Determining factors of informal enterprise closure by gender: a microeconometric study applied in Senegal

Factores determinantes del cierre de empresas informales por género: un estudio microeconómico aplicado en Senegal

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Abstract: this article aims to investigate the factors influencing the closure of informal businesses during the COVID-19 pandemic, with a specific focus on the differences between businesses led by women and men. The research employed a logistic regression approach and utilized the matching method to evaluate the pandemic's impact. The study relied on a database created by the Development Policy Analysis Laboratory, Cheikh Anta Diop University, Dakar, which encompassed 923 informal businesses operating in diverse sectors in Dakar. The findings demonstrate that businesses managed by women experienced a more severe impact from the pandemic, leading to a higher likelihood of temporary closure. These results underscore the disproportionate effect of the crisis on women entrepreneurs within the informal sector and emphasize the necessity for tailored measures to support this vulnerable population during and after the pandemic. Such measures should address the unique challenges faced by women-led informal businesses and help foster their recovery and long-term sustainability.

Keywords: COVID-19, business closures, propensity score matching, informal sector, gender disparities, logistic regression, female-led businesses, male-led businesses.

Resumen: el objetivo de este artículo es examinar los factores determinantes del cierre de empresas informales durante la pandemia COVID-19, centrándose en las diferencias entre las empresas dirigidas por mujeres y las dirigidas por hombres. Para ello, se utilizó un enfoque de regresión logística, junto con el método de emparejamiento para evaluar el impacto de la pandemia. El estudio se fundamenta en una base de datos elaborada por el Laboratorio de Análisis de Políticas de Desarrollo, Universidad Cheikh Anta Diop, Dakar, que comprende 923 empresas informales de diversos sectores en Dakar. Los resultados revelan que los negocios manejados por mujeres se vieron más afectados por la pandemia, con una mayor probabilidad de cierre temporal. Estos resultados subrayan el impacto desproporcionado de la crisis sobre las mujeres empresarias del sector informal, y ponen de relieve la necesidad de medidas específicas para apoyar a esta población vulnerable durante y después de la pandemia.

Palabras clave: COVID-19, cierre de empresas, coincidencia de puntuaciones de propensión, sector informal, disparidades de género, regresión logística, empresas dirigidas por mujeres, empresas dirigidas por hombres.

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Introduction

The COVID-19 pandemic had a significant impact on businesses and working environments. The public health measures put in place forced many establishments to close suddenly, while the risk of infection prompted rapid adoption of modern sales and communication technologies to avoid physical contact. School closures also added childcare responsibilities for many working parents. These changes have put particularly strong pressure on small businesses, where central responsibilities are often shared between just a few people (Buffington *et al.*, 2020).

During the 2009 financial crisis, women-led businesses faced a higher probability of permanent closure. In addition, these companies experienced a greater decline in long-term sales than those run by men (Ahmed *et al.*, 2020). At the same time, they also experienced a more pronounced contraction in credit supply (Aristei and Gallo, 2022). This disparity in performance between female- and male-led businesses can be explained by a variety of factors, such as gender-based discrimination, limited access to finance and a lack of professional networks and support (Chaudhuri *et al.*, 2020). Indeed, women entrepreneurs often encounter more difficulties in obtaining financing and bank loans than their male counterparts (Shoma, 2019), which can hamper their ability to keep their businesses afloat during a period of economic crisis.

During the COVID-19 pandemic, businesses across various sectors experienced significant disruptions in both supply and demand, leading to adverse impacts on sales, employment, and financial stability (Apédo-Amah *et al.*, 2020; Bloom *et al.*, 2020; Karalashvili and Viganola, 2021; Amin and Viganola, 2021). Moreover, a study conducted in 24 countries globally revealed that women-led businesses had a higher likelihood of remaining temporarily closed and for extended durations compared to businesses led by men during the COVID-19 pandemic (Liu *et al.*, 2021).

Various studies have demonstrated that, in general, firms led by women exhibit lower productivity and smaller size compared to firms led by men (Islam *et al.*, 2019; Kiefer, 2022; Oladipo *et al.*, 2023). Additionally, it is common for these businesses to face challenges in accessing necessary financial resources (Andriamahery and Qamruzzaman, 2022). In the context of the COVID-19 crisis, which has particularly affected the retail sector and other service sectors, it is crucial to understand the specific effects of this crisis on women-led enterprises. Such understanding would enable the design of policies aimed at supporting these vulnerable businesses.

Gender inequality remains a pervasive problem in developing economies, significantly hampering economic development (Bui *et al.*, 2018; Ud Din *et al.*, 2018). Recent studies by Gezici and Ozay (2020) and Montenovo *et al.* (2022) have highlighted a worrying trend towards greater job losses among women than men. For example, Dang and Nguyen (2021) analyzed data from several countries, including the USA, UK, Italy, Japan, South Korea and China, and found that women were 24% more likely to suffer permanent job loss, and should expect a 50% greater reduction in labor income than men.

Further evidence from Bennett *et al.* (2021) based on Norwegian data revealed that following a positive long-term economic shock, such as the discovery of oil and gas in 1969, male workers saw their income increase by 7%, while their female counterparts suffered a decline of up to 14%.

The COVID-19 pandemic exacerbated these inequalities, as shown by Kikuchi and al. (2021), who observed that the Japanese labor market was disproportionately affected, with a greater negative impact on women. In addition, women-owned businesses, particularly in developing economies, suffered unfair consequences during the COVID-19 crisis (Liu *et al.*, 2021; Nieves *et al.*, 2021).

When we examine the influence of sector and company size, absolute gender disparities tend to decrease (Chaudhuri *et al.*, 2020), probably because female entrepreneurs often operate in sectors with lower profit margins and smaller workforces than their male counterparts (Mroczek-Dąbrowska, 2020).

Notably, cross-national studies have demonstrated that businesses led by women tend to achieve greater success and scale in sectors predominantly dominated by men (Campos *et*

al., 2019). Nevertheless, it is imperative to acknowledge that company characteristics alone do not fully account for disparities in productivity, sales, and profits. Even after accounting for a variety of factors, incorporating an extensive set of controls, Islam *et al.* (2020) discovered that the gender-based gap in labor productivity persisted without significant change.

Moreover, a focused investigation into the garment industry in Ghana conducted by Hardy and Kagy (2018, 2020) uncovered that male-owned microenterprises achieve notably higher profits than female-owned microenterprises, even after accounting for diverse firm, firm owner, and product characteristics.

Women are often confronted with societal expectations that place primary responsibility for care on them. In the aftermath of the pandemic, many countries implemented containment measures and imposed closures on schools and small businesses. These restrictions and closures could potentially exacerbate gender inequalities, given that women generally take on a greater share of household tasks (Power, 2020).

Existing research indicates that the COVID-19 pandemic has had different effects on men and women in the workforce. For example, women's productivity has fallen more than men's, and they are more likely to reduce their working hours (Collins *et al.*, 2020; Cui *et al.*, 2022; Alon *et al.*, 2022).

Considering the literature prior to the COVID-19 pandemic, it is pertinent to emphasize gender differences as a significant factor in business performance. Typically, companies owned or managed by females demonstrate lower levels of labor productivity and total factor productivity compared to those owned or managed by males (Alibhai *et al.*, 2018; Munyegera and Precious, 2018; Islam *et al.*, 2020). Furthermore, recent research indicates that the COVID-19 crisis has had an unequal impact on female entrepreneurs (Chawla *et al.*, 2020; Jaim, 2021).

Regarding the COVID-19 pandemic and its relevance to our research, there is a substantial body of recent studies and reports in mainstream media indicating that the impact of the crisis has been disproportionately felt by female entrepreneurs. This phenomenon has been well-documented through cross-country data sets by reputable organizations like ANDE (2020a), Facebook, OECD, and World Bank (2020). Furthermore, country-level investigations conducted in Bangladesh (Jaim, 2021), India (ANDE 2020b; Chawla *et al.*, 2020), the United Kingdom (Reuschke *et al.*, 2021), the United States (Fairlie, 2020; Manolova *et al.*, 2020; Bloom *et al.*, 2021), and other regions have provided additional supporting evidence for this claim. It is essential to acknowledge that some of these studies, particularly those centered on developing countries, rely on relatively small sample sizes, typically encompassing only a few hundred firms or even fewer. Additionally, certain studies utilize sampling methods that may not be well-suited for drawing accurate inferences about a target population (Schneider, 2020).

Given these realities concerning gender inequalities and the predominance of the informal sector in many contexts, it is essential to look at the complex interactions between these two aspects. Indeed, understanding the dynamics of the informal sector can shed crucial light on persistent gender disparities.

On the one hand, progress in reducing gender gaps in various areas cannot be considered sufficient, as substantial inequalities persist in key sectors such as education, health, employment, and others (Klasen, 2020; Islam and Amin, 2023). To promote women's empowerment and effectiveness, it is therefore crucial to recognize the prevalence and consequences of these inequalities (Wodon and de la Brière, 2018).

On the other hand, a relevant approach to understanding these gender gaps lies in analyzing the informal or unregistered sector. Due to its significant scale in developing economies, where it accounts for around a third of GDP and employs nearly 70% of the workforce (Ohnsorge and Yu, 2021), the informal sector plays a decisive role in the economic lives of many women.

In addition, women are more frequently found in the informal sector than in the formal sector, accounting for a significant share of self-employed workers in low- and lower-middle-income countries (Hyland and Islam, 2021). While this may sometimes be a choice motivated by the search for flexibility between caring responsibilities and

economic activities (Elgin *et al*., 2021), other factors, such as limited opportunities in the formal sector or constraints imposed by social norms and discriminatory laws, may also influence this concentration (Hyland and Islam, 2021).

Hence, analyzing gender gaps within the informal sector is crucial for gaining a comprehensive understanding of the overall gender inequality landscape and identifying the factors that contribute to women's economic participation and empowerment.

Using a database established by the Laboratory of Development Policy Analysis of the Faculty of Economics and Management of the Cheikh Anta Diop University of Dakar, we analyze a representative sample of 923 informal enterprises operating in various sectors in Dakar. The aim of this research is to investigate potential disparities in the impact of women-led versus male-led enterprises in Dakar. To do so, we seek to answer two main questions:

First, what are the determinants of business closure in dakar? Using the Marginal Effects of Probit models, we identified several factors with a significant influence on the probability of temporary business closure since the start of the pandemic. Among these factors, we observed that the gender of the company's manager plays an important role, as do declining sales, bankruptcy, and the company's sector of activity. These results highlight the importance of taking factors such as the gender of the manager into account when analyzing the impact of the pandemic on companies.

Secondly, we investigate the likelihood of business closure during the pandemic in relation to the gender of the business owners. Our findings indicate that businesses led by women exhibit a higher probability of closure compared to those led by men. To be precise, the propensity score matching results reveal that female-led firms face a disadvantage with a 16% increased likelihood of closure compared to male-led firms.

COVID-19 in Senegal

The World Health Organization (WHO) declared in March 2020 the COVID-19 outbreak as an official global pandemic. As of the end of September 2021, the virus had impacted nearly 30 million individuals worldwide, leading to almost one million fatalities.

In addition to the direct effects on health and well-being, the pandemic has amplified pre-existing situations of vulnerability and discrimination affecting various people, including women and children. This is seen through repercussions on their economic activities, as well as restricted access to essential social services such as health, reproductive health, nutrition, education, protection, and other aspects linked to gender dynamics and intra-family or community relations.

Senegal is a Sahelian country in West Africa, with an estimated population of 16,705,608 in 2020, according to demographic projections by the National Institute of Statistics and Demography. Among these inhabitants, there are 8,391,358 women (50.2%) and 8,314,250 men (49.8%). Most of the population concentrates in the Dakar region, which accounts for around 30% of the total, as well as in the outlying regions of Dakar, namely Thiès and Diourbel, which account for 62% of the population according to 2020 estimates. The population is expanding rapidly, with an annual growth rate of 3.8%. In less than 7 years, it has gone from 12 million to 16 million inhabitants. Over 55% of the population is under 20, and the average age is 19. The average fertility rate is 5 children per woman. Most Senegal's inhabitants, over half (53.3%), live in rural areas, while 46.7% live in urban areas.

Like many other countries around the world, Senegal has been facing a sustained spread of the coronavirus epidemic since March 2020. Since the first case was detected on March 2, 2020, the country has recently surpassed 10,000 positive cases and ranks among the countries most affected by the pandemic in Africa. As of September 24, 2020, Senegal has recorded 14,816 confirmed cases of COVID-19, with 11,818 people cured and 304 deaths. All 14 regions of the country are affected, but higher cases are observed in highly urbanized areas such as Dakar (10,165 cases) and Thiès (1,696 cases). Men are more affected than women,

with a ratio of 1.39 (i.e., 139 men for every 100 women, or 14 men for every 10 women)[1].

Senegal learned from its experience during the Ebola epidemic in 2013 and 2014 and quickly took stringent measures to try and limit the spread of the disease. For example, in addition to introducing a curfew, schools and universities were closed, prayers in places of worship were banned, travel between regions was restricted and strict hygiene rules were imposed. Although these measures helped to contain the epidemic, they also led to a deterioration in living conditions for households, which in many cases were deprived of resources. Some 85% of households reported a drop in income[2].

To limit the economic impact of this health crisis, the government has created a response and solidarity fund called Force-COVID-19, with a budget of 1,000 billion FCFA (around 164 million US dollars). An amount of 50 billion FCFA (around 82 million US dollars) has been specifically allocated to the purchase of foodstuffs for emergency food aid.

In Senegal, informal employment is the main source of employment, accounting for 95.4% of total non-agricultural employment, and the vast majority (97%) of the country's economic units are informal businesses (ANSD, 2019). Following the outbreak of the first case of Covid-19 on March 2, 2020, the government implemented several measures from March 15, 2020, such as a ban on gatherings, the temporary suspension of cruise ship hospitality and the closure of schools and universities (MEPC, 2020).

The most restrictive measures were taken on March 23, 2020 with the introduction of a state of emergency and curfew, resulting in the regulation and prohibition of travel between Senegal's cities and regions. From May 29, 2020, the prefecture of Dakar, as part of the state of emergency, took measures to set the days and hours when markets would be open and prohibit sales in public spaces (MEPC, 2020).

These decisions have consequences for the activities of informal sector workers, particularly those in the food industry in the Dakar region. This region, densely populated with nearly four million inhabitants, is home to around a quarter of Senegal's population in an area covering less than 3% of the national territory (ANSD, 2016). It concentrates most of the country's economic activity, particularly informal trade, processing, food transport and catering, which are likely to be hard hit by the restrictive measures imposed by the Senegalese government.

The main aim of this article is to present evidence concerning the effects of the crisis on the population, with a particular focus on women, especially female managers of informal enterprises in the Dakar region.

Description of the sample

The data used came from the survey conducted in 2022 on the impact of the Covid-19 pandemic on informal businesses in Dakar. The aim of this survey is to provide an in-depth understanding of the conditions and challenges faced by informal and formal businesses in Dakar as a result of the pandemic. The survey was carried out by the Laboratory of Political Advances and Development of the Faculty of Economics and Management of the University Cheikh Anta Diop of Dakar on a sample of 923 informal businesses in different sectors of activity in the city of Dakar.

Data were collected using a structured survey with questions on company characteristics, economic activity, size, access to finance and resources, the effects of the pandemic on their business and future prospects.

Table 1 provides an overview of the variables used in this study, together with descriptive statistics for each. Variables include the gender of the company director, the company's sector of activity, company size, sales decline since the start of the pandemic, company bankruptcy, temporary closure of the company since the start of the pandemic, and permanent closure of the company since the start of the pandemic.

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1 Response to the epidemic of the new coronavirus COVID-19, Senegal. Situation report no. 58 of September 24, 2020, Ministry of Health.

2 Bulletin 1 ANSD, World Bank, DGPPE, household welfare impact monitoring; September 2020.

Table 1

Presentation and statistical description of the variables

Variables	Modality	Mean	Standard deviation
Gender of the business leader.	**1:** Woman **0:** Man	0,627907	0,4836591
Marital status of business leader.	**1:** Married **2:** Divorced **3:** Single **4:** Widowed	1,531212	1,03579
Education level of business leader.	**1:** Superior **2:** Secondary **3:** Primary **4:** No education	3,228886	0,8315164
Loss of customers since the beginning of the pandemic.	**1:** Yes **0:** No	0,6156671	0,4867351
Government support in response to the COVID-19 pandemic.	**1:** Yes **0:** No	0,0636475	0,2442735
Temporary closure of the business since the start of the pandemic.	**1:** Yes **0:** No	0,4320685	0,4956673
Sales down since the start of the pandemic.	Proportional drop in sales since the beginning of the pandemic.	53,14311	22,50299
Sector of activity	**1:** Commerce **2:** Service **3:** Industry	2,887393	1,296507

Note: Authors based on data from the survey on the impact of the covid 19 pandemic on informal businesses in Dakar (2022).

Figure 1 shows a graphical representation of the proportion of businesses headed by women and men. This visualization enables us to better understand the distribution of management positions between the two sexes, and to measure the representativeness of women and men in these roles. By examining the respective proportions, we can observe whether women are under- or over-represented in management positions compared to men.

The data presented in Figure 1 shows the proportion of businesses run by women, with the data indicating that 63% of businesses are run by women, while 37% are run by men. This information highlights the significant presence of women in business leadership positions, although the proportion of male-led businesses also remains significant.
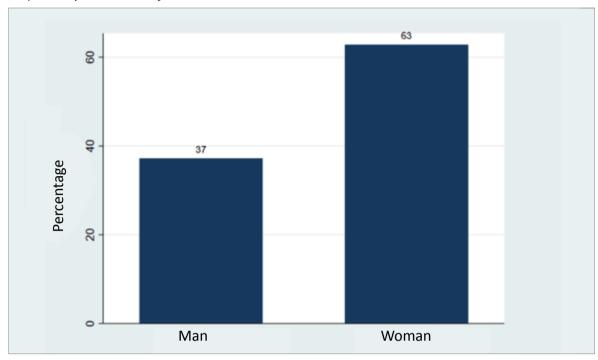
Figure 1
Proportion of business led by a woman or a man

Note: Authors based on data from the survey on the impact of the covid 19 pandemic on informal businesses in Dakar (2022).

Figure 2 illustrates the proportion of temporary closure of female/male-run businesses due to the COVID-19 pandemic. The results show that during the pandemic, 30% of female-led businesses closed temporarily, while 13% of male-led businesses experienced a temporary closure. In contrast, 32% of female-led businesses and 24% of male-led businesses did not experience a temporary closure during the pandemic.

This difference in the proportions of temporary closures may be due to several factors, such as the business sector, company size, financial capacity and management skills. Businesses run by women may have been more affected because they operate in sectors more affected by the pandemic, are smaller in size and may have fewer financial resources to cope with the crisis.

Figure 3 shows that only 3% of businesses received government support, either at national or local level, in response to the COVID-19 pandemic. This means that most businesses, 97%, did not receive government support during this difficult period.

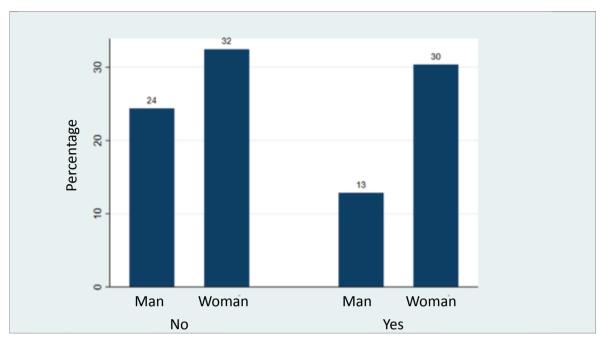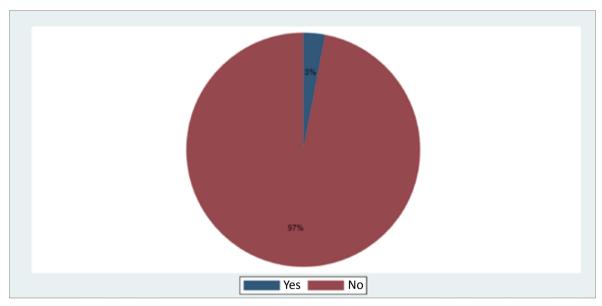*Proportion of temporary closure of businesses run by women/men due to the pandemic*

Proportion of businesses that received government support, whether national or local, in response to the COVID-19 pandemic

Note: Authors based on data from the survey on the impact of the covid 19 pandemic on informal businesses in Dakar (2022).

This underlines the importance of putting in place effective support measures to help businesses through crisis situations such as this to preserve jobs and the economy in general. It is

essential that governments take steps to help businesses in need, in order to reduce the economic impact of the COVID-19 pandemic.

Empirical methodology

This section presents the empirical methodology selected to address the problem. Indeed, the literature proposes numerous econometric techniques for identifying the causal relationship of a program. In our case, we opted for a propensity score matching procedure. This method was chosen for the following reasons: ideally, to identify the effects of business closures during the COVID-19 period, it would be necessary to be able to compare the closure of a business run by a woman with that of the same business run by a man. However, this comparison is not always possible in practice. Using the propensity score matching procedure, we can construct a control group made up of businesses similar to those run by women, but run by men, enabling us to measure the impact of business closures by gender.

As stated by Rosenbaum and Rubin (1983), matching is a non-experimental approach utilized to estimate the impact of a program or intervention when random assignment is not feasible. This method offers the advantage of mitigating potential sources of bias by endeavoring to create treated and untreated groups that share similar characteristics.

Formally, we can express the treatment effect Δ_{it} on a business *i* at time *t* as the difference between the potential outcome Y_{it}^T for a female-led business and the potential outcome Y_{it}^C for a male-led business. In other words, *T* refers to the treatment group, while *C* refers to the treatment group, while

$$\Delta_{it} = Y_{it}^T - Y_{it}^C$$

However, a direct comparison of potential results could introduce a bias into our analysis. To avoid this, it is preferable to compare the average effects that the gender of the manager would have on a randomly selected business in the population. This measure is known as the Average Treatment Effect on the whole population (ATE)

and can be expressed using the mathematical expectation operator E(.) :

$$ATE = E(Y_i^T) - E(Y_i^C) = E(Y_{i1} \mid T_i = 1) - E(Y_{i0} \mid T_i = 0)$$

The ATE estimator, also known as the naive estimator, assumes that the simple difference in mean results between the treatment and control groups. However, this does not necessarily correspond to what we are seeking to measure, which is the difference in average outcomes between businesses run by women (treatment businesses) and those run by men (control businesses). Therefore, to obtain an appropriate estimate, we need to use the ATT, i.e., the average effect of the treatment on treated businesses, which is calculated using the following formula:

$$ATT = E(Y_i^T - Y_i^C \mid T_i = 1) = E(Y_{i1} \mid T_i = 1) - E(Y_{i0} \mid T_i = 1)$$

The PSM method involves creating a statistical comparison group (also known as a counterfactual group) based on the conditional probability of participating in treatment T, as a function of observed characteristics X. This probability is represented by the propensity score, denoted $P(X)=\Pr(T=1 \mid X)$. This matching is based on two main assumptions: the conditional independence assumption (CIA) and the common support assumption.

The first hypothesis posits that all variables responsible for selection bias are observable. This implies that the average causal effect of treatment can be determined solely by considering observable variables, denoted as X, which may include factors like gender, age, educational background, parental socio-economic status, and other relevant characteristics. These observable variables contain all the necessary information to characterize the potential outcomes of individuals. Stated differently, the assumption of selection based on observables means that the unobserved outcome variables (Y_i^T, Y_i^C) are independent of treatment assignment (T) given the observable variables (X), i.e., X, i.e. $(Y_i^T, Y_i^C) \perp T \mid X$.

Matching treated and control individuals becomes challenging when attempting to match based on observable data that involves a large number of variables. This difficulty arises from

the struggle to find two comparable individuals in two different groups.

To address this constraint, Rosenbaum and Rubin (1983) introduced a conditional independence hypothesis (CIA) that relies on propensity scores[3]

$$PS = P(X) = P(T = 1|X)$$

The second hypothesis (the common support hypothesis), introduced by Rosenbaum and Rubin (1983), asserts that there is at least one individual, if not several, in the comparison group with the same observable characteristics or the same probabilities of accessing treatment as each participant. This hypothesis can be expressed by the following equation:

$$0 < Pr\ (T=1 \mid X=x) < 1 \text{ for all } x$$

Results and discussion

Before examining the effect of female leadership on businesses with the propensity score matching method, it is planned to conduct a logistic regression analysis to understand the factors that influence business closure. This will enable us to identify the variables that have the greatest impact on business survival and control for them when assessing the effect of female leadership. Once controlled these variables, we will be able to examine more precisely the effect of female leadership on business performance. Logistic regression is a statistical method used to model the probability of a business closing as a function of various explanatory variables. Using this method, we can identify the factors that have the greatest impact on business survival.

The Probit model is used to study the determinants of business closure, given that the variable to be explained is a binary dummy variable. Consequently, the probit model is defined as follows:

$Prob(close)=\beta_0+\beta_1 gender_i+\beta_2\ reduc\_sales_i+\beta_3\ mar\_status_i+\beta_4\ educ\_level_i+\beta_5\ client\_loss_i+\beta_6\ bankruptcy_i+\beta_7\ gov\_sup_i+\beta_8 sector_{i+\varepsilon\_i}$

The dependent variable indicates whether a business has temporarily closed since the start of the pandemic (suspension of services or production) by taking the value 1, and 0 otherwise. The gender variable is a dichotomous variable that takes the value 1 if the business is run by a woman, and 0 if it is run by a man. The reduc_sales variable represents the proportion of sales decline. The variables mar_status and educ_level indicate the marital status and level of education of the business leader, respectively. The variable client_loss is binary and takes the value 1 if the business has lost customers since the beginning of the pandemic, and 0 otherwise. The bankruptcy variable is also binary, taking the value 1 if the business has declared bankruptcy or insolvency. Finally, the variable gov_sup takes the value 1 if the business has received any support from the national or local government, and 0 otherwise.

Table 2 shows the estimated marginal effects of probit models on the determinants of business closure in Dakar. The results of the analysis show that certain factors have a significant influence on the probability of temporary business closure since the start of the pandemic. These factors include the gender of the business leader, sales decline, bankruptcy and business sector.

The results of the analysis indicate that several factors are associated with the probability of temporary closure of businesses in Dakar since the start of the pandemic. Specifically, businesses run by women have a 21% higher probability of temporary closure than those run by men. This difference could be explained by gender differences in management and decision-making.

On the other hand, reduced sales are an important factor in increasing the likelihood of temporary closure, which is not surprising given the economic impact of the pandemic on business activities. In addition, businesses that have already experienced financial difficulties, such

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3   Rosenbaum and Rubin (1983) introduce the concept of "propensity score" (PS), which represents the probability of an individual with specific characteristics receiving a particular treatment. In other words, the PS denotes the conditional probability of an individual benefiting from a treatment, given the observed covariates.

as bankruptcy, also have a higher probability of temporary closure.

Finally, the business sector is another important factor, with some industries more affected than others by the health crisis. For example, the retail and construction sectors are particularly vulnerable, which may explain their higher probability of temporary closure.

Table 2
Marginal effects of Probit models on closure determinants

Closure	dy/dx	Std. Err	z	P>|z|	[95% Conf. Interval]	
Gender	0,2133393	0,0386664	5,52	0,000***	0,1375545	0,2891241
Reduc_sales	0,0054907	0,0008224	6,68	0,000***	0,0038788	0,007026
mar_status	-0,0104316	0,0185012	-0,56	0,573	-0,0466933	0,0258301
educ_level	-0,0237368	0,023567	-1,01	0,314	-0,0699273	0,0224536
client_loss	0,0228739	0,0409622	0,56	0,577	-0,0574106	0,1031583
bankruptcy	0,2402105	0,0527635	4,55	0,000***	0,136796	0,343625
gov_sup	0,0917198	0,0799703	1,15	0,251	-0,0650191	.2484588
Sector	0,0317902	0,014484	2,19	0,028**	0,0034021	0,0601783

Note: Authors' calculations, STATA software. Note :*: p<0.1; **: p<0.05; ***: p<0.01.

Having investigated the marginal effects of Probit models on the determinants of business closure, we now turn to the impact of gender on this phenomenon during the COVID-19 pandemic. To do this, we will use the propensity score matching method.

More specifically, we will seek to understand whether gender plays a role in the probability of business closure during the health crisis. To do this, we'll use the propensity score matching method, which creates comparable groups of female and male entrepreneurs with similar characteristics in terms of business size, sector of activity, level of qualification, etc.

Table 3 displays the disparities in means and standard deviations of the variables employed in our analysis. These variables were utilized in the estimation process to enhance the comparability between the two groups. Specifically, the outcomes of the Student t-test reveal that, on average, the two groups exhibit similarities across all variables, except for marital status, level of education of the business owner, and sector.

Table 3
Difference in variable means

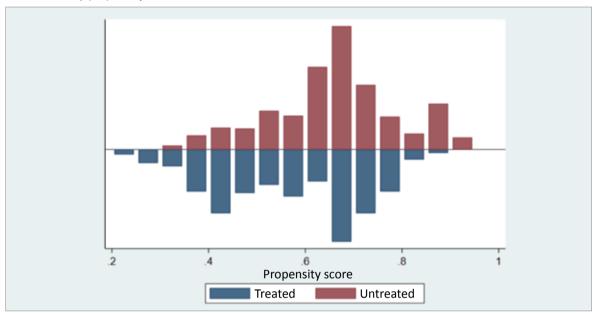| Variable	Treated			Control			Statistic T
	N. Treated	Mean	Std. Err	N. Control	Mean	Std. Err	
Reduc_sales	335	53,81493	1,174545	224	52,13839	1,599685	-0,8630
mar_status	513	1,664717	0,0516367	304	1,305921	0,0404279	-4,8515
educ_level	513	3,274854	0,0350268	304	3,151316	0,0509421	-2,0567
client_loss	513	.5945419	0,0216985	304	0,6513158	0,0273773	1,6131
bankruptcy	513	.1559454	0,0160338	304	.1282895	0,0192115	-1,0826
gov_sup	513	0,0584795	0,0103701	304	0,0723684	0,0148847	0,7854
Sector	513	2,65692	0,0459933	304	3,276316	0,0897997	6,7799

Note: Authors' calculations, STATA software.

Once the Student's t test has been carried out, we will proceed to test the common support hypothesis. This step enables us to ensure that individuals have similar observable characteristics, unaffected by the treatment variable. Common support thus enables us to identify businesses run by men and those run by women, which have virtually identical propensity scores.

In other words, the common support represents the area where the propensity score curves of the two groups overlap perfectly. In our case, the common support obtained lies between 0.3251008 and 0.9078215, as shown in Figure 4.

Figure 4

Distribution of propensity scores in the common medium

Note: Authors' calculations, STATA software.

Once the propensity score and the common support region have been identified, the units in the treatment group can be matched with those in the comparison group with the most similar score. This can be done using a variety of methods, including the four-propensity-score-based matching methods: Kernel[4], Nearest neighbor[5], Stratification[6] and Radius[7].

The matching results for the whole sample show a statistically significant difference in outcome variables between businesses run by women (treatment group) and those run by men (control group) with similar observable characteristics (table 4).

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4   In the matching process, multiple individuals from the control group are paired with each treated individual, with the assignment of weights inversely proportional to the distance between the treated and untreated individuals.

5   An individual who has received treatment is paired with an untreated individual based on their closest propensity score.

6   Propensity score stratification involves estimating the effect of treatment within strata defined most often by propensity score quintiles or deciles.

7   An individual from the untreated group is paired with an individual from the treated group based on their closest propensity score, ensuring that the maximum distance between them is not exceeded.

Average effect of treatment on outcome variables

Method	n. treated	n. control	ATT	Std. Err	t
Closure of business					
Nearest neighbor	513	256	**0,167**	0,063	**2,656**
Kernel	513	291	**0,163**	0,035	**4,716**
Radius	387	250	**0,225**	0,053	**4,240**
Stratification	513	291	**0,145**	0,045	**3,234**
Bankruptcy					
Nearest neighbor	513	256	0,058	0,045	1,291
Kernel	513	291	**0,068**	0,023	**2,895**

Note: Authors' calculations, STATA software.

The results of the four analysis methods (Kernel, Nearest neighbor, stratification and radius) confirm that the gender of the manager has a significant causal effect on the variable of business closure during the Covid-19 pandemic. Businesses run by women have a 14% higher probability of closure using the stratification method, a 16% higher probability using the nearest neighbor and kernel methods, and a 22% higher probability using the radius method, compared with those run by men. These results are all statistically significant at the 1% level.

These findings reinforce the idea that the gender of the manager may have an impact on the resilience of the business to the economic difficulties generated by the pandemic. Indeed, this is confirmed by the marginal effects of the Probit models on the determinants of closure, presented in Table 2. These results show that the gender of the manager is a significant variable in the probability of business closure.

These results from are in line with those obtained by Liu *et al.* (2021), who also showed that businesses run by women tend to close more often during the Covid-19 pandemic.

For the bankruptcy outcome variable from the estimates, female-led businesses have a higher probability of bankruptcy during the COVID-19 crisis, with a difference of 7% compared to male-led businesses. This may be a cause for concern for women's businesses, which may be more vulnerable to the negative economic effects of the pandemic.

Having calculated the average treatment effect on the outcome variables, which include business closure and bankruptcy, we will now proceed to calculate the treatment effect on the closure of businesses that received financial support from the national or local government. This step is particularly important, as it enables us to understand the real impact of financial support programs on business survival.

The average effect of gender on the closure of businesses with or without financial support from national or local government

	Coef.	Std. Err	z	P>|z|	[Conf. Interval 95%]	
gov_sup=0	0,1705906	0,0503605	3,39	**0,001***	0,0718859	0,2692954
gov_sup=1	0,0944444	0,2390417	0,40	0,693	-0,3740687	0,5629576

Source: Authors' calculations, STATA software.

Businesses run by women and receiving no financial support from national or local govern-

ment are around 17% more likely to close than those run by men and receiving no similar su-

pport. This disparity can be attributed to various factors such as gender discrimination, gender stereotypes, differences in access to financing and to the market. On the other hand, the impact of gender on the closure of businesses benefiting from such support is not significant.

The COVID-19 pandemic has had a significant impact on women-led businesses, as our study shows. The results show that these businesses were harder hit than those run by men. One notable consequence is that women-led businesses were more likely to temporarily close their operations during the pandemic (Islam *et al.*, 2019).

This disparity in the impact of the pandemic on women-led businesses can be attributed to several factors. Firstly, the economic sectors most affected by containment measures, such as personal services and creative industries, are often dominated by female entrepreneurs (Amin and Islam 2014). As a result, these sectors have been particularly vulnerable to the economic disruption caused by the pandemic.

In addition, women entrepreneurs often face pre-existing structural barriers and inequalities, such as limited access to finance and professional networks (Ahmed *et al.*, 2020). The health crisis has exacerbated these disparities, making it more difficult for women to maintain their businesses and cope with the economic challenges caused by the pandemic.

Conclusions

The COVID-19 pandemic, like other crises, exhibits a gender-disparate impact, as crises are inherently non-gender-neutral. The pandemic has significantly affected businesses and work environments, with small and informal enterprises being particularly affected. Women-led businesses, in comparison to those led by men, are more likely to experience longer and more frequent temporary closures during the COVID-19 pandemic.

In developing economies, women often face societal norms that assign them caregiving responsibilities, placing additional strain on female business owners during the pandemic. When formulating policies to support vulnerable businesses, it becomes crucial to comprehensively understand the specific impact of the crisis on women-led businesses and endeavor to mitigate unconditional gender disparities in productivity, revenues, and profits.

This article investigated the impact of the COVID-19 pandemic on businesses led by women and men. The research findings revealed that female-led businesses experienced a more significant adverse effect from the pandemic compared to those led by men. Specifically, these businesses were more prone to temporary closures than their male-led counterparts.

These outcomes raise concerns, considering that women-run businesses generally tend to be smaller and less productive than businesses run by men. Moreover, women entrepreneurs encounter additional hurdles, including gender discrimination, limited access to financial resources, and a lack of professional networks and support. The COVID-19 pandemic has exacerbated these pre-existing challenges, underscoring the urgent need for proactive measures to support women-led businesses.

This article emphasizes the considerable impact of the pandemic on informal businesses led by women. It underscores the necessity for targeted measures to provide support and enhance the long-term resilience of these enterprises. Policymakers and development stakeholders should consider these findings when formulating policies and programs that specifically address the challenges faced by women entrepreneurs in the informal sector.

Despite its valuable insights into the impact of the COVID-19 pandemic on women-led informal businesses, this article acknowledges certain limitations that warrant consideration. Primarily, the study's focus solely on the city of Dakar restricts its generalizability to other geographical and cultural contexts. Replicating this research in different regions would be valuable to gain a deeper understanding of potential variations in the pandemic's effects on women-led informal businesses.

In terms of future research, it would be interesting to dig deeper into the analysis of factors that have contributed to the pandemic's disproportionate impact on women-led informal businesses.

For example, it would be useful to examine in detail the specific obstacles they face in terms of access to finance, resources and markets. An in-depth study of the coping and resilience strategies implemented by these women entrepreneurs could also provide valuable information to inform policies and support programs.

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