THE ECONOMIC JOURNAL

The Economic Journal, **130** (*October*), 2272–2290 DOI: 10.1093/ej/ueaa040
Advance Access Publication Date: 16 June 2020

IT'S GETTING CROWDED IN HERE: EXPERIMENTAL EVIDENCE OF DEMAND CONSTRAINTS IN THE GENDER PROFIT GAP*

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This article considers market-level contributors to the well-documented gender profit gap among micro-entrepreneurs. We combine data from a garment-making firm census and market research survey in Ghana, uncovering a gender gap in the market-size-to-firm ratio and observing disproportionate self-reports of 'not enough customers' from female owners. We develop a simple model and discuss implications of potential gender differences in demand constraints. As experimental corroboration, we show that female-owned firms expand production and experience profit increases in response to random demand shocks, while male-owned firms do not. Nationally representative data echoes our experimental findings, showing more crowding in female-dominated industries.

Understanding barriers to the economic empowerment of women is of primary importance within any country's path toward development (Duflo, 2012). In low-income countries, micro-entrepreneurship is a common and growing form of employment and often a woman's only alternative to agriculture for work outside of the home (Hallward-Driemeier, 2013; Gindling and Newhouse, 2014; Calderon *et al.*, 2016). Similar to the gender wage gap found in high-income countries (Blau and Kahn, 2017), female-owned micro-enterprises in low-income countries earn less than those owned by men (Klapper and Parker, 2010; Bardasi *et al.*, 2011). In other words, female entrepreneurs experience a gender profit gap.

We know that micro-enterprises owned by men and women are different along a number of dimensions (Nichter and Goldmark, 2009). However, much of the gender profit gap is unexplained

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This paper was received on 11 January 2019 and accepted on 13 March 2020. The Editor was Hans-Joachim Voth.

The data and codes for this paper are available on the Journal website. They were checked for their ability to reproduce the results presented in the paper. The authors were granted an exemption to publish parts of their data because access to these data is restricted. However, the authors provided the Journal with temporary access to the data, which allowed the Journal to run their codes. The codes for the parts subject to exemption are also available on the Journal website. The restricted access data and these codes were also checked for their ability to reproduce the results presented in the paper.

For helpful comments and suggestions, we are grateful to the referees, David Blakeslee, Raquel Fernández, Andrew Foster, Dustin Frye, Rachel Heath, Jamie McCasland, Martin Rotemberg, Christopher Woodruff and seminar participants at Vassar College, New York University Abu Dhabi, Vanderbilt University, University of Washington, University of Illinois Urbana-Champaign, the Entrepreneurship and Private Enterprise Development (EPED) in Emerging Economies Conference, The International Population Conference, The International Growth Center—Private Enterprise Development in Low-Income Countries Conference, The American Economics Association Annual Meeting and The Center for the Study of African Economics Conference, for helpful comments and suggestions. We also thank Lois Aryee, Robert Obenya, Charles Sefenu, Yani Tyskerud, Edna Kobbinah and Innovations for Poverty Action-Ghana for excellent field assistance, and Osman Mutawakil for collaborating on the design of the weaving technique used in the demand shock. We also thank April Lonchar and Mina Kim for excellent research assistance. This research was supported by funding from PEDL, 3ie, USAID, The World Bank, the William and Flora Hewlett Foundation, the Barrett Hazeltine Fellowship for Graduate Research in Entrepreneurship, the Watson Institute for International Studies and the Population Studies Center at Brown University. All errors are our own.

by basic firm and firm-owner characteristics.[1] Why the gender profit gap in micro-enterprises persists, even after controlling for observable firm and firm-owner characteristics, and what can be done to reduce the gap remains an unanswered and important research question.

A large body of literature has explored interventions that adjust the inputs of production in hopes of improving micro-enterprise performance.[2] Numerous experiments have shown that male and female firm owners respond differently to interventions aimed at easing constraints within the production function. Specifically, female firm owners do not reap the same benefits that male firm owners do from financial (De Mel *et al.*, 2009a) and human capital (Berge *et al.*, 2014) interventions.[3] It has been shown that female-owned firms respond more to in-kind capital grants than cash (Fafchamps *et al.*, 2014) and that business capital grants are less effective if a woman's husband also owns a business (Bernhardt *et al.*, 2019). However, the reason for this heterogeneous response is still an open puzzle, as is how to best improve the performance of female-owned micro-enterprises.

In contrast to the large and growing body of literature exploring input-focused interventions, literature exploring the effectiveness of demand-focused interventions on micro-enterprise performance is scant.[4] This article is the first to test for differences in female-owned and male-owned firm responses to a demand-focused intervention. That is, this article considers a new factor possibly holding the self-employed women of the developing world back: relative to men, women experience higher within-industry crowding and a lower market-to-firm ratio, rendering them relatively more demand constrained.

We find evidence supporting a theory of relative within-industry crowding and binding demand constraints for female firm owners both descriptively and experimentally, using data representing the universe of garment making firms from the mid-sized district capital of Hohoe, Ghana. We use this same sample of firms in Hardy and Kagy (2018), in which we document a large and robust gender profit gap, where male garment making micro-enterprise owners earn almost double the profits that their female counterparts do. Hardy and Kagy (2018) finds that this gender profit gap is not explained by a plethora of firm and owner level characteristics, compelling us, in this article, to consider potential market-level factors.

We first combine our firm census and market research survey to calculate back of the envelope market-size-to-firm ratios for male and female firm owners. We know from our firm census that there are three times as many female-owned firms in the market as there are male-owned firms. We also learn through our market research survey that female customers typically buy from female-owned firms while male customers typically buy from male-owned firms, creating gender

[1] Nix *et al.* (2015) show that the majority of the gender profit gap is not explained by differences in owner characteristics (marital status, experience, education, number of children and average monthly hours worked) and ten broadly defined firm industry categories. In a related article, using data from Ghana's garment making industry, Hardy and Kagy (2018) find that the gender profit gap remains large and unexplained, even after controlling for cognition of the firm owner, firm productivity, reasons for self-employment and product quality, in addition to the previously considered firm and firm owner characteristics.

[2] Seminal papers consider capital constraints (De Mel *et al.*, 2008), savings constraints (Dupas and Robinson, 2013) and managerial ability (Bloom *et al.*, 2013). Reviews of this literature can be found in: Banerjee (2013) and Banerjee *et al.* (2015), which summarise the findings of the impact of micro-credit; McKenzie and Woodruff (2013) summarise the impact of business training programmes; Grimm and Paffhausen (2015) synthesise the findings of the impact of micro-enterprise interventions on job growth.

[3] See Campos and Gassier (2017) for a comprehensive review of the literature.

[4] In a recent exception, Atkin *et al.* (2017) randomly vary access to export markets, finding increases in firm profits and product quality.

segregation in the market for demand. Importantly, women also order approximately the same number of garments as men.[5]

Taken together, these facts imply a much lower market-size-to-firm ratio for female-owned firms in this context. This lower market-size-to-firm ratio implies fewer customer orders available, i.e., less demand, for female-owned firms. This implication is consistent with self-reports from our sample. Women garment-making micro-enterprise owners report that their most common barrier to business growth is lack of customers, while male firm owners most commonly report input-focused constraints.

This descriptive evidence leads us to develop a simple model, allowing for demand constraints (and not just the more commonly studied input constraints) to limit profitability of the firm. Motivated by the differences in descriptive evidence by gender, we assume binding demand constraints for women and binding input constraints for men, and discuss the implications for the baseline profit gap and the predicted effects of a demand shock for both genders. Our model predicts that a demand shock would increase profits for women, but not for men.

To corroborate this descriptive evidence and model experimentally, we exploit a random demand shock on these garment-making firms and compare the response by firm owner gender. In the experiment we randomly order 0, 1, 4 or 10 garments from a firm. We see that male-owned firms decrease their usual production in response to experimental order offers and completion, while female-owned firms accommodate these new orders without displacement. We also see that female-owned firms increase wages and input expenses in response to the demand shock, while male-owned firms do not. Ultimately, these experimental demand shocks increase both sales and profits for female-owned firms, but do not affect sales or profits for male-owned firms. This difference in results suggests that, during the order period, male-owned firms were producing at capacity, while female-owned firms had the capacity to produce more than was being demanded by the baseline market.

To gain insight about why female garment makers remain in such a highly crowded industry relative to men, we use the Ghana Living Standards Survey (GLSS), a nationally representative repeated cross-section, to investigate their outside options. We document three findings that hold true across all five rounds of the GLSS from 1987–88 through to the most recent survey in 2012–13. First, we re-confirm the well-known fact that working women are more likely to be in self-employment than men. Secondly, we show that, even within self-employment, women are working in fewer industries than men. Finally, we document that the industries in which these self-employed women are working are more crowded than those occupied by self-employed men. This implies that, on average, employment opportunities available to women are more crowded than those available to men. The women in our sample may be choosing to enter into, and remain in, a market with such a low market-size-to-firm ratio relative to men because there is no market available to them in which the ratio is more favourable.

This article proceeds as follows: in Section 1, we describe the context and sample. In Section 2, we present our baseline descriptive evidence. In Section 3, we develop and discuss our simple model. In Sections 4 and 5, we describe the experiment and results. In Section 6, we present our analysis using the nationally representative GLSS. Section 7 concludes.

[5] Women in our random customer sample ordered only approximately one more garment in the last year than men.

1. Project Background and Summary Statistics

1.1. *Ghanaian Context*

In this article, we analyse data collected on micro-enterprises in the garment-making industry in Ghana. Our study takes place in the mid-size district capital of Hohoe, Ghana. Hohoe District borders Togo and is considered a middle-income district by Ghanaian standards.[6]

The Ghanaian garment-making industry has several salient characteristics that are similar to other micro-enterprises in developing countries. First, Ghanaian garment-making firms are of small-scale and typically have no paid employees besides the owner. Secondly, they require minimal capital investment, using only simple production technology.[7] Thirdly, these micro-enterprises are ubiquitous and produce similar products. Demand for garments comes almost exclusively from the local population, as garments are individualised and made to order.

A key characteristic of micro-enterprises in the garment-making industry in Ghana is that firms are owned by both men and women. It should be noted that firms owned by men and women make arguably different products, on average. The most commonly produced garments for female-owned firms are Slit and Kabbah (traditional Ghanaian skirt and top for women), while male-owned firms most commonly produce men's shirts.[8] However, the production function components required for these products are identical, making this within-industry comparison closer than a broader one across industry.[9]

1.2. *The Hohoe Garment Maker Study*

The Hohoe Garment Maker Study (HGMS) began with a project census identifying all garment-making firms in Hohoe town and surrounding suburbs. To ensure that all firms in the town were included in the study, field staff acquired a list of firms from the local trade association and had surveyors canvass the town identifying any commercial store fronts for garment-making firms and inquiring with locals in commercial areas about any less visible garment-making firm owners. The census, completed in February 2014, identified 445 garment-making firm owners. We consider this the universe of garment-making firms in Hohoe in 2014.[10]

1.3. *Experiment Sample*

There were 322 firms owned by women and 95 firms owned by men, 417 in total, which were confirmed to be still operational as of June 2015, the time of our experiment.[11] Of these, we were

[6] The district had a population of 73,641 in 2010.

[7] In this context, a mixture of human powered and electrically powered sewing machines are used to produce garments.

[8] In Hohoe, school uniforms are not a large part of business for garment-making firms. As part of our baseline questionnaire, only 3% of men and 1% of women in our sample listed school uniforms as their most or second most commonly ordered garment.

[9] This low overlap in products does, however, make directly measured price comparisons less useful in this context. A simple theoretical structure, described below in Section 2, allows us to abstract away from direct price measurement.

[10] We use firm owner as the unit of measurement instead of firm. The 12% of our sample that co-own are able to easily divide expenses and revenues. Co-ownership in this context comes about because two people share the same physical space, however they always have separately defined roles (for example, one owner may sew male shirts while the other embroiders them), which allow them to easily divide services and thus profits. In the entire sample, there is only one instance of co-owners being of different genders. These co-owners divide roles generally by gender of customer (and gender of garment).

[11] This gender imbalance in firm owner within an industry is common in Sub-Saharan Africa, as many industries with micro-enterprises are heavily—or exclusively—dominated by one gender (Bardasi *et al.*, 2011). While the garment-

Table 1. *Descriptive Statistics.*

	(1) Men	(2) Women	(3) Difference
Panel A: Firm characteristics			
Profits last month (GHS)	222.34	115.60	106.74
	(225.63)	(120.40)	(24.50)***
Sales last month (GHS)	316.49	166.76	149.73
	(316.83)	(170.48)	(34.43)***
Profits/Sales	0.70	0.69	0.02
	(0.13)	(0.13)	(0.02)
Number of garments made last month	25.66	19.79	5.88
	(19.87)	(18.97)	(2.35)**
Panel B: Reported barriers to business success			
Not enough customers	0.43	0.57	−0.14
	(0.50)	(0.50)	(0.06)**
Not enough time	0.06	0.04	0.01
	(0.23)	(0.21)	(0.03)
Not enough access to cash/savings	0.48	0.50	−0.02
	(0.50)	(0.50)	(0.06)
Not enough access to credit	0.08	0.07	0.01
	(0.27)	(0.25)	(0.03)
Not enough apprentices	0.26	0.26	0.01
	(0.44)	(0.44)	(0.05)
Supply problems—materials	0.14	0.04	0.09
	(0.35)	(0.21)	(0.04)**
Supply problems—wages/electricity	0.55	0.45	0.11
	(0.50)	(0.50)	(0.06)*
Observations	92	291	383

Notes: This table reports summary statistics on firm characteristics and reported barriers to business success for firms owned by men and those owned by women. The mean is presented, with the standard error in parentheses. The third column gives the difference between men and women. Standard errors are clustered at the firm owner level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

able to implement an experimental demand shock and follow-up survey on 383 (291 female-owned and 92 male-owned) firms. The majority of the 34 firm owners missing in our experiment sample had travelled temporarily during the period of fieldwork. Online Appendix Tables A.1 and A.2 show tests for differences on observable characteristics between our sampling frame and our experiment sample separately by male and female owners.[12] We find neither significant differences on observables, nor order treatment assignment, indicating that attrition is as good as random.

The sampling frame of this article is the same as the sampling frame considered in Hardy and Kagy (2018), which documents the gender profit gap and describes firm and firm owner characteristics separately by gender of firm owner. For reader convenience, Panel A of Table 1 and the paragraphs below summarise that discussion.[13]

Firms owned by men are significantly more profitable than those owned by women, with male-owned firms making nearly twice as much profit on average. Male-owned firms also have

making industry is dominated by female-owned firms, we know from geocoded data collected as part of the HGMS that firms owned by men and women are located in the same areas in Hohoe.

[12] We test separately by gender, because our main analysis separates our sample by gender.

[13] For the original discussion and documentation of our sample characteristics, see Sections III and Table 1 of Hardy and Kagy (2018).

significantly more sales and orders in the last month, but the profits/sales ratio is similar between male-owned and female-owned firms (Table 1, Panel A). From Hardy and Kagy (2018), we know that male-owned firms are also older and have more assets, and the firm owners work longer hours. However, firms owned by men and women have similar levels of productivity, as measured by the typical time that it takes to make a garment.

Men and women firm owners are similar along several demographic dimensions. The men and women are equally likely to be married, have similar levels of education (approximately nine years), and similar levels of cognitive functioning.[14] For both men and women, the garment-making firm is their primary economic activity. While men are more likely to also engage in farming, women are more likely to have an additional retail business creating a similar level of additional economic activity between men and women.

The gender profit gap seen in the garment makers of Hohoe remains large, and of a similar 2:1 magnitude, even when firm owner characteristics, cognition of the firm owner, firm characteristics, productivity measures, reasons for self-employment and product quality are accounted for. Even with the inclusion of all of these detailed observable characteristics, the gender profit gap remains sizable and robust (Hardy and Kagy, 2018).

2. Descriptive Evidence

We thus turn our attention to investigating other potential contributors to the gender profit gap. Our census and market research survey data[15] point to a particularly compelling reason for this difference in profit. We find a large gap in the firm-to-market ratio by gender in our context.

From our firm census, we know that there are over three times as many female firm owners in the market than male firm owners (321 versus 95) in Hohoe. This translates into a supply of garment firms that is 77% female owned. Importantly, from our market research survey, we know that demand is segregated based on gender.[16] Additionally, customers from female-owned firms order only approximately one more garment per year than male-owned firm customers.[17] Given the much larger share of female-owned firms, the approximately equal amount of men and women in Hohoe, the gender segregation in demand market, and the only slightly higher level of demand by women, we are left with a large gap. A female-to-male firm ratio of $\sim$3, combined with a female-to-male demand market ratio of $\sim$1.5, means a female-to-male firm-to-market ratio of $\sim$2.

Next, we examine the self-reported business barriers of the firm owners. As part of our firm baseline, firm owners were asked what are the three largest barriers to growth in their businesses. Table 1 breaks down the responses by gender. The most common barrier to growth for female owners was not having enough customers: 57% of female-owned firms cited lack of customers as a barrier to growth, while only 42% of male-owned firms did.[18] The most common barrier

[14] Cognitive functioning is measured by the Ravens Matrix Reasoning Test.

[15] The market research survey was conducted in March and April 2015. In the market research survey, nearly 1,600 Hohoe individuals were interviewed. Respondents reported how much and how often they buy from garment makers, which specific garment makers they purchase from, and reasons for buying from that specific firm. The survey allows us to link customers to the firm(s) they purchase garments from. The individuals interviewed in the market research survey were chosen at random from public places near each of the garment-making firms in our sample.

[16] From our market research survey, we calculate that 83% of customers at female-owned firms are female, while only 12% of customers at male-owned firms are female.

[17] The average number of garments ordered for women we interviewed was 4.1, while the average for men was 2.7.

[18] The World Bank Enterprise Surveys do not typically include access to customers as an option to be self reported, so we are unable to compare these rates with those from nationally representative surveys.

to growth for male owners was supply side related, in lack of supply of electricity and water. This difference in self reports is consistent with the gender gap in firm-to-market ratio described above. We are left to consider the possibility that at least part of the gender profit gap is driven by differences in access to customers by gender.

3. Theoretical Framework

This section presents our theoretical framework. We use this stylised framework as an aid in thinking about the possible interplay between potentially binding input and demand constraints in a firm's profit maximisation problem. We begin with a basic set-up, allowing for either input or demand constraints. Motivated by our descriptive evidence presented in Section 2, we then assume different levels of demand available to each firm by gender of the firm owner. Finally, we discuss the implications of this difference for expected effects of a hypothetical demand shock on firm production and profits.

3.1. *Basic Set-Up*

We begin with a basic model of unconstrained firm profit maximisation. A firm can produce a certain quantity q at cost c per input i, according to the production function: $q = i^{\alpha}$, where $0 < \alpha < 1$. The firm can sell q at price p. Therefore, the firm's profit function is: $\pi = p \cdot q - c \cdot i$.[19] In this unconstrained situation, the firm will choose to produce a quantity q^*:

$$\frac{\delta \pi}{\delta i} = 0 \text{ (First order condition)}$$

$$\Rightarrow MR = MC$$

$$\Rightarrow p = \frac{c}{\alpha} \cdot (q^*)^{\frac{1-\alpha}{\alpha}},$$

$$q^* = \left(\frac{\alpha p}{c}\right)^{\frac{\alpha}{1-\alpha}}.$$

Now, we introduce the possibility of an input constraint limiting production, the subject of much of the previous literature. We model the firm's production function as follows: $q = \min(i^{\alpha}, \bar{i}^{\alpha})$, where $\bar{i}$ is a possibly binding input constraint. This input constraint could derive from credit constraints (an inability to fund more $\bar{i}$), managerial constraints (an inability to manage more $\bar{i}$), or any other constraint that may enter into the production function. This input constraint will bind if:

$$q^* > \bar{i}^{\alpha} \text{ (Binding input constraint condition).}$$

[19] In reality, prices are set by negotiation between the firm owner and the customer. Customers often repeat business at the same firm multiple times, making these price negotiations a repeated game. It is likely that the true market structure is somewhere in between monopolistic and competitive, with customers paying search costs to switch sellers. That said, firm owners anecdotally report perceptions of high demand elasticity in response to price changes in this context. This would suggest that firm owners are close to quality-adjusted price takers for some price equal to the customer's expected outside price plus some search cost. We believe that complicating our framework to include these (not yet understood) nuances would distract from, as well as leave unchanged, the broader points being illuminated here. Any action on price would enter through a difference in the marginal revenue curve, the shape and slope of which do not drive the model's main predictions.

Although historically less acknowledged in policy and literature, in order for a firm to earn p on an additional unit of q, there must be a customer willing to purchase that q. Therefore, in addition to the possibility of a binding input constraint in the firm production function, we next add the possibility of a binding demand constraint d in the firm's profit function: $\pi = p \cdot \min(q, d) - c \cdot i$. This demand constraint binds if:

$$q^* > d \text{ and } \bar{i}^{\alpha} > d \text{ (Binding demand constraint conditions).}$$

3.2. *Baseline Constraints and Demand Shock Effects*

Our market-level descriptive evidence alludes to different levels of d for male-owned and female-owned firms, with fewer customer orders available per female-owned firm, d_f, than male-owned firm, d_m. Our baseline self-reports also suggest differences in the relevant binding constraint, with male-owned firms' most reported constraint being input-related ('electricity') and female-owned firms' most reported constraint relating to demand ('lack of customers'), in further support of the following assumptions:

$$q^* > \bar{i}^{\alpha} \;\&\; d_m > \bar{i}^{\alpha} \text{ (Binding input constraints for male-owned firms),}$$
$$q^* > d_f \;\&\; \bar{i}^{\alpha} > d_f \text{ (Binding demand constraints for female-owned firms).}$$

Subfigure (a) of Figure 1 visually depicts the implications of these binding constraints for firm-owner production and profits, by gender, as well as the resulting profit gap. This theoretical framework suggests the baseline profit gap is driven by the distance between d_f and $\bar{i}^{\alpha}$.

Now, suppose that there is an increase in demand, D. This new D enters into the profit function: $\pi = p \cdot \min(q, d + D) - c \cdot i$. Subfigure (b) of Figure 1 visually demonstrates the implications by firm-owner gender. Because $\bar{i}^{\alpha} < d_m$, adding D to d_m does not relax the relevant binding constraint for male-owned firms:

$$q^* > \bar{i}^{\alpha} \;\&\; d_m + D > \bar{i}^{\alpha} \text{ (Unchanged binding input constraints for male-owned firms).}$$

Male-owned firms may weakly prefer to sell their output to the new demand source, but overall q will not increase past the $\bar{i}^{\alpha}$ produced prior to the increase in demand. This leaves male-owned firm profits unchanged. The binding constraint for female-owned firms, on the other hand, is relaxed:

$$q^* > d_f + D \;\&\; \bar{i}^{\alpha} > d_f + D \text{ (Relaxed binding demand constraints for female-owned firms).}^{20}$$

Female-owned firm output increases to $d_f + D > d_f$. Female-owned firm expenses also increase to $c \cdot (d_f + D)^{1/\alpha} > c \cdot (d_f)^{1/\alpha}$. Finally, female-owned firm profits increase to $p \cdot (d_f + D) - c \cdot (d_f + D)^{1/\alpha} > p \cdot (d_f) - c \cdot (d_f)^{1/\alpha}$. This difference in response by firm-owner gender to a demand increase is exactly what we see in our experiment, which we turn to next.

[20] Note that this assumes this new demand is such that $D + d_f$ is still $\leq \bar{i}^{\alpha}$, which is likely representative of the size of the shock we introduced during our experiment. If $D + d_f > \bar{i}^{\alpha}$, then production would increase to equal that of male-owned firms $\bar{i}^{\alpha} < d_f + D$ and the profit gap would completely disappear.

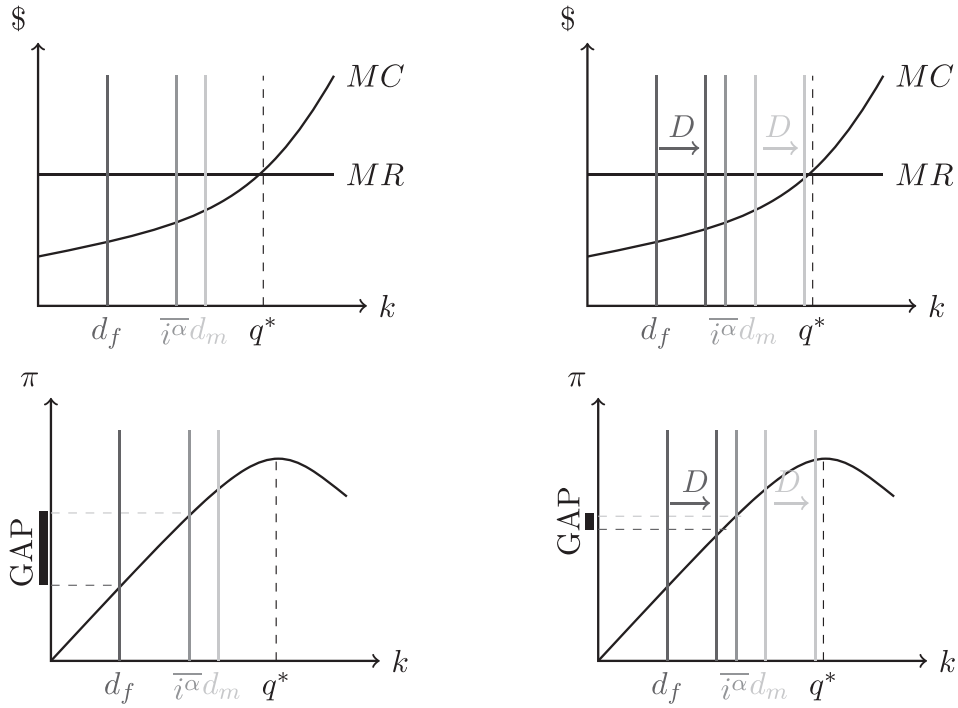


Fig. 1. *Theoretical Framework Assumptions and Predictions.*
Notes: These figures are intended to help visualise the baseline assumptions and testable predictions of our theoretical framework. Subfigure (a) depicts the baseline assumptions, and implications for the gender profit gap, supported by our observable evidence: binding input constraints for male-owned firms and binding demand constraints for female-owned firms. Subfigure (b) visually demonstrates the predicted impact of an exogenous demand shock for female-owned and male-owned firm production and profits. In the profit graph for both subfigures, the shaded area represents the gender profit gap.

4. Experiment Design, Data and Empirical Methodology

4.1. *Experiment Design*

As part of an earlier experiment designed to study technology diffusion between industry peers, two things were randomly offered to garment-making firm owners in Hohoe, Ghana: (*i*) an invitation to learn a new design technique that is used to decoratively embroider garments; and (*ii*) demand for garments with the new design. Both randomisations were stratified by gender and the demand randomisation was additionally stratified by training invitation to ensure balanced treatment propensity across these groups. The new design is a type of embroidery from multi-coloured woven thread that can be used to adorn garments. The design was commissioned specifically for this project, is unisex and is appropriate for use in both male and female clothing.[21]

[21] Execution of the design requires no electricity. The only capital required is a deconstructed common children's toy car easily found in local markets for 5 GHS (approximately 1.1 USD). Additional details the technology can be found in Hardy and McCasland (2016).

In early March 2015, approximately 15% of the sample were invited to attend government training on the new design technique. Invited women and men showed up to this training at an equally high rate of 93%. All those invited to the one-day training session mastered the technique.

After lower-than-expected demand for this new technique, the experimenters introduced experimental demand for garments featuring the technique.[22] In June 2015, firms were randomised to receive a demand shock of either 0, 1, 4 or 10 garments that used the new design technique. The price offered for each garment was fixed at 35 GHS, the going price in the market for a shirt with a complex design feature. Approximately 50% of the sample received an order size of 1, 20% received an order size of 4 and approximately 10% received an order size of 10.[23]

Baseline characteristics are generally balanced, for both male and female firm owners, for the demand shock randomisation. Online Appendix Tables A.3, A.4, A.5 and A.6 show the baseline characteristic balance checks for the demand shock randomisation by gender for both the sampling frame (417) as well as the final sample of analysis (383).[24] Additionally, if we regress order size on the baseline observables in our balance tables for our female sampling frame, male sampling frame, female sample and male sample, our F-stats are 0.71, 0.71, 1.23 and 1.25, respectively. This indicates overall balance on observables for our key explanatory variable in our main specification.

4.2. *Data*

Our self-collected data come from three sources: (*i*) a firm census and baseline survey done prior to randomisation; (*ii*) a detailed follow-up survey measuring firm inputs and outputs during the time of the random demand shock; and (*iii*) a market research survey conducted in the weeks leading up to the demand shock.

Baseline data was collected from July to September 2014. The baseline survey collected information from each firm owner about their personal characteristics, reasons for self employment, family structure, cognitive ability, information about the firm's assets, workers, previous month's sales, expenses, profits and productivity measures.

At the time of the experimental demand shock in June 2015, 417 of the original 445 firm owners were still in operation. As noted in Subsection 1.3, the experiment was conducted on 383 of these 417 firms. Follow-up data collection obtained information from each firm owner about both experiment specific and other sales, expenses and garments produced for the two weeks directly after the experimental demand shock.

These data on firm inputs and outputs were elicited as recall by category for a specific two-week period immediately preceding the interview day.[25] Operating expenses included all

[22] The original experiment was registered with the American Economics Association (AEA) Randomized Controlled Trial Registry, complete with a Pre-Analysis Plan (PAP). Because demand was meant to be naturally generated, this PAP did not include random demand for the design, which was inspired part way through implementation as a result of iterative fieldwork lessons. This article does not have a PAP, as the question and resulting analysis plan were conceived after the design, collection, and analysis of data for the originally intended purpose.

[23] The size of these orders respectively correspond to the median, 90th percentile and 99th percentile of a firm's weekly sales in the sample.

[24] We show balance tests separately by firm owner gender, because we estimate treatment effects separately by gender as the main focus of this article. All test results hold, and often improve, for the pooled sample.

[25] For treated firm owners, this interview happened approximately two weeks after the random order was placed and very soon after the random order was collected. As part of the technology diffusion experiment (Hardy and McCasland, 2016), this exact interview day was random due to the random timing in rollout of orders for treated firm owners. For firm owners who did not receive a random order, the interview day was directly randomised to create balance in interview timing between control and treatment firm owners.

'money changing hands' during the two-week period in question, and were elicited by operating expense categories (wages, outsourcing fees and input costs). Sales responses included all 'money changing hands' during that same two-week period, by product type (e.g., man's shirt, slit and kabbah, skirt and top etc.). Total profits were calculated by differencing total sales and total operating expenses.[26]

4.3. *Empirical Methodology*

To examine the impact that a random garment order offer has on a firm, we use an intent to treat (ITT) framework. Specifically, we use the following specification separately for men and women:

$$Y_i = \alpha + \beta_1 \cdot OrderSize_i + \epsilon_i, \tag{1}$$

where Y_i is the outcome of interest, and $OrderSize_i$ is the number of garments randomly ordered (0,1,4, or 10), for firm owner i. Standard errors are clustered at the firm owner level.

To test the differences in β_1 between men and women, we run a pooled regression with both men and women:

$$Y_i = \alpha + \beta_1 \cdot OrderSize_i + \beta_2 \cdot Male_i + \beta_3 \cdot Male \times OrderSize_i + \epsilon_i, \tag{2}$$

where $Male_i$ is a binary indicator for the gender of firm owner i being male and β_3 is the key coefficient of interest. Standard errors are again clustered at the firm owner level.

These specifications measure the (difference in) effect of each additional random order offer on the following outcomes during the two weeks that the experimental order was made: experimental and non-experimental orders completed, non-experimental sales, total wages, total input costs, total outsourcing fees, total owner hours, total sales and total profits. We consider these ITT estimates to be the main test of our model predictions, as they more closely represent the idea of randomly increasing demand. Our treatment on the treated (TOT) estimates, on the other hand, tell us something about how these outcomes change in response to the completion of these additional experimental orders.

We estimate TOT effects by using random order assignment as an instrument for number of experimental orders completed. Men are more likely than women to complete a randomised order if offered. Although this difference is not statistically significant, it is necessary to consider any possible differences in non-compliance when interpreting any TOT results. This gender difference in compliance is likely due to the fact this article is a secondary use of data from an experiment originally designed to study technology diffusion, meaning that the demand shock in this article is for a particular technique that was intentionally seeded to only a small subset of the population ($\sim$15%).

The most common reason that men refused to accept the experimental order was because they were too busy, while women most commonly refused the order because of difficulty in finding another garment maker to teach them the necessary technique (Subfigure (a) of Figure A.1). Men and women who were offered training on the new technique were equally likely to

[26] During piloting, we found that when collecting immediate recall data at the weekly level, a single summary question similar to that of De Mel *et al.* (2009b) was slower and less effective. We should also note that some larger expenses (e.g., taxes, association fees, land use fees and lights bills) are paid on a monthly, annual, or bi-annual basis. These expenses are not included in our profit estimates, as weekly measures of them are rarely positive and, when positive, are quite large. These expenses, if included, were trivially unaffected by our demand shocks due to their infrequency and lack of malleability.

Table 2. *Effect of Experimental Demand on Orders and Sales.*

	Experimental orders		Non-experimental orders		Non-experimental sales	
	Women	Men	Women	Men	Women	Men
Panel A: ITT	(1)	(2)	(3)	(4)	(5)	(6)
Order size	0.62***	0.83***	−0.32	−1.52***	−1.47	−14.13**
	(0.09)	(0.11)	(0.21)	(0.47)	(3.20)	(6.86)
Constant	0.01	−0.18	11.46***	25.42***	124.27***	301.67***
	(0.11)	(0.15)	(0.86)	(2.63)	(10.54)	(36.16)
Difference (men − women)	0.20		−1.20**		−12.66*	
	(0.14)		(0.51)		(7.54)	
Observations	291	92	291	92	291	92
Panel B: TOT	(1)	(2)	(3)	(4)	(5)	(6)
Order size			−0.51	−1.84***	−2.34	−17.07**
			(0.35)	(0.60)	(5.17)	(8.18)
Constant			11.47***	25.09***	124.29***	298.58***
			(0.86)	(2.57)	(10.59)	(35.14)
Difference (men − women)			−1.33*		−14.73	
			(0.69)		(9.64)	
Observations	291	92	291	92	291	92

Notes: This table reports intent to treat and treatment on the treated effects of the random number of garments ordered on orders and sales two weeks after the experimental order was made. Orders and sales are broken down into experimental and non-experimental components. The difference row presents the coefficient on the interaction term between male and order size in a pooled regression with both men and women. For the treatment on the treated effects the random assignment of order size is used as an instrument for order size accepted. Standard errors are clustered at the firm owner level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

accept the experimental order offer, with the difference in acceptance by gender only arising in the group not offered this training (Subfigure (b) of Online Appendix Figure A.1). Ultimately, these patterns in compliance suggest that the local average treatment effects of the TOT will be estimated on relatively less busy male-owned firms and relatively more entrepreneurial (and likely more busy) female-owned firms. We believe this biases our estimates against finding the differences we see by gender. Online Appendix Figure A.2 provides additional empirical support for this interpretation of compliance, showing that men who refused the order are, on average, more profitable than men that accept the order. The opposite is true for women; those that refused our order are, on average, less profitable than those who accept the order.

5. Experimental Findings

5.1. *Experimental Demand Displaces Other Demand in Male-Owned Firms*

Panel A of Table 2 shows the ITT estimates, depicting the effect of a random garment order offer on experimental garment orders completed according to our administrative data (compliance), as well as non-experimental orders and non-experimental sales, reported in our survey data. Panel B of Table 2 shows TOT estimates, depicting the effect of a random increase in experimental orders completed on non-experimental orders and non-experimental sales.

Men and women's non-experimental orders and sales do not respond in a similar way to an experimental order offer. An experimental order offer does not reduce non-experimental orders

or non-experimental sales in female-owned firms, as shown in Panel A, Columns 3 and 5, indicating that they are able to accommodate the increased demand for garments. In contrast, Columns 4 and 6 of Panel A show that, for each experimental order offered, male-owned firms significantly reduce non-experimental orders completed by 1.5 garments and non-experimental sales by 14.12 GHS (slightly less than half the sale price for each experimental order).[27] Overall, we see a statistically significant difference in response between male-owned and female-owned firms to the increases in the number of orders offered that suggests female-owned firms have the capacity to take on additional orders while male-owned firms experience displacement in order to accommodate additional orders.

The TOT estimates show that the displacement of non-experimental orders and sales experienced by male owners grows larger in magnitude compared with the ITT estimates. Male-owned firms decrease their non-experimental orders by 1.8 garments for each experimental order completed, and their non-experimental sales by 17.07 GHS for each experimental order completed (Table 2, Panel B, Columns 4 and 6). These effects are statistically significant at the 1% and 5% levels, respectively. The TOT estimates show no statistically significant displacement for women in non-experimental orders and sales when an experimental order is completed (Table 2, Panel B, Columns 3 and 5).

5.2. *Only Female-Owned Firms Expand Production for Demand Shocks*

We unpack this significantly different response to experimental demand shocks by gender in Table 3 by considering the following components of production: labour expenses (wages), input costs, outsourcing fees and owner hours. Again, we present both the random assignment of demand shocks results in Panel A (ITT) and the completion of the demand offer (TOT) results in Panel B. Columns (1) and (3) of Panels A and B show significant increases in both labour and input expenses paid by female-owned firms in response to increases in both order offers and order completion. In contrast, Columns (2) and (4) show no significant evidence of production input expansion for male-owned firms. Female-owned firms increase wages by 1.40 GHS and 2.05 GHS more than male-owned firms per order assigned and completed, respectively. Similarly, female-owned firms increase input spending by 2.83 GHS and 3.89 GHS more than male-owned firms per order accepted and completed, respectively. Neither gender of firm owner increases production through increases in owner labour, nor increases in outsourcing fees (Columns 5 to 8), indicating that female- and male-owned firms both handle the experimental increase in demand 'in house'.

Taken together, Table 3 indicates that female-owned firms expand production through increases in both labour and capital inputs in response to demand shocks. This response is not consistent with a theory that female-owned firms were previously operating at their absolute production capacity, in which case they would not have been able to increase these inputs. Male-owned firms, on the other hand, display behaviour consistent with the constraints more commonly studied in the micro-enterprise barriers literature, where they are either unable or unwilling to increase capital and/or labour inputs to expand production and absorb new demand.

[27] This 'larger than 1-to-1' reduction is likely due to a higher complexity (but higher sales price) of our orders to the average firm's market order.

Table 3. *Effect of Experimental Demand on Firm Expenses and Owner Hours.*

	Wages		Input costs		Outsourcing fees		Owner hours	
	Women	Men	Women	Men	Women	Men	Women	Men
Panel A: ITT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Order size	0.94*	−0.46	1.19*	−1.63	−0.10	0.06	0.49	−0.87
	(0.54)	(0.52)	(0.71)	(1.36)	(0.08)	(0.12)	(0.63)	(1.29)
Constant	4.27***	7.75***	23.61***	46.05***	1.95***	1.30***	71.34***	94.73***
	(1.51)	(2.42)	(2.36)	(8.68)	(0.44)	(0.49)	(2.58)	(4.55)
Difference (men − women)	−1.40* (0.75)		−2.83* (1.53)		0.17 (0.15)		−1.36 (1.43)	
Observations	291	92	291	92	291	92	291	92
Panel B: TOT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Order size	1.50*	−0.55	1.91*	−1.97	−0.16	0.08	0.79	−1.05
	(0.82)	(0.64)	(1.05)	(1.73)	(0.13)	(0.14)	(0.96)	(1.57)
Constant	4.26***	7.65***	23.60***	45.69***	1.95***	1.32***	71.33***	94.54***
	(1.50)	(2.34)	(2.33)	(8.46)	(0.44)	(0.48)	(2.57)	(4.41)
Difference (men − women)	−2.05** (1.04)		−3.88* (2.01)		0.24 (0.20)		−1.83 (1.83)	
Observations	291	92	291	92	291	92	291	92

Notes: This table reports intent to treat and treatment on the treated effects of the random number of garments ordered on the number of hours worked by the owner, wages paid to other workers, input costs and outsourcing fees, two weeks after the experimental order was made. The difference row presents the coefficient on the interaction term between male and order size in a pooled regression with both men and women. For the treatment on the treated effects the random assignment of order size is used as an instrument for order size accepted. Standard errors are clustered at the firm owner level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.3. *Demand Shocks Increase Profits Only in Female-Owned Firms*

Table 4 shows gender differences in the total sales and firm profits response to random demand shocks. Columns (1) and (2) of Panel A show a statistically significant increase of 9.65 GHS in total sales and 7.618 GHS in total profits in female-owned firms for each random garment order offered. The effect of completing orders appears larger, at a 15.42 GHS increase in total sales and 12.17 GHS increase in total profits for each order completed in female-owned firms (Panel B: TOT). In contrast, we cannot detect a change in either total sales or total profits in male-owned firms in response to orders assigned or completed.

5.4. *Robustness to Interactions with Technology Training*

Because our data come from a previous experiment designed to look at technology diffusion, one may worry that the results that we see in this secondary use of the data may be driven by the need to gain access to a teacher of the new weaving technique. Among those who did not receive training on the new weaving technique, women were less likely to accept the order than men (although the difference is not statistically significant). Women also more frequently cited 'difficulty in finding someone to teach them this technique' than men did as a reason for refusal (see Online Appendix Figure A.1). However, an empirical exploration of the interaction between access to the new weaving technique training and the demand shock does not support the theory that lack of access to the new weaving technique drives the key differences we find in demand response by men and women.

Table 4. *Effect of Experimental Demand on Total Sales and Profit.*

	Total sales		Profits	
	Women	Men	Women	Men
Panel A: ITT	(1)	(2)	(3)	(4)
Order size	9.65**	−6.56	7.62*	−4.53
	(4.59)	(7.20)	(4.41)	(6.46)
Constant	121.31***	306.93***	91.48***	251.84***
	(11.35)	(36.51)	(10.00)	(31.15)
Difference	−16.21*		−12.15	
(men − women)	(8.51)		(7.79)	
Observations	291	92	291	92
Panel B: TOT	(1)	(2)	(3)	(4)
Order size	15.42**	−7.93	12.17*	−5.48
	(6.66)	(8.74)	(6.62)	(7.77)
Constant	121.19***	305.49***	91.39***	250.85***
	(11.05)	(35.50)	(9.81)	(30.25)
Difference	−23.35**		−17.65*	
(men − women)	(10.95)		(10.18)	
Observations	291	92	291	92

Notes: This table reports intent to treat and treatment on the treated effects of the random number of garments ordered on total sales and firm profit two weeks after the experimental order was made. The difference row presents the coefficient on the interaction term between male and order size in a pooled regression with both men and women. For the treatment on the treated effects the random assignment of order size is used as an instrument for order size accepted. Standard errors are clustered at the firm owner level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

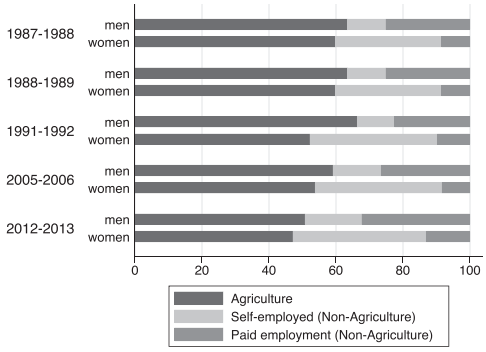
Online Appendix Table A.7 replicates Table 2, interacting our order size variable with an indicator for those who did not receive training on the new weaving technique. Our coefficients on order size remain quite stable in facing these added interaction terms. In this table, we also report the triple interaction of a firm owner not receiving the training with male and order size, to test for an increased difference in the differential response to demand by gender through lack of training. The triple interactions are all insignificant, with coefficients of the opposite sign to what would be predicted by the alternative hypothesis of concern. This helps reassure us that our findings are driven by differences in response to demand rather than some feature of the previously used research design.[28]

6. It's Getting Crowded in Here

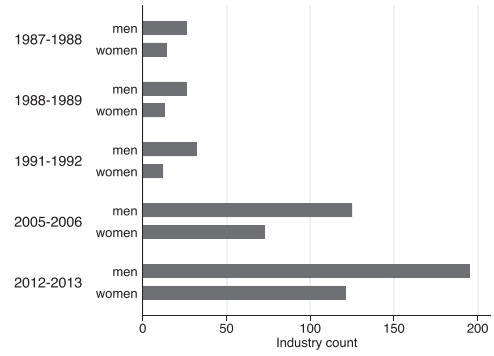
Why might women opt for employment in such a crowded market? Why wouldn't rationally optimising women exit toward relatively less crowded employment opportunities, equalising the firm-to-market ratio? In this section, we turn to the GLSS to explore what a Ghanaian women's outside employment options are.[29]

[28] As a further robustness check, available on request, we replicate all main result tables using only the 15% of our sample with direct access to the technology. Although our sample is much smaller, these tables show the same broad patterns matching the main results in this article.

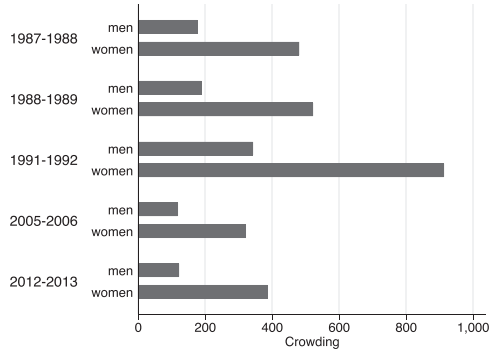
[29] The GLSS is a nationally representative repeated cross-section. It includes questions about employment status, in terms of both sector and industry. We use all five rounds of the GLSS from 1987 to 2012.



(a) Employment Category



(b) Number of Industries Reported by Non-Agriculture Self-Employed



(c) Average number of other people with employment in same industry (non-agricultural self-employed)

Fig. 2. *Crowding by Industry in Ghana.*

Notes: Using five rounds of the nationally representative Ghana Living Standards Survey, this figure depicts the percentage of adult men and women in different employment categories (Subfigure (a)), the total number of industries reported by non-agriculturally self-employed men and women (Subfigure (b)), and the average number of other respondents reporting employment in a non-agriculturally self-employed men and women respondent's own industry (Subfigure (c)). Individuals age 18 and older are included. Four-digit industry codes are used for Subfigures (b) and (c).

Subfigure (a) of Figure 2 shows us the percent of working adults in different types of employment by gender. We group employment into three categories: non-agricultural paid employment, non-agricultural self-employment and agriculture (both self and paid). In the GLSS, women employed outside agriculture are more likely to be in self-employment than men employed outside of agriculture, across all rounds of the GLSS from 1987 to 2012. Potential reasons for this gender segregation are numerous. They include differences in responsibilities within the home, mobility and motivations for self-employment (Bardasi *et al.*, 2011). However, these potential reasons are not the focus of this article. Instead, we are interested in the consequences of gender differences in employment patterns.

The difference in employment patterns does not stop with sector of employment. Using four-digit NAICS industry codes, Subfigure (b) of Figure 2 shows that (non-agriculturally)

self-employed men report employment in a greater number of industries than (non-agriculturally) self-employed women, across all rounds of the GLSS. Subfigure (c) of Figure 2 displays the natural result of this higher number of self-employed women squeezing into fewer numbers of industries: crowding within industry.[30] This figure graphs the average number of other people reporting employment within a respondents' industry of employment, by gender. The industries in which the average (non-agriculturally) self-employed female is employed are approximately three times as crowded as the industries in which the average male is (non-agriculturally) self-employed for 2012–13.[31]

It should be noted that, in this nationally representative data, we do not have a market research survey like the one we conducted in Hohoe. Thus, we are not able to calculate nationally representative back of the envelope firm-to-market ratios. However, the fact that the supply-side 'crowding' component of localised calculations is consistent throughout Ghana and across decades is compelling. Facing this stylised fact, one might find it less surprising that female garment-making firm owners in Hohoe have opted into employment that is nearly three times as crowded as their male counterparts. The grass may not be greener on the other side, at least not on the other side accessible to women.

7. Conclusion

Micro-enterprises matter greatly for the lives of individuals living in the developing world, especially women. Within these micro-enterprises there exists a large and robust profit gap between firms owned by women and those owned by men. Understanding barriers to the success of small firms, particularly small firms owned by women, is thus of key importance to policy makers focused on increasing the welfare of women around the world.

Production constraints, such as access to credit, have historically been the focus of both researchers and policy makers. This article provides evidence pointing to an under-considered side of the story: demand constraints. We show experimental evidence that female-owned firms expand production to absorb random demand shocks, while male-owned firms do not.[32] We show descriptive evidence from self reports that access to customers is the female firm owner's most common barrier to business growth in this context. We go on to provide compelling stylised facts, both within our context and on a nationally representative level, that self-employed women are operating in more crowded markets than self-employed men.

Taken together, the evidence presented in this article is inconsistent with the argument that factors affecting the production function, such as access to credit and capital, are the binding constraint for increasing female-owned micro-enterprise profits in this context. Rather, it

[30] Using these four-digit industry codes we have 245 unique industries. In Nix *et al.* (2015), who also use the GLSS, they categorise ten unique broader industries. Their industries are: agriculture/fishing, mining/energy, manufacturing, construction, wholesale/retail, trade, finance, public services and other.

[31] Industry concentration and segregation for women, similar to what we find using the GLSS, has also been found in a broader array of contexts in Latin America and other countries in Sub-Saharan Africa and East and Central Asia (Bardasi *et al.*, 2011).

[32] It should be noted that our experimental findings do not speak to the inter-temporal nature of constraints on production. It is possible that the expansion that we see in production from female-owned firms who received a positive demand shock could not be sustained for long-term increases in demand. Understanding exactly how much extra demand female-owned firms need, and how they respond to longer-term demand shocks is a key area for future research. However, we argue that, regardless of the amount of and length of slack in women's production functions, women are not fitting the typical capital and managerial constraint story more commonly considered in this literature. These results, though short run, compel the consideration of demand constraints as a potential barrier to the success of female firm owners.

supports an alternative explanation: limited formal employment opportunities for women in developing countries causes a relative oversupply of female micro-entrepreneurs. Even within self-employment, women are limited in the work they can do, causing further crowding in female-present industries.[33] This crowding induces a lower market-size-to-firm ratio, leading to lower demand availability per female-owned firm. This relatively lower availability of customer orders per female-owned firm decreases average profit per owner for women, relative to men, thus contributing to the gender profit gap.

This explanation sheds new light on the inconsistent impacts of input focused interventions on female-owned firms. For input-focused interventions to be effective, women must not face binding demand constraints. Similar to an argument made in Atkin *et al.* (2017), demand-focused interventions may be complementary to input constraint-focused interventions in the quest to improve women's economic empowerment. Our findings suggest the need for future research focused on the impact of providing sustained demand-focused interventions for female-owned micro-enterprises.

Furthermore, this explanation highlights the need to better understand the reasons behind sector and industry choice by gender. It compels a policy focus on increasing alternative employment opportunities for women in the developing world. Meaningfully increasing the option set for women entering the labor force could reduce crowding in the markets in which they ultimately operate.[34] This decrease in crowding may see large impacts on the welfare of women and is largely ignored in comparison to the micro-credit or skill training more commonly supported by governments.

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Additional Supporting Information may be found in the online version of this article:

Online Appendix
Replication Package

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[33] A similar form of segregation has even been found in agriculture, where women do not participate in commercial or export production (Croppenstedt *et al.*, 2013).

[34] For example, Campos *et al.* (2017) shows that women who enter male-dominated forms of employment earn just as much as men.

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