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BARRIERS TO PENSION AFFILIATION IN BOLIVIA: EVIDENCE ON ACCESSIBILITY, AFFORDABILITY, AND ACCEPTABILITY

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Barriers to Pension Affiliation in Bolivia: Evidence on Accessibility, Affordability, and Acceptability*

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Abstract

This paper uses a multidimensional framework that incorporates constraints of *accessibility, affordability,* and *acceptability* to examine the determinants of *effective access* to the contributory component of Bolivia's pension system. Using nationally representative household surveys from 2005 and 2019, we evaluate the influence of labor-market segmentation, financial capacity, informational barriers, and sociocultural factors on workers' likelihood of affiliation. To address key empirical challenges, including nonlinearity, non-random selection into employment, and perfect or near-perfect prediction, we estimate Probit, Heckprobit, and Firth–Logit models and compute gender-specific average marginal effects. The results indicate persistent structural barriers across periods and settings. Self-employment, unpaid work, and low or unstable earnings consistently reduce affiliation. Informational constraints and distrust were decisive in 2005, while digital access became a critical determinant by 2019. Sociocultural factors, particularly Indigenous identity, also emerged as significant acceptability constraints in the later period. Gender differences in affiliation mainly reflect disparities in employment status, income, and access to information, rather than heterogeneous behavioral responses. Overall, the findings underscore the need for integrated policies that address informational gaps, financial constraints, and labor-market segmentation to bolster access to the contributory component of Bolivia's pension system.

Keywords: Pension systems, social protection, informality, labor markets, gender gaps, access barriers, selection models, nonlinear probability models.

JEL Codes: J26; H55; J21; C35; D14; O54; I38; J16.

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Barreras para la Afiliación a Pensiones en Bolivia: Evidencia sobre Accesibilidad, Asequibilidad y Aceptabilidad

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Resumen

Esta investigación utiliza un marco multidimensional que incorpora las restricciones de *accesibilidad, asequibilidad* y *aceptabilidad* para examinar los determinantes del *acceso efectivo* al componente contributivo del sistema de pensiones de Bolivia. Con base en encuestas de hogares representativas a nivel nacional de 2005 y 2019, evaluamos la influencia de la segmentación del mercado laboral, la capacidad financiera, las barreras informativas y los factores socioculturales sobre la probabilidad de afiliación de los trabajadores. Para abordar desafíos empíricos cruciales, incluidos la no linealidad, la selección no aleatoria hacia el empleo y la predicción perfecta o casi perfecta, estimamos modelos Probit, Heckprobit y Firth–Logit, y calculamos efectos marginales promedio específicos por género. Los resultados indican la persistencia de barreras estructurales a lo largo de los periodos y los contextos analizados. El empleo independiente, el trabajo no remunerado y los ingresos bajos o inestables reducen de manera consistente la afiliación. Las restricciones informativas y la desconfianza fueron decisivas en 2005, mientras que el acceso digital se convirtió en un determinante crítico en 2019. Los factores socioculturales, en particular la identidad indígena, emergieron como restricciones significativas de aceptabilidad en 2019. Las diferencias de género en la afiliación reflejan principalmente disparidades en la situación laboral, los ingresos y el acceso a la información, más que respuestas conductuales heterogéneas. En conjunto, los hallazgos subrayan la necesidad de políticas integradas que aborden las brechas informativas, las restricciones financieras y la segmentación del mercado laboral para fortalecer el acceso al componente contributivo del sistema de pensiones de Bolivia.

Palabras Clave: Sistemas de pensiones, protección social, informalidad, mercados laborales, brechas de género, barreras de acceso, modelos de selección, modelos de probabilidad no lineales.

Códigos JEL: J26; H55; J21; C35; D14; O54; I38; J16.

1 Introduction

Ensuring income security in old age is one of the most important challenges for social protection systems in low- and middle-income countries, and Bolivia is no exception. Despite more than two decades of pension reforms, enrollment in the contributory pillar[1] of the country's pension system remains low, particularly among non-salaried workers, rural populations, and women. These patterns persist despite substantial institutional changes, the expansion of digital platforms, and reforms in social policy. Understanding why large segments of the labor force remain outside the contributory system requires an analytical framework that considers not only statutory eligibility and economic incentives but also the structural, informational, and sociocultural conditions under which affiliation decisions are made.

Most existing analyses of pension participation in Bolivia and the wider Latin American region interpret pension affiliation through the lens of institutional design, labor-market formality, and individual characteristics. This perspective has provided valuable insights into how contribution rules, employment trajectories, and earnings profiles influence coverage disparities. However, this approach tends to treat affiliation as the outcome of a supply-demand process in which individuals respond to price-like incentives or regulatory requirements. These approaches struggle to explain why legally eligible, financially capable, and potentially willing workers remain outside the system. These approaches also offer little guidance on how to expand access to the pension system for labor segments operating outside of formal employment relationships.

To address these limitations, this paper adopts the multidimensional concept of *effective access*, originally developed in the health economics literature, and adapts it to the context of contributory pensions. The framework distinguishes three complementary dimensions: *accessibility, affordability*, and *acceptability*. Each dimension captures a different set of constraints that shape the feasibility and desirability of affiliation. *Accessibility* refers to the institutional, administrative, geographical, and informational conditions that enable individuals to interact with the system. *Affordability* captures income, liquidity, and household structure constraints affecting workers' ability to allocate resources to contributions. *Acceptability* encompasses trust, perceptions of system credibility, behavioral factors, and sociocultural norms that influence the perceived value of affiliation. Together, these dimensions provide a more comprehensive structure for understanding affiliation outcomes in heterogeneous labor markets.

Using microdata from the 2005 and 2019 Bolivian Household Surveys, two of the few surveys with specific questions about affiliation or enough variables to apply the effective access framework, this study examines how each dimension affects affiliation probabilities in urban and rural areas. The analysis uses Probit, Heckprobit, and Firth-Logit estimators to address three empirical challenges: the binary outcome, employment selection, and perfect or quasi-perfect prediction in subsamples. Average marginal effects by gender provide meaningful measures of

[1] Bolivia's pension system has three pillars. The first is a *contributory system* of individual accounts that covers fewer than 20% of the working population. The second is a *semi-contributory* Solidarity Fund, which is financed by employers, progressive worker levies, and public transfers. The third is the *non-contributory Renta Dignidad* cash transfer program, which reaches over 90% of adults aged 65 and older. The latter two provide minimal, near-subsistence benefits not comparable to contributory pensions, and both create growing fiscal pressures.

how structural, economic, informational, and sociocultural constraints influence affiliation.

The results show that Bolivia's contributory pillar of the pension system is not aligned with its labor market structure. Barriers to accessibility related to self-employment and unpaid work persist over time and across settings. Affordability constraints, such as poverty, low earnings, and high dependency ratios, continue to lower affiliation probabilities. Informational accessibility changes over time. While knowledge gaps about the pension system were prevalent in 2005, digital access became a key factor in 2019. Acceptability factors, including institutional distrust and indigenous identity, also influence participation, particularly in rural areas. Gender differences in affiliation are almost entirely explained by structural disparities in employment, income, and digital access rather than by gender-specific behavior.

By integrating these findings into the Access–Afford–Accept framework, this paper offers a comprehensive explanation for the persistently low coverage of Bolivia's contributory pension system. It shows that increasing access effectively requires policies that go beyond administrative simplification. Rather, reforms must address structural labor-market segmentation, reduce liquidity constraints on low-income households, and bridge the sociocultural gap between formal pension institutions and their intended beneficiaries.

The remainder of the paper is organized as follows: Section 2 situates the analysis within the relevant literature and highlights the conceptual gap addressed by the *effective access* approach. Section 3 presents the conceptual framework. Section 4 describes the data, and Section 5 outlines the empirical strategy. Section 6 reports the econometric results, and Section 7 discusses their implications and concludes with directions for policy and future research.

2 The Missing Perspective of Effective Access

Income security in old age, disability, or death is a core component of social protection and job quality. Since 1948, this right has been recognized internationally, with pension systems as the main way to fulfill it. These systems follow principles like universality, equality, equity, uniform treatment, solidarity, income redistribution, and financial sustainability. Pension systems use contributory, tax-financed, or mixed arrangements (Bertranou and Casalí, 2007).

Within this framework, the literature has evolved along two main lines. The first examines the design, rules, and performance of pension systems, including benefit formulas, contribution modalities, replacement rates, compensatory measures, and regulatory structures. This perspective emphasizes how employment heterogeneity, especially the divide between wage and non-wage categories, interacts with system rules and influences how well pension systems achieve equity and universality goals (Bonnet et al., 2004; Mesa-Lago, 2008; MacKellar, 2009; Jefferson, 2009; Antolin et al., 2012; Arza, 2012*a*, 2012*b*, 2015; Beetsma and Romp, 2013; ECLAC, 2019). A consistent finding is that coverage gaps are not just administrative but stem from the structure of pension systems in relation to heterogeneous labor markets.

Extending contributory coverage to non-salaried workers has been a particular challenge. These

workers—including self-employed individuals, microentrepreneurs, cooperative members without a wage, and unpaid family workers (Muriel, 2019)—typically have lower and more variable incomes. They lack an employer responsible for affiliation and often value immediate consumption over future benefits. Even mandatory programs in Argentina and Uruguay have struggled to reach these groups (MacKellar, 2009; Arza, 2012*a*; Bertranou and Casalí, 2007).

The literature also emphasizes the gendered aspects of pension systems. Differences in labor force participation, employment type, wage levels, savings capacity, work experience, and occupational segregation create gender gaps in pension outcomes. Care responsibilities, interrupted careers, and part-time employment hinder women's ability to contribute (Jefferson, 2009; Arza, 2012*b*, 2015; Joubert, 2015; ECLAC, 2019). Without explicit corrective mechanisms, pension systems tend to reproduce or worsen existing gender inequalities.

A second line of research focuses on individual-level affiliation decisions, typically examined through microeconomic and behavioral lenses. These studies explore how factors such as income, education, formality, gender, age, marital status, financial inclusion, system knowledge, and personal preferences influence participation (for instance, Li and Olivera, 2005; Geri et al., 2019; Robles, 2020; Miti et al., 2021; van Hekken et al., 2022). This work implicitly acknowledges that affiliation is a multidimensional decision shaped by opportunity structures, liquidity constraints, and perceptions of institutional credibility.

In Bolivia, the pension system has been extensively analyzed from macroeconomic and institutional perspectives, especially after the 1996 and 2010 reforms. Studies have examined regulatory changes, implementation challenges, system evolution, and financial sustainability (Mercado, 1991; von Gersdorff, 1997; Escobar and Nina, 2004; Evia and Fernández, 2005; Olivera, 2010; Gamboa, 2014; Escobar, 2014; Calderón, 2022). However, issues related to employment dependency categories (Gamboa, 2023) and gender disparities (Bonadona, 2004; Navarro, 2010) have received less emphasis in this tradition.

Micro-level studies of affiliation in Bolivia highlight persistent barriers. Evia and Fernández (2004) estimated workers' valuation of long-term insurance, as shown by affiliation decisions, before and after the 1996 reform. They found low valuation overall. In a later analysis, Evia and Fernández (2005) show that affiliation reflects a mix of individual and firm characteristics using Probit models for the pre- and post-reform periods. Molina and Soria (2006) identify workplace size, income, and age as key predictors and document lower probabilities among women, indigenous individuals, and rural residents.

Taken together, the literature shows that affiliation depends on more than statutory rules and economic incentives. It stems from the interplay of labor market structures, financial constraints, informational barriers, trust, and entrenched gender and ethnic inequalities. However, few studies, either internationally or in Bolivia, explicitly conceptualize these mechanisms as dimensions of *effective access* or *integrate* such a framework into empirical analyses. This paper addresses this gap by operationalizing accessibility, affordability, and acceptability, and estimating their joint influence on affiliation using robust econometric techniques.

3 Effective Access to the Pension System

Conventional analyses of pension affiliation typically use a supply-demand framework. On the supply side, institutional rules determine eligibility and conditions for participation. On the demand side, observable individual and household characteristics influence workers' willingness and ability to comply with contribution requirements. While informative, this perspective does not fully capture the mechanisms in settings such as Bolivia, where labor markets are highly segmented, institutional contact is uneven, and many workers engage with the pension system sporadically. In these environments, affiliation decisions reflect more than just observable incentives and statutory obligations.

To address these limitations, this study adopts the concept of *effective access*, originally developed in the health economics literature (see, for example, McIntyre and Birch, 2009; Agafitei, 2023). Rather than replacing traditional supply-demand logic, effective access broadens and integrates it. The framework recognizes that affiliation depends on the interplay of formal rules, economic capacity, informational conditions, behavioral patterns, and sociocultural factors. This multidimensional view is especially relevant in systems where many workers, such as non-salaried workers in Bolivia, face voluntary instead of compulsory enrollment mechanisms.

In this integrated approach, *effective access* has three reinforcing dimensions: *accessibility, affordability*, and *acceptability*. These dimensions form a basis for understanding how institutional design, economic conditions, and behavioral factors influence affiliation outcomes.

Accessibility: Accessibility includes the institutional and logistical factors that help or hinder enrollment. These factors are the presence and proximity of service points, availability of in-person, digital, or mobile registration channels, service hours, and the clarity, relevance, and linguistic adequacy of information from pension administrators. In supply-demand terms, accessibility links the institutional supply of services with individuals' ability to access them procedurally and informationally. In Bolivia, salaried workers usually meet accessibility requirements through employer-based enrollment. Non-salaried workers must navigate the entire process on their own (Gamboa, 2023). Gender differences in financial and digital literacy, access to technology, and language also create unequal levels of practical access.

Affordability: Affordability refers to the financial feasibility of joining and contributing to the pension system. It reflects household budget constraints, income stability, liquidity constraints, and the *trade-offs* workers face when allocating resources between contributions and immediate needs. In a supply-demand view, affordability comes from the interplay between contribution requirements and households' economic capacity to meet them. This explains why financially vulnerable households may remain outside the system, even when formal rules are inclusive. Gender roles, care responsibilities, and segmented employment trajectories further shape affordability constraints, especially for women and non-salaried workers.

Acceptability: Acceptability includes subjective, behavioral, and sociocultural factors that influence the desirability of affiliation. These factors include trust in pension institutions, expec-

tations about future benefits, cultural norms regarding saving in general and long-term saving in particular, financial literacy, and behavioral tendencies such as present bias, myopia, and optimism about future employment. In the supply-demand framework, acceptability bridges the gap between the system's expected value and the perceptions and preferences that shape individual demand. Where contributions are voluntary, acceptability is paramount. Even when services are accessible and contributions are financially feasible, workers may not affiliate if they do not see the system as credible, relevant, or aligned with their values.

The three dimensions of *effective access* work together. A worker may understand the system and value its benefits (*accessibility* and *acceptability*), yet still be unable to participate because of liquidity constraints (*affordability*). Similarly, a worker with enough income and proximity may remain unaffiliated if institutional distrust or cultural preferences reduce the perceived value of participation. In Bolivia, this multidimensional structure reflects well-documented patterns (Machicado, 2022; Calderón, 2022; Gamboa, 2023; Herrera and Muriel, 2024): (*i*) Non-salaried work reduces accessibility; (*ii*) Low income and high dependency ratios constrain affordability; and (*iii*) Institutional distrust and alternative saving traditions limit acceptability.

This framework provides a coherent structure for interpreting the determinants of affiliation presented in Section 6. It also explains why reforms focused only on administrative simplification or financial incentives often fail to expand coverage. Table 1 summarizes how the factors identified in the literature map onto the Access–Afford–Accept framework.

Table 1: Dimensions and Factors Influencing Effective Access to the Pension System

Factor	Effective Access Dimensions			Conceptual Justification
	Access	Afford	Accept	
Inclusive nature of the system	✓	✓		It determines formal eligibility and how easily affiliation occurs. In Bolivia, mandatory registration applies to salaried workers, while non-salaried workers are subject to voluntary rules (Gamboa, 2023).
Geographical distance	✓			Physical distance raises the time and monetary costs of accessing pension services, limiting the feasibility of affiliation and contributions. This effect is pronounced in rural areas without nearby offices (Azuara et al., 2021; Herrera and Muriel, 2024), but it can also restrict access in peripheral urban zones with poor transportation connections.
Service delivery modalities	✓		✓	Service channels like language, hours, waiting times, paperwork, and digital access influence procedural accessibility and perceptions of system reliability. Evidence shows that simplifying procedures and improving delivery channels increases program participation (Ericson et al., 2023; Fox, 2020; Scholta et al., 2019).

Table 1 (continued)

Factor	Effective Access Dimensions			Conceptual Justification
	Access	Afford	Accept	
Information about the system	✓		✓	Adequate information about costs, procedures, and expected benefits improves accessibility by reducing informational friction and increases acceptability by building trust and setting clearer expectations. Studies show that information and knowledge of the system significantly influence pension enrollment and uptake of social protection (Li and Olivera, 2005; Molina and Soria, 2006; Robles, 2020).
Workplace characteristics	✓			Workplace characteristics such as formality, firm size, public-sector employment, and job tenure influence workers' likelihood of automatic enrollment and ongoing contact with the system. Previous studies in Bolivia and other contexts show these factors significantly increase affiliation probabilities (Evia and Fernández, 2004, 2005; Dummann, 2008; Mehdi and Ali, 2016; Muriel, 2019).
Payment capacity		✓	✓	Payment capacity reflects disposable income, liquidity, and household budget constraints. Typically, higher labor or per capita income makes contributing more feasible (Li and Olivera, 2005; Geri et al., 2019), although high-income households may diversify savings instead (Dummann, 2008). Dependency ratios and household size reduce affordability (Robles, 2020), while housing quality can serve as a proxy for broader socioeconomic capacity (Arza, 2012*a*).
Saving preferences		✓	✓	Preferences for saving through livestock, informal groups, or other assets shape how attractive pension contributions seem. Behavioral biases like present bias and expectations of non-contributory benefits also influence demand (Bosch et al., 2019; Machicado, 2022; Herrera and Muriel, 2024).
Education	✓	✓	✓	Education is a cross-cutting factor in all three dimensions of effective access. It improves understanding of system rules, enhances the ability to assess payment capacity and potential benefits, and, as human capital theory predicts (Becker, 1964), is positively associated with labor income. Education also helps individuals form more realistic perceptions and expectations about the system. Empirical studies consistently show that higher educational attainment increases the likelihood of affiliation (Evia and Fernández, 2004, 2005; Li and Olivera, 2005; Molina and Soria, 2006; Geri et al., 2019; Robles, 2020).

Table 1 (continued)

Factor	Effective Access Dimensions			Conceptual Justification
	Access	Afford	Accept	
Age	✓	✓	✓	Age influences all dimensions of effective access. Older adults often have more stable employment, higher labor income, and a greater likelihood of working in the formal sector (Geri et al., 2019). They usually have fewer dependents and more predictable finances. In contrast, younger individuals may show behavioral biases, such as present bias and overoptimism about future work, which lead them to undervalue old-age benefits and postpone affiliation.
Marital status	✓	✓	✓	Marital status affects all three dimensions of effective access. Married or cohabiting individuals often have greater household financial obligations, which can affect affordability. Meanwhile, widows and widowers may be eligible for survivor benefits under specific pension rules (Arza, 2012*a*). Younger single individuals may display behavioral patterns, such as present bias or short-term planning, that reduce the perceived value of long-term pension savings.
Sociocultural factors			✓	Sociocultural norms and traditional savings practices shape perceptions of the pension system and the appeal of affiliation, especially in rural areas. In Bolivia's highland regions, for example, owning livestock is recognized as retirement security (Herrera and Muriel, 2024), showing how cultural preferences can substitute for or compete with formal pensions.

Source: Own.

4 Data

This study uses microdata from the Bolivian Household Surveys (Encuestas de Hogares, EH), collected annually by the National Institute of Statistics (INE-Bolivia). Two survey years are used: 2005 and 2019. These years were not chosen arbitrarily. As explained in this section, they are the only survey waves with explicit questions about affiliation or the variables needed to measure *effective access* and estimate the nonlinear econometric models in Section 5. Together, these years provide a unique 15-year window to examine how the determinants of pension affiliation evolved amid institutional reforms and changing labor market conditions.

The 2005 EH survey is valuable for two reasons. First, it is the only nationally representative survey that asked workers why they did not participate in the pension system. The questions address informational and behavioral constraints related to the *accessibility* and *acceptability* of

effective access, such as lack of knowledge about Pension Fund Administrator (AFP) procedures, distrust of the system, and the perception that contributions are unaffordable. No later EH included comparable questions. Thus, 2005 is the only year for which direct measurements of informational barriers and institutional distrust regarding the pension system are available. Second, the 2005 EH offers a snapshot of affiliation patterns more than a decade after the 1996 reform and just before the institutional restructuring introduced by the 2010 Pension Law.[2] This timing makes 2005 a particularly informative reference point because formal employment was limited, non-salaried work was widespread, and voluntary participation was common among much of the labor force.

The 2019 Household Survey plays an essential role in the analysis. As the last survey before the pandemic, it captures the pre-pandemic state of Bolivia's labor market and pension system, before the disruptions from the health crisis, political instability, and economic deterioration. The survey also predates the transfer of pension administration from the private AFPs to the Gestora Pública, mentioned above, allowing consistent comparisons with the 2005 survey within a single institutional framework. The 2019 questionnaire includes the socioeconomic variables needed to measure *accessibility, affordability,* and *acceptability* of *effective access*, such as employment category, labor income, education, ethnicity, internet use, poverty status, and household dependency structure. The 2019 survey sample is also representative at the departmental level in both urban and rural areas. This coverage enables the disaggregated analysis in Section 6 and makes 2019 the only post-2005 survey year in which the conceptual framework and empirical strategy can be implemented without compromising comparability.

Taken together, 2005 and 2019 are the only years in which the following conditions are met: (*i*) the informational and behavioral variables needed to measure *acceptability* exist (2005); (*ii*) the socioeconomic, demographic, and employment variables for constructing accessibility and affordability indicators are available with consistent definitions (in 2005 and 2019); and (iii) the sample structure allows nonlinear estimation with correction for the empirical challenges presented in the next section. These characteristics make the paired surveys uniquely suited for analyzing the determinants of pension affiliation over time.

For both surveys, our sample is restricted to individuals aged 18–55 to comply with pension eligibility rules and ensure comparability with the existing literature. The dependent variable indicates whether the respondent is affiliated with an AFP. All covariates were constructed using the Access-Afford-Accept framework detailed in the previous section. Table Table 2 summarizes the full set of variables used in the empirical analysis, their mapping to the three effective-access dimensions, and their availability across the two survey years.

[2]The 2010 Pension Law (Law 065) established the *Gestora Pública de la Seguridad Social de Largo Plazo* to replace the two private pension fund administrators, *AFP Futuro de Bolivia S.A.* and *Previsión BBVA AFP S.A.*, which had managed individual accounts since the 1997 reform. Although Law 065 mandated a full transition to public administration of the contributory pillar, the transfer did not occur until 2022-2023. For more than a decade, the Gestora managed only the non-contributory *Renta Dignidad* program (Calderón, 2022).

Table 2: Variable Dimensions, Availability, and Definitions (Bolivian Household Surveys 2005 and 2019)

Variable	Effective Access Dimensions			Availability		Description
	Access	Afford	Accept	2005	2019	
Self-employed	✓			✓	✓	This is a dummy variable that equals one if an individual earns labor income but does not receive wages. This occurs if the individual is self-employed, an employer who does not pay themselves a salary, or a member of a production cooperative. Otherwise, the variable equals zero. This variable indicates whether workers operate under voluntary rather than mandatory affiliation rules within the contributory component of the Bolivian pension system.
Unpaid worker	✓	✓		✓	✓	This is a dummy variable that equals one if an individual performs work without receiving monetary compensation. This includes unpaid family workers, unpaid apprentices, and unpaid members of production cooperatives. Otherwise, it equals zero. This variable captures situations of low or zero earning capacity and limited institutional linkage to the contributory component of the pension system. These factors affect affordability and accessibility, respectively.
Salaried worker	✓	✓		✓	✓	This is a dummy variable that equals one if an individual is paid for their work. This includes employees, salaried employers, partners, and independent workers with a Tax Identification Number (NIT), which indicates formal registration. Otherwise, it equals zero. This variable serves as a proxy for formal employment conditions and the likelihood of automatic enrollment in AFPs.
Female	✓	✓		✓	✓	This is a dummy variable that equals one if the individual is female and zero if not. This variable captures gender-related differences in access to and affordability of the pension system.
AFP office	✓				✓	This dummy variable is equal to one if the respondent's municipality has an AFP office and zero otherwise. This variable captures both institutional proximity and access to local affiliation.
Urban area	✓	✓	✓		✓	This is a dummy variable that equals one if the individual lives in an urban area, as defined by the INE as a settlement with at least 2,000 inhabitants. It equals zero otherwise. This variable captures the differences in proximity to services and labor market structure between urban and rural areas.
Lacks AFP information	✓			✓		This is a dummy variable that equals one if the respondent reports not knowing how AFPs operate and zero otherwise. It captures informational barriers that limit access to the pension system.

Source: Own elaboration.

Table 2 (continued)

Variable	Effective Access Dimensions			Availability		Description
	Access	Afford	Accept	2005	2019	
Uses internet	✓			✓	✓	This is a dummy variable that equals one if an individual used the internet in the last three months, regardless of the device or access method used (fixed, mobile, or Wi-Fi), and zero otherwise. It captures digital accessibility, including the ability to access pension information online, enroll virtually, and use other online services.
Job tenure	✓			✓	✓	This is a continuous variable that measures how many months an individual has worked in their current job or occupation. This variable captures employment stability and sustained institutional contact, both of which are relevant for pension affiliation.
Income-to-contribution ratio	✓	✓		✓	✓	This is a continuous variable defined as the ratio of monthly labor income to the minimum AFP contribution. It captures both affordability and access, as workers must reach the minimum contribution threshold to remain in the system's contributory component (Gamboa, 2023).
Poor	✓	✓		✓	✓	This is a dummy variable that equals one if the per capita household income falls below the INE's basic food basket threshold. This variable captures affordability constraints and limited practical access because poverty restricts one's ability to meet minimum contribution requirements.
Not enough money		✓		✓		This is a dummy variable that equals one when the respondent reports "not having enough money" as the main reason for not affiliating with the pension system. It captures the direct barrier of affordability and reflects the financial constraints that prevent contributions.
Labor income per capita		✓		✓	✓	A continuous variable measuring per capita household labor income is calculated by dividing total household labor earnings by the number of household members. Domestic workers and their relatives are considered a separate household. It reflects a household's economic capacity, which is relevant for affordability.
Dependent children to adults ratio		✓		✓	✓	This is a continuous variable defined as the ratio of dependent children aged 0–10 to employed adults aged 14 and older in the household. Higher values indicate greater budgetary constraints and reduced affordability.

Source: Own elaboration.

Table 2 (continued)

Variable	Effective Access Dimensions			Availability		Description
	Access	Afford	Accept	2005	2019	
Owns house		✓	✓	✓	✓	This is a dummy variable equal to one if the household owns its dwelling through title, inheritance, usucaption, or settlement; otherwise, it is equal to zero. It serves as a proxy for long-term economic security and the ability to make sustained contributions.
Has assets or savings for retirement		✓	✓	✓		This is a dummy variable that equals one if the respondent reports having savings or assets intended for old-age security, including livestock, financial savings, or property. It reflects broader economic capacity beyond current income.
Years of schooling	✓	✓	✓	✓	✓	Years of education completed (population aged 19 and over). Education improves understanding of pension rules, increases income potential, and facilitates long-term financial planning.
Illiterate	✓	✓	✓	✓	✓	This is a dummy variable that is equal to one if the respondent cannot read or write, and zero otherwise. This indicates significant informational and procedural disadvantages.
Age	✓	✓	✓	✓	✓	This is a continuous variable that captures completed years of age. Older adults tend to have more stable employment, a higher income, and stronger incentives to form affiliations.
Young		✓	✓	✓	✓	This is a dummy variable equal to one for individuals aged 18–29. Younger workers often have liquidity constraints and biases that reduce their early participation in the pension system.
Marital status M	✓	✓	✓	✓	✓	This is a set of dummy variables, each of which is equal to one for individuals whose marital status is M (married/cohabiting, or widowed). They capture family-related financial obligations and eligibility for survivor benefit provisions. Both of these factors affect affordability and acceptability.
Distrusts AFPs	✓		✓	✓		This is a dummy variable that is equal to one when the main self-reported reason for non-affiliation is distrust of AFPs. It represents a central acceptability barrier.
S Identity			✓	✓	✓	This is a set of dummy variables, each of which is equal to one for individuals who self-identify as S (Aymara, Quechua, or Guaraní). These indicators capture the ethnic and cultural factors that shape acceptability of and perceptions about the pension system.

Source: Own elaboration.

The variables in Table 2 reflect the multidimensional nature of affiliation decisions in the contributory component of the Bolivian pension system. No single variable can capture access alone. Each variable contributes to a distinct mechanism that enables or restricts participation. Variables like self-employed, salaried worker, urban area, and the presence of an AFP office capture institutional and logistical conditions central to *accessibility*. Indicators of information and digital connectivity, such as internet use or knowledge of AFP operations, proxy informational frictions that affect individuals' ability to navigate the system.

Measures of household economic capacity, such as the income-contribution ratio, poverty status, labor income per capita, and the dependent-children ratio, inform *affordability*. These variables reflect households' ability to meet minimum contribution requirements, manage liquidity constraints, and sustain contributions over time. Ownership of housing or assets shows longer-term financial security, which is relevant for contributory participation. The *acceptability* dimension appears in perceptions, expectations, and sociocultural preferences, including distrust of AFPs, lack of system knowledge, ethnolinguistic identity, and behavioral traits linked to age or household structure. These variables distinguish workers who are institutionally or economically able to affiliate from those who refrain because of credibility concerns, misaligned expectations, or alternative saving norms.

By integrating these variables across the three dimensions of effective access, the table shows how the conceptual framework is operationalized in both survey years. The table also highlights the unique contributions of the two survey years: 2005 captures informational and behavioral constraints directly, while 2019 provides a richer account of structural determinants related to demographics, income, employment, and sociocultural context. Together, these variables enable a consistent, multidimensional empirical analysis of the determinants of affiliation.

4.1 Descriptive Statistics

Table 3 presents the 2005 descriptive statistics, showing notable differences across demographic groups and employment categories. These differences inform the affiliation patterns discussed later. Urban affiliation rates were low at 20%, with women slightly less likely to be affiliated than men. Employment structure was important: about 40% of urban workers were self-employed and 7% were unpaid, both outside mandatory enrollment. Only 46% lived in a municipality with an AFP office, indicating significant geographical barriers. Informational barriers were also common: 43% of respondents lacked adequate knowledge of AFP operations, and fewer than 5% used the internet when digital channels were still emerging.

Socioeconomic indicators also reveal high heterogeneity. The coefficient of variation for labor income per capita is large for the 2005 sample, consistent with the segmentation between informal self-employment and more stable salaried work. Job tenure averaged 75 months, but there was substantial dispersion. Educational attainment averaged about 10 years, though illiteracy persisted even in urban areas. Household structure also varied; the dependent-children ratio averaged 0.44, and 73% of households reported owning assets or savings for old age.

Table 3: Descriptive Statistics for Urban Areas - 2015 Household Survey

	Urban			Urban Women			Urban Men		
Variable	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Affiliated	0.196	0.397	2.025	0.182	0.386	2.120	0.207	0.405	1.958
Self-employed	0.404	0.491	1.214	0.444	0.497	1.119	0.374	0.484	1.295
Unpaid worker	0.073	0.260	3.567	0.114	0.317	2.794	0.042	0.200	4.807
AFP office	0.456	0.498	1.093	0.470	0.499	1.063	0.445	0.497	1.116
Lacks AFP information	0.425	0.494	1.164	0.460	0.499	1.085	0.398	0.490	1.231
Uses internet	0.049	0.217	4.386	0.063	0.242	3.870	0.039	0.194	4.948
Job tenure	75.48	85.41	1.13	75.10	84.05	1.12	75.77	86.47	1.14
Income-to-contributions ratio	23.59	35.86	1.52	16.36	21.20	1.30	29.15	43.12	1.48
Not enough money	0.528	0.499	0.945	0.508	0.500	0.985	0.544	0.498	0.916
Labor income per capita	741.53	1028.25	1.39	748.68	1002.67	1.34	736.02	1047.77	1.42
Dependent ratio	0.436	0.521	1.194	0.414	0.527	1.273	0.453	0.515	1.138
Has assets/savings	0.732	0.443	0.605	0.728	0.445	0.611	0.735	0.442	0.601
Years of schooling	9.983	4.741	0.475	9.429	5.128	0.544	10.410	4.375	0.420
Illiterate	0.028	0.164	5.940	0.050	0.217	4.382	0.011	0.103	9.638
Age	35.001	10.198	0.291	35.401	10.205	0.288	34.694	10.185	0.294
Age squared	1329.06	741.64	0.56	1357.26	744.30	0.55	1307.34	739.06	0.57
Head of household	0.503	0.500	0.994	0.226	0.418	1.852	0.717	0.451	0.629
Young	0.348	0.476	1.369	0.328	0.470	1.433	0.363	0.481	1.324
Student	0.130	0.336	2.588	0.136	0.343	2.519	0.125	0.331	2.646
Married/cohabiting	0.666	0.472	0.709	0.606	0.489	0.807	0.712	0.453	0.637
Widowed	0.017	0.131	7.510	0.035	0.184	5.256	0.004	0.063	15.933
Distrusts AFP	0.108	0.310	2.878	0.093	0.291	3.120	0.119	0.324	2.723
Aymara identity	0.100	0.301	2.993	0.114	0.317	2.794	0.090	0.287	3.175
Quechua identity	0.124	0.330	2.656	0.133	0.340	2.551	0.117	0.322	2.745
Female	0.435	0.496	1.140	–	–	–	–	–	–

Note: SD: Standard deviation; CV: Coefficient of variation.

Source: Own based on the 2005 Household Survey (INE-Bolivia).

The demographic characteristics in 2005 are consistent with expected patterns. The average age was 35, with a similar distribution across sexes. One-third of adults were between 18 and 29 years old, and two-thirds were married or cohabiting. Behavioral and sociocultural factors were present. Distrust in AFPs was reported by 11% of respondents, and around 10% identified as Aymara or Quechua. This highlights the importance of contextual factors in pension-related decision-making.

Table 4 presents descriptive statistics for 2019, disaggregated by area of residence and sex. It reveals differences in labor-market participation, access to information, income, and human capital. Affiliation rates show a pronounced urban-rural gradient: 28% of urban workers were affiliated, compared to 11% of rural workers. Gender differences within urban areas were modest, while rural men had slightly higher affiliation rates than rural women. Employment patterns differed substantially; self-employment and unpaid work were much more common in rural areas.

One of the largest disparities is in access to information. Over 70% of urban respondents used the internet, compared with just 31% in rural areas. Although women in both areas reported slightly lower usage, the rural–urban gap overshadowed gender differences. Job tenure was substantially higher in rural areas due to more stable, albeit less formal, occupational trajectories. Income-related indicators further contrast the two settings. Labor income per capita was higher in urban areas, while the poverty incidence was nearly twice as high in rural areas. The income-contribution ratio also differed markedly, suggesting a more limited ability to contribute regularly among rural workers.

Table 4: Descriptive Statistics - 2019 Household Survey

	Urban			Rural			Urban Women			Urban Men			Rural Women			Rural Men		
Variable	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Affiliated	0.283	0.450	1.593	0.110	0.313	2.839	0.262	0.440	1.679	0.299	0.458	1.530	0.096	0.294	3.076	0.121	0.327	2.690
Self-employed	0.422	0.494	1.169	0.516	0.500	0.969	0.406	0.491	1.211	0.436	0.496	1.138	0.354	0.478	1.351	0.637	0.481	0.756
Unpaid worker	0.065	0.247	3.782	0.271	0.445	1.641	0.103	0.304	2.950	0.036	0.185	5.200	0.496	0.500	1.009	0.103	0.303	2.959
Uses internet	0.710	0.454	0.639	0.310	0.463	1.492	0.681	0.466	0.684	0.733	0.442	0.604	0.256	0.437	1.704	0.350	0.477	1.363
Job tenure	76.21	80.46	1.06	133.95	116.44	0.87	70.90	78.32	1.10	80.39	81.87	1.02	136.05	114.48	0.84	132.37	117.90	0.89
Income-to-contributions ratio	11.230	8.713	0.776	6.431	7.838	1.219	9.007	7.843	0.871	12.977	8.963	0.691	3.430	6.052	1.765	8.679	8.260	0.952
Poor	0.248	0.432	1.742	0.474	0.499	1.053	0.243	0.429	1.765	0.252	0.434	1.725	0.516	0.500	0.969	0.444	0.497	1.120
Labor income per capita	1837.65	1496.94	0.81	1102.22	1258.79	1.14	1807.33	1371.88	0.76	1861.49	1588.04	0.85	1005.22	1099.74	1.09	1174.88	1361.63	1.16
Years of schooling	11.892	4.368	0.367	7.784	4.512	0.580	11.641	4.772	0.410	12.089	4.013	0.332	7.055	4.779	0.677	8.330	4.221	0.507
Dependent ratio	0.374	0.480	1.283	0.472	0.556	1.177	0.379	0.512	1.350	0.370	0.454	1.225	0.505	0.598	1.183	0.448	0.522	1.165
Illiterate	0.008	0.091	10.922	0.064	0.245	3.818	0.016	0.126	7.788	0.002	0.046	21.811	0.107	0.309	2.888	0.032	0.176	5.493
Age	35.95	10.01	0.28	36.84	10.85	0.29	36.27	10.03	0.28	35.69	9.98	0.28	37.42	10.79	0.29	36.41	10.89	0.30
Age squared	1392.28	737.69	0.53	1475.26	800.51	0.54	1416.00	741.93	0.52	1373.63	733.86	0.53	1516.54	797.09	0.53	1444.35	801.90	0.56
Head of household	0.541	0.498	0.921	0.535	0.499	0.932	0.303	0.460	1.515	0.728	0.445	0.612	0.230	0.421	1.833	0.764	0.424	0.555
Young	0.302	0.459	1.521	0.297	0.457	1.539	0.290	0.454	1.567	0.311	0.463	1.487	0.270	0.444	1.645	0.317	0.465	1.469
Student	0.114	0.318	2.790	0.055	0.229	4.131	0.126	0.332	2.631	0.104	0.305	2.934	0.064	0.244	3.842	0.049	0.217	4.393
Married/cohabiting	0.631	0.483	0.765	0.740	0.439	0.594	0.569	0.495	0.871	0.680	0.466	0.686	0.734	0.442	0.603	0.744	0.437	0.587
Widowed	0.015	0.122	8.055	0.015	0.121	8.176	0.025	0.158	6.187	0.007	0.084	11.825	0.030	0.170	5.704	0.003	0.059	17.029
Aymara identity	0.064	0.245	3.828	0.128	0.334	2.613	0.069	0.254	3.662	0.060	0.237	3.974	0.156	0.363	2.326	0.107	0.309	2.896
Quechua identity	0.098	0.297	3.033	0.362	0.481	1.329	0.102	0.302	2.973	0.095	0.294	3.083	0.381	0.486	1.275	0.347	0.476	1.371
Female	0.440	0.496	1.128	0.428	0.495	1.156	-	-	-	-	-	-	-	-	-	-	-	-

Note: SD: Standard deviation; CV: Coefficient of variation.

Source: Own based on the 2019 Household Survey (INE-Bolivia).

Patterns of human capital reflect longstanding inequalities. Urban adults averaged nearly 12 years of schooling, compared with fewer than eight in rural areas. Illiteracy was concentrated in rural populations. Household structures differed: dependency ratios were higher in rural areas, and married or cohabiting individuals were more common. Widowhood rates were low overall but higher among rural women. Ethnolinguistic markers followed expected geographic patterns. Aymara and Quechua identities were much more prevalent in rural areas, especially among women. These factors highlight the sociocultural context for pension decisions.

Overall, the 2019 descriptive statistics highlight persistent structural differences between urban and rural populations. While gender differences exist, they are smaller than regional disparities. These contrasts provide essential context for interpreting the econometric results.

5 Empirical Strategy

This section outlines the econometric strategy to identify factors determining *effective access* to the contributory component of Bolivia's pension system. The goal is to quantify the impact of labor market structures, affordability constraints, informational frictions, and sociocultural factors on affiliation probability. Three empirical challenges arise: (*i*) the binary nature of the affiliation outcome, (*ii*) affiliation observed only for employed individuals in the Households Surveys samples, raising concerns about non-random selection, and (*iii*) perfect or near-perfect prediction for key variables in specific subsamples. To address these, we use three complementary estimators: Probit, Heckprobit, and Firth-Logit. We interpret all results using gender-specific average marginal effects.

5.1 Baseline Probit Model

Let D_i denote an indicator equal to one if individual i is affiliated with a Pension Fund Administrator (AFP)[3] and zero otherwise. Each individual's decision to participate in the contributory component of the pension system (i.e., affiliate) is represented by the latent index:

$$D_i = \mathbb{1}(D_i^* > 0), \qquad D_i^* = X_i\beta + \varepsilon_i, \tag{1}$$

where X_i contains the covariates that capture the three dimensions of effective access stipulated in Section 3: *accessibility* (employment category, geographical and digital access, information), *affordability* (income, poverty, dependency burdens), and *acceptability* (trust, behavioral traits, cultural identity). Intuitively, equation (1) assumes affiliation results from an underlying, unobservable decision process. Each individual i has a latent, continuous propensity D_i^* to affiliate, which changes according to the characteristics in X_i. When this latent propensity crosses zero, the individual is observed as affiliated ($D_i = 1$). If the propensity stays below zero, the individ-

[3]Private AFPs administered pension funds in Bolivia during the analyzed years of 2005 and 2019. Later, in 2023, the *Gestora Pública*, a public entity, took over. Therefore, the analysis reflects the prevailing institutional environment in which the data used in this study were collected.

ual is observed as unaffiliated ($D_i = 0$). Thus, the binary outcome reflects a continuous decision that is only partially observed. The random term ε_i captures all factors affecting the affiliation decision not included in the observed covariates.

Given D_i, the baseline probability model is the standard Probit:

$$\Pr(D_i = 1 \mid X_i) = \Phi(X_i\beta), \tag{2}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function. The Probit model is a flexible and intuitive method for translating latent propensity into observable probability. The cumulative distribution function maps the real line to the interval $[0, 1]$ in a smooth, monotonic, S-shaped way. This means changes in $X_i\beta$ have the strongest impact near the middle of the distribution, where the curve is steepest, and smaller impacts at the tails.

This last feature aligns with the Bolivian context, where informality, poverty, liquidity constraints, and distrust are expected to impact affiliation decisions in nonlinear ways. For instance, self-employed individuals and unpaid family workers frequently fall below the affiliation threshold. Consequently, better information about AFPs or higher income results in only modest increases in affiliation probability. In contrast, salaried workers, who are closer to mandatory enrollment and have greater job stability, experience more significant changes in affiliation probability when affordability or trust factors vary. However, the Probit estimator becomes unreliable in subsamples where certain variables almost perfectly predict non-affiliation, as seen in 2005 and among rural men in 2019. This motivates the use of complementary estimators.

5.2 Correcting for Non-Random Selection: Heckprobit

Household surveys only collect information on pension affiliation for individuals who report being employed at the time of the interview. This creates a fundamental empirical challenge because affiliation outcomes are never observed for individuals outside the labor force. Therefore, they cannot be directly compared with employed individuals. If the factors influencing employment also affect affiliation, then the observed worker sample is not randomly selected. In such cases, a standard probit model confounds the determinants of affiliation with the determinants of labor force participation, producing biased estimates.

To address this problem, we use a *Heckprobit* model (Van de Ven and Van Praag, 1981), which, unlike equation (1), separates affiliation from employment. It assumes two latent processes:

$$D_i^* = X_i\beta + \varepsilon_{1i}, \tag{3}$$

$$S_i^* = Z_i\gamma + \varepsilon_{2i}, \tag{4}$$

where D_i^* captures the latent propensity to affiliate and S_i^* captures the latent propensity to be employed. We observe D_i only when $S_i^* > 0$. The error terms $(\varepsilon_{1i}, \varepsilon_{2i})$ follow a bivariate

normal distribution:

$$(\varepsilon_{1i}, \varepsilon_{2i})' \sim \mathcal{N}\left(0, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}\right).$$

and the correlation coefficient ρ plays a central role. If $\rho \neq 0$, the unobserved factors influencing employment also influence affiliation, confirming that the observed sample is not random. A statistically significant ρ therefore justifies the Heckprobit correction. Identification relies on exclusion restrictions in Z_i that affect employment but not pension affiliation conditional on employment. Following labour-market theory and prior Bolivian evidence, these include youth indicators, student status, and household-role variables.

5.3 Addressing Perfect Prediction: Firth–Logit

In some subsamples, certain variables predict non-affiliation almost perfectly. For instance, the 2005 data show that workers who lack pension information or distrust AFPs are nearly all non-affiliates. These situations create perfect or quasi-perfect separation. Under perfect separation, standard Probit and Logit estimators try to assign infinitely large coefficients to perfectly predictive variables because this continuously improves the likelihood. As a result, maximum-likelihood estimates fail to converge, and the model produces no meaningful results.

To address this empirical challenge, we use the penalized likelihood estimator proposed by Firth (1993) and adapted to logistic regression by Heinze and Schemper (2002). The key idea is to adjust the standard likelihood so the coefficients do not diverge. The Firth estimator maximizes the modified objective function:

$$\ell^*(\beta) = \ell(\beta) + \tfrac{1}{2}\log\left|I(\beta)\right|, \tag{5}$$

where $\ell(\beta)$ is the standard log-likelihood and $I(\beta)$ is the Fisher information matrix. The last penalty term ensures that estimates are finite and well-behaved under separation and rare events. In our empirical setting, this correction is essential because rare but meaningful events, such as affiliation among specific groups, must be analyzed without letting separation dominate estimation. We apply the Firth–Logit estimator only in subsamples where separation is empirically detected, specifically the 2005 survey. This ensures comparability across specifications and preserves valid inference for variables that would otherwise cause standard models to fail.

Finally, since coefficients from nonlinear binary dependent variable models cannot be directly interpreted as changes in probability, we rely on average marginal effects (AMEs) to quantify the impact of each factor on affiliation.

$$\text{AME}_k = \frac{1}{N}\sum_{i=1}^{N} \frac{\partial \Pr(D_i = 1 \mid X_i)}{\partial X_{ik}}.$$

AMEs enable consistent comparisons across variables, survey years, and population subgroups. They also provide direct, policy-relevant interpretations of estimated relationships. For Heck-

probit models, AMEs are computed conditional on employment, ensuring that all effects are evaluated on a common, comparable scale. These AMEs are presented in Section 6. Because of significant gender disparities in Bolivia's labor market, including employment trajectories, income profiles, caregiving responsibilities, and access to information, we present all AMEs separately for men and women. This disaggregation helps identify structural drivers of gender gaps in affiliation instead of attributing observed differences to inherent individual characteristics.

Therefore, Probit, Heckprobit, and Firth-Logit form an empirical strategy that addresses three main data challenges: the nonlinear nature of affiliation decisions, nonrandom selection of employed individuals, and rare-event behavior leading to perfect prediction. This approach aligns with the conceptual framework and supports the empirical findings in the next section.

6 Results

This section presents empirical results on the determinants of affiliation to the contributory component of the Bolivian pension system, using the conceptual framework of *effective access* and the econometric methodology presented above. The dependent variable is binary, so the coefficients from the Probit, Heckprobit, and Firth-Logit models show direction and statistical significance, but not direct changes in probabilities. Interpretation relies on the corresponding marginal effects. We also report the gender-specific averages of key covariates to highlight the heterogeneous patterns of effective access. The discussion is organized into three parts: (*i*) 2005 (urban), (*ii*) 2019 (urban), and (*iii*) 2019 (rural), followed by a comparative synthesis.

6.1 Results for 2005 (Urban Areas)

The 2005 urban results in Table 5 show a consistent pattern across the Probit, Heckprobit, and Firth-Logit estimators. Though they address different empirical challenges, the estimators converge on a similar set of constraints shaping *effective access*. Occupational status, financial feasibility, and informational and trust-related variables all emerge as central determinants of affiliation. These patterns are easier to interpret in probability terms using the marginal effects in Table 6 and the gender-specific covariate averages in Table 7.

The first key result in Table 5 concerns occupational structure. Self-employment and unpaid family work are consistently and negatively associated with affiliation. The marginal effects in Table 6 show that self-employment reduces the probability of affiliation by about 0.18 to 0.24, depending on gender and estimator, compared to salaried employment. This reflects the design of the contributory component of the Bolivian pension system. Salaried workers are automatically enrolled through payroll withholding, whereas non-salaried workers must voluntarily approach AFPs and complete administrative steps (Gamboa, 2023). Table 7 shows that over 40% of the urban workforce was self-employed in 2005, highlighting the importance of accessibility barriers caused by labor-market segmentation.

Informational constraints are an additional, highly influential factor. Variables capturing lack of knowledge about AFP procedures almost perfectly predict non-affiliation. This appears in Table 5, where, as explained in Subsection 5.3, residualization or Firth correction is needed. Even after these corrections, information-related variables remain among the strongest predictors of affiliation. The marginal effects in Table 6 show reductions of more than 17 percentage points for women and over 30 percentage points for men. This underscores the central role of informational accessibility when financial literacy, internet access, and institutional outreach are limited.[4] The descriptive evidence in Table 7, showing very low internet usage and limited exposure to formal financial channels, supports this interpretation.

Financial feasibility also plays a substantial role. Workers who report "not having enough money to affiliate" are significantly less likely to join, and this association remains strong across all estimators in Table 5. The income-to-contribution ratio, which reflects the capacity to make regular contributions, enters with the expected positive sign. Table 6 shows that these *affordability* constraints have stronger marginal effects for women, consistent with Table 7, where women have a lower average ratio and a higher incidence of informal employment.

Trust-related factors reinforce these patterns. Individuals who distrust AFPs have significantly lower affiliation probabilities. Table 6 shows that distrust has a stronger negative impact among men, which matches their higher baseline levels of distrust in Table 7. In contrast, sociocultural indicators such as Indigenous identity did not show statistically robust associations in 2005. This may reflect measurement limitations, lower visibility of ethnic identity in urban labor markets at the time, or the limited institutional presence of the pension system among Indigenous workers before more recent financial inclusion efforts.

Demographic and human capital variables behave as expected. Higher education and older age are associated with a greater propensity to affiliate, as shown in Table 5. Table 6 confirms that both translate into positive marginal effects. These effects tend to be slightly larger for men, which is consistent with their greater representation in formal jobs, as documented in Table 7. The gender dummy itself is not statistically significant in any model, suggesting that gender disparities in observed affiliation rates stem from structural differences in employment, earnings, and access to information rather than from gender itself.

Together, Tables 5, 6, and 7 depict an ineffective pension system constrained by labor-market segmentation and pervasive informational and financial barriers. These constraints are linked to occupational status, affordability tied to income and liquidity, and acceptability related to distrust. They create a set of obstacles that reinforce each other, limiting effective access to pensions. Gender differences in affiliation probabilities largely reflect differences in the distribution of these structural and informational factors rather than behavioral differences. Overall, the 2005 results portray a system whose reach was sharply limited beyond the formal sector.

[4] Herrera and Muriel (2024) present evidence from a pilot intervention involving financial and pension education for informal agricultural producers in Bolivia. They show that participants, especially women, began formulating and diversifying retirement plans after learning about the pension system and long-term savings. This reduced the prevalence of having no retirement strategy and increased interest in affiliating with the pension system.

Table 5: Determinants of Effective Access to the Pension System (EH, 2005)

	(1)	(2)	(3)	(4)	(5)	(6)
Self-employed	-1.446***	-1.412***	-1.309***	-1.444***	-1.398***	-1.303***
	(0.100)	(0.098)	(0.205)	(0.100)	(0.098)	(0.205)
Unpaid worker	-2.611***	-2.443***	-3.032***	-2.610***	-2.383***	-3.029***
	(0.500)	(0.490)	(0.882)	(0.499)	(0.482)	(0.882)
Lacks AFP info (residual)	-2.153***	-2.090***		-2.153***	-2.060***	
	(0.113)	(0.114)		(0.114)	(0.117)	
Lacks AFP info (dummy)			-9.256***			-9.013***
			(2.191)			(2.022)
Job tenure	0.002***	0.002***	0.003***	0.002***	0.002***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Income-to-contributions ratio	0.003***	0.003***	0.013***	0.003***	0.003***	0.012***
	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.004)
Not enough money	-1.690***	-1.655***	-2.947***	-1.695***	-1.622***	-2.966***
	(0.107)	(0.107)	(0.183)	(0.107)	(0.110)	(0.185)
Dependent ratio	0.372***	0.324***	0.750***	0.368***	0.320***	0.742***
	(0.078)	(0.078)	(0.153)	(0.078)	(0.077)	(0.154)
Years of schooling	0.085***	0.081***	0.099***	0.086***	0.079***	0.101***
	(0.011)	(0.011)	(0.020)	(0.011)	(0.011)	(0.020)
Age	0.030***	0.027***	0.050***	0.030***	0.026***	0.050***
	(0.004)	(0.005)	(0.010)	(0.004)	(0.004)	(0.010)
Distrusts AFPs (residual)	-2.827***	-2.764***		-2.837***	-2.707***	
	(0.122)	(0.125)		(0.125)	(0.133)	
Distrusts AFPs (dummy)			-7.298***			-7.296***
			(1.434)			(1.430)
ρ (Selection)		-0.411***			-0.504***	
		(0.118)			(0.124)	
Female				-0.055	0.119	-0.152
				(0.077)	(0.080)	(0.170)
Constant	-2.420***	-2.098***	-2.181***	-2.401***	-2.055***	-2.131***
	(0.223)	(0.242)	(0.452)	(0.224)	(0.241)	(0.455)
Observations	3,156	7,447	3,156	3,156	7,447	3,156

Note: The dependent variable is affiliation to a AFP. Columns (1), (2), and (3) report estimates from a Probit model, a Heckprobit model, and a Firth-logit model, respectively. Columns (4), (5), and (6) replicate these models, adding a dummy variable for biological female sex. All variables are defined in Table 2. To avoid perfect prediction as described in subsection 5.3, the variables "Lacks AFP information" and "Distrusts AFPs" are included in residualized form, i.e., each variable is first regressed on wage-employee status using a Probit model. The predicted value is then subtracted from the original value, and the resulting residual is used as regressor. Robust standard errors are reported in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

6.2 Results for 2019 (Urban Areas)

The results for the 2019 urban sample in Table 8 show patterns consistent with the 2005 results and reflect major socioeconomic and institutional changes over the past decade. The Probit and Heckprobit estimates yield similar signs and levels of statistical significance for most covariates, indicating a stable underlying structure of determinants. At the same time, several shifts are evident. Digital access has become more important, sociocultural characteristics have gained salience, and the magnitude of some affordability constraints has changed with the evolving income distribution. These developments are most evident in the marginal effects in Table 9,

Table 6: Marginal Effects (EH, 2005)

	Women			Men	
	dy/dx	[95% C.I.]		dy/dx	Signif. Diff.
Self-employed	-0.203	-0.249	-0.157	-0.194	
Unpaid worker	-0.202	-0.226	-0.177	-0.195	
Lacks AFP info (residual)	-0.172	-0.211	-0.133	-0.319	✓
Job tenure	0.000	0.000	0.000	0.000	
Income-to-contributions ratio	0.001	0.000	0.001	0.000	
Not enough money	-0.229	-0.282	-0.176	-0.269	
Dependent ratio	0.020	-0.000	0.041	0.038	
Years of schooling	0.008	0.005	0.011	0.011	
Age	0.002	0.001	0.003	0.005	✓
Distrusts AFPs (residual)	-0.198	-0.238	-0.158	-0.430	✓

Note: The average marginal effects were obtained from Heckprobit models that were corrected for selection. These models were estimated separately for urban women and men aged ten and older.

Table 7: Differences in Averages by Gender (EH, 2005)

	Women	Men	Total
Affiliated	0.182	0.207	0.196
Self-employed	0.444	0.373	0.404
Unpaid worker	0.114	0.042	0.073
Lacks AFP info	0.459	0.398	0.425
Job tenure	75.100	75.767	75.477
Income-to-contributions ratio	16.359	29.150	23.586
Not enough money	0.508	0.544	0.528
Dependent children to adults ratio	0.414	0.453	0.437
Years of schooling	9.429	10.410	9.983
Age	35.401	34.693	35.001
Distrusts AFPs	0.093	0.119	0.108

Note: Mean values are computed using the urban subsample of the 2005 Household Survey.

when interpreted with the gender-specific averages in Table 10.

The occupational structure remains central. Self-employed individuals and unpaid family workers have significantly lower affiliation probabilities, and these effects persist even when accounting for selection. Table 9 shows that unpaid employment reduces affiliation probabilities by about 0.13 to 0.19, depending on gender. However, these penalties are smaller than in 2005. Nevertheless, the results suggest that voluntary participation remains challenging for non-salaried workers despite broader economic growth and administrative reforms.

Informational constraints do not disappear but change form. Although direct questions about knowledge of AFP procedures are no longer available in 2019, internet access has become a strong predictor of affiliation. Table 8 shows a positive and statistically significant relationship between having internet access and affiliation. Table 9 indicates that internet access increases predicted affiliation by several percentage points for both men and women. These results reflect a shift toward digital accessibility, consistent with the growing importance of online information

channels, virtual platforms, and mobile financial services. Table 10 shows that internet access was more common among urban men than women in 2019, which partly explains the gender difference in affiliation rates, even when marginal responses are similar.

Affordability continues to exert a strong influence. In Table 8, the income-to-contribution ratio remains positively associated with affiliation, and the marginal effects in Table 9 confirm that liquidity and earnings capacity are key determinants of contribution behavior. Poverty status is strongly and negatively associated with affiliation, reducing predicted probabilities by roughly six to eight percentage points, depending on gender. Sociocultural characteristics become more salient. Table 8 shows that identifying as Aymara significantly reduces the likelihood of affiliation among urban workers, even after controlling for occupation, income, and other characteristics. The marginal effects in Table 9 show a slightly stronger negative association for men, consistent with the patterns in Table 10. These results suggest that acceptability constraints related to perceptions of institutional reliability, compatibility with traditional savings norms, and experiences with public programs are more visible in 2019 than in 2005.

Demographic and human capital variables retain their expected influence. Education is strongly and positively associated with affiliation. Table 9 indicates that each additional year of schooling increases the predicted probability of affiliation by around two percentage points for both genders. Consistent with delayed labor-market consolidation and shorter planning horizons among new entrants, younger urban workers (ages 18–29) are significantly less likely to affiliate. As in 2005, the gender dummy variable is not statistically significant after controlling for the effects of other variables. This indicates that the observed gender gaps in affiliation reflect differences in occupational structure, income, and digital access rather than a direct effect of gender.

Tables 8, 9, and 10 collectively depict the urban pension landscape in 2019, which was still constrained by accessibility and affordability but was also influenced by digital inclusion and the increased visibility of sociocultural diversity. Self-employment and unpaid work continue to limit access, while liquidity constraints and poverty remain central issues. At the same time, internet access emerges as a meaningful facilitator of affiliation, and Indigenous identity becomes a clearer marker of acceptability-related barriers. As in 2005, gender differences in predicted probabilities stem from disparities in covariate distributions rather than differential marginal responses. Thus, the 2019 urban results depict a system in transition where longstanding structural barriers coexist with new patterns linked to digital access and cultural diversity.

6.3 Results for 2019 (Rural Areas)

The 2019 rural results in Table 11 show patterns similar to the urban results, but the differences are much more pronounced. The rural pension environment has low affiliation rates, high levels of informal and non-remunerated work, and significant structural and sociocultural constraints. Occupational structure is again the dominant factor, with much larger effects than in urban areas. Self-employment and unpaid family work are linked to extremely low affiliation probabilities. Table 12 shows that self-employment reduces affiliation probabilities by roughly 0.22

Table 8: Determinants of Effective Access to the Pension System (EH, 2019 - Urban Areas)

	(1)	(2)	(3)	(4)
Self-employed	-1.437***	-1.439***	-1.438***	-1.438***
	(0.041)	(0.041)	(0.041)	(0.041)
Unpaid worker	-1.060***	-1.042***	-1.059***	-1.042***
	(0.106)	(0.106)	(0.106)	(0.106)
Uses internet	0.249***	0.245***	0.249***	0.245***
	(0.046)	(0.046)	(0.046)	(0.046)
Income-to-contributions ratio	0.046***	0.045***	0.046***	0.045***
	(0.003)	(0.003)	(0.003)	(0.003)
Poor	-0.224***	-0.223***	-0.225***	-0.222***
	(0.046)	(0.046)	(0.046)	(0.046)
Years of schooling	0.118***	0.116***	0.118***	0.116***
	(0.006)	(0.006)	(0.006)	(0.006)
Age	0.025***	0.025***	0.027***	0.025***
	(0.003)	(0.003)	(0.003)	(0.003)
Young	-0.217***	-0.204***	-0.218***	-0.203***
	(0.056)	(0.056)	(0.055)	(0.056)
Aymara	-0.314***	-0.325***	-0.315***	-0.325***
	(0.079)	(0.080)	(0.079)	(0.079)
Female			-0.012	0.008
			(0.033)	(0.034)
ρ (Selection)		-0.076*		-0.079**
		(0.039)		(0.040)
Constant	-3.073***	-3.034***	-3.068***	-3.036***
	(0.141)	(0.142)	(0.141)	(0.142)
Observations	11,066	24,676	11,066	24,676

Note: The dependent variable is affiliation to a AFP. Columns (1) and (2) report estimates from a Probit model and a Heckprobit model, respectively. Columns (3) and (4) replicate these models, adding a dummy variable for biological female sex. All variables are defined in Table 2. Robust standard errors are reported in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

to 0.13, depending on gender, a larger difference than in urban settings. This pattern matches Table 13, which shows that over two-thirds of rural workers are self-employed and about one-quarter are unpaid family workers. These conditions severely restrict accessibility in a system designed mainly for salaried urban employment.

Informational constraints appear differently in rural areas. While AFP-specific information variables are unavailable, internet access again serves as a proxy for informational connectivity. Table 11 shows a positive and significant relation between internet use and affiliation. Table 12 indicates that using internet increases predicted affiliation by several percentage points. Table 13 highlights the rural digital divide: Internet access is low and unevenly distributed, with rural men more likely than rural women to have access.

Sociocultural characteristics strongly influence rural areas. Identifying as Aymara significantly reduces affiliation in Table 11, and these effects remain after controlling for occupation, income,

Table 9: Marginal Effects (EH, 2019 - Urban Areas)

	Women			Men	
	dy/dx	[95% C.I.]		dy/dx	Signif. Diff.
Self-employed	-0.278	-0.298	-0.257	-0.331	✓
Unpaid worker	-0.129	-0.162	-0.096	-0.199	✓
Uses internet	0.034	0.010	0.058	0.060	✓
Income-to-contributions ratio	0.011	0.009	0.012	0.008	✓
Poor	-0.059	-0.083	-0.035	-0.036	✓
Years of schooling	0.021	0.019	0.023	0.024	✓
Age	0.004	0.003	0.006	0.006	✓
Young	-0.029	-0.057	-0.000	-0.049	✓
Aymara	-0.013	-0.063	0.037	-0.087	✓

Note: The average marginal effects were obtained from Heckprobit models that were corrected for selection. These models were estimated separately for urban women and men aged ten and older.

Table 10: Differences in Averages by Gender (EH, 2019 - Urban Areas)

	Women	Men	Total
Affiliated	0.262	0.299	0.283
Self-employed	0.406	0.436	0.422
Unpaid worker	0.103	0.036	0.065
Uses internet	0.681	0.733	0.710
Income-to-contributions ratio	9.006	12.977	11.230
Poor	0.243	0.252	0.248
Years of schooling	11.641	12.089	11.892
Age	36.268	35.693	35.946
Young	0.289	0.311	0.302
Aymara	0.069	0.060	0.064

Note: Mean values are computed using the urban subsample of the 2019 Household Survey.

and demographics. The marginal effects in Table 12 show probability reductions that are among the largest in absolute value outside occupational status. This suggests that acceptability-related barriers, linked to trust in formal institutions, preference for community-based financial practices, and reliance on family support in old age, are deeply rooted.

Demographic and human capital variables function similarly to those in urban areas, but with different strengths. Education is positively associated with affiliation. The marginal effects in Table 12 show that each additional year of schooling increases the probability of affiliation more in rural areas than in urban areas. This aligns with the greater variation in educational levels shown in Table 13, where the difference between urban and rural areas is evident. Younger rural workers are less likely to affiliate, reflecting early-life paths dominated by seasonal, family-based, or agricultural work, which offer few links to the formal contributory system.

Overall, Tables 11, 12, and 13 show a rural affiliation with significant structural, informational, financial, and sociocultural limitations. The occupational structure is the greatest barrier to effective access, followed by affordability and acceptability. Informational access, especially

Table 11: Determinants of Effective Access to the Pension System (EH, 2019 - Rural Areas)

	(1)	(2)	(3)	(4)
Self-employed	-1.251***	-1.243***	-1.221***	-1.224***
	(0.094)	(0.094)	(0.094)	(0.092)
Unpaid worker	-1.796***	-1.812***	-1.949***	-1.933***
	(0.267)	(0.270)	(0.269)	(0.272)
Uses internet	0.528***	0.531***	0.515***	0.508***
	(0.097)	(0.096)	(0.097)	(0.097)
Income-to-contributions ratio	0.046***	0.047***	0.052***	0.052***
	(0.006)	(0.006)	(0.006)	(0.006)
Years of schooling	0.102***	0.102***	0.100***	0.099***
	(0.011)	(0.011)	(0.011)	(0.010)
Age	0.024***	0.023***	0.024***	0.025***
	(0.006)	(0.006)	(0.006)	(0.007)
Young	-0.412***	-0.413***	-0.386***	-0.384***
	(0.150)	(0.150)	(0.151)	(0.151)
Aymara	-0.521***	-0.517***	-0.523***	-0.526***
	(0.145)	(0.145)	(0.142)	(0.142)
Female			0.395***	0.419***
			(0.090)	(0.092)
ρ (Selection)		0.083		-0.100
		(0.119)		(0.116)
Constant	-2.807***	-2.819***	-2.969***	-2.954***
	(0.315)	(0.315)	(0.317)	(0.318)
Observations	3,052	6,861	3,052	3,052

Note: The dependent variable is affiliation to a AFP. Columns (1) and (2) report estimates from a Probit model and a Heckprobit model, respectively. Columns (3) and (4) replicate these models, adding a dummy variable for biological female sex. All variables are defined in Table 2. Robust standard errors are reported in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 12: Marginal Effects (EH, 2019 - Rural Areas)

	Women			Men	
	dy/dx	[95% C.I.]		dy/dx	Signif. Diff.
Self-employed	-0.188	-0.227	-0.148	-0.132	✓
Unpaid worker	-0.183	-0.241	-0.125	-0.184	
Uses internet	0.034	0.009	0.060	0.069	✓
Income-to-contributions ratio	0.003	0.002	0.005	0.006	✓
Years of schooling	0.004	0.002	0.006	0.012	✓
Age	0.001	-0.001	0.002	0.004	
Young	-0.038	-0.066	-0.018	-0.033	
Aymara	-0.014	-0.039	0.010	-0.058	✓

Note: The average marginal effects were obtained from Heckprobit models that were corrected for selection. These models were estimated separately for urban women and men aged ten and older.

digital connectivity, plays a smaller but meaningful role. The 2019 rural results show a system that struggles to reach large segments of the rural workforce. There are pronounced disparities rooted in labor-market structure, poverty, and sociocultural distance from formal institutions.

Table 13: Differences in Averages by Gender (EH, 2019 - Rural Areas)

	Women	Men	Total
Affiliated with the AFPs	0.096	0.121	0.110
Self-employed	0.354	0.637	0.516
Unpaid worker	0.496	0.103	0.271
Uses internet	0.256	0.350	0.310
Income-to-contributions ratio	3.430	8.679	6.431
Years of schooling	7.055	8.330	7.784
Age	37.420	36.413	36.844
Young	0.270	0.317	0.297
Aymara	0.156	0.107	0.128

Note: Mean values are computed using the rural subsample of the 2005 Household Survey.

6.4 Comparative Synthesis Across Years and Areas

Comparing the results from 2005 and 2019 (urban and rural) reveals both enduring regularities and shifts in the determinants of *effective access*. Across all three contexts, occupational structure is the most influential factor in affiliation (see Tables 5, 8, and 11). Self-employment and unpaid family work have consistently negative effects, reflecting the mismatch between a system built around formal salaried employment and a labor market where non-salaried work is prevalent. While the penalties for unpaid workers declined modestly in urban areas between 2005 and 2019, this reduction is insufficient to offset the underlying structural asymmetry.

Rather than disappearing, informational constraints evolve in form. In 2005, explicit measures of knowledge about AFP procedures yielded a nearly perfect prediction of non-affiliation (Table 5), suggesting severe informational exclusion. By 2019, these variables were no longer available; however, digital access emerged as a key proxy. Internet access was positively and significantly associated with affiliation in both urban and rural areas (Tables 8 and 11). However, the gains were concentrated in urban areas and among men, where digital coverage was much higher (Tables 10 and 13). This left rural populations with persistent informational disadvantages.

Affordability constraints remain central across all years and areas. Poverty, income-to-contribution ratios, and dependency burdens consistently affect affiliation probabilities (see Tables 6, 9, and 12). The persistence of affordability barriers underscores that contributory pensions are largely inaccessible to low-income households unless accompanied by income-stabilization or liquidity-constraint-relief mechanisms.

Acceptability-related factors change over time. In 2005, distrust of AFPs had a clear negative effect on affiliation (see Table 5), while direct trust measures were absent in 2019. Instead, ethnic identity became a stronger indicator of acceptability constraints, especially among rural Indigenous workers (Table 11). These findings suggest that, once basic informational and administrative conditions improve, institutional distance, perceived relevance, and alignment with cultural norms become more visible drivers of contribution behavior.

In all contexts, the gender variable is statistically insignificant when controlled by covariates.

This shows that gender gaps in affiliation result from structural and informational differences, not gender itself. Comparative evidence shows that while access to pensions improved modestly in urban areas between 2005 and 2019, major barriers persist, especially in rural regions. Structural labor-market segmentation, economic vulnerability, and sociocultural distance from formal institutions remain the main obstacles to establishing an inclusive, equitable contributory component of the Bolivian pension system.

7 Conclusions

This study uses detailed microdata from 2005 and 2019 to assess the determinants of *effective access* to the Bolivian contributory pension system. The analysis applies three econometric approaches—Probit, Heckprobit, and Firth-Logit—to identify structural, financial, informational, and sociocultural factors influencing affiliation decisions in urban and rural areas. The results show that the system's contributory design maintains the privilege of formal salaried employment, structurally excluding large segments of the workforce. Although urban access has improved modestly over time, rural areas continue to face persistent and compounded barriers.

Three main conclusions emerge. First, accessibility constraints tied to occupational structure are the main barrier to affiliation. A system focused on stable wage employment does not fit a labor market dominated by self-employment, unpaid family work, and other precarious arrangements. Second, affordability constraints still influence affiliation in all settings. Low earnings, high dependency burdens, and income volatility reduce many workers' capacity to contribute regularly, even when they have access. Third, acceptability and informational factors, such as distrust in institutions, limited financial literacy, sociocultural norms, and unequal digital access, reinforce and amplify existing disparities in pension participation.

These findings imply that expanding *effective access* requires reforms beyond incremental administrative improvements. Policies that offer stronger incentives for voluntary contributors, expand financial inclusion tools, and consider sociocultural norms and perceptions can help bridge structural gaps. Similarly, reducing informational and digital divides, especially in rural and Indigenous communities, is crucial so potential contributors can navigate the system, understand its rules, and evaluate its advantages.

Although the data predate the transition to the public pension fund administrator Gestora Pública, the structural barriers identified here will not disappear without deliberate policy efforts. Changing administrative institutions alone does not alter occupational structures, income constraints, or the sociocultural distance between formal institutions and parts of the population. Future research should examine how ongoing administrative reforms, changes in contribution rules, and expanded digital service platforms affect access. Continued focus on gender, rural–urban disparities, and Indigenous communities is essential to evaluate whether Bolivia's pension system will move toward broader, more equitable coverage or if structural exclusion will persist under new institutional arrangements.

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