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Opportunistic behavior and discrimination in the Mexican Solar PV market: An audit experiment

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We conducted an audit experiment in which fictional households requested quotes for the purchase, installation, and interconnection of solar photovoltaic systems in four cities across Mexico. This allowed us to identify whether there was opportunistic behavior among local sellers and to quantify the extent of discrimination based on characteristics of residential users, such as gender, socioeconomic status, product knowledge, and access to external financing sources. The main findings indicate that women and customers with higher socioeconomic status not only face price discrimination but are also offered oversized systems. There is no evidence of such practices towards customers with prior product information or those who have secured external financing for the purchase.

KEYWORDS

Solar panel adoption, price discrimination, gender discrimination, audit experiment, residential electricity consumption

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Comportamiento oportunista y discriminación en el mercado mexicano de paneles solares: Un experimento de auditoría

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En este trabajo llevamos a cabo un experimento de auditoría en el cual hogares ficticios solicitan cotizaciones para la compra, instalación e interconexión de sistemas fotovoltaicos solares en cuatro ciudades de México. De esa forma identificamos si existe un comportamiento oportunista por parte de los vendedores y cuantificamos la discriminación basada en características de los usuarios residenciales tales como género, nivel socioeconómico, conocimiento del producto y acceso a fuentes externas de financiamiento. Los principales hallazgos indican que las mujeres y los clientes con un nivel socioeconómico más alto no solo enfrentan discriminación de precios, sino que también se les ofrecen sistemas sobredimensionados (de mayor capacidad comparada con la óptima). No hay evidencia de tales prácticas hacia los clientes con información previa sobre el producto o aquellos que se han asegurado financiamiento externo para la eventual compra de los paneles solares.

KEYWORDS

Adopción de paneles solares, discriminación de precios, discriminación por género, experimento de auditoría, consumo de electricidad

1 | INTRODUCTION

In most countries, distributed photovoltaic (DPV) generation still constitutes a small fraction of the overall electricity generation mix. In the case of Mexico, less than 2% of the total electricity produced comes from PV technologies, and only 0.3% of households have adopted DPV systems.[1] Previous studies have documented the determinants and the potential of DPV adoption in Mexico, both at the household level (Hancevic et al., 2017) and in small and medium-sized businesses (Hancevic and Sandoval, 2023). These studies underscore the potential profitability of adoption, demonstrating positive returns to investments. However, adoption rates remain low, primarily due to challenges such as a lack of basic information on costs and operating characteristics of the equipment, financial constraints, and issues related to ownership status (e.g., the principal-agent problem between landlords and tenants).[2] While the solar PV market can be considered a monopolistic competitive market,[3] given the large number of suppliers, including manufacturers, importers, and retailers in each local market, no prior study has analyzed the behavior of the solar panel market from the supply side.

In this paper, we study the performance of the residential solar DPV market by analyzing the behavior of solar panel providers in four cities across Mexico. Specifically, we conducted an audit experiment in which we randomized the characteristics of fictitious residential customers requesting quotes from actual DPV system providers. We manipulated four characteristics to identify and quantify their influences on discrimination practices. Our first experimental variable involves *gender*: female customers directly interact with a provider. The second variable focuses on *socioeconomic status* (SES), which is determined by the customer's home address: customers disclose their home address where the solar panel is intended to be installed by submitting their electricity bill. Our third variable is *information*: informed customers indicate prior knowledge and experience with solar panels. Lastly, we examined *financing*: customers mention securing external funding for purchasing the solar panel system. All four experimental variables (treatments) are integrated into a within-subjects design.

Our main research hypotheses are as follows. First, we hypothesize that there is no gender-based discrimination. However, potential price discrimination against a specific gender may arise due to various factors, such as gender stereotypes, market segmentation, or unequal access to information.[4] Discrimination based on unchangeable attributes, such as gender, might be considered acceptable as a strategy when companies offer a product at a fixed price or determine charges based on a consumption variable correlated with costs, such as the accident risk associated with travel distances in the car insurance market (Buzzacchi and Valletti, 2005). Despite the extensive research that has focused on pay disparities and gender diversity, there has been relatively less emphasis on instances where individuals of different genders face varying charges (Ferrell et al., 2018; Goldberg, 1996). The existing

[1]See the Energy Information System of the Mexican Ministry of Energy, available at `https://sie.energia.gob.mx/`

[2]A recent paper by Sandoval and Hancevic (2023) documents the split incentive problem in the Mexican residential sector.

[3]Specifically, this market is characterized by search costs, asymmetric information, and product differentiation.

[4]Gender stereotypes could play a role in shaping pricing strategies, with traditional gender roles and stereotypes influencing perceptions of product usage. For instance, if a product is perceived as primarily catering to women because, on average, women spend more time at home, it might be priced higher based on assumptions about their purchasing power. Market segmentation is another potential factor, where providers might engage in price discrimination by segmenting the market based on perceived differences in willingness to pay. If women are assumed to be more willing to pay for specific products or services, prices may be set accordingly. Finally, unequal access to information is also a possibility, as disparities in access to information about prices or market dynamics may contribute to price discrimination against women.

evidence on gender-based pricing in consumer-packaged goods is mixed (Moshary et al., 2023). Nevertheless, the question of whether discrimination exist in more sophisticated goods, such as experienced goods or tailor-made products like solar panels, remains open.

Our second hypothesis posits that upper-middle and upper-class households are susceptible to surcharges. If residence location is highly correlated to socioeconomic status, as it is the case in Mexico, solar panel suppliers can discriminate by segmenting the market based on the geographical location of customers' addresses. As an almost indispensable part of requesting a quote involves providing the electricity bill, the segmentation task is relatively simple for solar panel providers. The evidence on price discrimination based on SES is also mixed but relatively more extensive (Sabatini, 2006; Angerer et al., 2019; Jacob et al., 2022).

The third hypothesis suggests that informed consumers receive lower quotes than those that appear to be naive.[5] In adopting new technologies, internet tools can facilitate buyers' access to information. We argue that if consumers better understand product characteristics and costs, they reveal that they have already invested in learning about the product. Thus, sellers are more likely to charge them competitive (fair) prices. This hypothesis is based on the idea that sellers perceive an informed buyer more as someone seeking a competitively priced private good than a consumer of a credence good. As a result, the informed buyer is less likely to be overcharged.

Our final hypothesis is that quotes for cash-based requests will be lower than those for requests with external financing. Solar panels are durable goods that require several years to pay off. When a third party finances the purchase, buyers might be less inclined to haggle for better prices, as the price differences will be spread over the payment period. Consequently, if a seller holds this belief, they may try to charge higher prices for the product.[6] However, other conjectures are also possible.[7]

Since Becker (1971), economists have studied discrimination methodically. Moreover, audit experiments have been used to assess discrimination in labor markets (Bertrand and Mullainathan, 2004; Arceo-Gomez and Campos-Vazquez, 2014) and vehicle markets (Ayres and Siegelman, 1995). Similarly, the presence of fraudulent experts in credence good markets has been stated by (Emons, 1997; Dulleck et al., 2011) and quoting field experiments have found differences between informed and uninformed customers in credence good markets (Gottschalk et al., 2020), and also differences by race or ethnicity (Balafoutas et al., 2013; Zamora et al., 2021). In this study, we vary the characteristics of artificial households that are requesting quotes for residential solar DPV. However, nothing is known about discrimination practices in a market like the one analyzed in this study.

In our context, discriminatory practices could lead to undesirable outcomes. First, some inefficiencies may result from oversizing the capacity of the solar panels that the home needs. In this situation, the additional benefits for the consumer are less than the additional costs. Buyers could fail to realize the net benefits of solar panel adoption if oversizing is an extensive practice. Conversely, in the case of undersizing –the solar panel installed in the home is inferior in capacity and/or quality– the sellers lower the adoption costs, inducing

[5] Some studies in the field of marketing science delve more deeply into various consumer behaviors, particularly regarding the intensity and quality of information search, encompassing attributes of goods and their prices (Viswanathan et al., 2007).

[6] In other words, when purchases are financed, the seller can conceal price increases since consumers still receive lower electricity bills net of the monthly loan payments. As a result, sellers tend to charge higher prices to consumers who opt for financing instead of cash payments.

[7] For instance, people who pay in cash may indicate that they have already saved up for the purchase and hold stronger preferences for the product. This could also signal that they are in a better economic situation. It is important to note that in these cases, the effect of having an external source of funding may be the opposite of that mentioned above, with sellers charging lower prices to customers with external financing. Another possibility is that having cash may reflect different time preferences or that the buyer is credit-constrained.

larger adoption rates. However, the consumer is left paying an electric bill that, in the long run, does not compensate for the initial investment. Second, even in a situation of efficiency in which the size of the DPV system is appropriate, the seller may charge the consumer more than it is actually worth. This can also lead to inefficiencies in the long run if the fear of being overcharged deters consumers from buying –an issue reminiscent of the classic problem outlined by Akerlof (1970). In short, uncovering the mechanism of discriminatory practices in this market and determining the specific sign and magnitude of the effects of different factors on the quotes provided by firms is an empirical question, with policy implications, that we aim to elucidate in this study.

Our main results indicate that women and customers with higher socioeconomic status face price discrimination with overcharges of around 3.5%. These surcharges combined reach levels above 7% for female customers from the medium-high and high SES. Moreover, the discrimination is exacerbated because, when controlling for the optimal capacity of solar panels, this same group of people is quoted for equipment with a higher capacity. In other words, there is also an oversizing of the solar panels offered. Specifically, women are offered PV systems that are 6% larger in capacity, and people from higher SES are offered systems that are 8%-13% larger. There is no evidence of such practices towards customers with different levels of prior product information or those who have secured external financing for the purchase.

This paper makes three key contributions to the literature. First, it is the first academic article that rigorously studies the solar panel market from the supply side, employing a robust empirical approach. To achieve this, we implement a field experiment that randomizes relevant factors from the demand side, and observe the behavior of sellers in a systematic way. Second, this is the first paper studying discrimination in the solar panel market, not only uncovering price discrimination against women but also revealing other opportunistic behavior on the part of sellers, such as offering oversized panels. Finally, the study is conducted in an emerging country abundant in natural resources, providing significant potential for advancing renewable energy practices. By comprehending the intricacies of supply-side behavior, it becomes possible to identify crucial aspects to optimize economic, social, and environmental outcomes within the context of the energy transition in emerging countries.

More broadly, this paper contributes to the literature studying the determinants of solar PV adoption in the residential sector (Kwan, 2012; De Groote et al., 2016), the impact of policy incentives (Hughes and Podolefsky, 2015; Crago and Chernyakhovskiy, 2017), disparities in solar PV adoption (Borenstein, 2017; Sunter et al., 2019; Crago et al., 2023), and the different pricing mechanism applicable to the solar panel market (Gillingham et al., 2016; Liang et al., 2020).

The rest of the paper is organized as follows. Section 2 describes the context, discussing solar energy and the residential electricity sector in Mexico. We briefly describe the relevant characteristics of the four metro areas where the experiment took place. Section 3 provides detailed overview of the experimental design, the response to the experiment, and our empirical strategy. Section 4 reports our main results regarding discriminatory practices in the solar panel market. Section 5 discusses the results and provides policy implications. Finally, Section 6 offers the concluding remarks of this study.

2 | BACKGROUND

2.1 | Solar energy in Mexico

Mexico possesses one of the most appealing solar irradiation profiles globally, featuring daily solar irradiance levels ranging from 4.5 kWh/m2 to 6.3 kWh/m2. With its extensive territory, the country has the potential to install more than 1,800 GW of PV generation capacity in areas with plant factors ranging between 14 and 30 percent. This potential generation capacity is 21 times the total installed capacity in the National Electric System, including all generation sources (86 GW in 2023).[8] In that context, DPV has the potential of becoming a reliable alternative for small and medium-sized electricity users, such as residential users which want to save money on electric bills and also be part of the energy transition phenomenon. However, as of 2022, solar panel penetration in the residential sector is less than 0.3%,[9] implying significant potential for expanding the adoption of this technology.

The regulation of distributed generation in Mexico falls under the jurisdiction of the Energy Regulatory Commission (*Comisión Reguladora de Energía*, CRE). In general terms, distributed generation is governed by the Electric Industry Law and its regulations. Some key points related to distributed generation include:

- The mandatory use of bidirectional measurement systems to measure both consumed and generated energy.
- Residential users who own distributed generation facilities are not subject to connection fees and network access charges.
- Although net-billing is an option, all households in Mexico operate under net-metering schemes.[10]
- There are technical standards that distributed generation systems must comply with to ensure the safety and stability of the electrical grid.[11]

In this paper we concentrate on residential users, for which the current policies (indirectly or directly) aimed at enhancing DPV adoption seem to have several drawbacks. On the one hand, the residential tariffs in Mexico are highly subsidized (see tariffs in the next section), making energy efficiency investments and green technology adoption unprofitable for many homes (Hancevic and Lopez-Aguilar, 2019; Hancevic et al., 2022). On the other hand, for those consumers for whom adoption is still profitable under the current tariff scheme, financial constraints and the lack of information undermine adoption. For instance, *Hipoteca Verde* (HV) was a salient program for financing the adoption of green technology in Mexico funded by The National Workers' Housing Fund (INFONAVIT).[12] By financing eco-technologies that save water, electricity, and gas, the program aimed to help households save money and contribute to caring for the environment.[13] The HV program was discontinued

[8] This data is taken from the International Renewable Energy Agency (IRENA). Available at http://www.irena.org/DocumentDownloads/Publications/IRENA_.

[9] Based on the National Survey of Household Income and Expenditures 2022 (ENIGH-2022) available at: https://www.inegi.org.mx/programas/enigh/nc/2022/

[10] Net Billing does not offer any advantage over Net Metering for two reasons: The Local Marginal Price (PML) is lower than the electricity tariff rates, making the energy netted with Net Metering more valuable than that of the PML. The second reason is that it requires the household to have a higher level of knowledge of the electricity market and to behave more strategically.

[11] The NOM-001 SEDE is the official standard for installing solar panels in Mexico, available at https://dof.gob.mx/nota_detalle_popup.php?codigo=5280607

[12] INFONAVIT is a tripartite public body with workers' participation, the business sector, and the government.

[13] Among the technologies included were faucets, toilets, energy-efficient light bulbs, thermal insulation, solar

in 2022. It is an open secret that due to the way HV was implemented, the program had deficiencies that translated into overpricing by contractors and ultimately led to low DPV adoption. Ideally, programs like HV should help mitigate the financial constraints of potential adopters, and even more, they should overcome the negative NPV of a large group of potential adopters. This is true even with subsidized electricity tariffs that imply lower future recovery flows at the expense of a relatively large initial investment. With the aid of a financing program, the initial down payment is close to zero, and borrowers can afford only the monthly loan payments while significantly reducing their energy bills.

2.2 | The residential electricity sector in Mexico

Mexico has approximately 37 million households and a fairly complex tariff scheme which consists of increasing blocks that vary between localities based on the average temperature during the summer months. The tariff structure is designed to subsidize energy consumption in the hottest areas, enabling households to regulate the climate in their homes. As a result, there are seven tariffs labeled 01, 1A, 1B, 1C, 1D, 1E, and 1F. Each letter signifies larger blocks of consumption (measured in kWh/month), and in some cases, a greater number of blocks are included. To further complicate matters, each rate has an annual consumption threshold. Crossing this threshold results in transitioning to a two-part rate structure known as high consumption demand (DAC, for the Spanish acronym). This tariff includes a fixed charge of 132 MXP per month, along with a higher variable charge ranging between 4.670 and 5.592 MXP per kWh, contingent on the distribution region. Table 1 illustrate the residential rates for June 2023.

TABLE 1 Monthly residential tariffs for June 2023

	Regular tariff				Annual
Tariff	**Block 1**	**Block 2**	**Block 3**	**Block 4**	**Threshold**
01	0–75	76–140	>140		3,000
	$ 0.975	$ 1.188	$ 3.474		
1A	0–100	101–150	>150		3,600
(>25 Celsius)	$ 0.871	$ 1.010	$ 3.474		
1B	0–125	126–225	>225		4,800
(>28 Celsius)	$ 0.871	$ 1.010	$ 3.474		
1C	0–150	151–300	301–450	>450	10,200
(>30 Celsius)	$ 0.871	$ 1.010	$ 1.302	$ 3.474	
1D	0–175	176–400	401–600	>600	12,000
(>31 Celsius)	$ 0.786	$ 1.016	$ 1.310	$ 3.496	
1E	0–300	301–750	751–900	>900	24,000
(>32 Celsius)	$ 0.722	$ 0.904	$ 1.175	$ 3.474	
1F	0–300	301–1200	1201–2500	>2500	30,000
(>33 Celsius)	$ 0.722	$ 0.904	$ 2.198	$ 3.474	

Source: CFE. Data available at: `https://app.cfe.mx/Aplicaciones/CCFE/Tarifas/TarifasCRECasa/Casa.aspx`. Rates are in Mexican Pesos (MXP). As a reference, the average official exchange rate in June 2023 was 17.09 MXP/USD.

heaters, efficient washers, refrigerators, and stoves, as well as solar panels.

On average, consumers only pay about half of the true cost of electricity service, implying that, in numerous cases, many households don't even consider the the possibility of adopting solar panels (Bejarano, Hancevic and Sandoval, 2023; Hancevic, Nuñez and Rosellon, 2022). In this paper, we include four metropolitan area for the analysis: Aguascalientes, Guadalajara, Mérida, and Monterrey. The first two locations are under tariff 01, whereas Mérida has tariff 1D and Monterrey has tariff 1C. The selection of these locations was guided by the goal of achieving representativeness at the national level, encompassing diverse climates (i.e., different tariffs), and efficiently utilizing existing research resources.

2.3 | Metropolitan areas

The metropolitan area of Aguascalientes, with a population of 1.14 million in 2020, is located in central Mexico and exhibits a semi-arid climate, marked by a pronounced dry season with limited rainfall. Summers are warm, with average daily highs around 82-86°F (28-30°C), while winters are cooler, with average daily highs ranging from 72 to 75°F (22-24°C). The city typically experiences increased electricity demand during the warm summer season due to the use of cooling systems. The metropolitan area of Guadalajara, situated in the western region and ranking as the third-largest metro area in Mexico with nearly 5.27 million, enjoys a more temperate climate. It features warm to hot temperatures and undergoes a wet season from June to September. The hot season can see average highs of 86-88°F (30-31°C), while winters are mild with high temperatures ranging from 75 to 79°F (24-26°C). Electricity consumption exhibits seasonal variations, with higher demand during the wet season. Mérida, the largest city on the Yucatan Peninsula with a population of 1.32 million, features a tropical climate with consistently high temperatures throughout the year. Summers are particularly hot, with average daily highs reaching 95-97°F (35-36°C), and winters are warm, ranging from 84-88°F (29-31°C). The city experiences a longer wet season from June to October, marked by heavy rainfall and occasional tropical storms. Its climate results in relatively stable electricity consumption across seasons, with a slight uptick during the wet season. The metropolitan area of Monterrey, located in the northeastern part of the country and ranking as the second-largest metro area with a population over 5.34 million, is one of the most industrialized cities in Mexico. It features a semi-arid climate characterized by high temperatures throughout the year. Summers are hot, with average daily highs often exceeding 93°F (34°C), while winters are milder with average daily high temperatures around 72-77°F (22-25°C). Rainfall is scarce, and the city is known for its arid conditions, experiencing a notable peak in electricity consumption during the summer months.

3 | EXPERIMENTAL DESIGN AND IMPLEMENTATION

To identify whether there is opportunistic behavior among local solar panel providers and to quantify the extent of price discrimination based on characteristics of residential users such as gender, socioeconomic status, product knowledge, and access to financing, we conducted an audit experiment. In this experiment, artificial customers requested quotes for purchasing, installing and connecting a solar PV system to the power grid.

To conduct the experiment, we first constructed a list of solar panel providers and a set of artificial customers (homeowners) with their respective energy consumption. We then contacted the providers and requested quotes for solar panels using these artificial customers. The details behind the construction of the list of providers and the set of customers, as well as their interactions, are described below.

3.1 | Solar panel providers

We compiled separate lists of solar panel providers for each of the following metropolitan areas: Aguascalientes, Guadalajara, Mérida, and Monterrey. Using publicly available sources, we identified and obtained business contact information for each provider, including the business name, physical address, website, email addresses, phone numbers, and social media accounts. To ensure comprehensive coverage, we conducted an intensive search using Google (and Google Maps), Yellow Pages, social networks (such as Facebook and Twitter), and specialized web pages for solar panel providers. The physical existence of each establishment was verified using Google Maps. Exclusions were made for businesses exclusively serving the commercial and industrial sectors, as our focus was solely on the residential sector. We also excluded establishments with incomplete contact information and those operating in more than one city included in the study. The latter exclusion, though rare, aimed to minimize the risk of providers sharing information and recognizing the artificial nature of the request. Our final list comprised 31 providers in Aguascalientes, 43 in Guadalajara, 39 in Mérida, and 59 in Monterrey. Given that Guadalajara and Monterrey are among the largest metro areas in Mexico, a higher number of providers was anticipated in these cities.

3.2 | Artificial customers

We constructed a set of artificial customers (homeowners) with varying profiles based on factors that could lead to potential price discrimination, such as gender, socioeconomic status, energy consumption, product knowledge, and access to external financing.

Gender is determined from the name of the artificial customer, which is disclosed during the interaction with the provider. The name also appears on the artificial utility bills created for the experiment (more on this below). The names were carefully chosen, considering the most common male and female names and last names in Mexico.[14] They are quite standard, so there is no concern about the possibility of confusing the gender of the customer.

Socioeconomic status is determined by the home address in which the artificial customer resides, which is also the location where the solar panel is intended to be installed. The provider learns the address from the utility bill, provided by the customer when requesting the quote. For simplicity, we classified the addresses into low, medium, and high socioeconomic status based on the neighborhood where each is located.

Solar panels providers typically request a copy of the utility bill to provide a quote, as they use the electricity consumption to determine the size of the solar system required to meet the customer's needs. For this reason, and to enhance the authenticity of our experimental requests, we created a fake utility bill for each artificial customer. Each fake bill is an exact replica of those issued by Mexico's state-owned electric utility, the Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE). CFE bills for residential customers are issued bimonthly and include consumption in kWh and the amount due in Mexican pesos for the current billing period. Additionally, they provide information on consumption and charges from the last eleven periods, offering a two-year history of electricity usage. To generate the electricity consumption data for the past two years for each consumer, we considered three consumption levels: middle consumption (approximately the 65th percentile), middle-high consumption (~ 80th percentile), and high consumption (~ 95th percentile).

[14] This information is published by the National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía* , INEGI) and is publicly available at https://cuentame.inegi.org.mx/poblacion/natalidad.aspx?tema=P.

Consumption levels were calculated separately for each city using data from the 2022 National Survey of Household Income and Expenses (ENIGH) and the 2018 National Survey on Energy Consumption (ENCEVI).[15] Specifically, for the 65th percentile, electricity consumption was determined by selecting a random number within the 60th and 70th percentiles to avoid two bills displaying the exact same consumption.[16] Starting at the 65th percentile is justified as lower energy consumption levels would not be beneficial for adopting solar panels, given the tariff levels (Hancevic et al., 2017). Figure 1 in the Appendix shows one of the artificial utility bills used in the experiment.

Finally, to assess the effect of product knowledge and access to financing, the artificial customers disclose or withhold information about these aspects in their communication with the providers. Specifically, to gauge product knowledge, some customers reveal that they have acquired information about solar panels from a relative or a friend who recently installed them. The expectation is that a provider will not overcharge an informed consumer. For access to financing, some customers disclose having access to external funding through an approved credit line or loan from a financial institution. In the experiment, we interacted these two customer characteristics, creating four additional profiles (uninformed with and without financing, and informed with and without financing).

Table 2 reports summary statistics of the characteristics of the artificial consumers who submitted requests by metropolitan area. In total, 535 requests were submitted. As shown in the table, half of the customers are female, one-third belong to a low socioeconomic status (SES), another third to a medium SES, and remaining third to a high SES. In terms of the energy consumption, one-third falls into the middle consumption category, another third into the middle-high consumption category, and a final third into the high category. Additionally, the table provides average electricity consumption and expenditure for reference.

[15] Both surveys are conducted by the National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía*, INEGI), an autonomous agency of the Mexican Government coordinating the National System of Statistical and Geographical Information.

[16] For instance, for the 65th consumption percentile in Monterrey, we randomly selected consumption within the range of 600 to 700 kWh. For the 80th and 95th percentiles, we considered the ranges 900 to 1,000 and 1,600 to 1,700, respectively.

TABLE 2 Characteristics of artificial customers

	Metropolitan Area				
	Aguascalientes	Guadalajara	Merida	Monterrey	Total
# of providers	31	43	39	59	172
# of quotes requested (customers)	131	137	133	134	535
Customer's gender identity					
Male	47.3%	49.6%	51.1%	51.5%	49.9%
Female	52.7%	50.4%	48.9%	48.5%	50.1%
Socieconomic stratum					
Low	33.6%	32.8%	35.3%	32.8%	33.6%
Medium	34.4%	34.3%	31.6%	32.1%	33.1%
High	32.1%	32.8%	33.1%	35.1%	33.3%
Product knowledge & Access to financing					
Uninformed without financing	25.2%	25.5%	26.3%	26.9%	26.0%
Uninformed with financing	26.0%	25.5%	26.3%	25.4%	25.8%
Informed without financing	25.2%	24.8%	23.3%	23.9%	24.3%
Informed with financing	23.7%	24.1%	24.1%	23.9%	23.9%
Electr. Consumption level					
Middle (65th percentile)	31.3%	32.8%	33.1%	33.6%	32.7%
Middle-high (80th percentile)	35.9%	32.8%	32.3%	31.3%	33.1%
High (95th percentile)	32.8%	34.3%	34.6%	35.1%	34.2%
Electr. consumption (kWh)	413.47	398.49	1,206.53	1,093.10	777.01
	(62.43)	(62.27)	(510.20)	(427.63)	(502.03)
Electr. expenditure ($MXP/bill)	969.78	831.45	2,219.08	2,108.51	1,530.15
	(273.37)	(252.49)	(1,660.71)	(1,527.18)	(1,304.41)

This table reports summary statistics of the characteristics of the artificial costumers who submitted requests by metropolitan area. Standard deviations are in parentheses. Data source: own calculations based on primary data collection.

3.3 | Interaction between providers and artificial customers

We identified several communication channels between potential customers and providers: on-site visits, phone calls, e-mails, submitting a form via the provider's website, and WhatsApp messages.[17]

On-site visits and phone calls were excluded from consideration due to the challenges of standardizing interactions, particularly in a multi-city experiment. Additionally, the personal traits of the field team members could introduce biases (Heckman, 1998), making it difficult to account for potential confounding factors. An email-based audit experiment was ruled out based on the almost negligible response rate observed during the pilot run in Aguascalientes. Initial attempts to contact firms via email resulted in only one response out of 36 attempts. Similarly, no responses were received when using the contact forms available on providers' websites. Ultimately, WhatsApp messages emerged as an effective commercial channel. During the pilot phase, we received a total of 13 complete quotes out of 15 attempts

[17]WhatsApp is a free messaging app from Meta Platforms that enables users to send text, voice, and video messages, make voice and video calls, and share images, documents, and other content. WhatsApp Business, a specialized version, is increasingly utilized by businesses in Mexico for customer service, sales, and bookings.

using this channel (86.7% response rate). An added advantage of using WhatsApp is its notification feature, which informs the sender about the delivery and reading status of the message.[18] To the best of our knowledge, this is the first WhatsApp-based audit experiment conducted in Latin America.

Each city had a designated field person responsible of contacting the providers and requesting a quote through WhatsApp. These exchanges took place between June and September of 2023. WhatsApp uses a phone number verification step for account creation and user identification.[19] Therefore, to prevent contacting the same provider as a different customer with the same number, the field person in each city had seven different cellphone numbers (SIM cards) available.

The messages sent to providers were simple and written in a colloquial manner. Table 3 provides an example of the messages sent through WhatsApp. To mitigate seller suspicions, four slightly different versions of the text were used, rearranging the sequence of paragraphs and rewording sentences slightly without altering the content significantly. A screenshot of an actual exchange between a customer and a seller is available in the Appendix.

TABLE 3 Example of a WhatsApp message

Category	**Text**
Greeting	*Hello*
Initial text	*My name is Melissa. I'd like to install solar panels at home.*
Product knowledge	*My neighbor installed solar panels on his rooftop and gave me quite a bit of information about them. However,*
Request	*I'd really appreciate if you could provide me with a price quote for the purchase and installation of the solar panels..*
Consumption data	*I spend on average 1,200 Pesos in my electricity bill.*
Access to financing	*Let me tell you that I already have arranged the external financing for the purchase.*
Utility bill	*Please find attached the last utility bill for your reference.*
Final message	*Looking forward to your kind response.*
	Thank you

This table shows one of the four alternative text messages that artificial customers sent to solar panel providers through WhatsApp.

We staggered the delivery of messages to each provider over several days to simulate a realistic rate of customer inquiries. Specifically, we ensured a minimum seven-day interval between messages sent to the same provider with the aim of reducing the risk of vendors detecting any artificial elements in the request.

To further standardize the process, we conducted a training session with the field team and developed a protocol to govern the interactions between artificial consumers and providers over WhatsApp. The protocol determined the number of requests to keep open per day and the allowed times of the day for contacting providers. It also included a comprehensive set of responses in case of 'unexpected' messages from the sellers, such as

[18]While this feature could be implemented in email communications, it is likely to raise suspicion among providers, as it is not a standard practice for typical email users.

[19]Once activated and validated, the account can be used on a computer through a web browser or the desktop version of the app.

inquiries about financing details, roof structure, or requests for a home inspection.

Moreover, the protocol outlined specific procedures for dealing with scenarios in which there was no response or a limited response from the seller (e.g., sending follow-up messages, extending waiting periods, making multiple attempts, etc.). For instance, if the message was delivered and read by the provider but received no response, the protocol indicated waiting until the next day to send a reminder message requesting the quote. Overall, there was no reason to believe that the providers were aware they were part of an experiment.

Finally, the protocol included the procedure for collecting information from the quotes and the WhatsApp interactions between customers and sellers to create the final dataset for analysis. Specifically, from each interaction, we recorded whether the provider replied to the message and whether it provided a complete quote, along with any additional quotes. For each quote, we collected the amount in Mexican pesos and the characteristics of the offered system, such as capacity (in Watts), brand of the solar panel and inverter. Additionally, we recorded whether the provider offered financing, asked for a down payment, or whether the quote broke down the costs of the job into line items.

3.4 | Audit experiment response

In total, 535 artificial customers contacted 172 providers across the four cities, with each provider being contacted an average of 3.1 times. This information, along with the breakdown by city, is reported in Panel A of Table 4. The table also reports the response to the experiment and the descriptive statistics of the main quote in Panels B and C, respectively.

As expected from the pilot study, the overall response rate was 94.6%, with a similar response rate across cities, except for Aguascalientes, which had an 88.5% response rate (close to the pilot's 86.7%). Additionally, most of the requests sent resulted in a complete quote for the solar panel, with an overall 77.4% of all requests ending with a quote.[20] Aguascalientes had the smallest share of requests with a quote at 68.7%, while Guadalajara had the largest at 86.9%. In few cases, providers gave an additional quote, and around 11% of the requests ended with more than one quote. In these cases, we asked the providers to identify the main quote. It is worth noting that the additional quote was typically for a larger panel, offered as an option if the customer anticipated increasing their electricity consumption in the future.

Panel C provides summary statistics of the main quotes. On average, the quoted amount was $63,186 Mexican pesos (equivalent to approximately $3,673.64 USD), and the average panel capacity was 3.23 kW. There were noticeable differences across cities, with higher-priced quotes and larger panel capacities in Monterrey and Mérida, and lower-priced quotes and smaller panels in Aguascalientes and Guadalajara. This pattern aligns with the electricity consumption across the cities, as the artificial utility bills from both Monterrey and Mérida displayed higher electricity consumption. The average inverter capacity was 3.45 kW, slightly higher than the panel capacity, as expected. A larger inverter is needed to help the system operate closer to its peak efficiency. The fact that the results reflect this is reassuring regarding the veracity of the quotes.

In addition to the quote amount and the capacity of the panel and inverter, we also collected information from the quote regarding whether the provider offered financing, requested a down payment, and whether the quote included a breakdown of the budget. In general terms, 30% of quotes included a financing offer, 68.6% asked for a down payment, and only 22.7% broke down the quote into separate items.

[20] This percentage is calculated with respect to the total number of quotes requested (535) and not relative to those with a replied message (506). That is, $414/535 \times 100 = 77.4\%$.

TABLE 4 Audit experiment response and characteristics of the main quote

	Metropolitan Area				
	Aguascalientes	Guadalajara	Merida	Monterrey	Total
Panel A: Providers and customers					
# of providers	31	43	39	59	172
# of quotes requested (customers)	131	137	133	134	535
Average requests per provider	4.2	3.2	3.4	2.3	3.1
Panel B: Providers response					
Replied the message	116	132	130	128	506
	88.5%	96.4%	97.7%	95.5%	94.6%
Provided a quote	90	119	107	98	414
	68.7%	86.9%	80.5%	73.1%	77.4%
Provided an additional quote	13	6	16	23	59
	9.9%	5.1%	12.0%	17.2%	11.0%
Panel C: Main quote					
Quote amount ($MXP)	42,894.78	37,782.12	83,738.10	90,506.10	63,185.64
	(11,679.76)	(9,043.65)	(30,684.22)	(33,992.85)	(33,558.07)
Panel capacity (Watt)	1,891.80	1,722.44	4,835.69	4,604.89	3,226.35
	(455.62)	(471.29)	(1,898.92)	(1,816.11)	(1,987.41)
Price per watt ($MXP/Watt)	22.84	22.49	17.89	20.16	20.85
	(5.50)	(4.14)	(2.40)	(4.03)	(4.55)
Inverter capacity (Watt)	2,119.12	1,855.75	5,095.78	4,825.44	3,448.03
	(716.80)	(560.76)	(1,780.29)	(1,811.38)	(2,019.20)
Offered financing	6.7%	24.4%	55.1%	31.6%	30.2%
Down payment asked	63.3%	89.1%	68.2%	49.0%	68.6%
Budget breakdown	43.3%	10.9%	29.9%	10.2%	22.7%

This table presents the summary statistics of the audit experiment response. Data source: own calculations based on primary data collection.

3.5 | Empirical strategy

To quantify the extent of price discrimination based on characteristics of residential users such as gender, socioeconomic status, product knowledge, and access to financing, we considered four outcome variables:

- **Answered the message**: binary variable equal to 1 if the provider responds to the messages.
- **Sent quote**: binary variable equal to 1 is the provider sent a quote for a solar panel system.
- **Average price**: The final amount that the consumer should pay for the purchase, installation, and connection of the DPV system expressed in Mexican Pesos per watt of installed capacity.
- **Capacity**: solar panel capacity in Watts.

We then estimate the following model,

$$\begin{aligned} Y_{i,j} =& \alpha_1 INF_{i,j} + \alpha_2 FIN_{i,j} + \alpha_3 INF_{i,j} \times FIN_{i,j} + \delta_1 FEM_{i,j} \\ &+ \delta_2 MED_{i,j} + \delta_3 HIGH_{i,j} + \mathbf{X}_{i,j,} + \theta_i + \varepsilon_{i,j} \end{aligned} \tag{1}$$

where $Y_{i,j}$ is the outcome variable, which depending on the specification can be a binary variable that equals one if the firm i responds to the WhatsApp message of artificial consumer j, a binary variable for sending a quote (= 1 if the firm sends a quote), the price of the solar panel (in Mexican Pesos/Watt), or the capacity of the solar panel in Watts. INF and FIN are the information and external financing treatments, respectively, whereas FEM is the gender variable (= 1 if consumer is a female). LOW, MED and HIGH are dummy variables for low, medium, and high socioeconomic status, respectively. The vector **X** represents the control variables, encompassing consumption level or watt capacity, product characteristics, binary variables indicating the presence of a second quote and offered financing from the provider, and another binary variable reflecting whether the quote breaks down the costs of the job into line items. θ_i is the provider fixed effect.[21] Finally, ε is the idiosyncratic error term. In some specifications, we interact the variable FEM with socioeconomic status variables (LOW, MED, and HIGH) to uncover further heterogeneous effects.

4 | RESULTS

In this section, we present the results from various econometric models. In columns (1) and (2) of Table 5, the dependent variable is binary and takes a value of one when a response to WhatsApp messages is obtained. Columns (3) and (4) consider a binary dependent variable that takes on the value of one if the firm sent a quote.

[21]The specification does not include city fixed effects because providers are nested within the city. By design, there is no provider in more than one city.

TABLE 5 Answered the message and sent quote

	(1)	(2)	(3)	(4)
Dependent variable:	Answered	Answered	Sent quote	Sent quote
Female	-0.049*		0.038	
	(0.027)		(0.033)	
Medium SES	0.016		-0.040	
	(0.028)		(0.040)	
High SES	0.018		-0.005	
	(0.033)		(0.043)	
Female=0 × Medium SES		-0.024		-0.097*
		(0.045)		(0.057)
Female=0 × High SES		0.033		-0.033
		(0.040)		(0.056)
Female=1 × Low SES		-0.066*		-0.015
		(0.038)		(0.047)
Female=1 × Medium SES		-0.012		0.004
		(0.036)		(0.057)
Female=1 × High SES		-0.066		0.016
		(0.051)		(0.060)
Info=0 × Financing=1	0.025	0.022	0.017	0.015
	(0.030)	(0.031)	(0.047)	(0.048)
Info=1 × Financing=0	-0.000	-0.001	-0.007	-0.007
	(0.035)	(0.035)	(0.045)	(0.045)
Info=1 × Financing=1	0.037	0.035	0.037	0.036
	(0.034)	(0.034)	(0.043)	(0.044)
Constant	0.946***	0.956***	0.815***	0.841***
	(0.029)	(0.031)	(0.041)	(0.046)
Observations	517	517	486	486
R^2	0.403	0.410	0.567	0.569

This table presents the estimates from the Linear Probability Model, where the dependent variables indicate whether the provider answered the messages and whether it sent a quote. The specifications include fixed effects for provider and text version. Robust standard errors are shown in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As can be seen in the table, there is no effect that can be attributed to the treatments or the main explanatory variables of the model, as all coefficients are not statistically significant at conventional levels. The only exceptions are the gender variable in column (1), the interaction of gender with low SES in column (2), and with medium SES in column (4), which are marginally significant (at the 10% level). In the case of specifications in columns (1) and (2), where the dependent variable measures whether the company responds, the effect of female tends to be negative. In the case of columns (3) and (4), where the dependent variable is the submission of the quotation, the signs tend to be positive. However, the analysis does not warrant further attention given the lack of significance in the coefficients. It could be concluded that neither the responses to the messages nor the sending of quotes by the suppliers are affected by the variables of gender, socioeconomic status, prior information, and external financing of consumers.

In table 6, we present a second group of estimates related to the quotes sent by suppliers to fictitious clients. The dependent variable in all specifications is the logarithm of the average price of photovoltaic systems, measured in Mexican Pesos per Watt of capacity. The different specifications include the gender and socioeconomic status effects separately (columns 1 and 2) or through interactions (columns 3 and 4). Additional control variables are included in models (2) and (4), whether the provider offers some source of financing, a second quote, and breaks down the quote into line items. All specifications include, as explanatory variable, the log of panel capacity in watts, as well as fixed effects for provider, inverter brand, and the text version.[22]

The information and prior external financing treatments do not have statistically significant effects in any of the specifications. On the contrary, in all cases, highly significant effects of the gender and socioeconomic status variables are observed. Specifically, controlling for all factors, women receive a quote with an average surcharge of 3.5%, while medium and high SES face a surcharge ranging from 3.5% to 4%. Gender and SES interactions are also highly significant, amplifying the effects mentioned earlier. For instance, a woman with a medium or high SES receives an average surcharge in the range of 7-8%. Regarding the control variables, the estimated coefficient of log(capacity) indicates that a 10-percent increase in the capacity implies a 2% decrease in average price. Providers offering a second quote tend to decrease the price of the first one by approximately 6% and providers that include a full budget breakdown tend to charge lower prices (6% less, on average). Finally, firms offering financing does not have a significant effect on the value of the quote.

[22] Another set of regressions were also carried out, but including the logarithm of consumption in kWh instead of the logarithm of the offered capacity. The results are very similar. In the paper, we only report the specifications that include the logarithm of the capacity because the interpretation of the coefficients is more direct and interesting. The alternative results are available upon request.

TABLE 6 Experiment Results: Quotes in Mexican Pesos

	(1)	(2)	(3)	(4)
Dep. var.: log(average price)				
log(capacity panel)	-0.20365***	-0.20676***	-0.19973***	-0.20232***
	(0.02812)	(0.02781)	(0.02790)	(0.02748)
Female	0.03387***	0.03559***		
	(0.01175)	(0.01191)		
Medium SES	0.03532**	0.04127***		
	(0.01582)	(0.01511)		
High SES	0.03776**	0.03999**		
	(0.01743)	(0.01749)		
Female=0 × Medium SES			0.04996**	0.05482**
			(0.02418)	(0.02388)
Female=0 × High SES			0.05056**	0.05534**
			(0.02266)	(0.02199)
Female=1 × Low SES			0.04994**	0.05268***
			(0.01974)	(0.01914)
Female=1 × Medium SES			0.06866***	0.07713***
			(0.02411)	(0.02382)
Female=1 × High SES			0.07014***	0.07049***
			(0.02655)	(0.02654)
Info=0 × Financing=1	0.00982	0.00476	0.00984	0.00436
	(0.01664)	(0.01454)	(0.01721)	(0.01497)
Info=1 × Financing=0	0.01557	0.01350	0.01547	0.01310
	(0.01730)	(0.01707)	(0.01774)	(0.01726)
Info=1 × Financing=1	-0.00035	0.00732	-0.00042	0.00731
	(0.01681)	(0.01712)	(0.01669)	(0.01695)
Offers financing		-0.02806		-0.03084
		(0.02117)		(0.02180)
Sent second quote		-0.05984**		-0.06108**
		(0.02913)		(0.02898)
Break down budget w/values		-0.04224*		-0.04211**
		(0.02159)		(0.02121)
Constant	4.57970***	4.62977***	4.54163***	4.58875***
	(0.21958)	(0.21787)	(0.21870)	(0.21576)
Observations	329	327	329	327
R^2	0.875	0.882	0.876	0.882

This table presents the main results of the experiment, with the dependent variable being the logarithm of the average price (i.e., MXP per Watt of solar panel capacity). All specifications include fixed effects for provider, inverter brand, and text version. Robust standard errors are shown in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 reports the results of the experiment based on the size of the DPV systems offered by the firms. The organization of the table is exactly the same as table 6. As we mentioned before, discriminatory practices could also imply over-sizing or under-sizing the solar panel system. This is truly an empirical question, as conjectures of opportunistic behavior could go either way. Once again, there is no effect of product knowledge and external financing treatments. However, when controlling for all relevant factors, especially the optimal size of the PV system, women receive quotes for systems that are approximately 6% higher in capacity compared to those provided to men. Consumers with a medium SES receive quotes for equipment that are 12% larger, while those with high SES receive quotes for systems almost 9% larger. Once again, when gender is interacted with socioeconomic status, the effects are amplified. Thus, women with a medium- and high SES receive quotes for devices that are 19% and 14% larger, respectively, than men with a low SES (i.e., the reference category omitted in the regression).

TABLE 7 Experiment Results: Offered Capacity

Dep. var.: log(offered capacity)	(1)	(2)	(3)	(4)
log(optimal capacity)	0.302***	0.308***	0.304***	0.310***
	(0.047)	(0.048)	(0.048)	(0.048)
log(average price)	-0.591***	-0.618***	-0.550***	-0.578***
	(0.181)	(0.177)	(0.188)	(0.180)
Female	0.061*	0.061*		
	(0.033)	(0.032)		
Medium SES	0.116***	0.128***		
	(0.042)	(0.041)		
High SES	0.083*	0.088*		
	(0.048)	(0.047)		
Female=0 × Medium SES			0.061	0.069
			(0.063)	(0.061)
Female=0 × High SES			0.035	0.052
			(0.065)	(0.064)
Female=1 × Low SES			0.002	0.007
			(0.052)	(0.052)
Female=1 × Medium SES			0.173***	0.194***
			(0.059)	(0.058)
Female=1 × High SES			0.145**	0.138**
			(0.070)	(0.066)
Info=0 × Financing=1	-0.010	-0.020	-0.010	-0.021
	(0.040)	(0.039)	(0.040)	(0.039)
Info=1 × Financing=0	0.034	0.033	0.034	0.032
	(0.043)	(0.043)	(0.043)	(0.043)
Info=1 × Financing=1	-0.008	0.014	-0.007	0.013
	(0.047)	(0.047)	(0.047)	(0.047)
Offers financing		-0.055		-0.046
		(0.062)		(0.063)
Sent second quote		-0.200***		-0.200***
		(0.051)		(0.050)
Break down budget w/values		-0.005		-0.003
		(0.074)		(0.073)
Constant	7.313***	7.383***	7.206***	7.273***
	(0.774)	(0.769)	(0.793)	(0.776)
Observations	326	324	326	324
R^2	0.915	0.920	0.916	0.921

This table presents the main results of the experiment, with the dependent variable being the logarithm offered capacity in Watts. All specifications include fixed effects for provider, inverter brand, and text version. Robust standard errors are shown in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 | DISCUSSION AND POLICY IMPLICATIONS

The findings in the preceding section are highly significant. Women experience clear instances of price discrimination, similar to consumers in the middle and high socioeconomic status. These effects mutually amplify, disproportionately affecting middle-class and upper-class women. Adding to the complexity, these same demographic groups receive quotes that often exceed the optimal capacity needed for their photovoltaic systems.

If we only focus on socioeconomic status and associate them with different willingness to pay for products given varying levels of income and/or wealth, we know from economic theory that price discrimination can be justified in certain markets. Third-degree price discrimination (or group pricing), precisely involves charging different prices to different groups of consumers based on observable characteristics such as age, income, or location. From an efficiency perspective, there are situations where third-degree price discrimination can be justified for several reasons: increased market access, economic fairness and even maximization of economic surplus (i.e., consumer surplus plus producer surplus). We believe that there isn't much to be done from a public policy perspective. Perhaps conducting informational campaigns, providing free consultations to consumers, and other options that improve the situation of asymmetric information in this market.

From a gender perspective, the situation is quite complex and unpleasant, particularly for a country where 33% of households are headed by women.[23] On one hand, there is abundant evidence that women are discriminated against in the labor market, either by being relegated from hierarchical positions despite being equally qualified as men, or by receiving lower salaries for similar jobs compared to their male counterparts (Arceo-Gómez and Campos-Vázquez, 2014; González, 2020). On the other hand, in this article, we find evidence that women pay more for a specific product, and moreover, this product is oversized. Unfortunately, policy measures to prevent these situations are challenging to implement. For example, it is nearly impossible to enforce regulations that prohibit gender-based price discrimination in the acquisition of products, including solar panels. Both monitoring and imposing sanctions on companies practicing gender-based price discrimination and over-sizing of products are, as of today, a utopia. However, regulations requiring greater transparency in pricing and a clear justification for any cost differentials could be established. Additionally, promoting education and awareness about gender equity in access to products and services, such as solar energy, could contribute to changing discriminatory perceptions and behaviors. Ultimately, the combination of robust regulations and educational efforts could help address and prevent these inequities.

The key remaining questions are: What mechanism allows this discrimination to take place? Is it that the seller assumes that this social group is less informed or has a greater willingness to pay? Or is it simply discrimination per se? Unfortunately, we lack tools to answer these kinds of questions. However, we believe it is a valid reason to delve deeper into the topic in future research.

6 | CONCLUSIONS

Unlike all existing studies, in this paper we study the performance of the residential solar panel market from the supply side, analyzing the behavior of retailers in four Mexican cities. Concretely, we perform an audit experiment in which we randomize some characteristics of fictitious residential users who request quotes from real providers of DPV systems. The

[23] Population and Housing Census 2020, INEGI, https://cuentame.inegi.org.mx/poblacion/hogares.aspx?tema=P.

four main characteristics of the consumer are the following categorical variables: gender, socioeconomic status, prior product knowledge, and secured external financing. Controlling for other factors, such as the capacity of the panels (or the level of electrical consumption), as well as characteristics of the quote offered by the supplier, such as the availability of financing plans, delivery of multiple quotes, breakdown of the quote, inverter brand, and supplier fixed effects, we consistently find significant effects across multiple econometric specifications.

The main results indicate that women experience price discrimination of around 3.5%, as do clients from medium-high and high socioeconomic strata (between 3.5% and 4%). These surcharges combine, reaching levels above 7% for female clients from the medium-high and high strata. The discrimination situation is aggravated because, when controlling for the optimal capacity of solar panels, this same group of people is quoted for equipment with a higher capacity. In other words, there is an oversizing of the solar panels offered. In numbers, women are offered photovoltaic systems that are 6% larger in capacity, and people from the upper-middle and upper classes are offered systems that are between 8% and 13% larger in capacity. The experimental variables of customers with prior product information and secured external financing have no effect on quotes in any of the specifications.

The effect of the aforementioned experimental variables (namely, gender, SES, information, and financing) on two binary variables was also measured: one for response/non-response to quote request messages and the other for sending a quote (conditional on the supplier's response). No significant effects were found. It is therefore concluded that there are no biases in the results mentioned in the previous paragraph due to differences in responses among the different population groups.

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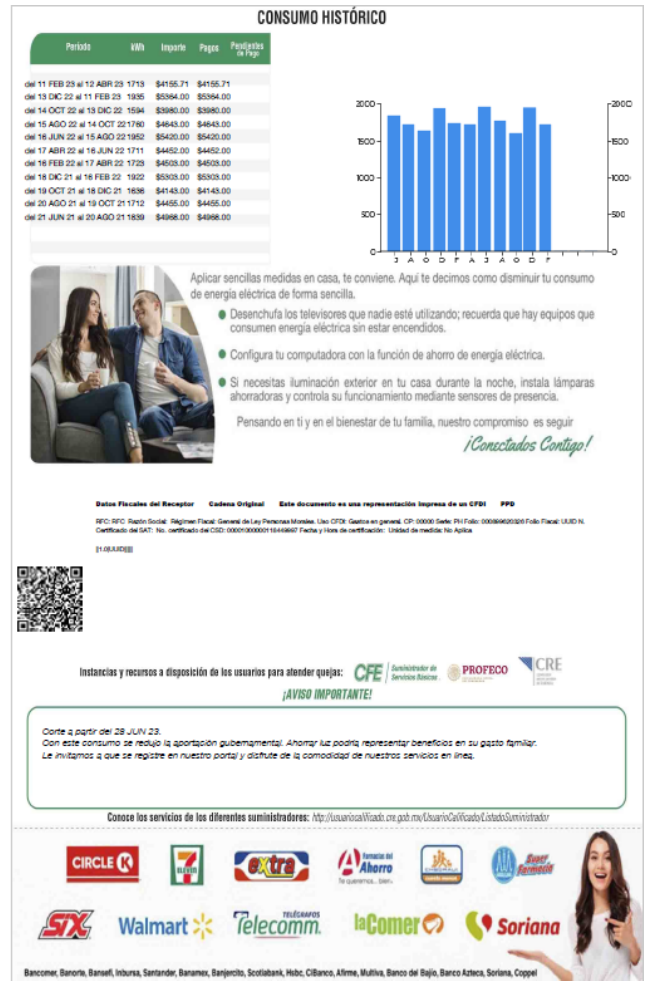
APPENDIX

FIGURE 1 Example of a fake electricity bill

(a) First page



(b) Second page

The figure shows an example of a fake electricity bill for the artificial customer *Maria Jose Lopez Gonzalez* in Monterrey. The first page displays the current billing period, while the second page presents the two-year history of electricity consumption.

FIGURE 2 Example of a real WhatsApp conversation

30/08/23 17:40 - 🙂: Buenas tardes
30/08/23 17:41 - 🙂: Mi nombre es Renata.
30/08/23 17:41 - 🙂: Nos gustaría instalar paneles solares en nuestra casa. Me gustaría que por favor me proporcione una cotización completa del costo y la instalación de los paneles.
30/08/23 17:41 - 🙂: Nuestro gasto promedio por cada recibo de luz es unos 4000 pesos.
30/08/23 17:42 - 🙂: Le comento que ya contamos con la aprobación de una fuente de financiamiento externo para la compra.
30/08/23 17:42 - 🙂: Esperando su amable respuesta, le envío un cordial saludo
30/08/23 17:43 - Solar+: Entones el pago es directo?
30/08/23 17:43 - Solar+: Mucho gusto Renata
30/08/23 17:43 - Solar+: Crees poder pasarme el último recibo de luz?
30/08/23 17:45 - 🙂: Ya tengo un préstamo bancario preaprobado. Además, estoy averiguando si puedo usar el REMODELAVIT de Infonavit. No descarto ver algún otro programa del gobierno o FIDE.
30/08/23 17:45 - 🙂: si, ahorita le mando mi recibo de luz
30/08/23 17:45 - 🙂: 411895410164.pdf (archivo adjunto)
411895410164.pdf
30/08/23 17:48 - Solar+: Trabajo el estudio y me reporto
30/08/23 17:48 - 🙂: Muchísimas gracias, quedo pendiente
30/08/23 17:49 - Solar+: A ti, buena tarde
03/09/23 19:07 - 🙂: Hola, buenas tardes, solo para recordarle lo de la cotización que tenemos pendiente. Muchisimas gracias
03/09/23 19:11 - Solar+: Que tal Renata, buena tarde si una disculpa por la tardanza tuvimos una carga de trabajo, pero en breve te la comparto
03/09/23 19:12 - 🙂: Muchas gracias
03/09/23 21:33 - Solar+: CasadeRenataPerez.pdf (archivo adjunto)
CasadeRenataPerez
03/09/23 21:36 - Solar+: Renata buenas noche, en el caso del financiamiento nosotros también podemos apoyarlos, si se tiene una cantidad la cual disponer como inicial y el resto lo podemos manejar a 12, 18 o 24 meses los dos primeros podrían ser sin interés y 24 con un 9% interés
03/09/23 21:36 - Solar+: La cotización contempla todo y con garantías más 3 años de mantenimiento incluido
04/09/23 15:44 - 🙂: Muchas gracias, buenas tardes. Voy a analizar su propuesta, y en su caso me comunico con usted de nuevo.
04/09/23 16:23 - Solar+: Cualquier duda quedo pendiente

This screenshot shows a WhatsApp conversation between a fictitious customer and a real solar panel supplier.

FIGURE 3 Example of a DPV system quote

VOLTERMA SOLAR
Tecnologías Renovables

NOMBRE	DOMICILIO
López González Regina	Paseo del Torreón 1460
CIUDAD	**TELÉFONO**
Zapopan, Jal.	33-4346-2212
E-MAIL	**NÚMERO DE SERVICIO**
	444-302-522-885
FECHA	**TARIFA**
28-Jul-23	DAC

¿Vale la pena invertir en paneles solares?

CONSUMO ACTUAL PROMEDIO BIMESTRAL EN kWh	CONSUMO PROMEDIO BIMESTRAL EN kWh CON PANELES SOLARES
323	9.91

COSTO DE CONSUMO ACTUAL DE ENERGÍA		PAGO ESTIMADO CON NUESTROS SISTEMAS SOLARES	
PROMEDIO BIMESTRAL	PROMEDIO ANUAL	PROMEDIO BIMESTRAL	PROMEDIO ANUAL
$1,981.95	$11,891.68	$49.07	$294.41

% de Generación	Generación kWh bimestral	Potencia instalada kWp
97%	313	1.10

¡No gastes más energía eléctrica, invierte en ella, instala paneles solares y ahorra hasta el 100% en tu factura de luz!

Presupuesto de sistema fotovoltaico con interconexión a CFE

Partida	Producto	Cantidad	Importe
1	Panel Fotovoltaico Risen 550 WP Monocristalino	2	$21,486.69
2	Micro inversor Hoymiles 1000 W 208-220 v	1	
3	Instalación	1	
4	Gestión del trámite con CFE	1	

Sub-total	$21,486.69
IVA 16%	$3,437.87
Total	$24,924.56

*Precios son L.A.B. ZMG.
El costo de la instalación puede variar de acuerdo a las condiciones y requerimientos del lugar. *Incluye estructura elevada

Para el monitoreo es necesario que haya internet en el lugar de instalación.

*Degradación de los paneles en 10 años: 5%
*Pérdida de eficiencia del inversor a 10 años: 5%
* Si el medidor bidireccional no es proporcionado por CFE de forma gratuita el cliente tendrá que comprarlo.

¡ Deduce el 100% de tu compra de ISR !
Art. 34 Fracción XIII de la Ley del Impuesto sobre la Renta

(a) First page

VOLTERMA SOLAR
Tecnologías Renovables

$ Ahorros

Ahorro Bimestral	$1,932.88
Ahorro Anual	$11,597.27
Retorno de inversión (Años)	2.15

*Ahorros estimados en base a la información de tarifas en la página de CFE.

Especificaciones de instalación

1	Estructura de ángulo de aluminio y/o fierro estructural según condiciones de instalación.
2	Tornillería de estructura en Acero Inoxidable
3	Anclaje epoxico para fijación de estructura.
4	Silicón e impermeabilizante para evitar filtraciones.
5	Riel de aluminio para sentar paneles solares.
6	Protección en corriente directa .
7	Interruptor en corriente alterna.
8	Tubería galvanizada para protección de cables.
9	Cable fotovoltaico de paneles a inversor.
10	Sistema de tierras.
11	Incluye armado de proyecto y papeleo con Comisión Federal de Electricidad.

Programa de trabajo

Fecha de entrega: A Programar de 5 a 10 días hábiles

Términos y condiciones

1. PAGOS: Pago del 60% de anticipo y el resto al finalizar la instalación del proyecto
2. REQUERIMIENTOS: Lo costos no incluyen posibles requerimientos o mejoras que pueda solicitar CFE a su sistema eléctrico para la interconexión.
3. VIGENCIA: Cotización con 7 días de vigencia.
4. FORMA DE PAGO: Mediante depósito, cheque nominal o transferencia electrónica SPEI

Garantías:	
Panel Solar:	12 años contra defecto de fabricación y 25 años de producción de energía.
Micro inversor:	12 años contra defecto de fabricación
Instalación:	2 años directo con Volterma Solar

A T E N T A M E N T E
César Orozco
Cel: 33-3397-5585

(b) Second page

The figure shows an example of a quote for the artificial customer *Regina López González* in Guadalajara, Jalisco.