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Article

Modeling labor income through ICT use and sociodemographic factors: A linear regression application in Tijuana's urban system

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Abstract: In the context of increasing digitalization and labor market transformation, income generation is influenced by multiple interrelated factors, including education, age, gender, and access to digital technologies. Understanding the impact of these variables is essential for designing equitable and efficient labor systems, particularly in border cities like Tijuana, where migration and urban growth create complex socioeconomic dynamics. This study examines how sociodemographic and technological factors affect workers' income in Tijuana's labor ecosystem. Using a linear regression model applied to survey data from 443 individuals, the analysis finds that age, years of schooling, and computer use have a positive and statistically significant effect on income, while marital status and internet access show no significant relationship. Notably, the model reveals a persistent gender wage gap, with male workers earning significantly more than their female counterparts. These findings highlight the importance of digital competencies and education as system-level drivers of income and suggest the need for targeted public policies to foster wage equity and technological inclusion in emerging urban economies.

1. Introduction

Salaries are a fundamental component of working and employment conditions within productive systems. They represent both a primary labor cost for firms and the main source of income for workers. According to the International Labour Organization (ILO), from an economic standpoint, "wages are an important part of labor costs and are an essential variable for the competitiveness of companies, which needs to be analyzed, also in its relationship with other factors such as employment, productivity, and investment" [1].

In the current landscape of the Mexican labor market, understanding the determinants of wage formation is essential for analyzing broader economic and social dynamics. As the economy becomes increasingly digitized, variables such as age, education, and technology adoption gain importance as drivers of

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productivity and wage differentiation. This article examines how these variables—along with marital status and gender-affect individual income levels in Mexico. Although the analysis focuses on Tijuana, the results may offer insight into broader national trends within urban labor systems undergoing digital transition.

At the international level, numerous studies have sought to identify the key variables that influence salary structures [2], revealing mixed results depending on the socioeconomic and technological context. This study addresses the question: What is the impact of education, marital status, gender, age, and the use of ICT on wage determination in the city of Tijuana?

Tijuana is a prominent migratory hub, serving both as a destination and transit point for individuals seeking improved economic conditions. Its labor market is shaped by a constant influx of internal and international migrants, introducing complex interactions between workforce supply, skill distribution, and wage structures. This dynamic environment presents a unique opportunity to explore how digital integration and demographic characteristics affect income disparities. Understanding these systemic interactions is vital for designing inclusive and adaptive labor policies.

The objective of this research is to analyze the impact of economic and sociodemographic variables on income, with particular attention to the role of digital tools—such as computer and Internet use—as indicators of modernization and digital integration in the workplace. Through a quantitative analytical approach, this study evaluates the nonlinear relationship between age and income, the significance of human capital (education), and the influence of technology use on labor compensation and efficiency.

In addition, the analysis addresses persistent wage disparities related to gender and marital status, emphasizing how these structural inequities manifest within the urban labor ecosystem. By investigating these relationships, the study aims to generate a comprehensive understanding of wage formation mechanisms and contribute to policy development for promoting equity and sustainable economic growth.

2. Literature Review

Wage determination has been the subject of extensive research from various disciplinary perspectives, confirming its multifactorial character. Numerous studies have identified key determinants including education, marital status, gender, and the use of Information and Communication Technologies (ICT) in the workplace [2–4].

Macroeconomic variables such as inflation and unemployment also play a decisive role. In the case of Spain, price levels have been found to be a long-term structural determinant of wages [5]. At the micro level, individual characteristics like age, gender, educational attainment, and nationality substantially shape income, often reflecting systemic inequalities [6].

Organizational and regional factors are equally important. Larger firms typically offer better compensation due to financial strength and economies of scale, while economically lagging regions often struggle with salary stagnation [7]. Beyond monetary compensation, wages are closely associated with job satisfaction and organizational commitment [8], although non-financial aspects like workplace stress and interpersonal relationships are also significant [9].

Despite recent economic crises and labor market disruptions, salary remains a critical motivator for workers [10]. This underscores the importance of maintaining income stability in evolving labor environments.

In the Mexican context, higher education continues to be a powerful predictor of better wages and employment opportunities [11, 12]. The influence of factors such as trade openness, technological change, and labor supply is particularly evident in the manufacturing sector, where these forces generate income disparities across occupational strata [13].

The demand for skilled labor directly influences wage differentiation. In sectors where skilled labor is scarce, wages are typically higher, deepening existing wage gaps [14]. Although GDP growth may

sometimes be associated with stagnant wages, improvements in productivity per worker are generally correlated with wage increases [15]. Interestingly, informal self-employment often yields better income than formal jobs, exposing the structural limitations of the formal labor market [16]. Moreover, institutional reforms—particularly in labor law and social security—continue to shape wage structures [11, 13].

The erosion of real wages during Mexico's neoliberal period led to a substantial loss in purchasing power and intensified income inequality [17]. These developments emphasize the complex and evolving nature of wage dynamics in the country.

ICT has emerged as a significant contributor to wage stratification. Studies in Mexico reveal that computer skills are associated with income advantages, though the extent of the wage premium varies across occupations [18]. In Catalonia, firms with greater ICT adoption tend to exhibit lower rates of overeducation among employees, underscoring the strategic importance of digital transformation in wage structures [19].

Empirical research confirms that ICT-related competencies are positively correlated with higher wages [20], especially for women, who benefit from improved earnings and increased access to well-paid jobs [21]. At the firm level, ICT implementation enhances organizational efficiency and decision-making processes [22, 23], while in accounting, digital tools contribute to higher quality and precision in financial reporting [24].

ICT is equally transformative in education and healthcare. It facilitates 21st-century learning through dynamic, student-centered methodologies [25], and improves healthcare delivery by enhancing service access and operational efficiency [26].

Collectively, these findings affirm the cross-sectoral role of ICT in boosting productivity, improving income distribution, and fostering inclusive development.

Education serves as the foundation for labor market competitiveness. According to Salas (1997) [1], education enhances worker productivity and income potential, which explains its rising social value. Numerous studies affirm that education reflects and increases individual productivity [4, 27, 28].

The human capital theory conceptualizes education, experience, health, and geographic mobility as personal investments that lead to higher wages [4]. In northern Mexico, research indicates that industries with technologically advanced production processes offer better wages due to higher demand for skilled labor [29].

Education supports innovation, raises productivity, and accelerates the adoption of new technologies. It also fosters social mobility, improves income equality, and contributes to sustainable growth [30, 31]. The economics of education explores how educational services are produced, distributed, and consumed, generating evidence for informed policy design [32].

Beyond economic gains, education improves quality of life through enhanced cognitive skills, better health outcomes, and sustainable consumption [33]. However, critiques of neoliberal narratives caution against oversimplifying the link between economic and educational development, urging a more nuanced policy framework [34, 35].

Marital status influences income through role specialization and time availability. Married individuals often invest more in human capital and are better positioned to develop job-related skills [36, 37]. Yet, gender-based differences persist: while marriage may increase men's income, women frequently face wage penalties linked to their marital status [37].

Gender itself remains a powerful determinant of labor income in Mexico. Women earn 54.5% less annually than men—ranking among the highest gender pay gaps within OECD countries [38]. Men earn 34.2% more per hour on average, highlighting entrenched structural and cultural disparities [38, 39].

The wage premium for digital literacy has been well-documented in both developed and developing economies. In Mexico, the adoption of new technologies by firms has led to increased demand for skilled

workers, raising wages for tech-savvy employees and reducing opportunities for less qualified workers [40]. This contributes to broader income inequality as access to digital tools and training remains limited for many.

Studies confirm that computer use in the workplace yields higher wages—on average, a 9.4% increase compared to non-users [41]. Employers who adopt ICT prefer to hire personnel already trained in digital tools, increasing wage disparities in technologically advanced environments.

The Internet also plays a key role in labor income. The Federal Telecommunications Institute (IFT) reports that a 1% increase in computer usage leads to a 0.5% rise in average salaries [42]. Furthermore, a 1% increase in employment obtained through the Internet correlates with a 6.9% increase in labor income, illustrating the growing importance of digital access in labor market outcomes [42].

Figure 1 illustrates the conceptual framework guiding this study, highlighting the primary sociodemographic and technological factors influencing labor income. Variables such as age, gender, education, marital status, and the use of Information and Communication Technologies (ICTs) converge to form human capital, which in turn shapes productivity and wage outcomes. This diagram synthesizes key insights from the reviewed literature, emphasizing the multidimensional nature of wage determination in the digital age.

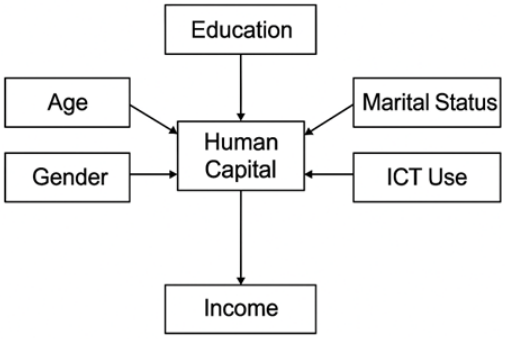

Figure 1. Determinants of Income through Human Capital Pathways.

3. Methodology

This study aims to evaluate how economic and sociodemographic factors—especially the availability and use of technology in the workplace—affect labor income in the city of Tijuana. A quantitative, cross-sectional design was adopted, applying a simple linear regression model estimated via Ordinary Least Squares (OLS). The model uses the natural logarithm of income as the dependent variable, allowing for interpretation of coefficients in terms of percentage changes. This analytical approach facilitates the assessment of the economic impact of individual and technological factors on wage disparities in a context of digital transformation.

3.1. Theoretical Foundation

The methodological design is grounded in the theory of human capital and empirical literature on wage determination. Several studies support the inclusion of education, age, gender, and technology as significant predictors of labor income [2, 43, 44]. Specifically, the inclusion of the squared age variable captures the nonlinear relationship between age and wages, where earnings typically increase with experience until a certain point and subsequently decline. Likewise, the incorporation of ICT usage reflects the growing wage premium associated with digital competencies in the labor market.

3.2. Data Collection

The empirical analysis is based on data collected through a structured survey administered to 443 working individuals residing in Tijuana during the first half of 2024. The sample size was determined using the formula: $n = \frac{z^2 * p(1-p)}{c^2}$, where: Z is the 95% confidence level, $p = 0.5$, and c is the margin of error (.04 = ±4), given the difficulty in accessing a centralized list of target respondents (ICT users in the workplace), a non-probability snowball sampling technique was employed. This method begins with a small group of participants who, in turn, refer others, creating a self-replicating chain of referrals appropriate for hard-to-reach populations.

3.3. Econometric Model

To estimate the determinants of income, the following linear regression model is specified:

$$\ln(y_i) = a + B_1 x_{1i} + B_2 x_{2i} + B_3 x_{3i} + B_4 x_{4i} + B_5 x_{5i} + B_6 x_{6i} + B_7 x_{7i} + e_i, \quad (1)$$

where:

- y_i It is the income or salary reported by each person surveyed, continuous quantitative variable
- $a =$ intercept
- x_{1i} is the age of the person surveyed, continuous quantitative variable
- x_{2i} is the age of the person surveyed squared, continuous quantitative variable
- x_{3i} represents sex, 1 Male and 0 Female, nominal qualitative variable
- x_{4i} indicates marital status, 0 Single (Single, widowed or divorced), 1 Married or free union, nominal qualitative variable
- x_{5i} are the years of study, ordinal qualitative variable:
  - 0, did not study
  - 2, preschool
  - 8, primary
  - 11, secondary
  - 14, high school
  - 16, technical career
  - 19, bachelor's/engineering
  - 21, master's
  - 24, doctorate
  - 25, postdoctorate
- x_{6i} Indicates whether the person uses computer equipment at work, nominal qualitative variable
- x_{7i} If the person uses the Internet at work, nominal qualitative variable
- e_i The error term, which captures unobserved influences on income.

Age is widely recognized as a critical determinant of wages, primarily due to its correlation with accumulated work experience. As individuals age, their experience and productivity typically increase, often leading to higher earnings. However, research suggests this relationship is non-linear, with income increasing up to a certain point before plateauing or declining. The squared age term in the model allows us to capture this curvature and better represent income dynamics across the life cycle [2, 43, 44].

Human capital theory also supports this specification by positing diminishing returns to experience: each additional year of work yields a smaller income increment than the previous one. The quadratic

formulation thus improves the econometric model's goodness of fit and offers a more nuanced interpretation of labor market behavior over time.

Sex is incorporated to examine the gender wage gap, enabling analysis of income differences attributable to gender when other variables are controlled. Marital status is another important variable, as it may affect income through pathways like labor supply decisions, household specialization, and social norms. Research shows married men often receive wage premiums, while married women may experience wage penalties.

Education is perhaps the most robust predictor of income in labor economics. Higher educational attainment generally translates to increased productivity and earning potential. Thus, the model includes years of education to measure this effect directly. Technological variables—namely, computer and internet use at work—serve as proxies for digital skills and workplace modernization. Their inclusion helps assess the extent to which ICT access contributes to wage differentials in a digitalized labor market.

All these variables are integrated into the regression framework to identify their individual and combined effects on the natural logarithm of income.

3.4. Analysis of Results

The analysis of regression results evaluates how each economic and sociodemographic factor, particularly ICT adoption, contributes to labor income variations in Tijuana. The findings are interpreted through the lens of economic theory and contemporary discussions surrounding digital labor markets, revealing both expected patterns and emerging dynamics in wage distribution.

3.5. Hypothesis Testing

The following hypotheses guide the empirical testing:

- **H1:** The availability and use of technology in the workplace has a positive and statistically significant effect on income.
- **H2:** Sociodemographic variables—age, gender, marital status, and educational attainment—significantly influence labor income.
- **H3:** Years of education, as an indicator of human capital, are positively associated with higher wages.

3.6. Conclusion and Implications

The methodological framework presented here offers a robust foundation for analyzing wage determinants in an urban context experiencing rapid digitalization. The study's conclusions emphasize the transformative role of ICT in shaping wage structures and underscore the enduring significance of education and demographic factors. The results have important policy implications for reducing wage inequality and promoting digital inclusion in the labor market.

This diagram summarizes the theoretical and empirical model used to estimate the determinants of labor income in Tijuana's urban system. It reflects the hypothesized relationship between sociodemographic variables (age, gender, marital status, and education) and digital inclusion indicators (computer and internet use) as independent variables influencing the natural logarithm of income.

The inclusion of both linear (age) and nonlinear (age^2) terms captures the diminishing returns associated with experience across the life cycle, in line with human capital theory [2,43,44]. Meanwhile, digitalization variables serve as proxies for technological modernization in the workplace, reflecting the transformative role of ICTs in income generation. This framework aligns with the empirical strategy of the linear regression model and illustrates the multidimensional nature of wage determination in digitally evolving labor markets.

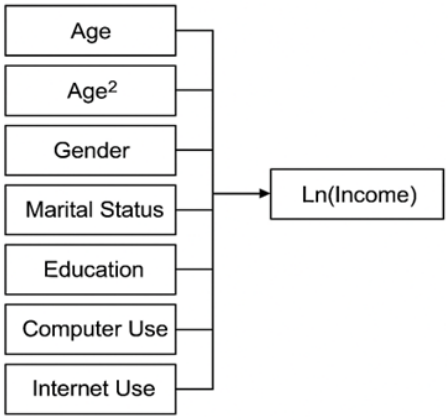

Figure 2. Conceptual framework of wage determinants.

4. Results

4.1. Descriptive Analysis

Table 1 presents the descriptive statistics for both the quantitative and qualitative variables included in the study. Among the continuous variables, the natural logarithm of income ($\ln\_income$) shows a mean of 9.26 and a standard deviation of 0.60, suggesting a relatively moderate dispersion. The age variable spans from 18 to 56 years, with a mean of 26 and a standard deviation of 8 years, while its squared term (age^2) exhibits significant variation, capturing the nonlinear component of work experience. Regarding years of schooling, the average is 16 years, with values ranging from 6 to 25, indicating that most respondents have at least completed upper secondary education and that some possess postgraduate qualifications.

In terms of categorical variables, the sample is nearly balanced by gender: 49% male and 51% female. Marital status reveals that 75% of respondents are in a union (married or cohabiting), while 25% are single, divorced, or widowed. Regarding technological variables, 76% of respondents report using a computer at work, and 83% have internet access in their workplace. These proportions suggest a high degree of

Table 1. Description of quantitative and qualitative variables

Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
ln y (income)	443	9.264499	.5984753	6.684612	11.15625
age	443	26	8	18	56
age2	443	726.4921	550.2093	324	3136
years of study	443	16	3	6	25
Qualitative variables					
Variable	**Observations**	**1**	**0**		
Sex: Men=1	443	219 (49%)	224 (51%)		
Marital Status: single=1	443	331 (75%)	112 (25%)		
computer	443	336 (76%)	107 (25%)		
internet	443	368 (83%)	75 (17%)		

Note: self-elaboration using Stata.

digital integration among workers in Tijuana. This combination of sociodemographic and technological data provides a robust foundation for examining income determinants in digitally evolving labor contexts.

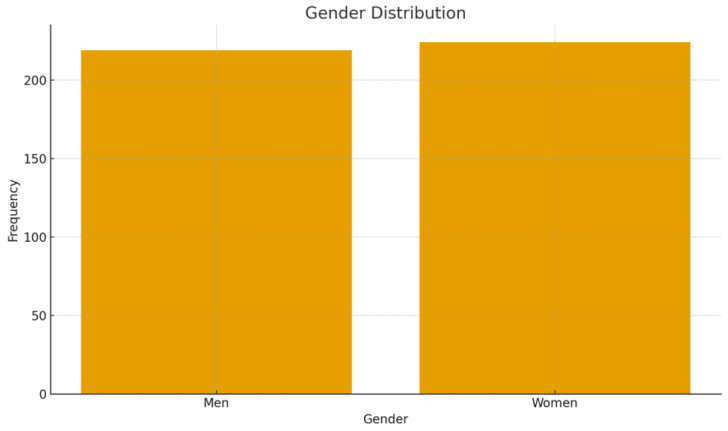

Figure 3. Gender Distribution.

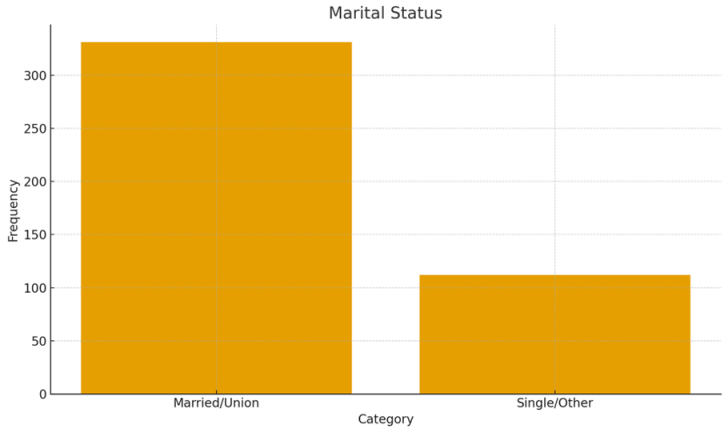

Figure 4. Marital Status.

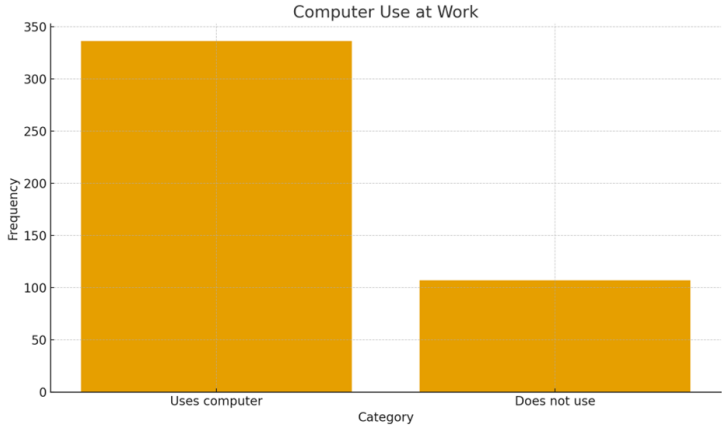

Figure 5. Computer Use At Work.

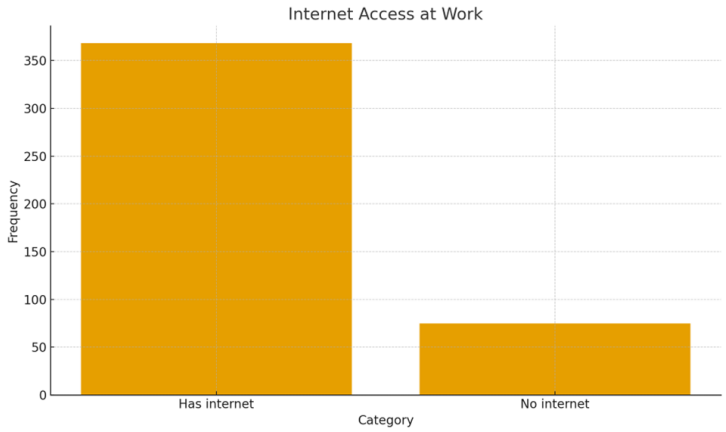

Figure 6. Internet Access at Work.

4.2. Regression analysis

Table 2 summarizes the results of the linear regression model predicting the natural logarithm of income. The model includes both sociodemographic (age, sex, marital status, education) and technological (computer and internet use) predictors.

Age has a positive and highly significant coefficient ($\beta = 0.108, p < 0.001$), while its squared term shows a negative effect ($\beta = -0.00131, p < 0.001$), indicating a concave relationship where income increases with age up to a point before tapering off—consistent with wage-experience profiles observed in the literature [2, 43, 44].

Gender is also statistically significant: being male is associated with higher income ($\beta = 0.179, p < 0.001$), highlighting a persistent wage gap. In contrast, marital status shows no statistically significant effect ($\beta = -0.104, p = 0.135$), suggesting limited explanatory power in this context.

Education, measured in years, has a positive and significant effect ($\beta = 0.0259, p < 0.01$), reaffirming its role as a core human capital component. Among technological variables, computer use is significantly associated with higher income ($\beta = 0.213, p < 0.001$), while internet use, though positive, is not statistically significant ($\beta = 0.0258, p = 0.768$).

Table 2. Model Summary

VARIABLES	ln income
age	0.108***
age2	-0.00131***
sex	0.179***
marital status	-0.104
years of study	0.0259***
computer	0.213***
internet	0.0258
Constant	6.856***
Observations	443
R-squared	0.255

Note: self-elaboration using Stata. * p<0.05, ** p<0.01, *** p<0.001.

The model's R-squared is 0.255, indicating that approximately 25.5% of the variability in income is explained by the included predictors—a reasonable level for social and behavioral research. The constant ($\beta = 6.856, p < 0.001$) represents the expected log-income when all predictors equal zero.

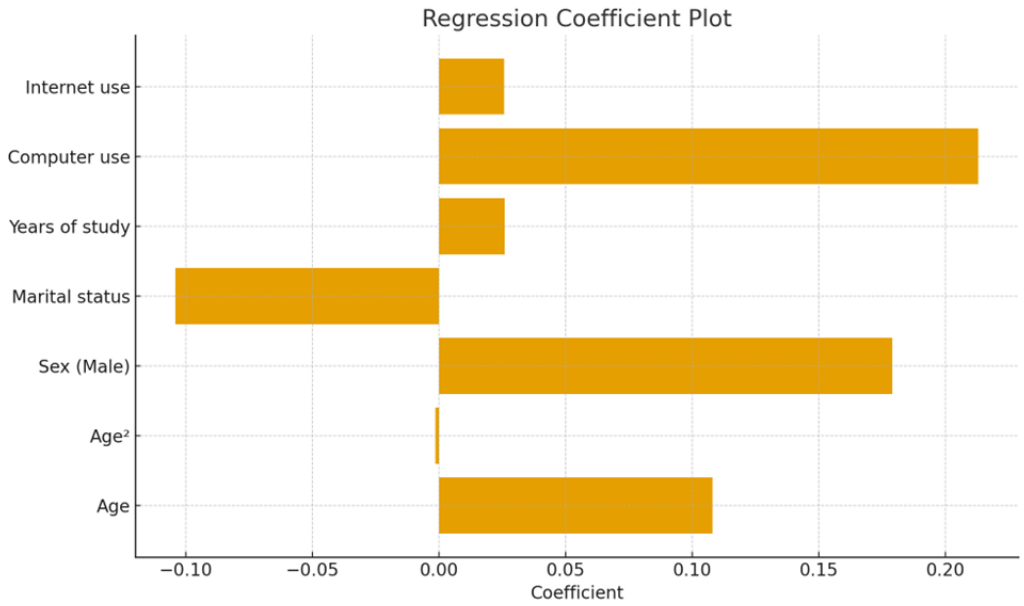

Figure 7. Regression Coefficient Plot.

4.3. Hypothesis Testing

The following hypotheses were tested based on the empirical results:

- **H1: The availability and adoption of technology in the workplace positively impacts income.**
  Supported. Computer use in the workplace shows a strong and statistically significant association with income ($\beta = 0.213, p < 0.001$), which corresponds to an estimated income increase of approximately 23.68% for users versus non-users, assuming log-linear transformation. This underscores the growing economic relevance of digital competencies.
- **H2: Sociodemographic factors such as age, sex, marital status, and education significantly affect income.**
  Partially supported. Age and its squared term confirm a non-linear, concave relationship with income. Gender shows a significant positive coefficient in favor of men, while years of study yield a positive impact. However, marital status lacks statistical significance, suggesting its limited role in income determination within this model.
- **H3: Years of study, as an indicator of human capital, positively relate to income.**
  Strongly supported. Each additional year of education is associated with a 2.62% increase in income, consistent with human capital theory and empirical evidence.

Table 3. Hypothesis Testing

Hypothesis	Description	Result	Evidence
H1	Workplace technology increases income	Supported	Computer coefficient = 0.213***
H2	Sociodemographic variables influence income	Partially supported	Significant: age, age^2, sex, schooling
H3	More years of schooling lead to higher income	Strongly supported	Years of schooling = 0.0259***

Note: self-elaboration using Stata.

4.4. Discussion

The findings confirm that both sociodemographic and technological factors significantly influence labor income in Tijuana. Age and education emerge as key drivers, aligning with classical and modern human capital frameworks [2, 43, 44]. The observed gender gap suggests persistent structural disparities, while the significant impact of computer use highlights the economic value of digital capabilities.

Despite a moderate R^2, the model captures crucial dynamics of wage formation. The non-significance of internet use may stem from its widespread access, limiting its ability to distinguish high-skill digital engagement.

These results emphasize the urgency of policies that promote digital inclusion and educational advancement—especially for underrepresented groups. The empirical evidence supports interventions aimed at enhancing technological adoption and reducing labor market inequalities in urban, digitally evolving contexts.

Table 4. Discussion: Estimated Percentage Change in Income

Variable	Estimated Percentage Change
One additional year of age	+11.35%
Male (vs. female)	+16.38%
One additional year of schooling	+2.62%
Computer use	+23.68%
Internet use	+2.60%
Marital status	-9.89%

Note: Self elaboration.

5. Conclusions

This study employed a linear regression model to examine how various sociodemographic and technological factors influence the logarithm of income (ln income) in the city of Tijuana. The variables included age, squared age, sex, marital status, years of schooling, computer use, and internet use.

The results show that age has a significant positive effect on income ($\beta = 0.1076$, $p < 0.001$), although this effect diminishes over time, as indicated by the negative coefficient of the quadratic term age^2 ($\beta = -0.0013$, $p < 0.001$). These results confirm the non-linear relationship between age and earnings, where income increases with age up to a peak, after which it tends to decline [2, 43, 44].

The variable for gender reveals a positive and statistically significant coefficient ($\beta = 0.179$, $p < 0.001$), indicating that, on average, men earn more than women in the sample. This reflects a persistent gender wage gap, aligned with findings in broader labor market studies.

Education, measured through years of schooling, has a statistically significant and positive effect on income ($\beta = 0.0259$, $p = 0.003$), underscoring the critical role of human capital in wage determination [45–47]. The use of computers at work also displays a strong positive association with income ($\beta = 0.2125$, $p = 0.007$), suggesting that digital competencies contribute meaningfully to income generation [50]. However, internet use does not show a significant effect ($\beta = 0.0258$, $p = 0.768$), potentially due to its widespread use or lack of variation in the sample.

The model's intercept ($\beta = 6.856$) reflects the expected log-income when all predictors are zero. The model's explanatory power, measured by the R-squared (0.2552) and adjusted R-squared (0.2432), indicates that approximately one-quarter of the variation in income is explained by the included variables. The overall model is statistically significant, as shown by the F-test ($F = 21.30$, $p < 0.001$).

Although the R-squared value is modest, the significant p-values of key variables affirm meaningful relationships between predictors and income. This may reflect the inherent complexity of wage determination, where unobserved variables—such as local economic conditions, industry sector, or employer-specific characteristics—also exert influence [45].

In terms of practical implications, a one-year increase in age results in an estimated 11.35% increase in income, though this effect tapers with age. Being male is associated with a 16.38% decrease in income compared to females in this sample. Marital status is associated with a potential 9.89% income reduction, though not significant. Each additional year of education increases income by 2.62%, while computer use at work yields a substantial 23.68% income increase. Internet use, while positive, remains statistically insignificant.

These findings reinforce the importance of education in enhancing earning capacity [46, 47]. They also confirm the persistence of gender disparities in the labor market, particularly disadvantaging women in higher occupational strata [48, 49]. Age and accumulated experience continue to be positively correlated with income, reflecting labor market rewards for tenure and seniority [6].

Furthermore, previous studies have noted that internet access is especially beneficial to low-skilled workers in developing contexts, potentially narrowing digital divides [50]. Ethnicity also remains a critical factor in wage disparities, with indigenous populations facing persistent disadvantages [51]. Finally, career choices significantly impact wages, with longer academic tracks and male-dominated fields typically yielding higher returns, while female-dominated sectors experience wage penalties for all genders [52]. Together, these results illustrate a multifaceted picture of income inequality shaped by education, gender, age, technology, and structural labor dynamics. Public policies aimed at promoting digital inclusion, equal pay, and equitable access to education are essential to address these challenges.

Recent evidence highlights that ICT adoption strengthens organizational competitiveness when technological capabilities are aligned with human and cultural dimensions. Studies show that effective ICT use enhances innovation and performance, particularly in project based and technology intensive contexts. Digital archetypes therefore offer a practical framework to link individual profiles, digital culture, and change management strategies in organizations [53].

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