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Female entrepreneurship, financial frictions and capital misallocation in the US[☆]

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ABSTRACT

We document and quantify the effect of a gender gap in credit access on both entrepreneurship and input misallocation in the US. Female entrepreneurs are found to be more likely to face a rejection on their loan applications and to have a higher average product of capital, a sign of gender-driven capital misallocation that decreases in female-led firms' access to finance. These results are not driven by differences in observable individual or businesses characteristics. Calibrating a heterogeneous agents model of entrepreneurship to the US economy, we show that the observed gap in credit access explains the bulk of the gender differences in capital allocation across firms. Eliminating such credit imbalance is estimated to potentially increase output by 4%, and to reduce capital misallocation by 12%.

1. Introduction

Entrepreneurs play a pivotal role in enhancing productivity, job creation and innovation in the US.[1] Yet, sizable gender gaps persist both in firm ownership rates and in several dimensions of business performance. For instance, female owners constitute only 35% of the entrepreneurial pool,[2] suggestive of an imbalance along the *extensive* margin of entrepreneur-

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[1] See Davis and Haltiwanger (1999).

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ship.[3] Focusing instead on business financing, in 2018 women received just 2.2% of total US start-up funding.[4] This type of asymmetry operates along the *intensive* margin of entrepreneurship and can be responsible for distortions affecting the optimal allocation of productive inputs across firms. However, to the best of our knowledge, empirical evidence of gender-based frictions at the firm-level is scarce, and quantitative estimates of their macroeconomic impact are yet to be provided. In this paper, we exploit rich micro data to document both gender disparities in firms' access to credit and gender-driven capital misallocation. Then, through a heterogeneous agents model, we quantify the effect of such financing gaps on entrepreneurial talent allocation, capital misallocation and aggregate output.

For our empirical analysis, we use the restricted-access version of the Kauffman Firm Survey (KFS hereafter), a panel of nearly 5000 US nascent entrepreneurs that covers the years between 2004 and 2011 and contains detailed information on owners' characteristics and firm balance sheet variables.[5] In principle, gender imbalances in entrepreneurship may be related to several factors, such as gaps in accessing finance – our focus – as well as differences in labor force attachment or individuals' backgrounds. Owing to the richness of our data, we can control for other potential sources of heterogeneities across genders and restrict our attention to understanding whether significant gender gaps in credit access still exist, and how they affect female entrepreneurial outcomes. We thus ask the following questions: (i) Do female entrepreneurs face tighter financial constraints compared to men? (ii) How does this affect total production and capital allocation? (iii) How much would the US economy gain if the gender gap in credit access was eliminated?[6]

First, we find evidence that credit constraints penalize female entrepreneurs relatively more. In particular, after controlling for agents' observable traits and firm and industry characteristics, no gender differences exist in the likelihood of applying for a business loan, suggesting a weaker role for any gender heterogeneity in the *demand* for credit. However, not only do female entrepreneurs report lower levels of business debt, but, among loan applicants, women have also a 10% higher probability of being rejected. Bank loans are the main source of financing for entrepreneurs in our sample, and an impaired access to such credit is likely to harm the business operations of female producers. Moreover, the higher loan rejection rates faced by women are not due to worse risk profiles or lower profitability. In fact, female entrepreneurs run businesses with better credit risk scores, higher profit margins and higher total factor productivity in revenues (hereafter *tfpr)*. In this regard, our evidence suggests that a lower access to credit may be acting as a barrier to entrepreneurship for female individuals, and it is hence consistent with a phenomenon of *selection* into entrepreneurship of marginally more productive women.

Second, female-led firms are found to have a 12% higher average revenue product of capital (hereafter *arpk*) relative to male ones of similar characteristics. Following the misallocation literature (Hsieh and Klenow, 2009; Restuccia and Rogerson, 2013), we interpret such gap in the return on assets as a sign of misallocation of capital across firms. Importantly, no differences exist in the average revenue product of labor (hereafter *arpl*) across genders, consistent with the fact that female entrepreneurs face higher barriers in accessing credit and, consequently, in financing capital acquisition. Moreover, the average female *arpk* decreases (and the average female business debt increases) in states where female representation among the entrepreneurial pool is stronger. Coupled with the evidence on differential credit access, we suggest that gender disparities in financial frictions could be responsible for the sub-optimal allocation of capital across female and male entrepreneurs. While misallocation alone is often regarded as an indicator of latent heterogeneities in financial constraints, the nature of the KFS data allows us to directly document a gender gap in credit access, and hence to link that result to the observed gender-driven capital misallocation.

To rationalize our empirical findings, we build on Buera and Shin (2013) and develop a general equilibrium (GE) heterogeneous agents model of entrepreneurial choice under financial frictions in which individuals differ by wealth, productivity and gender. In our framework, female entrepreneurs are subject to a tighter borrowing constraint in renting entrepreneurial capital, which leads to lower female representation and stricter female selection into the entrepreneurial pool. Such gender-based heterogeneity in accessing external funding is also responsible for the differences in *arpk* across female and male entrepreneurs, as financially constrained female-led firms are forced to operate with relatively lower levels of capital compared to male ones. As explained in Midrigan and Xu (2014), the negative effect caused by capital misallocation on aggregate production in the model is particularly severe if highly productive agents are often credit constrained.

We then calibrate our framework on available US data, following the strategies used in Buera and Shin (2013), Midrigan and Xu (2014), and Cagetti and De Nardi (2006). Despite introducing only one type of heterogeneity across genders in the baseline economy, the model can generate plausible differences in the levels of entrepreneurial capital, total output and total factor productivities across genders. In fact, as a consequence of the gender-based financial frictions, female entrepreneurs

[2] US Census Data for 2018: https://www.census.gov/newsroom/press-releases/2018/employer-firms.html

[3] As shown in Appendix Figure A.1, gender participation gaps are more severe for entrepreneurs than for employed workers; the fraction of female business owners lags behind the share of female agents in the employed workforce, which is now around 46% (see also Appendix Figure A.1 for a comparison of the gender earnings gap for employed and self-employed).

[4] See https://fortune.com/2017/03/13/female-founders-venture-capital/

[5] We focus on privately held firms, which are likely to be affected by financial frictions. Moreover, private firms are of paramount relevance in the US and account for over 70% of employment and 50% of output (see Asker et al., 2015).

[6] For example, Hsieh et al. (2019) argue that 20–40% of US growth in aggregate output between 1960 and 2010 can be explained by the improved allocation of talent due to the convergence in the occupational distribution between white men, women, and black men. Here, we ask by how much aggregate output could benefit from releasing gender-based firm borrowing constraints and from improving entrepreneurial talent allocation and capital allocation in the economy.

in our calibrated framework have roughly 11% higher *arpk* and 14% lower capital-to-labor ratio, whereas no such differences exist in their respective *arpl*, similar to what is documented in the data. In this sense, we are able to replicate between 70% and 90% of the gender differences in the level of capital observed in the KFS sample, while the model can also match other salient features of the data, including the size and distribution of debt, profits and revenues across firms, both in aggregate and by gender. Moreover, we can explain up to a third of the gender differences in US entrepreneurial rates. We also consider alternative versions of our setup that include a corporate sector, as well as gender heterogeneities in risk aversions, operational costs and returns to scale, which nonetheless all deliver consistent qualitative results and predictions.

Finally, the model is used to quantify the aggregate effects of the gender gap in credit access, by running a counterfactual exercise in which the gender imbalance in financial markets is eliminated. Guaranteeing equal access to credit to male and female entrepreneurs improves the allocation of entrepreneurial talent and capital, with female entrepreneurship increasing by 10% and capital misallocation decreasing by 12%. Since marginally more productive agents join the entrepreneurial pool and produce at their optimal scale, total production rises by 3.82%. We then analyze welfare changes by individuals' occupation and gender: due to reallocation effects, female entrepreneurial welfare increases and male entrepreneurial one decreases in our counterfactual exercise. However, thanks to general equilibrium forces, the increased demand for capital and labor raises both the value of savings and the wage of all workers. Overall, male and female welfare scale up by 2% and 5% respectively, and the economy gains 3.50% in welfare as a whole.

In a different set of exercises, we instead keep fixed the gender gap in credit access and analyze the effect on male and female-led firms induced by fiscal policies that target entrepreneurs. Specifically, we introduce subsidies to the profits, labor costs, capital costs or the credit needs of business owners. We find that these fiscal schemes foster female entrepreneurship, but the extent to which they mitigate the negative effects of the gender gap in credit access on both capital misallocation and female entrepreneurial under-representation depends on the specific subsidy implemented.

Related Literature. Our study builds on the body of applied research that examines the relationship between entrepreneurs' gender and business performance, focusing on access to funding, selection into less profitable sectors, and policies to support female entrepreneurship.[7] Within this broad topic, some papers have specifically used the KFS dataset to examine gender differences in firm financing, profits and business growth in the US (see Coleman and Robb, 2009; Coleman and Robb, 2010; Robb and Watson, 2012). We add to this literature by documenting not only a gender gap in US entrepreneurial financing, but also a novel empirical fact on the dispersion in *arpk* across genders and the resulting capital misallocation across female and male-led firms.

In addition, our work relates to several studies that analyze the macroeconomic impact of growing female labor force participation. For example, Hsieh et al. (2019) and Heathcote et al. (2017) focus on the effect of rising female employment for US output growth, while Bento (2021) investigates the increase in female entrepreneurship in the US from 1982 to 2012 and its implications for aggregate productivity and welfare. We also direct our attention on US female entrepreneurship and further document the nature of one existing gender imbalance, namely the gap in credit access, and the extent of gender-driven capital misallocation, whose impact is then quantified through an entrepreneurship model. In a similar spirit, Chiplunkar and Goldberg (2021) examine the effect of barriers to female entrepreneurship in India, and show that eliminating gender-based distortions with respect to entry, business registration and hiring costs can lead to sizable productivity and welfare gains, both for women and for the economy as a whole.

Moreover, our paper contributes to the literature on the productivity losses and resource misallocation generated by financial frictions (see Buera et al., 2011; Hsieh and Klenow, 2009 and Midrigan and Xu, 2014), as well as to the strand of research investigating the importance of personal wealth in determining entrepreneurial choices (see Cagetti and De Nardi, 2006). Differently from these studies, we allow for gender-based heterogeneity in access to capital, and assess the quantitative effect of a gender gap in credit access on misallocation and US total output. Along similar lines, Goraya (2021) investigates the relative importance of the caste system in explaining resource misallocation in India and quantifies its impact on Indian aggregate productivity. Finally, our analysis of the effects of fiscal policies on entrepreneurship relates to the works of Li (2002) and Kitao (2008). We analyze fiscal instruments that foster entrepreneurship in an economy characterized by gender-based financial frictions, and compare the consequences of subsidies on the credit needs, the capital and labor costs and the profits of female and male-owned firms.

The remainder of this paper is organized as follows. In Section 2, we use the KFS data to document gender differences in credit access and in *arpk*, our empirical indicators of gender-based financial frictions and gender-driven misallocation of capital. In Sections 3–4, we develop a model of entrepreneurial choice and gender-based borrowing constraints, and calibrate it on available US data. In Sections 5–6, we quantify the macroeconomic effects of the gender gap in credit access and the gender-driven capital misallocation, and assess if fiscal policies targeting all entrepreneurs in the economy can affect differently female and male-owned firms in the presence of gender gaps in borrowing constraints. Finally, Section 7 concludes.[8]

[7] See for example De Mel et al. (2008), Campbell and De Nardi (2009), Fairlie and Robb (2009), Cirera and Qasim (2014), Cuberes and Teignier (2016), Faccio et al. (2016), Delis et al. (2020), Naaraayanan (2019), Delecourt and Ng (2020).

[8] An Online Appendix with supplementary materials is available on the Science Direct website of the journal.

Table 1
Average Shares in Aggregate (%).

	Male	Female	Mixed
Number of firms	59.2	23.2	17.6
Employment	62.8	13.0	24.3
Wages	69.0	7.3	23.6
Revenues	67.5	9.23	23.4
Profits	67.6	12.4	20.4
Debt	62.6	13.5	24.1

Note: This table shows the shares of male, female and mixed-owned firms in the total number of firms and their shares of employment, wages, revenues, profits and debt in the KFS data.

2. Empirical evidence

This section presents our core empirical findings, which are drawn from the restricted access version of the KFS 2004–2011 dataset. First, we briefly describe the KFS survey and highlight the main features of our sample of entrepreneurs. Note that we conduct robustness checks using also the Survey of Consumer Finances (SCF), whose description is left for Section A12 of the Online Appendix.[9] Second, we investigate potential heterogeneities in the sources of financing and in the allocation of capital across female and male-owned firms, discussing their risk profile, productivity and profitability as well.

2.1. The Kauffman Firm Survey (KFS) data

The KFS sample includes 4928 US new firms that started their operations in 2004 and have been followed until 2011.[10] One of the main advantages of the KFS is to contain data both on the owners' and on the firm side.[11] At the entrepreneurial level, it reports rich demographic details for up to 10 owners per firm, including their age, gender, race, working hours, marital status, education, as well as working and other start-up experience. Especially in terms of the gender composition of the sample, the comparison in Table A.1 of the Online Appendix shows that the share of female and male entrepreneurs in the KFS closely resembles the one computed using the Census Annual Survey of Entrepreneurs (ASE).

Following the literature, we focus on entrepreneurs actively managing their business (see Cagetti and De Nardi, 2006).[12] Moreover, we define a female-led business to have female active owners only, and a male-led business to have male active owners only. In Section A11 of the Online Appendix, we also report robustness checks according to alternative definitions of the gender of the ownership, based on either the gender of the primary owner or a continuous measure of female ownership. Throughout the analysis, sample weights are used to ensure the representativeness of the sample.[13]

At the firm level, the KFS dataset includes detailed information on the geographical location and industry codes of the businesses, as well as on balance sheet variables such as the wage bill, assets, revenues, and profits of the firms, and their different types of financing sources (debt and equity). Appendix Table A.2 provides the summary statistics of the main variables of interest. Appendix Figure A.2 compares instead the distribution of KFS firms over size bins (measured in terms of employees) to the one obtained from BDS, which comprises information on the size of more than 3 million US firms per year, between 1978 and 2014. With respect to BDS, KFS moderately oversamples small firms (1–4 employees), whereas there are no other sizable differences across the two distributions.

Table 1 reports the average share of female, male and mixed-owned firms in the KFS sample, and contrasts their employment, wage bill, revenue, profit and total debt shares in aggregate.[14] This first comparison illustrates that women are less represented among entrepreneurs in the KFS sample, and are more likely to run on average smaller businesses. The next sections will then explore empirically how a gap between female and male-owned firms' access to credit can possibly explain the observed gender imbalances on the extensive and intensive entrepreneurial margins.

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[9] In the calibration of the quantitative model we rely also on the Census Annual Survey of Entrepreneurs (ASE) and the Census Business and Dynamics Statistics (BDS), which are briefly introduced in Section A2 of the Online Appendix.

[10] Over the sample period, some firms exit the market, as shown in Appendix Figure A.7, which tracks the share of active and exiting firms. Appendix Table A.5 also provides estimates of proportional hazard models across female and male-led firms.

[11] Instead, the KFS has two main limitations. First, it surveys entrepreneurs that have *already* started a firm. This comes at the expense of not being able to further investigate all the crucial forces driving agents into entrepreneurship. Second, being a panel of start-ups, it over-samples young firms and does not contain truly well-established businesses.

[12] Our analysis focuses on agents actively engaged in entrepreneurial activities, as there could be enterprises where the legal ownership is female but the person(s) actively involved in strategies and activities is(are) male. In these cases, it would be difficult to distinguish clearly gender differences in accessing credit and in business capital utilization.

[13] Robustness checks are also run without sample weights. All the results are available upon request.

[14] See Appendix Figure A.3 for a comparison of such shares over time.

Table 2
Business Debt and Equity.

	(1) log(Business Debt)	(2) log(Equity)
Female	-0.3109***	-0.0430
	(0.1164)	(0.1091)
Controls	Y	Y
Sector FE	Y	Y
Region FE	Y	Y
Year FE	Y	Y
Observations	13012	14335
R^2	0.177	0.246

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Survey weights are used. Controls for individual characteristics include education, experience, race and age. Other controls include the number of owners, legal status of the firm, and size (log(*revenues*)). Sector FE are at the 4-digit level.

2.2. Credit access

Our first step is to investigate potential gender heterogeneities in firm financing. Funding is classified into two main categories: business debt – a typical *external* source – and equity, which is mostly an *internal* source, especially for non-publicly traded firms like the ones in the KFS survey. As reported in Figure A.11 in the Online Appendix, bank loans and credit lines make up for most of the funding across the firms in our sample and hence constitute the primary focus of our analysis. Moreover, Table 2 documents that female entrepreneurs operate with lower business debt – regardless of their personal traits and the characteristics of their firms – which they do not compensate by means of higher levels of business equity.[15] Importantly, Appendix Figure A.14 breaks down the regression residuals by industry to further show that this result is not driven by one industry only, and is to be interpreted as a *within* sector and *across* sectors phenomenon.

However, the fact that female-owned enterprises report lower firm liabilities could be potentially imputed to an interplay of both supply and demand factors. Lower levels of business debt may be due to the fact that women find it more difficult to access credit (*supply*-side constraints), but women could also deliberately seek less external funding (*demand* effect). To partially disentangle these two relevant channels, in Appendix Table A.8 we first document that there is no statistically robust difference in the likelihood of applying for a loan across genders, suggesting a weaker role for any heterogeneity in the *demand* for credit.[16] We then focus on entrepreneurs who applied for funding and examine gender differences in loan rejections, as KFS provides data on credit application outcomes for the years between 2007 and 2011. In our sample, 22% of business loan applicants are turned down by financial institutions, with the average rejection rate being higher for female entrepreneurs (32%) compared to male ones (19%).[17] The likelihood of loan rejection for male and female owners in our sample can hence be estimated by running the following probit regression:[18]

$$Pr(Reject_{it} = 1) = F\left(\beta_0 + \beta_1 \mathbb{1}_{female} + \boldsymbol{\delta}'\boldsymbol{\Gamma}_{it} + \alpha_t + \eta_{s(it)} + \nu_{r(it)}\right) \tag{1}$$

where $Reject_{it}$ is a binary variable that takes a value of 1 if loan applications are rejected, and 0 if loan applications are approved. The key explanatory variable is $\mathbb{1}_{female}$, a dummy variable equal to 1 if the firm is 100% female-owned and to 0 if it is 100% male-owned. The regression includes a set of controls $\boldsymbol{\Gamma}$, which capture factors that may affect whether a loan application gets rejected or not (e.g. age, race, education, previous experience, owners' personal debt, firms' legal status,[19] size, and leverage, which is defined as business debt over assets), as well as sector ($\eta_{s(it)}$), region ($\nu_{r(it)}$) and year (α_t) fixed effects (hereafter FE).[20]

As reported in Table 3, female ownership strongly correlates with a higher probability of loan rejection, suggesting that women are subject to tighter constraints in accessing credit. In particular, female entrepreneurs face a 10% higher probability of having their loan application denied, and this is likely to impact firms' ability to fund their operations, as the main source of financing for entrepreneurs in the KFS sample, regardless of their gender, is precisely bank loans.[21] Results are

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[15] In Section A9 of the Appendix, we provide a comprehensive breakdown of the capital structure decision of female- and male-owned firms. Consistent with Table 2, Appendix Table A.6 shows that female-owned firms hold lower levels of debt, which are not compensated with more equity financing. We also verify this finding using data from the SCF in Appendix Table A.19.

[16] This is further confirmed by a similar regression using SCF data (see Table A.20 in the Online Appendix).

[17] In Appendix Figure A.13, we show that this gap in rejection rates persists over the time spanned by the KFS.

[18] Results from robustness checks using linear probability models are in Table A.9 of the Online Appendix.

[19] See Appendix Table A.4 for a breakdown and discussion of firm's legal status by gender.

[20] As a further check on the relevance of gender differences in loan application outcomes, we run probit regressions interacting the gender dummy with experience, personal debt of owners, legal form of the enterprise, size, and a dummy indicator for recession years. The gender margin remains nonetheless statistically significant throughout the different specifications.

[21] We also cross-check our results using SCF data (see Table A.20 in the Online Appendix).

Table 3
Loan Application Rejections.

	(1)	(2)	(3)	(4)	(5)
Female	0.0970**	0.0848*	0.0992**	0.0949*	0.1127**
	(0.0458)	(0.0517)	(0.0457)	(0.0503)	(0.0470)
Controls	Y	Y	Y	Y	Y
Leverage	N	Y	N	Y	Y
Personal debt	N	N	Y	Y	Y
Credit risk score	N	N	N	N	Y
Sector FE	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	613	458	589	445	404
Pseudo-R^2	0.236	0.275	0.271	0.311	0.401

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Survey weights are used. The dependent variable is a binary indicator = 1 if loan applications are rejected, and = 0 if loan applications are approved. Control variables include the number of owners, legal status of the firm, number of hours worked per week and size as measured by log(*revenues*), as well as owners' characteristics such as education, experience, race, and age. Sector FE are at the 2-digit level due to sample size limitations.

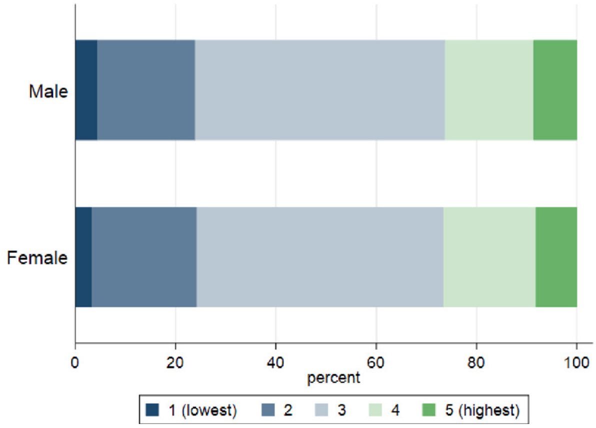

Fig. 1. Credit Risk Scores of Male and Female Entrepreneurs. *Note:* This figure shows the Dun & Bradstreet credit risk scores of entrepreneurs in KFS. Credit risk scores are given on a scale of 1 to 5, where 1 represents the lowest risk class and 5 is the highest risk class.

also statistically significant when different definitions of female ownership are considered (see Table A.10 in the Online Appendix). Note that crucial control variables in our regression specifications are the leverage of the firm, the personal debt burden of owners and business credit risk scores. These regressors are particularly important since entrepreneurial and business risk are often regarded as key determinants of loan application approval. If female entrepreneurs were to run riskier enterprises, this could be a candidate reason for facing higher rejection rates on their business loans applications.

To provide more evidence on the risk profile of female and male entrepreneurs in our sample, we also examine their credit risk scores, which are officially assigned to them by the Dun & Bradstreet rating agency. Fig. 1 shows that, overall, female entrepreneurs are not rated riskier than male ones (on a scale 1 to 5, numbers closer to 1 refer to low credit risk). Moreover, among successful applicants, the average risk score of male entrepreneurs is 2.62, whereas for female entrepreneurs is 2.44. As for rejected loan requests, the average score of male entrepreneurs is 3.22, while for female entrepreneurs is 2.87. Female-led firms have hence better credit risk profiles among both *accepted* and *rejected* loan applicants.[22]

As a further analysis of firm risk by owners' gender, we then compare female and male entrepreneurs' leverage. Since entrepreneurial assets are not recorded in the KFS dataset, we define leverage as the ratio between total business debt and fixed assets.[23] However, not observing entrepreneurial wealth could lead to a bias in the estimation of the real leverage of the firms in our sample. Small and nascent firms tend to rely more heavily on owners' personal assets to secure external

[22] Appendix Table A.7 also shows that there is no difference in the overall fraction of female and male entrepreneurs that did not apply for a loan due to fear of being rejected, notwithstanding their credit risk score. Moreover, Appendix Figure A.16 documents that female entrepreneurs do not have different attitudes towards business growth expectations and uncertainty.

[23] Here, we use fixed assets instead of total assets to ensure comparability with our model-implied measure. For further discussion on leverage measurement and robustness checks, see Section B4 in the Online Appendix.

Table 4
Measures of Risk-Taking and Profitability.

	(1)	(2)	(3)	(4)	(5)
	leverage (All)	leverage (FA > $10,000)	sd(ROA)	$\frac{Profit}{Assets}$	$\frac{Profit}{Revenues}$
Female	0.0923	-0.1532*	0.0504	0.3610**	0.0239*
	(0.1440)	(0.0991)	(0.1317)	(0.1367)	(0.0130)
Controls	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	8196	4935	4726	5901	5811
R^2	0.115	0.172	0.133	0.111	0.339

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Survey weights are used. Control variables include the number of owners, legal status of the firm, number of hours worked per week and size as measured by log(*revenues*), as well as owners' characteristics such as education, experience, race, and age. The regression on sd(ROA) also includes business debt-to-assets ratio as a control variable, following Faccio et al. (2016).

finance (Berger and Udell, 1998), as for example in the case of housing collateral (Schmalz et al., 2017). Since female-owned firms tend to be smaller, their leverage ratios might also suffer from a bigger estimation bias. As shown in columns (1) and (2) of Table 4, there is no statistically significant difference in leverage across genders when considering the full sample. When focusing however on relatively bigger firms, male entrepreneurs are found to be more leveraged.

The fact that female entrepreneurs are not systematically riskier than male ones is finally confirmed by comparing female and male-owned firms' volatility in their return on assets, as reported in column (3) of Table 4. Such measure is computed as the standard deviation of profits over assets in a three-year rolling window, and it is often used in finance as a measure of business risk (see Faccio et al., 2016).[24] Coupled with the evidence on credit risk scores, our empirical findings suggest that female entrepreneurs are not riskier clients for banks, which may exclude differential business risk as a confounding factor behind the observed gender disparities in credit access.

It could also be questioned whether the higher loan rejection rates faced by female owners should be attributed to gender differences in firm profitability. We compute standard profitability measures such as profits over assets $\frac{Profit}{Assets}$, and the profit margin $\frac{Profit}{Revenues}$, and compare them across female and male entrepreneurs.[25] As reported in columns (4) and (5) of Table 4 and in Appendix Figure A.9, after controlling for individuals' observable characteristics and other well-known determinants of firm performance, female-led firms seem to be more profitable compared to male ones.[26] This result holds when using different definitions of female ownership (see Tables A.11– A.12 of the Online Appendix), and a different sample of entrepreneurs from the SCF dataset (see Table A.21 of the Online Appendix). Hence, it can be argued that the observed gap in external funding is not evidently related to different firm profitability across genders.[27] Moreover, the fact that female-owned businesses may have better profit margins is consistent with a phenomenon of stricter *selection* into the entrepreneurial pool. In particular, if female agents face tighter borrowing constraints, this can imply that only the marginally more productive ones manage to start a business, resulting in the observed higher profitability.

2.3. Misallocation

The next set of results documents the presence of gender-driven capital misallocation in the KFS sample. To conceptualize the notion of misallocation, one can imagine an economy populated by heterogeneous firms that differ in their productivity A_i and produce a homogeneous good according to $y_i = A_i f(k_i, l_i)$, where f is a strictly increasing and concave production function in capital k and labor l. As explained by Restuccia and Rogerson (2017), absent misallocating forces, there should exist a unique choice for how labor and capital are allocated across firms to maximize total output. Misallocation arises if inputs do not flow to firms according to their productivity A_i, and differences in the average product of inputs are an empirical indicator of the misallocation of resources across producers (see Hsieh and Klenow, 2009). Moreover, inputs misallocation can be related to latent frictions that can disproportionately affect some entrepreneurs, such as borrowing constraints (see

[24] Faccio et al. (2016) use a five-year rolling window, while we opt for a smaller window as the KFS panel is shorter.

[25] We also check whether and how much entrepreneurs invest in their businesses through research and development (*R&D*) – e.g. worker training, product/service design, brand, software and organizational development – whose relevance for business performance has been widely documented (see Corrado et al., 2009). As reported in Appendix Figure A.10, even if female-owned firms are on average smaller and hence spend less in absolute terms, there are no statistically significant gender differences in the resources devoted by their businesses to *R&D* as a share of total expenses or total revenues, even if slightly less female entrepreneurs invest in R&D relative to males (13% and 16% respectively).

[26] Using KFS data from 2004 to 2008, Robb and Watson (2012) find no gender difference in business performance. Making use of the entire sample can potentially explain our different conclusions. Their result is also not inconsistent with our main point on the fact that the funding gap across genders is not being driven by differences in profitability.

[27] Our results are consistent with a 2018 study by the Boston Consulting Group, which found that for every $1 of investment raised, women-owned startups generated $0.78 in revenues, whereas men-run startups generated only $0.31, see https://www.bcg.com/publications/2018/why-women-owned-startups-are-better-bet

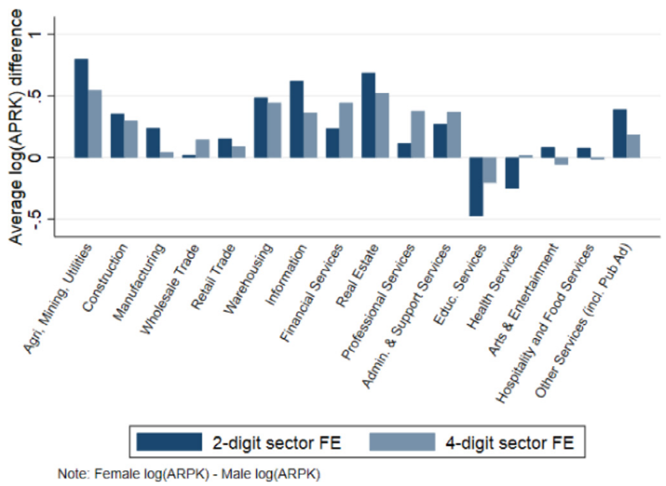

Fig. 2. Gender Differences in *arpk* Across Industries. *Note*: This figure shows the residual differences in female and male *arpk* across 2-digit sectors from the regression specification used in Table 5, with and without 4-digit sector FE.

Hopenhayn, 2014). For example, capital-constrained firms may operate with lower than average levels of capital, resulting in empirically higher average product of capital.

Following this reasoning, our approach is to measure misallocation of productive inputs at the firm-level and by gender, and try to establish a link with the observed credit gap across female and male-led firms. We begin by computing the average returns to capital and labor as follows:

$$arpk_{it} := \ln(ARPK_{it}) = \ln\left(\frac{Y_{it}}{k_{it}}\right) \qquad \text{and} \qquad arpl_{it} := \ln(ARPL_{it}) = \ln\left(\frac{Y_{it}}{l_{it}}\right)$$

where the Y_{it} is revenues, k_{it} is capital, and l_{it} refers to firm's labor. As in Hsieh and Klenow (2009), wage bill is used instead of employment as a measure of the labor input to control for differences in labor quality and actual hours worked across firms. Fixed assets are computed as the sum of all non-current asset categories in the KFS dataset, including inventory, equipment and machinery, land, buildings, vehicles and other properties.[28] We then run the following regression:

$$y_{it} = \beta_0 + \beta_1 \mathbb{1}_{female} + \boldsymbol{\delta}'\boldsymbol{\Gamma}_{it} + \alpha_t + \eta_{s(it)} + \nu_{r(it)} + \varepsilon_{it} \tag{2}$$

where $y_{it} = \{arpk_{it}, arpl_{it}\}$. The key explanatory variable is $\mathbb{1}_{female}$, a dummy variable that takes on a value of 1 if the firm is 100% female-owned and 0 if it is 100% male-owned. The regressions include a set of controls $\boldsymbol{\Gamma}$, which captures various factors apart from gender that may affect the allocation of inputs of production across firms, as well as 4-digits sector, region and year FE. As shown in Table 5, female-owned businesses are associated with 8–12% higher *arpk*,[29] which suggests the presence of gender-driven misallocation of capital across firms, and that female entrepreneurs are operating with lower levels of capital compared to men. In contrast to that, there is no statistically significant difference between the *arpl* of male and female-owned firms.[30] Our results are robust to using a continuous measure of female ownership or focusing on the gender of the primary owner (see Table A.13 of the Online Appendix).

In principle, a competing explanation for the observed gender gap in *arpk* would be that women run firms that use less capital-intensive technologies. Our analysis attempts to address such concern in two ways. First, we include 4-digit sector FE in Eq. (2) to ensure that the variation in capital utilization across genders is not primarily driven by differences in technologies at a finer industry level. As reported in Fig. 2, the residual differences in female and male *arpk* under the regression specification in Table 5 are smaller when including 4-digit sector FE as opposed to 2-digit sectors FE. Controlling for 4-digit sector FE is hence crucial to properly estimate the association between owners' gender and firm capital utilization. Consequently, the documented gender-driven capital misallocation can be interpreted as a *within* sector and *across* sectors phenomenon, insofar as the gender gap in *arpk* is not imputed to specific industries only.

Second, we further investigate the link between credit and capital misallocation, and highlight how access to external finance leads to a reduction of the gender gap in *arpk* in our sample of firms. To do so, we expand our baseline regression in Eq. (2) and interact the female ownership dummy $\mathbb{1}_{female}$ with a measure of firm debt holdings. We specifically look at both business debt and personal debt to see how each type of liability can differently affect capital allocation across entrepreneurs of opposite genders by running the following regression specification:

$$arpk_{it} = \beta_0 + \beta_1 \mathbb{1}_{female} + \beta_2 \log(\text{Debt}) + \beta_3 \mathbb{1}_{female} \times \log(\text{Debt}) + \boldsymbol{\delta}'\boldsymbol{\Gamma}_{it} + \alpha_t + \eta_{s(it)} + \nu_{r(it)} + \varepsilon_{it} \tag{3}$$

[28] Current assets in the KFS sample are cash and accounts receivable (see also Kochen and Guntin, 2021).

[29] Columns (3) and (4) in Table 5 show regressions on firms with empirically relevant levels of yearly sales.

[30] Our finding on *arpl* is consistent with the analysis of Bento (2021) on US Census aggregate data.

Table 5
arpk and *arpl* across genders.

	(1) *arpk*	(2) *arpl*	(3) *arpk* revenues>$10,000	(4) *arpl* revenues>$10,000
Female	0.0836*	0.0230	0.1219**	0.0689
	(0.0498)	(0.0545)	(0.0561)	(0.0565)
Controls	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	7766	5955	5723	4873
R^2	0.236	0.175	0.263	0.207

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Survey weights are used. Control variables include the number of owners, legal status of the firm, and number of hours worked per week, as well as owners' characteristics such as education, experience, race, and age.

Table 6
arpk and Debt.

	Business Debt	Personal Debt
	arpk	*arpk*
Female	0.1121*	0.2154***
	(0.0668)	(0.0747)
log(Debt)	-0.0121**	-0.0107**
	(0.0048)	(0.0047)
Female × log(Debt)	-0.0200*	-0.0237**
	(0.0112)	(0.0100)
Controls	Y	Y
Sector FE	Y	Y
Region FE	Y	Y
Year FE	Y	Y
Observations	5074	5557
R^2	0.277	0.274

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Survey weights are used. Control variables include the number of owners, legal status of the firm, and number of hours worked per week, as well as owners' characteristics such as education, experience, race, and age. Firms with revenues>$10,000 are considered.

As reported in Table 6, there is evidence of a strong interplay between debt and *arpk*.[31] In particular, a statistically significant coefficient on the female dummy means that, on average, there is misallocation of capital across genders that cannot be attributed to differences in the level of debt. The negative correlation between debt and *arpk* suggests that being able to borrow more can relax the financial constraint of firms and hence lower capital misallocation. Most importantly, a negative and statistically significant coefficient on the interaction term means that the effect is stronger for female entrepreneurs. As female-owned firms expand and gain access to finance, they reduce by relatively more their gap in capital utilization with respect to male-owned firms, which would not be necessarily the case if female-led businesses were to just operate less capital-intensive technologies. Coupled with the evidence on the gender disparities in financial frictions, the observed gap in *arpk* hence suggests that a differential access to credit across genders could be driving the sub-optimal allocation of capital documented in the data within and across industries.

As a further validation exercise and to complement our analysis, the left panel of Fig. 3 shows the relationship between female *arpk* and the share of female-owned firms across states, controlling for all the variables included in our main regressions. Note that, to compute a representative share of female-owned enterprises for each state, we use US Census statistics for the year 2007.[32] In states where women are more represented within the entrepreneurial force, female *arpk* is lower, implying lower gender-driven capital misallocation. Similarly, the right panel of Fig. 3 documents that the average debt level of female-owned enterprises is higher in states with a higher share of female entrepreneurs. Capital misallocation and credit differences across genders seem hence to be lower wherever female entrepreneurial representation is higher.[33]

[31] Table 6 focuses on firms with empirically relevant levels of revenues, based on our main definition of female ownership. Our results are robust to alternative definitions of female ownership, as documented in Appendix Table A.14. Additional results for the entire sample are available upon request.

[32] Since the KFS spans the period between 2004 and 2011, we work with estimates from the 2007 SBO sample.

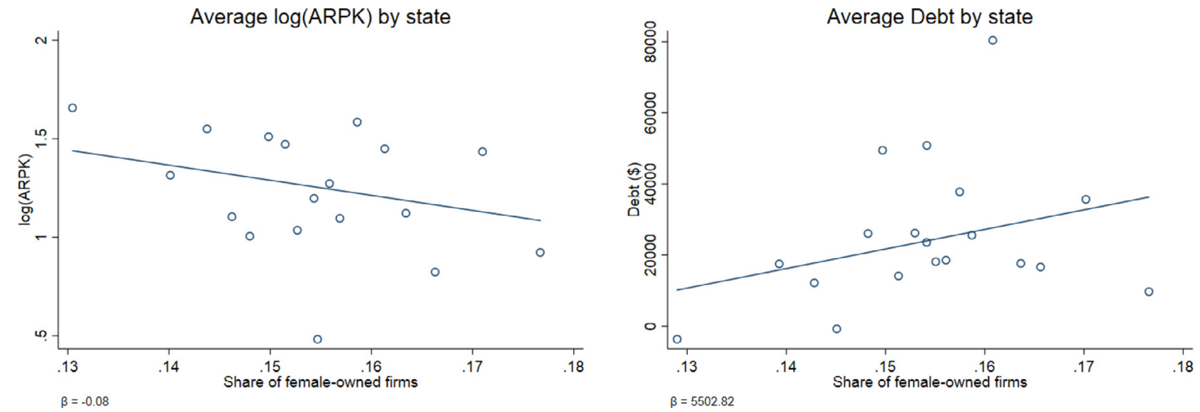

Fig. 3. Female *arpk* and Debt Across States. *Note*: Average *arpk* and debt level of female-owned firms versus the share of female-owned firms across states. Note that the plot (a binscatter) groups together states with similar female entrepreneurial rates and allows to control for all the variables used in our main regressions. See Appendix Figure A.17 for the breakdown by state.

Finally, we have previously shown that female-owned firms are associated with higher average business profitability, and argued that this phenomenon is consistent with a process of stronger *selection* of women into entrepreneurship. If female-owned firms face higher barriers after entry – for example, by means of an impaired access to credit, as we document – only marginally more productive women may find optimal to become entrepreneurs. As additional evidence of this mechanism, we follow Hsieh and Klenow (2009) and compute a revenue-based measure of total factor productivity – $tfpr$ – as the ratio between business revenues and output. This procedure requires choosing a functional form for the production function of the firms, which we have abstracted from so far given that we have analyzed *average* returns to capital and labor as opposed to *marginal* returns. Under a standard Cobb-Douglas production function, firm-level $tfpr$ can be defined as follows:

$$tfpr := \ln(TFPR_{it}) = \ln\left(\frac{Y_{it}}{(k_{it}^{\alpha} l_{it}^{1-\alpha})}\right)$$

where Y_{it} is revenues, k_{it} is capital measured using fixed assets, l_{it} is labor measured as wage bill, and $\alpha = 0.33$ as standard. Firm-level $tfpr$ is then regressed on the indicator of the business owners' gender following the same specification as in Eq. (2). Across different definitions of female ownership, we nevertheless find that $tfpr$ is higher for female-led firms. Consequently, it is possible to interpret this result as further indication of a stricter *selection* process of productive women into entrepreneurship.

Our analysis has documented gender gaps in financial frictions and in capital utilization. Previous papers have also found instances of gender imbalances with respect to firm financing, see Cavalluzzo et al. (2002), Bellucci et al. (2010), Aristei and Gallo (2016), De Andres et al. (2021) and Montoya et al. (2020) on the topic of loan requests, and Hebert (2020) and Ewens and Townsend (2020) on external funding. Other works have instead uncovered gender differences in the interest rate paid on loans (see Coleman, 2000 and Alesina et al., 2013), as well as in the frequency and size of the collateral asked to firms (see Calcagnini et al., 2015 and Xu et al., 2016).[34] In our investigation, having established as a novel empirical fact the presence and extent of gender-driven capital misallocation, we also suggest that the observed differential access to credit across genders in the KFS may be driving the misallocation of capital that we document empirically.

The nature of our data, however, does not allow us to reach a clear-cut conclusion on what is driving the heterogeneity in the access to credit across male and female entrepreneurs in our sample. In Section B2 of the Online Appendix, we discuss different types of discrimination that could be responsible for the observed gender gap in business financing. We examine taste-based and implicit-bias explanations proposed by previous literature for which we find some suggestive support in our analysis, but we cannot take any conclusive stand. Instead, in our quantitative investigation, we will condense this discussion in developing a heterogeneous agents entrepreneurship model enriched with gender-based borrowing limits, and treat the heterogeneity in firm debt across genders as stemming from the credit supply side of the economy. Even if reduced-form, such asymmetry in the access to funding is in line with our evidence on the tighter financial constraints faced by female entrepreneurs in KFS, and delivers consistent gender differences in capital utilization.

[33] A higher share of female entrepreneurs could relate to cultural norms, federal laws, or gender stereotypes, that may be more (less) present in some States. In Appendix Figure B.1, we also document that in states where there is higher female representation in financial sector jobs, the average debt of female-owned firms is also higher.

[34] In Appendix Figure A.12, we verify that female-owned firms in the KFS sample are more likely to be requested collateral both among successful and rejected loan applicants, whereas the reason for getting a loan application rejected is more often imputed to motivations that abstract from business performance, see Appendix Figure A.13.

Table 7
tfpr across genders.

	Baseline	Primary Owner	Share of Female Owners
Female	0.0937*	0.1117***	0.1153***
	(0.0487)	(0.0384)	(0.0427)
Controls	Y	Y	Y
Sector FE	Y	Y	Y
Region FE	Y	Y	Y
Year FE	Y	Y	Y
Observations	4024	5050	5091
R^2	0.215	0.208	0.201

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Survey weights are used. Control variables include the number of owners, legal status of the firm, and number of hours worked per week, as well as owners' characteristics such as education, experience, race, and age.

3. Theoretical framework

The empirical evidence gathered so far suggests that tighter financial frictions may be causing distortions in the level of capital with which female entrepreneurs operate their businesses. Our goal is hence to model and quantify the impact of gender differences in the degree of borrowing constraints, which can lead to distortions along both the *extensive margin* (i.e. entrepreneurial participation) and the *intensive margin* (i.e. optimal allocation of resources) of entrepreneurship.

Following Buera and Shin (2013), we develop a GE heterogeneous agents model in which individuals of different genders, entrepreneurial productivities and assets can decide whether to be workers or entrepreneurs. We assume that the amount of capital entrepreneurs can rent depends on their stock of assets, and embed a gender-based borrowing constraint that may lead female entrepreneurs to borrow less compared to male entrepreneurs with similar wealth and productivity. Along the *extensive margin*, tighter financial frictions cause women to face higher barriers in starting a business, discouraging their entry and strengthening their selection into the entrepreneurial pool. Along the *intensive margin*, we show how differential borrowing constraints can influence women's optimal choice of capital and lead to gender-driven capital misallocation.[35]

3.1. Model primitives

Time is discrete and the environment is populated by a continuum of infinitely-lived agents characterized by different productivity z, assets a, and gender g, giving rise to a distribution of individuals $H(z, a, g)$ in each t. While agents' productivity follows an exogenous stochastic process, financial wealth is determined endogenously by a standard consumption-saving problem.

Occupation: At each point in time, agents choose their occupation $o(a, z, g)$, based on their wealth, idiosyncratic entrepreneurial productivity and gender. They can decide to be workers (*work*) or entrepreneurs (*entr*). Entrepreneurs own and run a firm, from which they earn business profits π, while workers inelastically supply one unit of labor and earn a wage w, determined in general equilibrium. For simplicity, the wage w is assumed to be independent of agents' characteristics.[36]

Productivity: Entrepreneurial productivity z follows an exogenous stochastic process given by:

$$z_t = \rho_z z_{t-1} + \epsilon_t \quad \text{with} \quad \epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2)$$

which is further characterized by the conditional distribution $d\Xi(z'|z)$. In particular, ρ_z is the persistence in productivity, while ϵ_t is the idiosyncratic risk component. Hence, our model features idiosyncratic shocks to entrepreneurial productivity and no source of aggregate uncertainty.

Preferences: Agents have a strictly increasing concave utility function, which satisfies standard Inada conditions. The coefficient of risk aversion is denoted by γ and assumed to be the same across genders (this can be relaxed without changing the nature of our results).[37] Moreover, agents discount the future at a rate β and maximize utility over the following stream

[35] This leaves open the possibility of introducing other gender differences across entrepreneurs, which we abstract from in the current analysis but explore in Sections B5.2– B5.4 of the Online Appendix. Here, we show that a model of entrepreneurship and financial frictions, enriched with a gender gap in credit access, is sufficient to match well the observed features of our data.

[36] Our analysis abstracts from studying the gender gap in workers' earnings and rather focuses on the entrepreneurial credit gap only. Future work is needed to understand the relative strength and importance of both the wage and credit gaps, and further investigate their impact on female occupational choices.

[37] Our choice is motivated by the fact that we cannot find robust empirical evidence of gender difference in risk aversion in both KFS and SCF data, as explained in the Online Appendix. Nonetheless, we note that a higher coefficient of risk aversion would further discourage women from becoming entrepreneurs, inducing a stronger selection effect and amplifying capital misallocation. In this case, our baseline results would be a conservative estimate of the negative aggregate effects caused by the gender-driven misallocation of talent and capital (see Section B5.4 of the Online Appendix).

of consumption:

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma} - 1}{1-\gamma}$$

3.2. Firms' Production

Entrepreneurs produce with a standard production function that combines together entrepreneurial productivity z, capital k and labor l. The production function is increasing in all its arguments, strictly concave in capital and labor, and decreasing returns to scale, allowing for a non-degenerate distribution of the enterprise size. In particular, $f(z, k, l)$ is given by:

$$f(z,k,l) = e^z (k^\alpha l^{1-\alpha})^{1-\nu}, \quad \text{with} \qquad 0 < 1-\nu < 1$$

where $1-\nu$ is the span of control as in Lucas (1978).[38] Both capital and labor are static inputs and rented on their respective markets at each point in time. Entrepreneurs therefore pay capital rental costs $(r+\delta)k$ – where δ is the depreciation rate – and salaries wl as variable input costs.[39]

3.3. Financial markets

There is a perfectly competitive intermediary sector that receives deposits from savers and lends funds to firms, without intermediation costs. The rental rate of capital is given by r_t, where r_t is the deposit rate determined in general equilibrium. Financial markets are incomplete, and entrepreneurs can borrow up to a fraction of their assets a_t. Capital constraints are hence given by:[40]

$$k_t \leq \lambda_g a_t; \qquad a_t \geq 0$$

where $a_t \geq 0$ (intertemporal borrowing is ruled out for simplicity) and λ_g measures the degree of the constraints, which varies by gender. If $\lambda_g = 1$, agents operate in a zero credit environment, as opposed to the case in which $\lambda_g = \infty$ and individuals can borrow according solely to their productivity, regardless of their financial wealth. In addition to that, we allow for the possibility that female entrepreneurs in the model may borrow less than male ones, namely for $\lambda_m - \lambda_f > 0$.

3.4. Profit maximization

Entrepreneurs maximize revenues net of capital renting costs and labor costs, with the only gender disparity being the different borrowing constraint female entrepreneurs face when renting capital. Since the price of output is normalized to one, the profit maximization problem for an entrepreneur of given gender g can be written as:

$$\pi_t = \max_{l_t, k_t} \left\{ e^{z_t} (k_t^\alpha l_t^{1-\alpha})^{1-\nu} - w_t l_t - (r_t+\delta)k_t, \quad \text{s.t.} \quad k_t \leq \lambda_g a_t \right\} \tag{4}$$

Importantly, we do not assume any gender difference in the labor hiring process (or in labor costs), which is consistent with the findings in Section 2.3. As shown in Table 5, female entrepreneurs are associated with higher *arpk*, whereas no gender heterogeneities exist with respect to *arpl*.[41]

3.4.1. Understanding gender-driven misallocation

An intuitive way to disentangle the mechanism engineered by the gender differences in financial frictions is to derive the profit maximization problem for a female entrepreneur and compared it to the one of any male entrepreneur. We may assume in this analysis that $\lambda_f = \lambda_m - \tau > 0$, where τ is interpreted as a wedge on the capital input. Thus, for a female entrepreneur, one can write:

$$\max_{l_t, k_t} \left\{ e^{z_t} (k_t^\alpha l_t^{1-\alpha})^{1-\nu} - w_t l_t - (r_t+\delta)k_t - \mu_t \left(\frac{k_t}{\lambda_m - \tau} - a_t \right) \right\} \tag{5}$$

[38] In Section B5.3 of the Online Appendix, we also discuss a version enriched with gender differences in the span of control.

[39] In Section B5.2 of the Online Appendix, we also discuss a model version that includes differential operational costs.

[40] Recent literature has emphasized that the empirically relevant borrowing constraint for firms is based on earnings (see Lian and Ma, 2021 and Li (2022)). However, since businesses in the KFS dataset are startups, asset-based financial limits may still be the relevant borrowing constraint that these firms face, given that they are small and young and their cash flows may not be readily verifiable. To this end, Table B.1 of the Online Appendix shows that there is no statistically significant correlation between the leverage and the profitability (or productivity) of the firms we focus our analysis on, which instead should have been the case if these firms were borrowing against their earnings.

[41] Appendix Table B.2 shows that there is no gender difference in the wages paid to their employees across KFS entrepreneurs. We also abstract from modeling any (employee) gender wage gap, for we do not observe the breakdown of the wage bill across employees' gender for female and male owners in the KFS sample.

where μ_t is the Lagrangian multiplier on the financial constraint. Deriving the optimality conditions for both labor and capital, we first observe that:

$$l_t^{opt} = \left(\frac{(1-\nu)(1-\alpha)e^{z_t}(k_t^{\alpha})^{1-\nu}}{w_t} \right)^{\frac{1}{1-(1-\alpha)(1-\nu)}} \tag{6}$$

$$k_t^{opt} = \left(\frac{(1-\nu)\alpha e^{z_t}(l_t^{1-\alpha})^{1-\nu}}{r_t+\delta+\frac{\mu_t}{\lambda_m-\tau}} \right)^{\frac{1}{1-\alpha(1-\nu)}} \tag{7}$$

Gender differences in borrowing constraints do not affect female entrepreneurs' optimal choice of labor l_t^{opt}, while they do negatively impact their k_t^{opt} if $\mu_t \neq 0$. In this case, higher values of τ (which corresponds to relatively lower values of the borrowing limit λ_f) reduce k_t^{opt} for a female entrepreneur compared to a male one. Specifically, borrowing constraints distort all entrepreneurial capital choices, while the different borrowing limit across genders further biases downwards women's k_t^{opt} with respect to men's k_t^{opt}.[42] Thinking of the firms for which financial constraints are more likely to bind – for example young or small businesses – female-owned firms of such kind could be more often constrained relative to male-owned firms, which may create distortions in female entrepreneurs' business operations and limit their growth and expansion.

To provide a direct theoretical counterpart to the misallocation measures estimated empirically in the KFS sample and discussed in Section 2, we proceed to compute the model equivalent of the average product of capital and labor for a given female and male entrepreneur at time t:

$$arpk_f := \ln(ARPK_f) = \ln\left(\frac{Y_f}{k_f}\right) = \frac{r_t+\delta+\frac{\mu}{\lambda_m-\tau}}{(1-\nu)\alpha}$$
$$arpl_f := \ln(ARPL_f) = \ln\left(\frac{Y_f}{l_f}\right) = \frac{w_t}{(1-\nu)(1-\alpha)}$$
$$arpk_m := \ln(ARPK_m) = \ln\left(\frac{Y_m}{k_m}\right) = \frac{r_t+\delta+\frac{\mu}{\lambda_m}}{(1-\nu)\alpha}$$
$$arpl_m := \ln(ARPL_m) = \ln\left(\frac{Y_m}{l_m}\right) = \frac{w_t}{(1-\nu)(1-\alpha)}$$

Proposition 1. *: Denote the difference between $arpk_f(\tau)$ and $arpk_m$ as $D_k(\tau)$, where $D_k(\tau) = arpk_f(\tau) - arpk_m = \frac{\tau\mu}{(\lambda_m-\tau)\lambda_m}$. When $\mu_t \neq 0$, the following two results hold:*

$$\frac{\partial D_k}{\partial \tau} = \frac{\mu_t \lambda_m^2}{((\lambda_m-\tau)\lambda_m)^2} > 0 \tag{8}$$

$$\text{If} \quad \tau = 0 \quad \text{then} \quad D_k(\tau) = 0 \tag{9}$$

Similarly, denote the difference between $arpl_f$ and $arpl_m$ as D_l, where $D_l = arpl_f - arpl_m = 0$. D_l does not increase with the difference in borrowing constraints across gender τ.

Fig. 4 gives a graphical representation of Proposition 1 by plotting $arpk_f$ and $arpk_m$ (left panel), as well as $arpl_f$ and $arpl_m$ (right panel) as functions of the gender difference in the financial constraint wedge τ. The gender gap in credit access not only discourages women from becoming entrepreneurs, but also induces heterogeneities in the average product of capital across female and male-owned firms in the model. These effects can be reconciled with US aggregate evidence on lower female entrepreneurial rates, and with the gender differences in the level of financial constraints and *arpk* documented in Section 2. As such, the quantitative purpose of this paper will be to estimate the extent of the borrowing wedge τ, and assess how much it can impact the allocation of entrepreneurial talent and capital, as well as aggregate productivity in the economy.

3.5. Individual's problem

In each t, agents maximize expected utility given factor prices $\{w, r\}$, their assets and productivity, such that the budget constraint always binds. The value function that individuals maximize is:

$$V(a, z, g) = \max\{V^{work}(a, z, g), V^{entr}(a, z, g)\} \tag{10}$$

[42] An increase in λ_m and λ_f results in a release of borrowing limits. Since agents expect financial constraints to bind less often, the entrepreneurial productivity cutoff of both genders decreases, causing higher entry into entrepreneurship. However, if such increase is proportional, gender differences in credit access and in business performance remain.

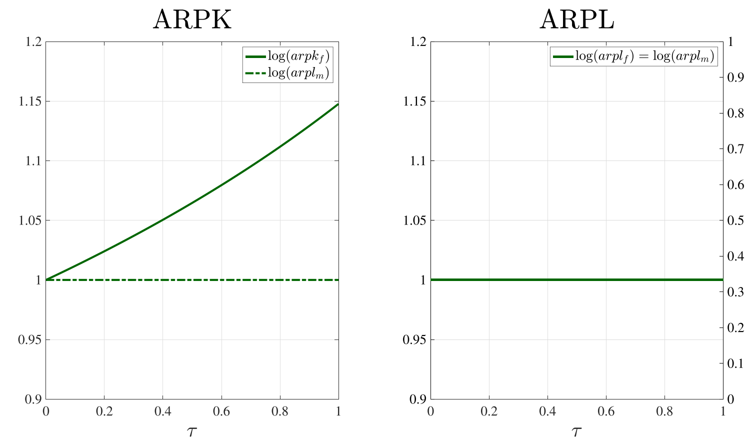

Fig. 4. Proposition 1.

Specifically, workers' value function is given by:

$$V^{work}(a,z,g) = \max_{c,a' \geq 0} \; u(c) + \beta \int V'(a',z',g) d\Xi(z'|z) \tag{11}$$

$$s.t. \quad c + a' \leq w + (1+r)a \tag{12}$$

while entrepreneurs' value function is given by:

$$V^{entr}(a,z,g) = \max_{c,a' \geq 0} \; u(c) + \beta \int V'(a',z',g) d\Xi(z'|z) \tag{13}$$

$$s.t. \quad c + a' \leq e^{z}(k^{\alpha} l^{1-\alpha})^{1-\nu} - wl - (r+\delta)k + (1+r)a \tag{14}$$

$$k \leq \lambda_g a \tag{15}$$

3.6. Recursive equilibrium

At time 0, given the distribution $H_0(z,a,g)$, the equilibrium of the economy is characterized by a sequence of allocations $\{o_t, c_t, a_{t+1}, k_t, l_t\}_{t=0}^{\infty}$, factor prices $\{w_t, r_t\}_{t=0}^{\infty}$, and $H_t(z,a,g)_{t=1}^{\infty}$ such that $\{o_t, c_t, a_{t+1}, k_t, l_t\}_{t=0}^{\infty}$ solves the individuals' policy functions for given factor prices $\{w_t, r_t\}_{t=0}^{\infty}$. Moreover, capital, labor and good markets clear according to the following conditions:

$$\int_{o_t(a,z,g)=e} k_t dH_t(a,z,g) - \int a dH_t(a,z,g) = 0$$

$$\int_{o_t(a,z,g)=e} l_t dH_t(a,z,g) - \int_{o_t(a,z,g)=w} dH_t(a,z,g) = 0$$

$$\int_{o_t(a,z,g)=e} \left[e^{z_t} (k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} \right] dH_t(a,z,g) = \int c_t dH_t(a,z,g) + \delta k_t$$

4. Quantitative exercise

This section of the paper quantifies how much of the gender differences in entrepreneurial rates and capital utilization can be explained by the gender gap in access to credit. We first begin by estimating the model on the US economy using various sources of data, and also analyze the main quantitative predictions of our framework in terms of individual choices and aggregate outcomes. The next section will then try to evaluate the extent of the output losses caused by the talent and resource misallocation operating at the *extensive* and *intensive* margins of entrepreneurship.

Table 8
Calibration.

Fixed	Value	Reference		
γ	1.5	Cagetti & De Nardi (2006)		
α	0.33	Cagetti & De Nardi (2006)		
δ	0.08	Clementi & Palazzo (2016)		
Fitted	Value	Target	Data	Model
β	0.925	Interest Rate	0.04	0.04
$1-\nu$	0.835	Earnings Share of Top 5% Individuals	0.35	0.36
σ_z	0.265	Employment Share of Top 10% Firms	0.65	0.66
ρ_z	0.93	Average Persistence in Firms' Employment	0.73	0.80
λ_m	2.70	Credit(Non-Financial Private Sector)/GDP	0.41	0.41
λ_f	1.90	$\frac{Debt_f}{Debt_m}$	0.55	0.55

Notes: Empirical moments are computed using the KFS sample (2004–2011) and the FRED data (1990–2014), except for the value related to the earnings share of the top 5% individuals, which is instead taken from Zucman (2019).

4.1. Calibration

In what follows, we present our calibration strategy and discuss the quantitative fit of our framework with respect to targeted moments from the data. A model period is one year. Of the nine parameters to be estimated and summarized in Table 8, three are fixed outside the model. As in Cagetti and De Nardi (2006), we set the coefficient of risk aversion $\gamma = 1.5$ and the capital share $\alpha = 0.33$, while opting for a depreciation rate $\delta = 0.1$.[43] As for the internally fitted parameters, we choose to match six empirical moments for the US economy that are further reported in Table 8, following mostly the calibration strategies in Buera and Shin (2013) and Midrigan and Xu (2014).

First, we pick $\beta = 0.925$ to match an average annual interest rate $r = 4\%$ for the US.[44] Second, the span of control parameter is fitted such that the income share of the top 5% agents in the distribution of earnings is the same in the data and in the model. This choice is motivated by the fact that $1-\nu$ regulates firms' scale of operations and, as a consequence, affects the profits of the entrepreneurs that are likely to be at the top percentiles of the earnings distribution. In that, we follow a recent and extensive literature on earnings and wealth distributions in the US (see Batty et al., 2019 and Zucman, 2019 for example), which shows that the top 5% richest Americans make up for almost 35% of total earnings in the economy.[45] Our estimated value for the span of control parameter $1-\nu = 0.835$ is close to the one obtained by several other papers on US entrepreneurship.[46] As a robustness check, $1-\nu$ could alternatively be calibrated to match the share of entrepreneurial wealth in aggregate, without changing the nature of our results.

To instead identify the volatility of the entrepreneurial productivity shock, we target the employment share of the top 10% largest firms, which is computed using the KFS dataset. A bigger σ_ϵ implies greater dispersion in the productivity process (by means of thicker tails in the distribution) and higher employment generation by large businesses.[47] Our final value $\sigma_\epsilon = 0.265$ is in line with the range of US estimates provided by Lee and Mukoyama (2015). For a further comparison, we also compute the average employment shares by firm size using BDS data. In both BDS and KFS, the employment share of the top 10% largest producers oscillates between 0.65 and 0.7, close to what found by Buera and Shin (2013). As previously stressed in Section 2, the KFS sample is in principle representative of the US firm distribution, and the distributions of businesses over size bins computed using KFS and BDS data overlay particularly for larger firms.

Next, to calibrate the parameters λ_m and λ_f, which govern the extent of the gender-based financial frictions, we use the difference in firm debt across genders, together with the US debt/GDP ratio. We first measure the average debt of female and male entrepreneurs in the KFS sample and target their relative ratio. Note that computing the average level of liabilities implies assigning a bigger weight to bigger firms, regardless of the gender of their owners. Measures of average firm credit should therefore suffer relatively less from the bias that characterizes the estimation of leverage ratios discussed in Section 2.3. Second, since the KFS spans a short period of time and surveys nascent businesses only, we choose to match the average US non-financial corporate debt over GDP between 1990 and 2014.[48],[49] We focus on non-financial corporate

[43] Values for δ range from 0.06, as in Buera and Shin (2013), to 0.1, as in Clementi and Palazzo (2016).

[44] This number reflects the average interest rate prevailing in the American economy over the last decades.

[45] In the period between 1997 and 2017, the top 10% income share oscillates between 45% and 50%.

[46] In quantitative works based on the US, values for $1-\nu$ usually range from 0.79, as in Buera and Shin (2013) to 0.88, as in Cagetti and De Nardi (2006). As noted by Hsieh and Klenow (2009), a lower span of control tends to reduce the (negative) impact on output stemming from capital misallocation. Yet, in our setup, a lower span of control $1-\nu$ can negatively affect entrepreneurial profits, resulting in even less women finding optimal to become entrepreneurs. These two effects on aggregate output tend to offset each other, meaning that the exact value of $1-\nu$ is not responsible for amplifying or reducing the effect of a gender imbalance in credit access on aggregate production.

[47] Size is measured in terms of total employees, as in Buera and Shin (2013) and Midrigan and Xu (2014).

[48] See the entire series on FRED website: https://fred.stlouisfed.org/graph/?g=VLW#0.

[49] The average debt-to-output ratio in the KFS sample is 0.49, close to the credit to non-financial corporate sector/GDP reported by the Federal Reserve Bank of St. Louis for the same period (about 0.42). Moreover, we conduct a robustness check by computing the ratio of current liabilities over revenues in

Table 9
Untargeted Moments.

	Data	Model
Capital		
% difference Female *arpk* vs Male *arpk*	0.12	0.11
% difference Female k/l vs Male k/l	-0.085	-0.14*
Business Dynamism		
Difference Male vs Female Entrepreneurial Rates	3 p.p.	1 p.p.
Average Entrepreneurial Rate	0.053	0.065
Average Exit Rate	0.10	0.11

Notes: Model-implied untargeted moments. Figures are to be considered in terms of percentages unless otherwise indicated.

debt because other measures of total debt merge together household and corporate debt and do not map correctly into our theoretical framework. Overall, the model identifies λ_m to be 30% higher than λ_f.

Finally, the KFS sample is used to compute the average serial correlation of employment across entrepreneurs, by estimating an AR(1) process on the total wage bill of female and male-owned firms. We then calibrate $\rho_z = 0.93$ in our baseline economy to generate the same persistence in the model and in the data.[50] As reported in Table 8, the average persistence in business employment is 0.73 in the KFS sample, which our simulated economy slightly over-predicts. This can be due to two reasons. First, the fact that our panel covers only 8 years may hinder the precision in the empirical estimation of the persistence in business employment. Second, producers in our sample are young and this may exacerbate the volatility of their performance particularly in the early years of their operations.[51]

4.2. Untargeted moments

To validate the performance of our framework, we test it against other moments from the data that were not targeted during the calibration, focusing on both mean values and distributional properties.[52] As shown in Table 9, our baseline model replicates the bulk of the gender differences in the *arpk* and *k/l* ratio across firms. Note that while the gap in credit access may not be the only reason behind the gender differences in capital utilization, it is the main margin we have estimated in our data and modeled theoretically. Due to the heterogeneity in borrowing limits, captured by λ_f and λ_m, female entrepreneurs in the model have on average an 11% higher *arpk* and a 14% lower *k/l* with respect to male ones, while these differences amount to 12% and 8.5% in the data.[53]

Turning to business rates, we are able to match the overall entrepreneurial and business exit rate in the US,[54,55] while accounting for roughly 30% of the observed percentage points (p.p.) gender differences in entrepreneurial rates. This may be due to the fact that the gap in credit access is potentially not the only reason behind the observed gender heterogeneities in firm ownership, a possibility which we explore in Sections B5.2– B5.3 of the Online Appendix through two alternative model specifications.[56]

As an additional validation exercise, we define firm leverage in the model and compare its quantitative estimates across genders.[57] In our framework, female-owned firms face tighter borrowing limits, as $\lambda_f < \lambda_m$. This implies that they are more likely to be credit constrained, and hence more often closer to their upper-bound for leverage, given by $\lambda_f - 1$. Since male-

Compustat, an extensive dataset covering publicly listed North American firms between 1965 and 2017. We obtain a ratio of 0.41, which is also close to our target.

[50] As discussed in Clementi and Palazzo (2016), estimates for ρ can be as low as 0.8 and as high as 0.97.

[51] We could also set ρ_z according to available estimates for the US, such as the ones reported in Lee and Mukoyama (2015) or in Clementi and Palazzo (2015). This strategy, while easier to adopt, would lead us to make use of external estimates that might have been drawn from a sample of firms slightly different from the ones in the KFS dataset.

[52] A list with all moments from the data and how we computed them is included in Section B5.1 of the Online Appendix.

[53] In addition, we compute the ratio between average assets and average revenues for female and male entrepreneurs both in the data and in the model simulation. This moment is tightly linked to the ability to take on debt, especially because financing is used to rent the capital employed in production. In the absence of gender-based borrowing constraints, there should be no differences in the unconditional assets-to-revenues ratio across genders, even if female and male entrepreneurs were to run businesses of different sizes. However, we find that female entrepreneurs in the KFS data have an 11% smaller assets-to-revenues ratio, consistent with the documented gender disparities in the *k/l* ratio, and our calibrated model estimates the difference in the female and male capital-to-output ratios to be roughly 16%.

[54] See https://data.oecd.org/entrepreneur/self-employed-with-employees.htm

[55] The average exit rate in KFS is 10.43%, similar to the one estimated by Buera and Shin (2013) in BDS.

[56] The first alternative specification allows for an *operational cost* that differs across female and male entrepreneurs, for which we target the relative difference in exit rates across genders. Introducing an extra cost that reduces female entrepreneurial profits strengthens the mechanism of women's *selection* into entrepreneurship, and allows for a more precise match of the share of female business owners. In the second alternative, we include gender heterogeneities in the *span of control* parameter, quantitatively pinned down by the ratio of the standard deviation of profits of female and male-owned firms. Since the span of control influences business earnings, a lower value for female entrepreneurs can negatively affect their participation choices, improving the fit of the gender differences in entrepreneurial rates.

[57] As in Gopinath et al. (2017) and to ensure comparability with our empirical measures, we define firm leverage as $\frac{k-a}{k}$, where the numerator $k - a$ is the debt taken by entrepreneurs for business purposes. Such ratio mimics how leverage is computed in KFS data, as we can observe firm capital (k), but

Table 10
Wealth and Business Debt Distributions.

	Data	Model
Business Debt		
Female vs Male Leverage Ratio	0.75	0.79
Top 10% Debt Share - All firms	0.59	0.63
Top 10% Debt Share - Female Firms	0.69	0.62
Top 10% Debt Share - Male Firms	0.58	0.63
Wealth		
Wealth Share in Top 10%	0.70	0.80
Entrepreneurial Wealth Share	0.30	0.47

Notes: Model-implied untargeted moments are displayed in the third column of the table. In the second column, we report the respective empirical moments related to leverage and business debt are computed using the KFS sample (2004–2011). Details on the entrepreneurial wealth share and the wealth share of the top 10% individuals in the US are taken from Cagetti and De Nardi (2006). Figures are to be considered in terms of percentages unless otherwise indicated.

Table 11
Distributional Properties: Revenues and Profits.

	All		Male		Female	
	Data	Model	Data	Model	Data	Model
Top 10% Profit Share	0.60	0.69	0.59	0.70	0.60	0.68
Top 10% Revenues Share	0.68	0.62	0.68	0.62	0.73	0.62
By Size Bins						
Top 25% Profit Share	0.59	0.72	0.58	0.75	0.57	0.70
Top 25% Revenues Share	0.68	0.66	0.68	0.67	0.69	0.65

Notes: Model-implied untargeted moments are compared to their empirical counterparts, which are computed using the KFS sample (2004–2011). Figures are to be considered in terms of percentages unless otherwise indicated.

owned firms are instead less likely to be financially constrained, they are more often below their upper-bound for leverage, given by $\lambda_m - 1$. Accordingly, the gender difference in firm leverage in our baseline economy should be smaller than the gender gap in total business borrowing. Comparing estimates in Tables 9 and 10, the gender gap in firm leverage ratios implied by our quantitative exercise is consistently half smaller than the one in business debt ratios.

We then analyze the distributional properties of firm debt and individual wealth across entrepreneurs and workers. As Table 10 shows, the model matches the debt share of the top 10% most indebted firms in KFS, considering both the aggregate pool of entrepreneurs and female and male-owned businesses separately (the goodness of the quantitative fit varies between 90% for the female sample and 60% for the male one). We can also replicate the skewness that characterizes the wealth distribution in the US, as well as the relative share of entrepreneurial wealth in aggregate. This is due to the fact that, in our framework, savings are crucial for entrepreneurs, who constitute a smaller fraction of the population but hold a sizable share of aggregate wealth. In particular, our model slightly over-predicts the top 10% wealth share, which recent work by Zucman (2019) has estimated to be around 70% in the US. Moreover, entrepreneurial wealth in the data accounts for 30% of the aggregate (see Cagetti and De Nardi, 2006), and for 47% in our baseline economy.

As a final quantitative exercise, Table 11 collects several moments related to the distribution of revenues and profits in the model and in the KFS data, which were also not targeted during the calibration. After having assessed its performance with respect to the properties and the gender differences in capital, debt, wealth and entrepreneurial rates, we verify that our model can also match the tails of the profit and revenue distributions, overall and by gender. Its fit is less accurate when computing the profit share of the top 25% largest firms – defining size using employment bins – whilst the revenue share of the top 25% largest firms is instead satisfactorily matched.

4.3. The effect of the gender gap in credit access

In this section, we take a closer look at the effect of the gender-based financial frictions on individual choices regarding savings, occupation and, in the case of entrepreneurs, production outcomes. Fig. 5 plots consumption and savings policies

not entrepreneurial personal wealth (a). The borrowing multipliers λ_f and λ_m hence pin down leverage only for constrained entrepreneurs. Unconstrained entrepreneurs, regardless of their gender $g \in \{f; m\}$, can have a level of leverage which is smaller than $\lambda_g - 1$.

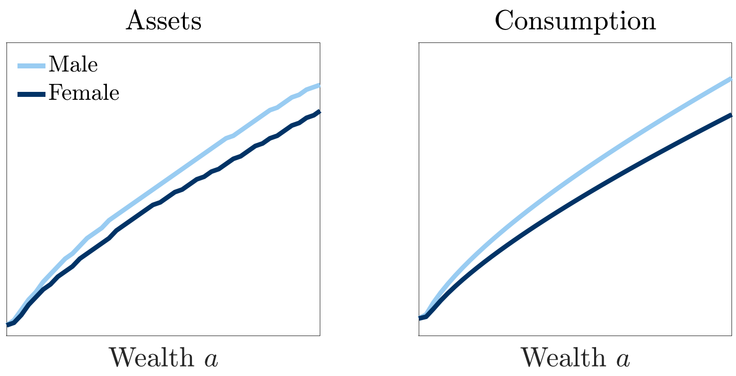

Fig. 5. Savings and Consumption Policies.

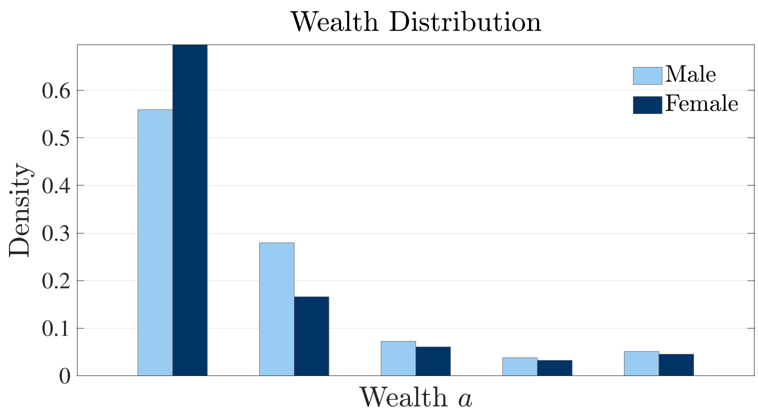

Fig. 6. Wealth Distribution.

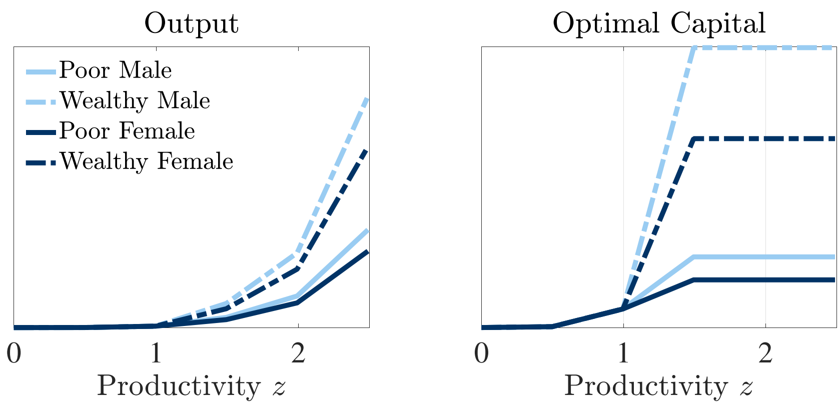

Fig. 7. Total Output and Optimal Capital.

comparing two equally highly-productive agents, one male and one female. At any level of wealth, male individuals sustain higher levels of consumption and accumulate more savings. In turn, differences in asset accumulation are reflected in the skewness of the distribution of wealth across genders, as documented in Fig. 6. In particular, women at the bottom of the wealth distribution have marginally lower incentives to save, as they expect entrepreneurship to be a less likely occupational outcome and to need relatively less their assets in order to overcome potential financial frictions. On top of that, tighter borrowing constraints lead female entrepreneurs to earn lower profits and accumulate less assets.

Importantly, entrepreneurial decisions in our model economy depend on the idiosyncratic productivity, wealth and gender of the agents. Higher productivity and/or greater levels of assets have a positive effect on agents' decision to become entrepreneurs. Since women face tighter financial constraints, they have a lower probability of becoming entrepreneurs, as reported in Table 12. In addition, Fig. 7 shows entrepreneurial capital and output as a function of individuals' idiosyncratic productivity z. Based on their wealth, we compare a poor and a rich male entrepreneur, and a poor and a rich female one.

Table 12
Model Results.

	Entrepreneurial Rates	*arpk*	*k/l*	*arpl*	*tfpr*
Female	0.06	0.92	4.10	1.26	1.12
Male	0.07	0.81	4.76	1.26	1.06

Notes: Model-implied untargeted moments. Figures in column (2) are to be considered in terms of percentages.

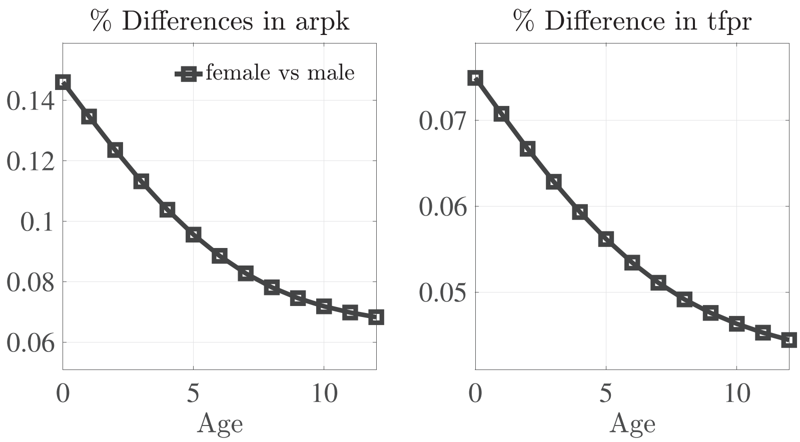

Fig. 8. Gender Differences in *arpk* and *tfpr* over Firms' Age.

Within both wealth categories and due to tighter borrowing constraints, female entrepreneurs produce smaller quantities of output and operate with inefficiently low levels of capital, resulting in the higher *arpk* summarized in Table 12.[58]

Furthermore, as documented in the last column of Table 12, female entrepreneurs show a relatively higher *tfpr*, consistent with the empirical evidence reported in Table 7. More specifically, female-led firms in the KFS sample have on average a 10% higher *tfpr* with respect to male-led ones, while in our calibrated economy the log difference in *tfpr* across genders is 6%. As previously argued, tighter financial constraints make entrepreneurship a relatively harder occupational choice for women, causing a stricter *selection* into the entrepreneurial pool. Since only very productive female agents manage to operate businesses in a profitable way, this implies that the marginal female entrepreneur is relatively more productive than the male one, resulting in the higher average *tfpr* observed in the sample of female firm owners, both in the data and in the model.

Finally, the gender differences in *arpk* and *tfpr* in the model decrease over time as firms grow older, as reported in Fig. 8. The relationship between the age of a firm and the progressive release of financial constraints has been pointed out in several other contexts, see for example Davis and Haltiwanger (1999). Similarly, in our simulated economy, the progressive reduction in the difference in both *arpk* and *tfpr* across genders is due to the fact that, as time passes, female entrepreneurs are able to accumulate wealth and partially overcome the tighter financial constraints they face by means of a higher asset base. As a consequence, they are able to rent higher levels of capital and expand their production, which progressively reduces the gender gaps in both *arpk* and *tfpr*. Figure B.2 in the Online Appendix illustrates the change in growth rates of capital, output and *arpk* over the age of the firm for female and male business owners.

5. Counterfactual: Removing gender-based financial frictions

In this section, we quantify the macroeconomic effect of removing the gender gap in financial constraints on both female entrepreneurial performance and aggregate outcomes. In particular, guaranteeing equal access to credit across genders is shown to improve the allocation of entrepreneurial talent and capital, and to generate output and welfare gains for the whole economy.

Table 13 reports our main counterfactual exercise, in which we remove the difference between the borrowing constraints λ_m and λ_f. Relaxing the tighter credit constraint that women face increases their participation in the entrepreneurial pool and their *k/l* ratio by roughly 10% and 22% respectively. When $\lambda_f = \lambda_m$, female business owners can operate their firms with higher levels of capital and, as a result, their *arpk* decreases by 12%. As further displayed in the left panel of Fig. 9, the mean of the distribution of female entrepreneurs' *arpk* substantially decreases when shifting from the baseline to the

[58] As shown in Appendix Figure B.3, the difference in the *arpk* of female and male entrepreneurs decreases along with their difference in business size. As female-led firms grow bigger, they are able to accumulate wealth and operate at a higher scale, gradually bridging the gap in the level of capital used in production with respect to male-led ones.

Table 13
Policy Simulation Results.

$\lambda_f = \lambda_m$	Total Output	Total Welfare	Female *arpk*	Female *k/l* Ratio	% Female Entrepreneurs
Increase wrt Baseline	+ 3.82%	+ 3.50%	-11.85%	+ 22.15%	+ 9.32%

Notes: % changes between the baseline economy and the counterfactual scenario where the gender financing gap is removed.

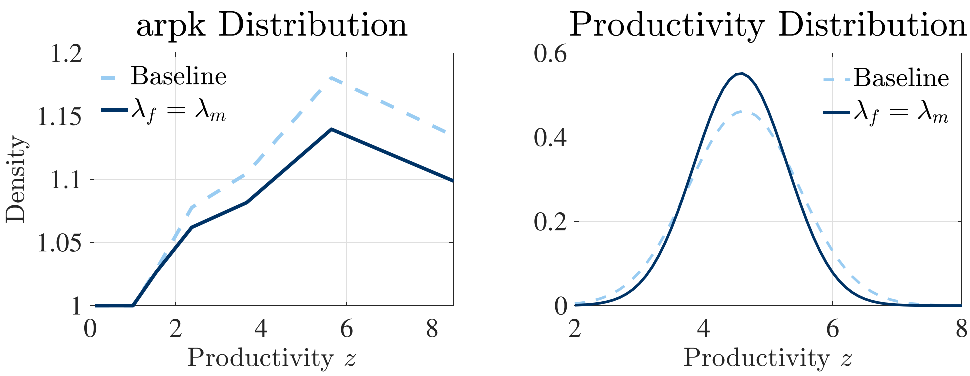

Fig. 9. Female *arpk* and Productivity in Counterfactual.

counterfactual case. In addition, an easier access to credit for female agents allows for a better allocation of entrepreneurial talent, as marginally more productive female individuals find profitable to enter entrepreneurship and start a firm. As illustrated in the right panel of Fig. 9, this implies a leftward shift in the mean of female business owners' productivity, as the idiosyncratic productivity cutoff for women to become entrepreneurs decreases.

In summary, when $\lambda_f = \lambda_m$, female and male entrepreneurial rates equalize and, absent any other gender difference, men and women operate with the same *k/l* ratio and produce the same level of output.[59] The fact that marginally more productive female agents can enter the pool of entrepreneurs and operate with their optimal level of capital directly affects the quantity of output that is supplied in the economy, owing to the improved allocation of both entrepreneurial talent and productive inputs. As reported in Table 13, aggregate output subsequently increases by 3.82% with respect to the baseline economy. Using the US GDP of 2019 as a reference, and given that entrepreneurial output is estimated to contribute by 40% to US total production,[60] this could represent a potential increase of roughly 0.35 trillion US dollars in GDP. It is important to note that the only productive sector in our model is the entrepreneurial one, which amplifies the increase in output achieved by eliminating the gender gap in credit access. In fact, if we included in our model another productive sector that was composed of financially unconstrained corporate firms, the resulting counterfactual gains would be lower but still quantitatively relevant, as shown in Appendix Table B.15.

We conclude our discussion with a note on aggregate welfare. In our counterfactual economy, welfare is computed as the sum of agents' utilities over consumption and compared to the one obtained in the baseline case. Thanks to strong general equilibrium effects, aggregate welfare grows by 3.50% when $\lambda_f = \lambda_m$. Since more productive female agents become entrepreneurs and crowd out marginally more inefficient male ones, both the demand for capital and labor in the economy increase. A higher wage benefits the workforce, whereas a rise in the interest rate leads to higher wealth accumulation for all households, despite increasing production costs for firm owners.[61] Considering both workers and entrepreneurs, we find that aggregate female welfare increases by +5.04%, while aggregate male welfare increases by +2%. In fact, the average welfare of male workers scales up by +3.09%, as the new counterfactual economy features higher wages, but the average welfare of male entrepreneurs decreases by 6.03%. Since entrepreneurs represent a smaller fraction of the male labor force, the average welfare of the total male population increases.

Our results can also be related to recent contributions in this literature. For instance, Bento (2021) estimates a rise in US aggregate welfare following the decline in several barriers to female entrepreneurship between 1982 and 2012. In particular, he finds that female entrepreneurial welfare has increased over time, and that the higher demand for labor has raised the equilibrium wage, benefiting all workers. Consistent with our conclusions, Bento (2021) shows a decline in the welfare of

[59] As a further consideration, we note that it is not beneficial to lower the borrowing constraint of male entrepreneurs until it reaches the one of women, as it constitutes a tightening of financial frictions for the productive sector as a whole.

[60] See https://advocacy.sba.gov/2019/01/30

[61] In a partial equilibrium (PE) counterfactual, keeping fixed the interest rate and the wage, the final aggregate increase in welfare would be 1.5%. Yet, the rise in production costs partially offsets the gain in aggregate output achieved by higher female participation into entrepreneurship. Our same exercise in a PE setting would achieve a higher increase in aggregate production and in female entrepreneurial rates (by roughly 3 and 7 percentage points respectively).

what he defines as 'would be' male entrepreneurs. Moreover, he argues that production-based gender gaps are the most detrimental to aggregate productivity – similar to the imbalances in capital renting in our model – and that their further decline could keep raising female entrepreneurial welfare. In addition, our paper echoes the findings in Chiplunkar and Goldberg (2021), who focus on the negative impact of barriers to female entrepreneurship in India, represented by higher hiring costs and firm formation/registration expenses. They also argue that the release of all barriers would improve female entrepreneurial rates, total output, and female and male welfare, with an important role played by the positive GE effects on equilibrium wages.[62]

Finally, Hsieh et al. (2019) have shown that the decline in direct market discrimination in the US from 1960 to 2010 has contributed to the increase in the female labor force participation margin and in market earnings per person. Although we model and focus on a different occupational choice, we estimate that the decline of gender gaps in financial constraints would similarly increase female entrepreneurial participation rates and profits and, through GE effects, their wages. Hsieh et al. (2019) also analyze the changes in earnings of black and white US men, and show that the latter group has experienced a progressive drop in welfare over time due to the reallocation of marginally less skilled workers from high-paid to low-paid occupations. A similar feature of our counterfactual exercise is that male entrepreneurial welfare decreases as marginally less-talented firm owners exit the entrepreneurial pool. However, a key assumption we made is that all workers earn the same wage. Hence, differently from Hsieh et al. (2019), the average welfare of men in our counterfactual does not decrease overall, thanks to a higher labor demand and equilibrium wage.

6. Fiscal policies

This final section explores and evaluates the differential effects that fiscal policies specifically targeting entrepreneurs have on female and male-led firms. Around the world, both in developed and developing countries, there are instances of government subsidies that have the typical goal of fostering entrepreneurial activities and investments, for example by easing the access to credit or by subsidizing production costs. In this spirit, the US Small Business Administration (SBA) has put forward a few programs to facilitate the funding of business owners, both male and female.[63] Currently, the SBA does not lend money directly to entrepreneurs, but instead sets guidelines for loans made by its nationwide network of partnering lenders. It can also guarantee loans between $500 and $5.5 million that can be used for most business purposes, thereby reducing risk for lenders and making it easier for entrepreneurs to access credit.[64] Other examples of subsidies that address entrepreneurs (or female entrepreneurs explicitly) are discussed in Appendix C.

Along these lines, we enrich our model with a public sector that collects lump-sum taxes on all households and redistributes them as entrepreneurial subsidies to business owners. First, we consider fiscal measures targeting either the profits, the employment costs or the capital costs of firms. Second, we analyze subsidies that aim to expand the asset base of entrepreneurs, by providing government-backed collateral or government credit to firms that are financially constrained. It is important to stress that, throughout these exercises, *all* entrepreneurs are targeted by the government subsidies. While in principle it may be sensible to envision fiscal policies directed to female entrepreneurs only, especially in the context of the documented gender gap in credit access, such policies may be difficult to justify and concretely adopt (we discuss this issue and provide examples in Section C on the Online Appendix).

Finally, before proceeding with the analysis, we emphasize that our baseline model features both a borrowing constraint that limits the rental of capital for all entrepreneurs in the economy, and a gender-specific wedge that decreases further the borrowing capacity of female-led firms with respect to male-led ones. The goal of our fiscal policies exercise is hence twofold. First, we explore the effects of different subsidies on both the *extensive* and *intensive* margin of entrepreneurship, comparing the consequences of each fiscal measure on entrepreneurial rates and capital utilization.[65] Second, we examine if and how public policies that generally target entrepreneurs can have a different impact on male and female firm owners in light of the heterogeneity in the access to credit that characterizes our model economy.[66]

62 Chiplunkar and Goldberg (2021) consider both entry and post-entry barriers to female entrepreneurship, and find greater gains from the release of post-entry barriers, which are close in spirit to the gender financing gap we focus on.

63 https://www.sba.gov/partners/lenders/7a-loan-program/types-7a-loans#section-header-12.

64 Li (2002) analyzes 1984–1998 SBA programs that involved interest subsidies to entrepreneurs. These subsidies lowered borrower payments by 7.2 percent on average.

65 Itskhoki and Moll (2019) discuss examples of optimal policies in a standard growth model with financial frictions that involve taxing entrepreneurs. In our setup, taxes on firms make entrepreneurship even less profitable for female agents, and add to the barriers created by the gender-based gap in credit access. For example, taxing entrepreneurial profits entails lowering entrepreneurial rates, labor demand and the equilibrium wage. At the margin, a fraction of wealthy/productive agents still choose to become entrepreneurs and produces facing lower labor costs, while lump-sum redistribution towards workers, who have the highest marginal utilities, increases welfare. However, such sequence of effects penalizes relatively more female agents who already face a barrier in entering entrepreneurship due to tighter borrowing constraints. Seeing their potential profits further been lowered by a tax, less female agents choose to become entrepreneurs, which worsens the underrepresentation of women in entrepreneurship and capital allocation.

66 In these exercises, government taxation introduces a fiscal burden on all agents in the economy. As such, the resulting GE effect on welfare is generally negative under our baseline calibration. Yet, the spirit of this analysis is not to propose optimal entrepreneurial policies, but to discuss the impact of fiscal subsidies on male and female-led firms.

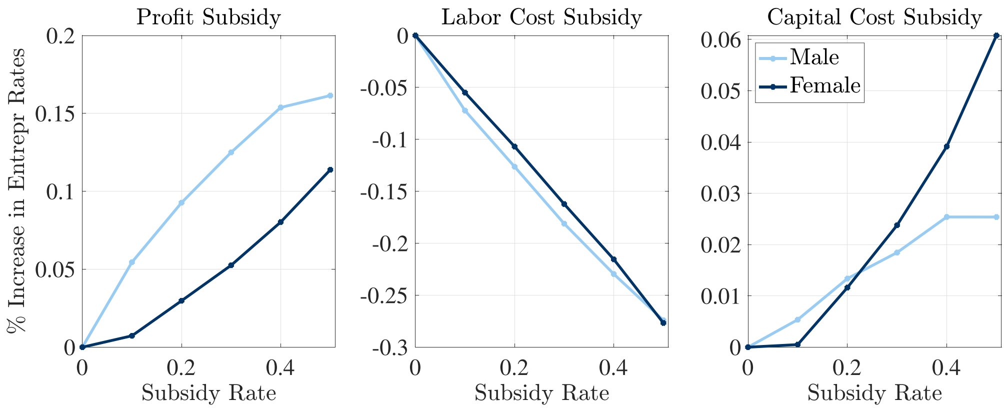

Fig. 10. Effect of Entrepreneurial Subsidies on the Extensive Margin.

6.1. Profits, labor and capital costs

In the first set of exercises, we introduce a government that collects lump-sum taxes on all the agents and redistribute them to entrepreneurs in order to target either their profits, their labor costs, or their capital costs. We make use of our calibrated economy – where the borrowing constraint for female-led firms is 30% lower than the one of male-led firms – and assess the effect that such fiscal measures have on both entrepreneurial rates and inputs choices for both female and male agents. In what follows, we proceed to characterize how the profit maximization problem of entrepreneurs is affected by each subsidy – indicated by the rates θ^{π}, θ^{l} and θ^{k} – and how we ensure that the fiscal budget constraint of the public sector clears in each period t.

Subsidy to Entrepreneurial Profits. The profits of entrepreneurs would be given by:

$$\pi_t = (1+\theta^{\pi})\left(e^{z_t}(k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} - w_t l_t - (r_t+\delta)k_t\right) \tag{16}$$

Moreover, the budget constraint for all agents in the economy would be given by:

$$a_{t+1} = \max\{\pi_t(a,z,c;r_t,w_t), w_t\} + (1+r_t)a_t - c_t - T_t \tag{17}$$

Hence, for the budget constraint of the fiscal sector to hold, in each t it must be true that:

$$\int_{o_t(a,z,g)=e} \theta^{\pi}\pi_t = T_t = T_t \tag{18}$$

Subsidy to Labor Costs. The profits of entrepreneurs would be given by:

$$\pi_t = \left(e^{z_t}(k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} - (1-\theta^{l})w_t l_t - (r_t+\delta)k_t\right) \tag{19}$$

Moreover, the budget constraint for all agents in the economy would be given by:

$$a_{t+1} = \max\{\pi_t(a,z,c;r_t,w_t), w_t\} + (1+r_t)a_t - c_t - T_t \tag{20}$$

Hence, for the budget constraint of the fiscal sector to hold, in each t it must be true that:

$$\int_{o_t(a,z,g)=e} \theta^{l} w_t l_t = T_t \tag{21}$$

Subsidy to Capital Costs. The profits of entrepreneurs would be given by:

$$\pi_t = \left(e^{z_t}(k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} - w_t l_t - (1-\theta^{k})(r_t+\delta)k_t\right) \tag{22}$$

Moreover, the budget constraint for all agents in the economy would be given by:

$$a_{t+1} = \max\{\pi_t(a,z,c;r_t,w_t), w_t\} + (1+r_t)a_t - c_t - T_t \tag{23}$$

Hence, for the budget constraint of the fiscal sector to hold, in each t it must be true that:

$$\int_{o_t(a,z,g)=e} \theta^{k}(r_t+\delta)k_t = T_t \tag{24}$$

We create a grid of values for the subsidy rates θ^{π}, θ^{l} and θ^{k} ranging from 0 (our baseline economy) to 0.5 (half of the respective profits or costs gets subsidized), and we solve for the steady state equilibrium. Then, we compute entrepreneurial rates and quantities of inputs for both female and male agents in the counterfactual economies and compare them in Figs. 10 and 11.

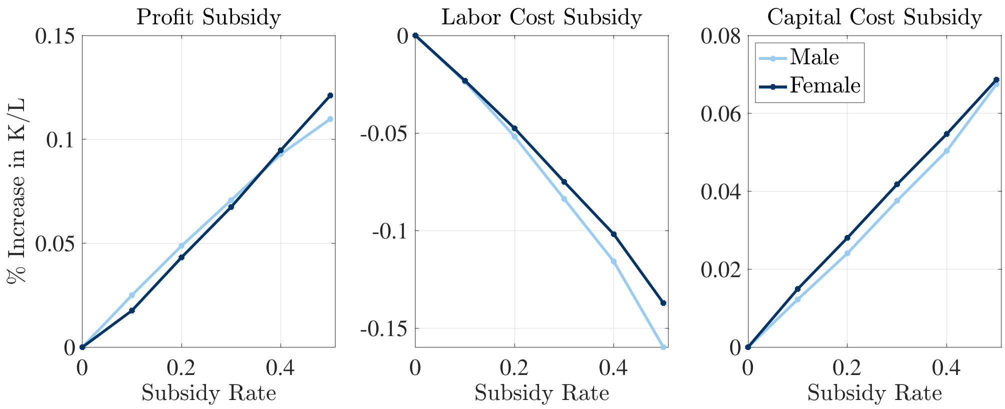

Fig. 11. Effect of Entrepreneurial Subsidies on the Intensive Margin.

As reported in the first panel of Fig. 10, subsidizing entrepreneurial profits naturally fosters the entry into entrepreneurship of both men and women, as it decreases the attractiveness of the outside option of becoming workers. However, this fiscal measure causes a bigger increase in the *extensive* margin of men, as the existing gender gap in credit access still makes entrepreneurship a relatively harder occupational choice for women compared to men. Moreover, even if the subsidy to entrepreneurial profits does not introduce distortions in firms' optimal choices of capital and labor, the first panel of Fig. 11 shows that the k/l ratio of both female and male-owned firms increases when profit subsidies are held in place. This is due to the fact that entrepreneurs can take advantage of higher profits to save more, increase the asset base against which they borrow on financial markets and hence raise the level of capital ultimately used in production.

In contrast, a subsidy on entrepreneurial labor hiring costs wl has a negative impact on both the *extensive* and *intensive* margin of entrepreneurship, with no stark distinction across male and female-led businesses. In particular, a subsidy on the labor costs directly affects the optimal hiring decision of firms, by increasing their demand for labor and the equilibrium wage. In turn, fewer agents prefer to run an enterprise over being workers, which depresses entrepreneurial rates, as documented in the second panel of Fig. 10. At the same time, since it becomes cheaper for firms to produce using relatively more labor, the increased reliance on workers in the production process decreases the k/l ratio, as documented in the second panel of Fig. 11.

Finally, a publicly-financed subsidy to the rental cost of capital faced by entrepreneurs makes capital a relatively cheaper input and hence boosts its use in production, as shown in the third panel of Fig. 11. There are no stark gender differences in the subsequent increase in the k/l ratio because constrained entrepreneurs – especially female ones – cannot equally scale up their demand for capital despite the reduction in its marginal cost. Moreover, such fiscal measure positively affects the firm ownership rates of both men and women in our model economy, as it reduces firms' capital costs $(r+\delta)k$ and increases entrepreneurial profits. However, as shown in the third panel of Fig. 10, the resulting increment in the *extensive* margin of entrepreneurship is relatively bigger for female agents. This is due to the fact that, at the margin, the subsidy to capital costs raises the attractiveness of starting a business by relatively more for female agents who are more often credit-constrained and hence limited in their optimal choices of capital.

6.2. Credit needs

In the second set of exercises, we introduce a lump-sum tax that is levied on all agents and subsequently rebated as a credit or collateral subsidy θ for entrepreneurs in the economy. Note that in the first case, the debt that is used to finance capital acquisition can come from both financial markets and the government. The credit subsidy increases the amount business owners of any gender g are able to borrow according to $k_t \leq \lambda_g * a_t + \theta$, without modifying their specific credit limit parameter λ_g. In the second case, the collateral subsidy increases the amount that male and female owners are able to pledge to finance their capital renting, and turns their borrowing constraint into $k_t \leq \lambda_g * (a_t + \theta)$. Under such modification, entrepreneurial wealth constitutes only part of the collateral for the debt issued on financial markets, while the rest is actually covered by the government. As in the previous exercises, we first characterize the profit maximization problem of entrepreneurs and the budget constraint of the fiscal sector in these two scenarios.

Credit Subsidy. The profit maximization problem of entrepreneurs would be given by:

$$\max_{l_t,k_t} \left\{ e^{z_t}(k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} - w_t l_t - (r_t+\delta)k_t, \quad \text{s.t.} \quad k_t \leq \lambda_f a_t + \theta \right\} \tag{25}$$

Moreover, the budget constraint for all agents in the economy would be given by:

$$a_{t+1} = \max\{\pi_t(a,z,c;r_t,w_t), w_t\} + (1+r_t)a_t - c_t - T_t \tag{26}$$

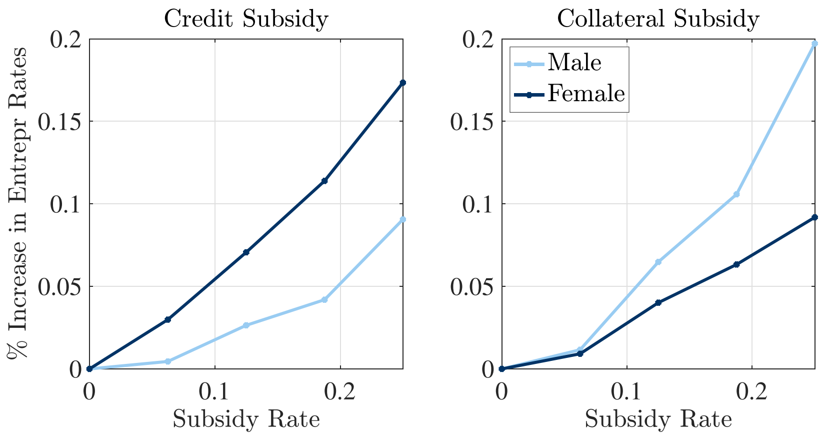

Fig. 12. Effect of Entrepreneurial Subsidies on the Extensive Margin.

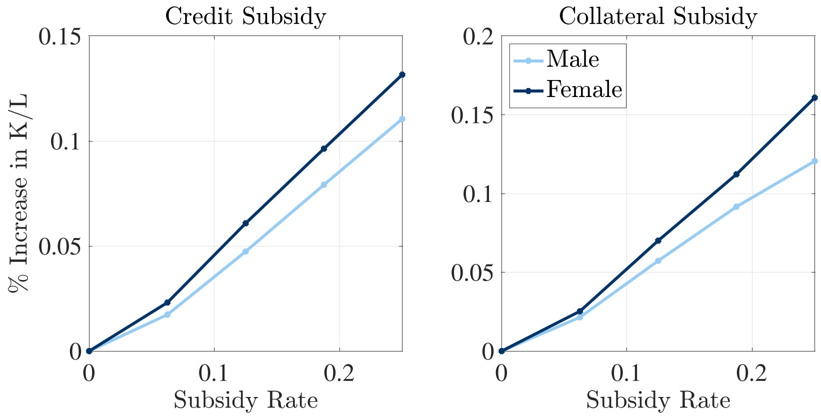

Fig. 13. Effect of Entrepreneurial Subsidies on the Intensive Margin.

Hence, for the resource constraint of the fiscal sector to hold, in each t it must be true that:

$$\int_{o_t(a,z,f)=e} (k_t - \lambda_f a_t) = T_t \tag{27}$$

Collateral Subsidy. The profit maximization problem of entrepreneurs would be given by:

$$\max_{l_t,k_t} \left\{ e^{z_t}(k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} - w_t l_t - (r_t+\delta)k_t, \quad \text{s.t.} \quad k_t \le \lambda_f(a_t+\theta) \right\} \tag{28}$$

Moreover, the budget constraint for all agents in the economy would be given by:

$$a_{t+1} = \max\{\pi_t(a,z,c;r_t,w_t), w_t\} + (1+r_t)a_t - c_t - T_t \tag{29}$$

Hence, for the resource constraint of the fiscal sector to hold, in each t it must be true that:

$$\int_{o_t(a,z,f)=e} \left(\frac{k_t}{\lambda_f} - a_t \right) = T_t \tag{30}$$

Figs. 12 and 13 document the change in the male and female *extensive* and *intensive* margins of entrepreneurship after the introduction of credit and collateral subsidies. For the purpose of the analysis, we create a grid of values for the subsidy θ that ranges from 0 to 25% of the average asset base of entrepreneurs in our economy. Unlike the previous exercise, these types of subsidies directly interact with the financial friction and the gender-based wedge present in the model and hence lead to starker differences in their subsequent effects across genders.

In particular, both the credit and collateral subsidies involve a relaxation of the borrowing constraint faced by entrepreneurs and thereby ensure higher levels of rented capital. As shown in Fig. 13, the increase in the k/l ratio is relatively bigger for female-led firms, whose baseline borrowing limit λ_f is relatively smaller. In addition, Fig. 12 illustrates that the credit subsidy fosters female entrepreneurship by relatively more, as government-backed financing is not subject to the tighter borrowing limit that women face on financial markets. On the contrary, the collateral subsidy raises the amount entrepreneurs can pledge to finance capital acquisition, but the subsequent increase in business ownership is higher for male agents, as male-led firms in our calibrated framework can still borrow up to a higher fraction of their collateral compared to female-led ones.

7. Conclusion

Despite the increase in the US share of female entrepreneurs over the past years, pronounced gender gaps in several entrepreneurial dimensions still persist. In this paper, we have attempted to shed light on this issue, by examining both empirically and quantitatively how the allocation of talent and capital, as well as aggregate production, are affected by gender-based financial frictions.

Using micro-level data from a panel of US firms, we have shown that it is more difficult for female-led businesses to access credit, despite the fact that they are neither riskier, nor less profitable compared to male ones. We have also documented that female entrepreneurs have a higher $arpk$, a sign of misallocation of capital across the productive units in our sample, and suggested that the observed gender gap in access to credit may be what is driving the misallocation of capital found in the data. Next, our empirical observations have been rationalized in a standard model of entrepreneurial choice and financial frictions augmented with gender differences in borrowing constraints, which has been quantified using available US data. Our calibrated framework matches well several targeted and untargeted moments computed empirically, and explains a substantial fraction of the gender heterogeneities in capital utilization and entrepreneurial rates.

Having evaluated the quantitative performance of our model, we have estimated the output losses that come from the misallocation of resources among entrepreneurs, and from the misallocation of entrepreneurial talent in the economy. In a counterfactual scenario where the gender gap in credit access is removed, we have shown that female entrepreneurship increases and capital misallocation decreases, leading to a 4% rise in aggregate output. Finally, we have assessed how policy instruments targeting firms can differently affect the *extensive* and *intensive* margins of entrepreneurship of men and women under the differential financial limits that characterize our model. In particular, we have analyzed subsidies to the (i) profits, the (ii) labor costs, the (ii) capital costs, the (iv) credit needs, and the (v) borrowing collateral of male and female entrepreneurs.

We believe our work leaves an important question unanswered: what is driving female entrepreneurs' lower access to credit? How could the theoretical gap in borrowing constraints be microfounded further? Ultimately, how should we think about the deep roots of gender-driven capital misallocation? Our paper opts for an indirect approach, insofar as it documents the presence and extent of gender-driven capital misallocation, links it to the observed gender differences in loan rejection rates, and quantifies its macroeconomic effect through an entrepreneurship model. Yet, many factors could be responsible for female entrepreneurs' impaired access to credit. For example, Restuccia and Rogerson (2017) note that discrimination, culture, and social norms may be potential drivers of misallocation of talent (and resources) across firms. At the same time, gender differences in information frictions or in entrepreneurial networks (see Wallskog, 2021) could also be important factors to further investigate and quantitatively model. We believe a deeper analysis of these channels could reach more persuasive and relevant conclusions, especially in terms of guiding policy interventions, and certainly constitutes an exciting avenue for future research.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmoneco.2022.03.007.

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