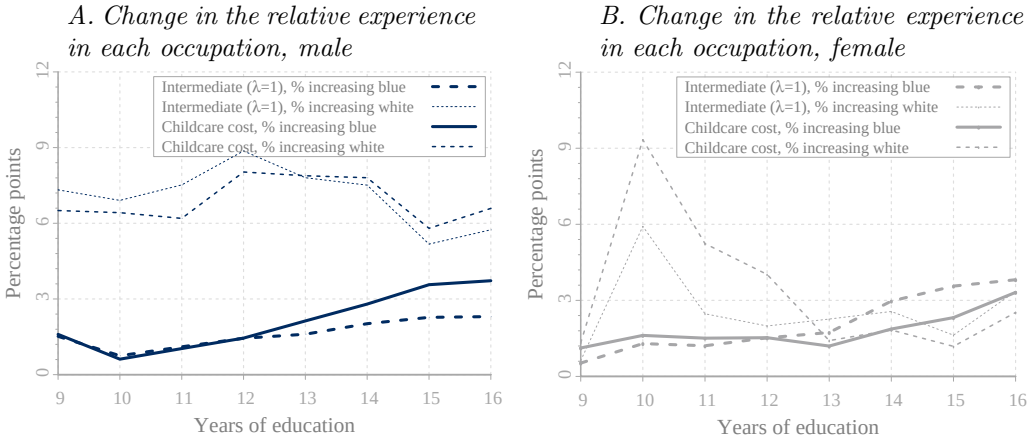


Note: The figure represents the difference between baseline and counterfactual education for males and females under the two counterfactual scenarios explained in the text and indicated by the legend. The top panel represents the proportion of individuals changing education (increasing and decreasing as indicated by the legend). The bottom panel represents the change in average years of education of the group (unconditional, conditional on increasing, and conditional on decreasing). The horizontal axis indicates the education level in the counterfactual, that is, in the absence of immigration. The plotted lines represent effects for individuals aged 25–54.

we can see that the increases are consistent to obtaining a college degree in most of the cases.

Importantly for this paper, the results are very different by gender. For males, the proportion of individuals that increase education is not as large as it is for female. Given that participation rates of male are much larger (and the effects of immigration on participation smaller), the main motivation to adjust is the change in the probability of following a white collar career. This motivates around 3 percent of otherwise high school dropout workers to undertake (mostly) a college education. The effect on individuals with some college, though, is somewhat larger, which leads to a net cancellation. For females, on the contrary, the probability of increasing education when they are low educated is much larger, especially when childcare cost adjustments are taken into account. This is so because the probability of detaching from the labor market when they have children is lower, which increases expected returns substantially. The competition effects on other-

FIGURE 9. EFFECTS ON OCCCATION



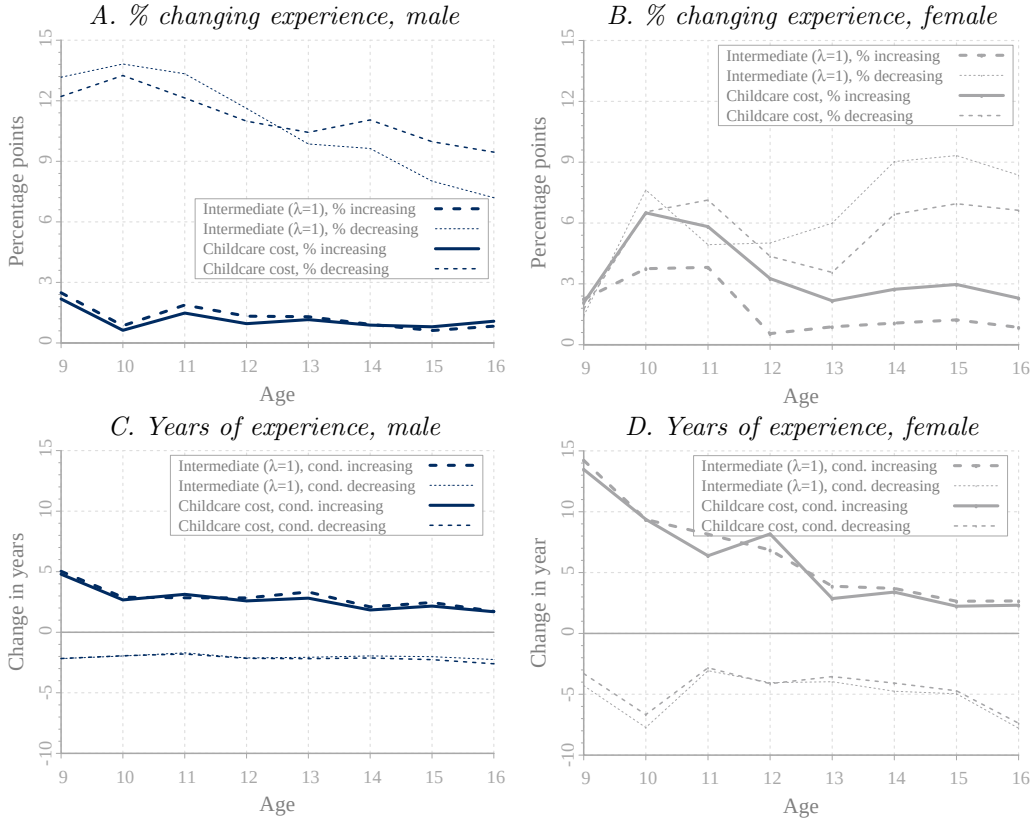
Note: The figure represents the proportion of individuals that increase and reduce their ratio of blue collar experience relative to overall experience between baseline and counterfactual simulations for males and females. TThe horizontal axis indicates the education level in the counterfactual, that is, in the absence of immigration. The plotted lines represent effects for individuals aged 25–54.

wise higher educated, on the contrary, are not very different to those on males. Therefore, immigration seems to have an overall positive effect on the education gap, especially driven by childcare cost adjustments.

Figure 9 shows how male and female adjusted their career paths conditional on counterfactual education (that is, education in the absence the observed increase in immigration). As apparent from the figure, there are important differences between males and females. Across all education levels, around 6% of males had (with immigration) a larger proportion of their experience bundle composed of white collar experience because of immigration. On the contrary, the proportion of those with relative increases in blue collar experience are more important among otherwise highly educated, most likely in coincidence with those who decided to reduce their education. For females, the adjustment patters are very different. Among the women who would have less than college education in the absence of the observed increase in immigration, a large fraction of them (going up to 9% for those with 10 years of education when childcare costs are taken into account) increase their white collar experience. This pattern mimics again the observed patterns in education decisions. On the contrary, unlike for male, the amount of them who increase and reduce white collar experience is similar among those otherwise college education. A possible interpretation has to do with their outside options: while male that decide to reduce their investment in education becomes more likely to work in blue collar, female becomes more likely to drop out from the labor market.

Figure 10 analyzes how the accumulation of overall experience is affected by the effects on labor force participation. Once again, the adjustments by male

FIGURE 10. EFFECTS ON WORK EXPERIENCE



Note: The figure represents the difference between baseline and counterfactual education for males and females under the two counterfactual scenarios explained in the text and indicated by the legend. The top panel represents the proportion of individuals changing work experience (increasing and decreasing as indicated by the legend). The bottom panel represents the change in average years of work experience of the group (unconditional, conditional on increasing, and conditional on decreasing). The horizontal axis indicates the education level in the counterfactual, that is, in the absence of immigration. The plotted lines represent effects for individuals aged 25–54.

and female are very different. For males, 12 percent of the lowest educated and 8–9 percent of the highest educated (Panel A) eventually spend, on average, two additional years (Panel C) not working compared to the case in the absence of the observed increase in immigration. A smaller fraction (1–2 percent) increase their participation, by roughly 2–3 years on average. For females, the situation is very different across ages, and also depending on the counterfactual scenario. When childcare costs are not taken into account, their reduction of labor force participation is way more dramatic. In this scenario, 6–9 percent of women across all ages reduce their labor market attachment, but at lower ages they do by as much as 15 years, which is essentially the difference between being active or inactive during their whole career. This important drop explains the large effects on wages at the bottom of the distribution. When childcare costs are allowed to adjust, this proportion is mitigated, especially for higher education. Importantly, a much larger proportion of women increase their labor market participation, on

average by about 5 years.

In sum, the differential human capital and labor supply adjustments explain the different effects of immigration on gender gaps at different points of the distribution. The effects on the higher educated males and females are not very different, and, if anything, lead to a higher participation of females relative to males when the effects on childcare costs are accounted for. At lower education levels, the effects are more dramatic for (some) females given their lower labor market attachment. The negative effects, however, are concentrated on a fraction of women who decide to detach from the labor market. A similarly large fraction become more attached to the labor market (to a large extent as a result of the lower childcare costs), increase their education substantially, and is more likely to pursue a white collar career as a result of immigration.

VI. Conclusions

This paper analyzes the effect of immigration on gender gaps in the labor market. Building on Llull (2018a), I use a structural model that takes into account human capital and labor supply adjustments by natives to simulate the role of two mechanisms in affecting gender gaps: labor market competition and the availability of cheaper childcare services. Consistent with the literature, aggregate effects of immigration on wage and (extensive margin) participation gaps are negligible. However, the distinction between the two effects is important to understand differential heterogeneity in the effects for male and female. Female are more severely affected by labor market competition effects, especially at the bottom of the skill distribution. The cheaper-childcare effects, on the other hand, are homogeneously benefiting women along the skill distribution. As a result, gender gaps at the top of the skill distribution are reduced, whereas they are substantially increased at the bottom, especially for labor force participation. The effects on women's education are also heterogeneous. Among women that would be low educated in the absence of the observed increase in immigration some increase their education substantially and pursue an active white collar career, as a result of the availability of cheaper childcare services, whereas others decrease it and detach from the labor market completely as a result of the stronger competition. These results highlight the importance of separating competition effects from those on childcare cost, and of accounting for human capital and labor supply adjustments.

The analysis above makes some simplifications with the aim of tractability. In particular, the model abstracts from endogenous effects on fertility and skill composition of immigrants, and from explicitly modeling the market of childcare

services. Understanding how these mechanisms can affect the conclusions of this paper is left for future research.

REFERENCES

Albert, Christoph, Albrecht Glitz, and Joan Llull, "Labor Market Competition and the Assimilation of Immigrants," mimeo, Universitat Autònoma de Barcelona, January 2020.

Amuedo-Dorantes, Catalina and Sara de la Rica, "Complements or substitutes? Task specialization by gender and nativity in Spain," *Labour Economics*, October 2011, *18* (5), 697–707.

Barone, Guglielmo and Sauro Mocetti, "With a little help from abroad: The effect of low-skilled immigration on the female labour supply," *Labour Economics*, October 2011, *18* (5), 664–675.

Borjas, George J., "The Labor Demand Curve Is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market," *Quarterly Journal of Economics*, November 2003, *118* (4), 1335–1374.

_ , "The Analytics of the Wage Effect of Immigration," *IZA Journal of Migration*, November 2013, *2* (22), 1–25.

Busch, Christopher, Dirk Krueger, Alexander Ludwig, Irina Popova, and Zainab Iftikhar, "Should Germany have built a new wall? Macroeconomic lessons from the 2015-18 refugee wage," *Journal of Monetary Economics*, August 2020, *113*, 28–55.

Card, David E., "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration," *Journal of Labor Economics*, January 2001, *19* (1), 22–64.

Cortés, Patricia, "The Effect of Low-Skilled Immigration on U.S. Prices: Evidence from CPI Data," *Journal of Political Economy*, June 2008, *116* (3), 381–422.

_ **and Jessica Pan**, "Outsourcing Household Production: Foreign Domestic Workers and Native Labor Supply in Hong Kong," *Journal of Labor Economics*, April 2013, *31* (2, Part 1), 327–371.

_ **and** _ , "Foreign nurse importation and the supply of native nurses," *Journal of Health Economics*, September 2014, *37*, 164–180.

_ **and** _ , "Immigration and Occupational Choice of Natives: the Case of Nurses in the United States," *CESifo Economic Studies*, September-December 2015, *61* (3-4), 797–823.

_ **and** _ , "When Time Binds: Substitutes for Household Production, Returns to Working Long Hours, and the Skilled Gender Wage Gap," *Journal of Labor Economics*, April 2019, *37* (2), 351–398.

_ **and José Tessada**, "Low-Skilled Immigration and the Labor Supply of Highly Skilled Women," *American Economic Journal: Applied Economics*, July 2011, *3* (3), 88–123.

Dustmann, Christian, Tommaso Frattini, and Ian Preston, "The Effect of Immigration along the Distribution of Wages," *Review of Economic Studies*, January 2013, *80* (1), 145–173.

_ **, Uta Schönberg, and Jan Stuhler**, "The Impact of Immigration: Why Do Studies Reach Such Different Results?," *Journal of Economic Perspectives*, Fall 2016, *30* (4), 31–56.

_ **,** _ **, and** _ , "The Impact of Immigration on Local Labor Markets: Evidence from the Opening of the Czech-German Border," *Quarterly Journal of Economics*, February 2017, *132* (1), 435–483.

Edo, Anthony and Farid Toubal, "Immigration and the gender wage gap," *European Economic Review*, February 2017, *92*, 196–214.

Ehrlich, Isaac and Jinyoung Kim, "Immigration, Human Capital Formation, and Endogenous Economic Growth," *Journal of Human Capital*, Winter 2015, *9* (4), 518–563.

_ **and Yun Pei**, "Human Capital as Engine of Growth: The Role of Knowledge Transfers in Promoting Balanced Growth within and across Countries," *Asian Development Review*, September 2020, *37* (2), 225–263.

Farré, Lidia, Libertad González, and Francesc Ortega, "Immigration, Family Responsabilities and the Labor Supply of Skilled Native Women," *The B.E. Journal of Economic Analysis & Policy*, December 2011, *11* (1 (Contributions)), Article 34.

Fasani, Francesco, Joan Llull, and Cristina Tealdi, "The economics of migration: Labour market impacts and migration policies," *Labour Economics*, December 2020, *67*, 101929.

Forlani, Emanuele, Elisabetta Lodigiani, and Concetta Mendolicchio, "Impact of Low-Skilled Immigration on Female Labour Supply," *Scandinavian Journal of Economics*, April 2015, *117* (2), 452–492.

_ **,** _ **, and** _ , "Natives and migrants in home production: the case of Germany," *Review of Economics of the Household*, 2020.

Furtado, Delia, "Can immigrants help women "have it all"? Immigrant labor

and women's joint fertility and labor supply decisions," *IZA Journal of Migration*, October 2015, *4* (19), 1–19.

_ , "Immigrant labor and work-family decisions of native-born women," *IZA World of Labor*, 2015, p. 139.

_ , "Fertility Responses of High-Skilled Native Women to Immigrant Inflows," *Demography*, December 2016, *53* (1), 27–53.

_ **and Heinrich Hock**, "Low Skilled Immigration and Work-Fertility Tradeoffs among High Skilled US Natives," *American Economic Review: Papers and Proceedings*, May 2010, *100* (2), 224–228.

Kennan, John and James R. Walker, "The Effect of Expected Income on Individual Migration Decisions," *Econometrica*, January 2011, *79* (1), 211–251.

Krusell, Per and Anthony A. Smith Jr., "Income and Wealth Heterogeneity in the Macroeconomy," *Journal of Political Economy*, October 1998, *106* (5), 867–896.

_ **, Lee E. Ohanian, José-Víctor Ríos-Rull, and Giovanni L. Violante**, "Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis," *Econometrica*, September 2000, *68* (5), 1029–1054.

LaLonde, Robert J. and Robert H. Topel, "The Assimilation of Immigrants in the U.S. Labor Market," in George J. Borjas and Richard B. Freeman, eds., *Immigration and the Work Force: Economic Consequences for the United States and Source Areas*, Chicago: The University of Chicago Press, 1992, chapter 3, pp. 67–92.

Lee, Donghoon and Kenneth I. Wolpin, "Intersectoral Labor Mobility and the Growth of the Service Sector," *Econometrica*, January 2006, *74* (1), 1–46.

Lessem, Rebecca H., "Mexico-U.S. Immigration: Effects of Wages and Border Enforcement," *Review of Economic Studies*, October 2018, *85* (4), 2353–2388.

Llull, Joan, "Immigration, Wages, and Education: A Labor Market Equilibrium Structural Model," *Review of Economic Studies*, July 2018, *85* (3), 1852–1896.

_ , "The Effect of Immigration on Wages: Exploiting Exogenous Variation at the National Level," *Journal of Human Resources*, Summer 2018, *53* (3), 608–622.

_ , "Selective Immigration Policies and the U.S. Labor Market," mimeo, Universitat Autònoma de Barcelona, June 2020.

_ , "The Impact of Immigration on Productivity," in Jordi Caballé Eugenia Vella and Joan Llull, eds., *Understanding Migration with Macroeconomics*, Cham: Palgrave Macmillan, 2020, chapter 2, pp. 27–58.

Manacorda, Marco, Alan Manning, and Jonathan Wadsworth, "The

Impact of Immigration on the Structure of Wages: Theory and Evidence from Britain," *Journal of the European Economic Association*, February 2012, *10* (1), 120–151.

Mincer, Jacob, *Schooling, Experience and Earnings*, New York: Columbia University Press, 1974.

Monràs, Joan, "Immigration and Wage Dynamics: Evidence from the Mexican Peso Crisis," *Journal of Political Economy*, August 2020, *128* (8), 3017–3089.

Ottaviano, Gianmarco I. P. and Giovanni Peri, "Rethinking the Effect of Immigration on Wages," *Journal of the European Economic Association*, February 2012, *10* (1), 152–197.

Peri, Giovanni, "Immigrants, Productivity, and Labor Markets," *Journal of Economic Perspectives*, Fall 2016, *30* (4), 3–30.

_ **and Chad Sparber**, "Task Specialization, Immigration, and Wages," *American Economic Journal: Applied Economics*, July 2009, *1* (3), 135–169.

Ruggles, Steven, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek, "IPUMS USA: Version 10.0 [dataset]," Minneapolis, MN: IPUMS, 2020.

The National Academy of Sciences, "Employment and Wage Impacts of Immigration: Empirical Evidence," in Francine D. Blau and Christopher Mackie, eds., *The Economic and Fiscal Consequences of Immigration*, Vol. 54, Washington, DC: The National Academies, July 2017, chapter 5, pp. 197–278.