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Systematic Determinants of Pensions in Latin America

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Resumen

En este documento evalúo los planes de pensiones contributivas de América Latina en términos de su rol en el reemplazo de ingresos laborales después de la jubilación. Busco elementos clave que puedan explicar las diferencias, resultando en recomendaciones de políticas útiles. Mi análisis se basa en microsimulaciones de historias laborales y derechos de pensión en 10 países latinoamericanos según las normas actuales y escenarios controlados. Utilizo superficies de respuesta para resumir los resultados, realizando un análisis de regresión para evaluar el impacto de las variables de control en la tasa de reemplazo efectiva (TRE). Se consideran los efectos de covariables a nivel de escenario y a nivel de régimen. Los resultados muestran que las elecciones individuales y la suerte son muy relevantes para determinar la TRE. También encuentro que algunas variables de política tienen un gran impacto. Este es el caso de la tasa de contribución. Estos hallazgos son particularmente relevantes para el debate actual sobre reforma de los sistemas de pensiones y la adecuación de las pensiones en América Latina.

Palabras clave: pensión, retiro, seguridad social, tasa de contribución, tasa de reemplazo

Abstract

In this paper I assess Latin American contributory pension schemes in terms of their role in replacing earnings after retirement. I look for key elements that can explain differences, resulting in useful policy recommendations. My analysis is based on microsimulations of work histories and pension rights in 10 Latin American countries according to current norms and controlled scenarios. I use response surface analysis to summarize the results, performing regression analysis to assess the impact of changes in control variables on the effective replacement rate (ERR). The effects of covariates at scenario level and at regime level are considered. Results show that individual choices and luck are very relevant in determining ERRs. I also find that some policy variables have a great impact. This is the case of the contribution rate. These findings are particularly relevant for the current discussion on pension reform and pension adequacy in Latin America.

Keywords: contribution rate, pension, replacement rate, retirement, social security

JEL: H55, J14, J26

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Introduction

There is a huge variety of social security arrangements around the world. Beyond local idiosyncrasies, it is reasonable to assume that there are systematic determinants of much of this diversity. Yet sources of information comparing the main characteristics of different programs in a systematic way have only become available in the last two decades.), Forteza and Ourens (2012), Gruber and Wise (1999, 2004, 2007), Rofman et al (2008), Social Security Administration (2004-2016), Whitehouse (2007) and Wise (2016) exemplify efforts to compare and explain some differences of pensions programs. Most of such new information shed light on social security regimes in developed countries.

In the 1990s and early 2000's, several Latin American countries reformulated their social security systems. The main concern was financial sustainability. As in the 1981 Chilean reform, they privatized in some degree their former pay-as-you-go (PAYG) public schemes. They replaced their previous regimes to a greater or lesser extent by individual retirement accounts (IRA) administered by public and/or private institutions. In the last two decades, some of these countries relaxed access to benefits. One of the main concerns now is pension's amount (Alonso et al 2014; Cetrángolo and Grushka 2004; Escóbar and Gamboa 2014; Mesa-Lago 2016; Shelton 2012; Wong 2013). It seems evident that pension amount is correlated with payroll contributions, their amount and for how long they are served. This is more directly appreciated in defined contribution schemes but is also true in defined benefit regimes.

Pensions systems primarly pursue four goals (Barr and Diamond, 2010; Holzmann and Hinz, 2005). From the public policy perspective, they aim to alleviate poverty and to redistribute wealth and income. From the individual viewpoint, pensions provide insurance against living too long and supply income or consumption smoothing. In this paper I assess Latin American contributory pension schemes in terms of their role in replacing earnings after retirement, one feature of the pension systems' *"piggy bank"* function as described by Barr (2001).

Since earnings are the main source of income before retirement and pensions are the main source of income after retirement, I choose to measure such function through the Effective Replacement Rate (ERR) defined as first pension to last net wage ratio. I look for key elements that can explain the differences between ERRs, resulting in useful policy recommendations regarding the role of pension schemes in consumption smoothness and labor income replacement.

Following Forteza and Ourens (2012), my analysis is based on microsimulations of work histories and pension rights in 10 Latin American countries according to current norms[1]. There is considerable diversity of pension designs. For instance, Brazil, Ecuador and Paraguay maintain their traditional PAYG defined benefit systems; Argentina has a partial collective capitalization scheme; Bolivia, Chile and Mexico moved to IRA; Colombia and Peru have both systems and contributors can choose between them; and Uruguay has a mixed system with two pillars and most contributors are covered by both.

Readers should keep in mind that I perform an analysis of social security design, not its actual performance. I do not address poor enforcement, which is an issue in some of these countries. My main concern is to find whether there are design elements that determine what pensioners can expect to get from their contributions to social security.

The paper is organized as follows: in the next section I describe the motivation, in the following section the methodology is presented, in Section 4 I discuss our results and in Section 5 some concluding remarks are presented.

1. Motivation

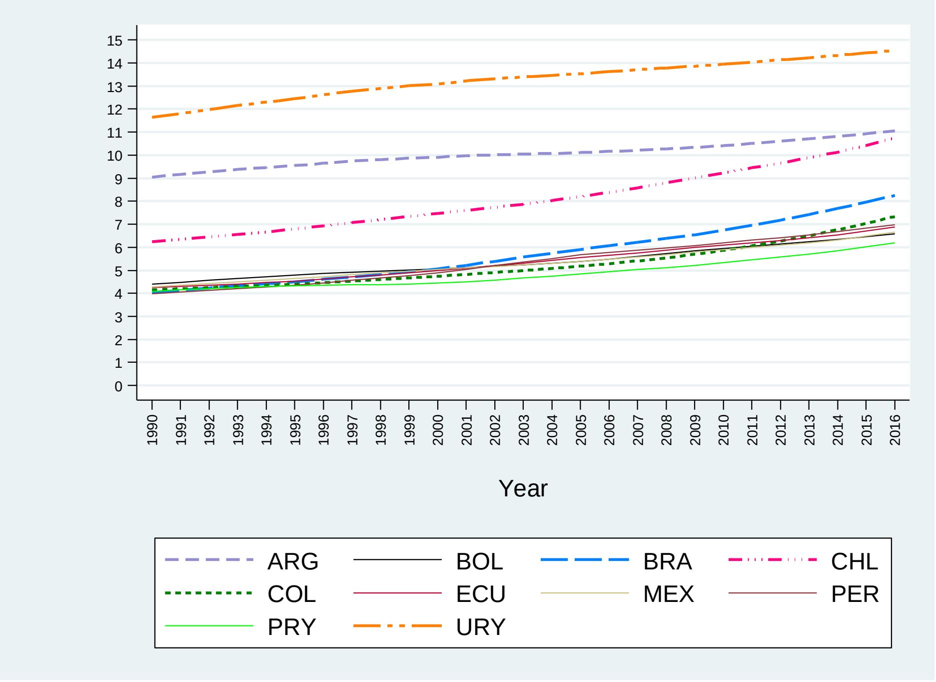
When population is relatively young, social security systems tend to be generous, paying high pensions in exchange for low individual contributions. In that situation contributors are a great mass and the share of population to be covered by pensions is relatively low. As population ages, fiscal sustainability problems arise, and pensions access conditions and/or amounts are adjusted. Then, concerns about pension amounts take place.

In Latin America, the population is aging rapidly, particularly in Brazil, Chile and Colombia, as shown in Figure 1. In the first five years of the 2010s, their population aged 65 and above increased around 15 to 20 per cent. In Brazil, the share of elderly people doubled in 25 years. In the other countries it grew 70 per cent. Also, in Brazil, life expectancy at birth increased 8 years between 1992 and 2012 and life expectancy at age 60

1Forteza and Ourens use 2007 norms and include the 2008 reforms in Chile and Uruguay. The latest norms included in this paper are: Law 26425 in Argentina (2008), Law 065 in Bolivia (2010), Law 10839 in Brazil (2004), Law 20255 in Chile (2008), Law 797 in Colombia (2003), Segundo Suplemento del Registro Oficial 417, 31-III-2011 in Ecuador (2011), Decree DOF 12-11-2015 in Mexico (2015), Law 4426 in Paraguay (2011), Law 29903 in Peru (2012) and Law 18395 in Uruguay (2008). Venezuela was excluded due to the lack of reliable updated data to set the parameters in the simulations.

increased 5 years in the same period. That implied a 25 and 30 per cent increase for women and men, respectively (World Bank, 2016).

Figure 1: Share of population 65+ in selected countries



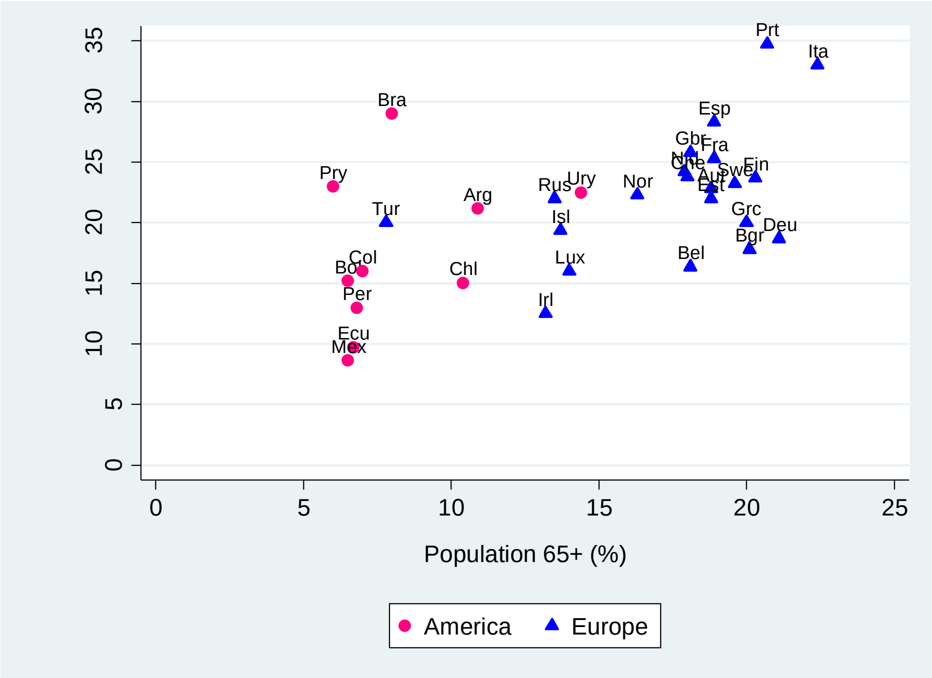
Notes: Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization.
Source: World Development Indicators (World Bank, 2016).

However, almost none of the most recent reforms increased contribution rates and some of them even reduced vesting period conditions and minimum retirement ages. These facts add extra pressure on social security schemes in terms of fiscal sustainability, social protection and income smoothness among the elderly.

Figure 2 shows social security contribution rates and share of population aged 65 and above, for selected countries. On one hand, most European countries are concentrated on the upper-right quadrant, with high contribution rates and a big share of aged population. On the other hand, most Latin American countries are located on the lower-left quadrant, with low contribution rates and small share of elders. There are some exceptions, for example, Uruguay is more alike to European countries than American ones. Also, Argentina, Brazil and Paraguay have relatively high contribution rates.

Figure 2: Social security contribution rates and population aged 65+

Year 2015 – Selected countries



Notes: Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization.
Source: World Development Indicators (World Bank, 2016) and Social Security Programs Throughout the World (Social Security Administration, 2016).

Some Latin American countries have relatively low social security contribution rates and are aging rapidly. Chile seems to be the best example. It seems that there is room to improve benefits of future pensioners. Other countries are in more difficult situations, such as Brazil, where contribution rates cannot further increase significantly.

2. Methodology

2.1.The Effective Replacement Rate (ERR)

Analyzing the design of social security is not an easy task. The interaction of demography and economic conditions adds complexity to already dense contracts. The ERR, defined as the first pension to the last net wage ratio, summarizes these interrelationships and provide a basis for comparing different contributory programs in a significant way.

ERRs should not be considered as an indicator of adequate social protection (Whiteford, 1995; Holzmann and Hinz, 2005; Chybalski and Marcinkiewicz, 2016).

Private or occupational pensions are not widely spread in Latin America, so not considering them is not an issue in this case. But there are other social protection elements that are not considered, such as non-contributory pensions and other cash and in-kind public benefits. ERRs are more likely to provide information on income smoothing of pensions systems, rather than consumption smoothing or other objectives.

ERRs can also shed light on how social security systems provide incentives to work. It is a proxy of the implicit tax to continue working. As Gruber and Wise (1997) argue, retirement decision relies heavily on how social security wealth would be modified with such decision. High ERRs at early ages can be interpreted as high implicit taxes to continue working, since juicy pensions are not cashed out if continue working.

The ERR is different from the technical replacement rate established by law in defined benefit regimes. The latter is the percentage of some predefined reference wage (usually an average of annual wages of several years of contribution) covered by monthly benefits after retirement, it typically changes with years of contribution and retirement age. The former is a direct measure of the proportion of the last formal earnings that is replaced by pensions.

Comparing technical replacement rates across social security regimes would not be informative about which is more generous, or which provides better income smoothness. In fact, it would not be informative at all to compare different countries since it is related to the program's specific reference wage. Another drawback is that it is only well defined for defined benefit programs.

I can compute ERRs under any regime that provides monthly benefits, whether a technical replacement rate is defined or not. The ERR would be practically unique for every individual, so there is no such thing as "the" replacement rate. Instead, I show how key variables affect ERRs, through response surfaces analysis, and find the systematic determinants behind the differences within and between regimes.

My analysis is somehow like the net pension replacement rate annually estimated by the OECD (OECD, 2017), since the indicator definition is basically the same[2] and both are based on microsimulation of work histories and pension entitlements. But while the OECD indicator is presented for one main scenario and its sensitivity to earning levels, I

[2]In my indicator the denominator is the individual last net wage and in the OECD indicator the denominator is the individual lifetime average earnings.

estimate over 2000 scenarios for each pension program and summarize the results estimating the effect of the relevant variables on my indicator.

2.2.Simulations

To compute ERRs, information on work histories and pension rights of contributors is needed. If actual performance of social security is to be analyzed and long enough administrative records are available, one can gather information on contributions and benefits to compute the indicator. If designs of social security programs are to be analyzed and compared, performing simulations of contributions and benefits paid under controlled scenarios is the best way to compute the indicator.[3] This distinction is particularly important in Latin American countries, where there are important differences between formal rules and their implementation.

I chose the strategy of simulating controlled scenarios to analyze the design of the programs and make a clear comparison across countries, avoiding the effects that economic or political circumstances could have on social security performance.

I simulate single male workers[4] born in 2016 who are subject to social security rules in force at that year. My programming of pension rules is based on Forteza and Ourens (2012), adapting them to my set of scenarios and updating pension rules for several countries. I briefly describe each program's rules and parameters in the Appendix. Most parameters were taken from Social Security Administration (2016) and World Bank (2016).

I simulate different scenarios, according to different workers' characteristics and states of nature. Worker's characteristics are: wage, age of enrollment to formal labor market and retirement age. Real interest rate and real wage growth also vary between scenarios. In each setting, once retired, workers claim their pensions as soon as they meet all requirements.

Labor earnings determine contributions and are vital in defining the amounts of future benefits. In defined benefit programs, wage levels and age earnings profiles define

[3]Gruber y Wise (1999), Lanza (2008) and Alvarez et al (2010) simulate work histories in order to compute synthetic indicators of incentives to work. The former for several developed countries, the later for developing countries.

[4]Despite retirement is usually an intra-family decision, simulating different meaningful family arrangements in every country analyzed could distract us from analyzing and comparing program design.

the reference wage; in defined contribution regimes, they affect the volume of the accumulated fund.

Three rates of growth of real wages are considered: 1, 2 and 3 per cent per year. I expect the wage profile to be more relevant in PAYG regimes when the period considered for computing the reference wage is short.

Workers can earn a quarter, half, three quarters, once, twice or four times the country's GDP per capita over their lifetime. I want to analyze if social security systems are more generous with poorer workers or not, while using some country specific but comparable measure. However, this choice has some drawbacks. First, all the selected grid values may not be equally relevant in all countries. Second, the effect of minimum wages can shrink the grid of simulations in terms of wages in some cases (for example Bolivia, Ecuador and Paraguay).

The alternative of using percentiles of each country income distribution would not be problem free. First, the information may not be available for all countries in the same period, some household surveys are publicly available, and others are not. Second, reported income is biased towards the mean. Also, formal workers income distribution is different from general income distribution, but information on formal workers is not always available.

Retirement age and length of labor history are also key elements in determining pension entitlements. Access to benefits in many regimes is subject to complying with vesting period and/or minimum pensionable age conditions. In the simulations I suppose that once enrolled, workers work through retirement without interruptions, so length of service is determined by ages of enrollment and retirement. I considered six enrollment ages, from 25 years old to 45, and four retirement ages, from 55 to 70 years old, both increasing 5 by 5. Retirement age is the age at which individuals stop working; it is not necessarily equal to pensionable age. Once retired, workers claim pensions as soon as they become eligible.

There is vast evidence on low density of contributions and frequent contribution interruptions in Latin America (Apella et al 2011, Berstein et al 2006, Betranou and Sánchez 2003, Bucheli et al 2010, Farall et al 2003, Forteza et al 2009, Lagomarsino and Lanzilotta 2004). Interruptions on contribution histories are not specifically simulated, but their effect is captured by simulating different lengths of service. Thus, workers who have short contribution histories have started to contribute as mature adults. As a result, pensions may be biased. In defined contribution programs, benefits could be biased downwards, because scarce contributions would be capitalized for a short period of time, shorter than if some of those contributions were made as young adults.

The real interest rate is also crucial in determining benefits under defined contribution regimes. Six levels of the real interest rate, from 2 per cent to 4.5 per cent, are considered.

For each scenario, I compute the expected contributions and benefits, conditional on being alive; using the World Health Organization life tables (World Health Organization, 2017).[5] Such calculations are used to compute ERRs. If the worker does not meet eligibility requirements and does not receive any benefit from contributory social security, ERR is zero, but give no information on the amount of losses involved. If the worker receives a lump sum benefit, ERR is not defined.

2.3.Response surfaces

It would not be practical, informative or even possible to describe each scenario. Too much information is no information at all. Instead, following Forteza and Ourens (2012), I use the response surface analysis to summarize the results, performing regression analysis to assess the impact of changes in control variables on the replacement rate.

In the simulations, covariables vary in two levels: scenarios and regimes. In the first level, individual scenarios represent one person with the characteristics defined at that specific setting. Some features depend on individual's decisions and some on luck. In the second level, regimes typify policy decisions and institutional characteristics. It is obvious to think that individuals within the same regime would be more alike between each other than individuals between regimes. Although simulations are deterministic, individuals within the same regime are subject to common rules and environment (GDP, type of regime, contribution rate, how pension is determined, etc.).

[5] Brown et al (2009), Forteza and Ourens (2012), Liebman (2001).

As stated by Rabe-Hesketh and Skrondal (2012), not considering all levels simultaneously would lead to biased estimators. I consider this issue acknowledging our data to be clustered data.[6]

I perform pooled data regressions including two types of regressors: a set related to the definition of simulated scenarios and a set related to regimes and countries particularities. The interest is to find systematic determinants of ERR's diversity. I am especially interested in the effect of the contribution rate.

Degrees of freedom, related to the number of clusters, set a limit to the quantity of covariates. To choose which covariables at the scenario level include, I first perform intra-regime estimations. This analysis is interesting by itself, helping to understand how individual decisions and luck can affect ERR within the same institutional environment.

The following OLS regressions are run on each regime:

$$ERR = \beta_0 + \beta_w w + \beta_{w^2} w^2 + \beta_{wsub} w \times Dsub + \beta_{w^2sub} w^2 \times Dsub + \beta_{\hat{w}} \hat{w} + \beta_{\hat{w}sub} \hat{w} \times Dsub + \beta_{Los} los + \beta_{Los^2} los^2 + \beta_{Lossub} los \times Dsub + \beta_{Los^2sub} los^2 \times Dsub + \beta_{ra} ra + +\beta_{rapen} ra \times Dpen + \beta_{rir} rir + \beta_{rirsub} rir \times Dsub + \beta_{sub} Dsub + \beta_{pen} Dpen$$

Where:

ERR: is the effective replacement rate, measured in proportion to one

w: is the wage level in proportion to GDP per capita, in proportion to one

$\hat{w}$: is the rate of growth of real wages, in proportion to one

los: is the length of service in years

ra: is the retirement age, age at which individuals opt out the labor market, in years.

rir: is the real interest rate, in proportion to one

$Dpen$: is a dummy variable equal one when retirement age is equal or greater than pensionable age.

$Dsub$: is a dummy variable equal one when the individual receives a minimum or a supplemented pension

[6] Thirteen regimes are considered, thus the Rabe-Hesketh and Skrondal's (2012) recommendation of having at least ten clusters has been met. Results are robust to different estimation methods: OLS clustered by regime, two level FLS with random effects using robust sandwich variance estimator or not, two level ML estimator.

Reader should remember each variable analysis is ceteris paribus. I expect to find the following effects:

(i) Wages

It is not clear in advance how the wage level affects our synthetic indicator. On one hand, wage would directly increase the ERR's denominator. On the other hand, in most cases, the numerator would increase with wage as well. For those receiving a minimum pension, the effect is expected to be negative, since in most regimes pension amount would be fixed at the minimum pension level.[7]

Also, since lower-income workers tend to have flatter income profiles than higher-income workers, it is relevant to study how the wage profile is linked to ERRs. But when interpreting the effect of wage profile, wage level remains constant, so flatter wage profiles are not necessary associated to lower wages. In defined contribution regimes, steeper wage profiles imply lower early contributions, those which are capitalized for a longer time, so I expect annuities to decrease as wage slope increases. In defined benefit schemes, wage slope is expected to positively affect pensions if reference period is short and linked to the last years of contribution. Only three of the considered PAYG regimes have a reference period of five years or less: Ecuador, Paraguay and Peru.[8] The rest of the programs link benefits to longer reference period. Also, in steeper wage profiles the last net wage would be higher than in flatter wage curves, implying a greater ERR's denominator for the former. The net effect in PAYG regimes is not clear in advance.

(ii) Length of service

The correlation between ERRs and length of service is not always simple. PAYG regimes usually involve vesting period conditions. Where such requirements exist, they may generate sharp discontinuities, imposing large gains on contributing an additional year to just meet the requirement, and huge loses to those who just fail to comply. In mixed or IRA systems, the effect of length of service is typically smoother, since workers can access pensions if they can finance a suitable annuity or just stop contributing at a certain age. Of course, the accumulated fund is increased by enlarging contributing history, but pensions usually do not have discrete jumps in these cases.

[7] In some regimes, minimum pension is not a fixed amount, but it varies with length of service.
[8] By construction, the last years of contribution are always the best years of contribution in our simulations.

Several of the regimes I study have minimum contribution requirements. However, I do not find sharp jumps or even significance of vesting period compliance variables when analyzing the isolated effect of years of contribution in most cases. Most of these regimes have more than one vesting period condition combined with different minimum retirement ages, and almost all simulated individuals comply with the laxer requirements. Also, ERRs are not as sensible to vesting period condition as indicators that consider full flow of social security contributions and benefits. Some regimes, as Paraguay, allow individuals to keep contributing after retirement until fulfilling minimum requirements. In addition, Mexico and both regimes in Colombia pay a lump sum benefit to workers who fail to comply with vesting period conditions. ERRs are not defined in such case. What I study in Mexico and Colombia is the effect of length of service on ERR of those who contribute for at least 25 years. A quadratic function of the length of service was better at capturing the effect of the length of service.

I expect length of service to positively affect ERRs, at least for non-subsidized recipients and subsidized pensioners in regimes that minimum pensions vary with length of service. Since IRA regimes make stronger linkages between benefits and history of contribution than PAYG schemes, I expect the effect to be greater in the former.

(iii) Retirement age

By retirement age, I understand the age at which the worker stops contributing. There may be discrete jumps in ERRs for delaying retirements to just comply with minimum pensionable age. But generally, a worker can retire early and claim his pension as soon as he becomes old enough (provided he complies with other requirements). PAYG regimes usually require a combination of minimum pensionable age and vesting period conditions to access pensions. IRA schemes often involve minimum pensionable ages and/or vesting period requirement and/or minimum annuity that can be provided with the accumulated fund.

Delaying retirement would increase pensions in both types of regimes if the individual is already eligible for a pension. In PAYG schemes, the technical replacement rate usually increases with the age at which benefits are claimed. In IRA regimes, annuity also raise given it would be paid for a shorter time, closest to death. Delaying retirement would also increase the last net wage. Net effect is uncertain.

(iv) Real interest rate

I expect the real interest rate to have a great positive income on ERRs in IRA regimes. Real interest rates affect the return obtained from the accumulated fund. Thus, other things equal, a higher real interest rate would imply higher annuities and higher ERRs. On the contrary, I do not except to have any effect in PAYG schemes.

Once the most relevant variables are identified, I perform the pooled data OLS regression with clusters. The regime level covariates include: contribution rate, the GDP per capita and if the regime is a PAYG scheme or not. Also, the interactions between PAYG regime and contribution rate and some scenario level covariates are included.

The following regression is run:

$$\begin{aligned} ERR_{ij} = \; & \beta_w w_{ij} + \beta_{\widehat{w}} \widehat{w}_{ij} + \beta_{\widehat{w}payg} \widehat{w}_{ij} \times Dpayg_j + \beta_{Los} los_{ij} + \beta_{lospayg} los_{ij} \times Dpayg_j \\ & + \beta_{rir} rir_{ij} + \beta_{rirpayg} rir_{ij} \times Dpayg_j + \beta_{sub} Dsub_{ij} + \beta_{con} contrate_j \\ & + \beta_{contratepayg} contrate_j \times Dpayg_j + \beta_{GDP} GDP_j + \beta_{payg} Dpayg_j \end{aligned}$$

Where:

ERR: is the effective replacement rate, measured in proportion to one

w: is the wage level in proportion to GDP per capita, in proportion to one

$\widehat{w}$: is the rate of growth of real wages, in proportion to one

los: is the length of service in years

rir: is the real interest rate, in proportion to one

$Dsub$: is a dummy variable equal one when the individual receives a minimum or a supplemented pension

$contrate$: is the insured plus employer contribution rate, in proportion to one.

GDP: is the country's GDP per capita in 2015, measured in US dollars divided by 1000.

$Dpayg$: is a dummy variable equal one when the regime is PAYG[9]

[9]Argentina is considered a PAYG regime. The general regime in Uruguay is considered as PAYG even though it is only exclusively PAYG for low income workers and mixed for the rest. The choice regime in Uruguay is considered as individual account even though it is mixed for everyone.

Finally, to overcome the problem of degrees of freedom and further disentangle the effect of contribution rate, I perform some counterfactual analysis, performing simulations with different contribution rates in IRA regimes.

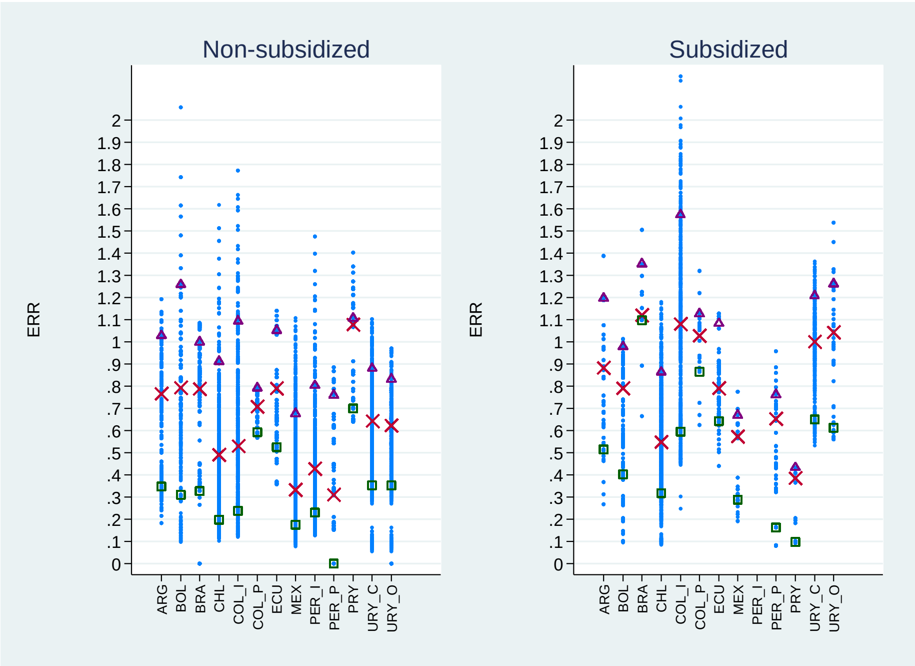
3. Results.

3.1. Describing the simulated database

The reader should interpret with caution the descriptive statistics of simulated ERRs, since specific sets of assumptions that define each scenario lie behind each ERR. However, since the same scenarios were run for every country, the descriptive statistics help to clarify why different social security schemes are more or less generous with their pensioners.

Figure 3 shows ERRs by regime. Since ERRs are quite different for non-subsidized pensions and subsidized pensions, simulations are presented in two panels. Panel "Non-subsidized" excludes minimum or supplemented pensions and panel "Subsidized" exclusively shows ERRs for minimum or supplemented pensions.[10]

Figure 3: Simulated ERRs by regime



[10] T-test comparing mean ERRs for non-subsidized and subsidized pensioners was performed, and null hypothesis of equal means was rejected at 95% confidence.

Notes: Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization. Suffix “I” stands for IRA, suffix “P” stands for PAYG, in Uruguay suffix “C” stands for choice (mixed regime for everybody) and “O” stands for ordinary (PAYG for low income workers and mixed for the rest).
Panel “Non-subsidized” shows regular ERRs, excluding minimum and supplemented pensions.
Panel “Subsidized” shows ERRs for those receiving minimum pensions or supplements.
In all cases, median ERRs by regime and subgroup are marked with a red x, p10 with a green square and p90 with a purple triangle.
Observations above p99 were excluded in all cases due to presentation purposes.
Source: Own computation.

Most regimes are relatively more generous with low income workers, since median ERRs are higher for minimum or supplemented pension recipients than non-subsidized ones. Paraguay seems to be the greatest counterexample, providing a median ERR of around 40 percent to low income workers and above 100 percent to regular recipients. While most non-subsidized workers get between 60 and 100 per cent of their average wage in the last three years in Paraguay, minimum pension is just a third of the minimum wage.

Regimes with relatively high vesting period requirements provide no contributory pensions to some of the simulated workers.[11] In the PAYG regime in Peru, errs is zero for contributors with length of service shorter than 20 years. In Brazil and the ordinary regime in Uruguay (i.e. PAYG for low income workers and mixed for the rest), ERR is zero for contributors with less than 15 years of contribution. As stated in Forteza and Rossi (2013), which seems paradoxically in wider international debate, in the case of Uruguay low income workers with scarce formal contributions, would be better off if they choose the mixed scheme. The reason is they do not comply with vesting period requirement, so they would not receive a contributory pension under a full PAYG regime, but they would receive an annuity from the capitalization pillar at age 65 (probably rather small) in the mixed scheme. In Paraguay, workers can keep on contributing after retirement until they become eligible for a pension. That is why, while minimum vesting period in Paraguay is 15 years, there are no zero ERRs in that regime.

Some ERRs are not defined; such is the case of Colombia and Mexico, where a lump sum benefit is provided when contributors do not meet pension access requirement.

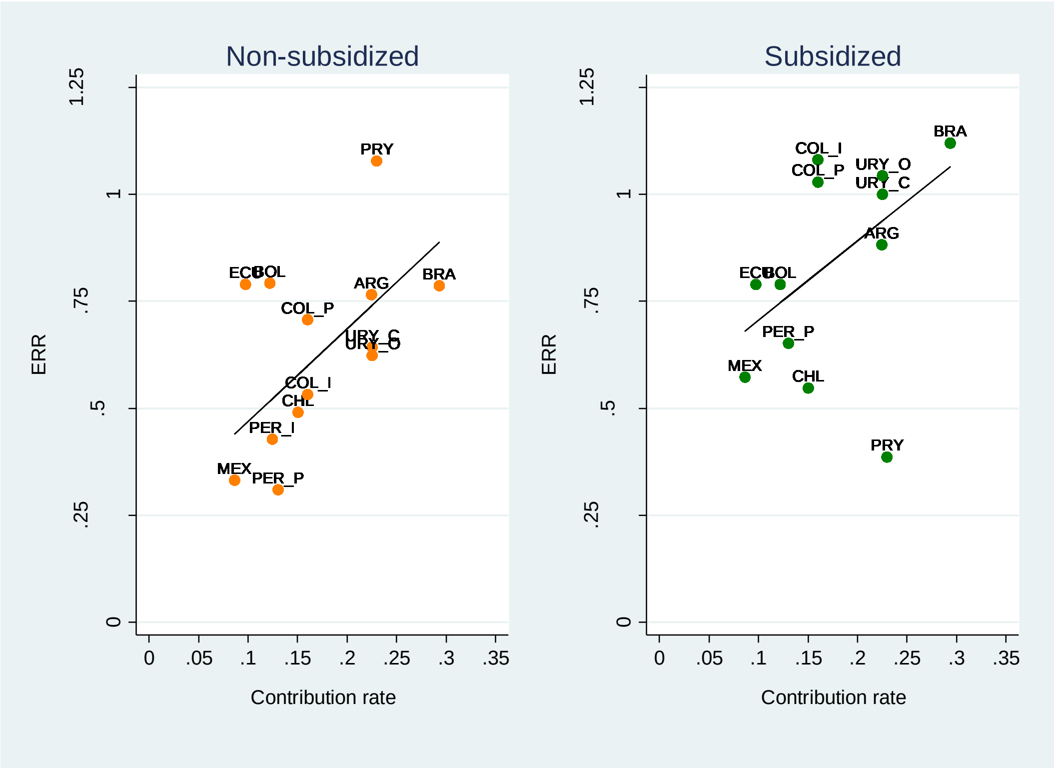
It seems there is much variety in ERRs across regimes. It is straightforward, and often overlooked, that “generosity” of social security schemes is correlated with contribution

[11]The choice of enrollment and retirement ages determine simulated length of service. Some eventual zero ERRs are excluded by these choices. Such is the case in Argentina, where contributors with less than 10 years of contribution would not receive a contributory pension. But all the workers simulated have at least 10 years of contributions.

rates, especially in aging populations. Contribution rates are not directly comparable across countries and schemes but can shed light on ERRs.

Figure 4 shows median ERRs[12] and total contribution rates by regime. Contribution rates include insured and employer contributions; they do not include explicit government contributions or government assistance to social security through taxes or other indirect sources. There is a positive correlation between ERRs and contribution rate for non-subsidized and subsidized pensions, which seems to be slightly stronger in the former case.

Figure 4: Simulated median ERR and contribution rate by regime



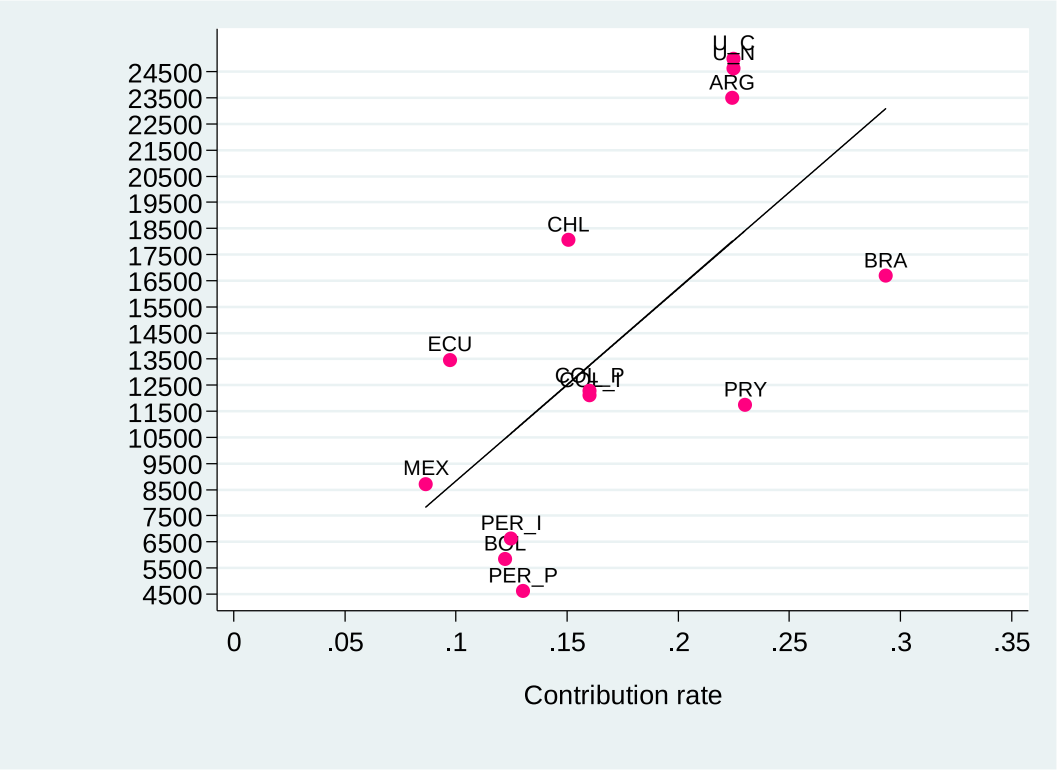
Notes: Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization. Suffix "I" stands for IRA, suffix "P" stands for PAYG, in Uruguay suffix "C" stands for choice (mixed regime for everybody) and "O" stands for ordinary (PAYG for low income workers and mixed for the rest).
In most cases, the contribution rate is unique per regime. Some differences are excluded by the scenarios run, for example there is no simulated worker earning above 16 minimum wages in Colombia (who have a differential contribution rate).
Panel "Non-subsidized" shows regular ERRs, excluding minimum and supplemented pensions.
Panel "Subsidized" shows ERRs for those receiving minimum pensions or supplements.
Source: Own computation.

[12] Other summary statistics of the simulated ERRs are available upon request. They all show a positive correlation with contribution rates.

There is a group of regimes with low ERRs and low contribution rates. Chile, Mexico and both schemes in Peru, provide ERRs lower than 50 per cent and request total contributions of 15 per cent or less. Among them, the PAYG scheme in Peru is the only one that would provide a zero ERR to some workers (those who fail to contribute for at least 20 years). Defined contribution regimes in Chile, Mexico and Peru provide strictly positive ERRs, but quite low.

Such relationship can also be found when looking at pension amounts. Figure 5 shows simulated median initial pension[13] and contribution rate by regime. To make a reasonable comparison, initial pensions are in annual US dollars, in real terms and conditional on being alive. Once again, there is a positive correlation between pensions and contribution rates.

Figure 5: Simulated median pension and contribution rate by regime



Notes: Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization. Suffix "I" stands for IRA, suffix "P" stands for PAYG, in Uruguay suffix "C" stands for choice (mixed regime for everybody) and "O" stands for ordinary (PAYG for low income workers and mixed for the rest).
In most cases, the contribution rate is unique per regime.
Pensions are in annual US dollars, in real terms and conditional on being alive.

[13]Other summary statistics of the simulated pensions are available upon request. They all show a positive correlation with contribution rates.

Source: Own computation.

The diversity of ERRs between regimes and their correlation with some policy variables makes worthy to further analyze these relationships. Trying to disentangle the effect of such variables on pension capability to smooth consumption and replace earnings, I perform response surface analysis.

3.2.Response surfaces

3.2.1. Individual regimes response surfaces

Estimations on individual regimes try to disentangle the effects of covariates varying within regimes. This analysis is also useful to choose the most relevant variables for the pooled estimation. The full OLS estimation is in the Appendix. Reader should keep in mind that the analysis of each variable is ceteris paribus.

As expected, most variables have a different effect on ERR for subsidized and non-subsidized pensioners.

(i) Wages

Most wage related coefficients are highly significant, the exceptions are non-subsidized recipients in Bolivia and Peru (IRA). When significant, the effect is generally negative.

Table 1 shows the effect of wage change on ERR for selected wage levels. The first set of rows show the impact of a 25 pp increase of wages on ERR of subsidized individuals: from 0.25 to 0.50 times GDP per capita and from 0.50 to 0.75. The second set of rows show the effect of a 100 per cent of wages on ERR of non-subsidized individuals: from 1 to 2 GDP per capita and from 2 to 4.

As expected, impacts are much greater for subsidized workers, since the increase on wages would increase the ERR denominator and, in most cases, the numerator would remain unchanged. Also, the effect is greater where the subsidy consists in a fixed amount minimum pension.[14] Impacts range from 6 to 60 pp, being the poorest in the Uruguayan ordinary system those who are worse off with a wage increase.

[14]Subsidy to pensions is not fixed in Bolivia, Chile, Ecuador and Mexico.

Non-subsidized individuals' ERR also decline as wage level increase, but impacts are much smaller ranging from 0.1 to 18 pp. It seems that pension increment does not compensate wage increase. The exception seems to be the richest individuals in the IRA system in Colombia, where an increase from 2 to 4 GDP per capita would lead to a 1 pp increase in ERR.

Table 1. Effect of wage change on ERR. Selected values.

Wage change	ARG	BOL	BRA	CHL	COL_I	COL_P	ECU	MEX	PER_I	PER_P	PRY	URY_C	URY_O
SUBSIDIZED													
From 0.25 to 0.5 GDP pc	-0.1929	*	-0.3819	-0.1177	-0.3965	-0.1939	*	-0.2988	**	-0.1283	*	-0.4569	-0.6013
From 0.5 to 0.75 GDP pc	-0.1769	*	-0.3873	-0.1050	-0.3476	-0.2774	-0.0628	-0.1076	**	-0.1160	*	-0.4570	-0.6024
NON-SUBSIDIZED													
From 1 to 2 GDP pc	-0.1804	**	-0.0720	-0.0597	-0.0563	-0.0029	-0.0130	-0.0724	**	-0.1179	-0.0216	-0.0818	-0.0551
From 2 to 4 GDP pc	-0.0416	**	-0.4068	-0.2346	0.0128	-0.0156	-0.0051	-0.0176	**	-0.1476	-0.0070	-0.1691	-0.1627

Notes: Wage level is presented as times GDP per capita. (*) minimum wage shrink the grid of wages and at least one of the selected values cannot be computed. (**) No significant.
Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization. Suffix "I" stands for IRA, suffix "P" stands for PAYG, in Uruguay suffix "C" stands for choice (mixed regime for everybody) and "O" stands for ordinary (PAYG for low income workers and mixed for the rest).
Source: Own computations.

The rate of growth of wages has substantial impact on ERRs. The effect is negative and usually bigger in IRA regimes and for non-subsidized individuals. For non-subsidized pensioners, steeper wage profiles always imply lower ERRs in IRA regimes. A 1 pp increase in the rate of growth of wages reduces ERRs in3 pp in the mixed regime in Uruguay and from 7 pp in Mexico to 16 pp in Bolivia. Steeper wage profiles imply lower early contributions than flatter profiles, negatively affecting annuities. For subsidized individuals, effects are less negative or even positive, minimum pensions and supplements dilute the effect of small early contributions.

As expected, the negative impact is greater in IRA regimes than in PAYG schemes. Keep in mind that by constructions, in the simulations the last years of contribution are also the best, so steeper wage profiles may positively affect ERR if only a few years of contribution are considered to compute pensions. Among the full PAYG regimes, the greatest negative impact is found in Brazil (6 pp), the country that considers almost all contribution history to define benefits (4/5 of total years of contribution). Also, the negative effect is much smaller in the cases of Ecuador, Peru and Paraguay, where the reference period to define benefits is rather short, between three and five years of contribution. It is even slightly positive for the latter. The Uruguayan mixed regime also follows this pattern, showing a greater negative impact in the regime that is mixed for everyone than in the case of full PAYG for low income workers and mixed for everyone else. Argentina seems to be the only exception, showing a 3 pp increase in ERRs for each 1 pp increase in the real rate of growth of wages. When significant, the impact for subsidized pensioners is also less negative or even positive in PAYG regimes.

(ii) Length of service

In almost all cases, ERRs increase as length of service does. As expected, ERRs are more sensitive to length of service in IRA regimes. In PAYG regimes, ERRs grow at a decreasing rate, the opposite is true in IRA regimes. Maximum effect ranges from 2 to 7 pp per a one-year increase in length of service. Minimum impact ranges from -1 pp to 2 pp per a one-year increase in length of service.

For subsidized pensioners, the effect is much smaller, being in most PAYG regimes even negative. The exception is Ecuador where, as in Bolivia and Chile, subsidies to pensions are not fixed but increasing in years of contribution.

(iii) Retirement age

The reader should keep in mind that I analyze the effect of the retirement age isolated from other factors; I am holding the length of service constant. If a worker stops contributing before being eligible for a pension, delaying his retirement age in one year would not increase his pension, but his last net wage would be slightly higher. That is why the ERR rate would decrease with retirement age at least until retirement age equals pensionable age. If workers delay retirement age beyond pensionable age, wages would be slightly higher, but also pensions so the net effect on ERR can go either way.

As expected, in most cases ERRs increase when retirement is postponed in one year beyond pensionable age and decrease when retirement is postponed, and pensionable age has not yet been reached. In Bolivia, Brazil, IRA in Colombia and Uruguay, ERRs always grow as retirement is delayed in one year, and is bigger when pensionable age has been reached. In Argentina and the PAYG regime in Colombia the opposite is true, impact is always negative. Effects are resumed in Table 2.

(iv) Real interest rate

Is expected to find a significant positive effect of the real interest rate on the ERR in IRA regimes (pure or mixed as in Uruguay). A higher real interest rate would increase the value of the accumulated fund and therefore the annuity and the ERR.

As expected, I found no effect of the real interest rate in PAYG systems, including subsidized individuals in the ordinary Uruguayan system, and high significant positive effects for non-subsidized pensioners in IRA regimes, including the Uruguayan mixed system. Excluding Uruguay, pure IRA regimes show huge impacts: a 0.5 pp increase in the real interest rate would increment ERRs from 5 to 10 pp. For subsidized pensioners, the effect is much smaller, being even negative in Colombia.

Table 2. Effect of delaying retirement in 1 year on ERR.

	ARG	BOL	BRA	CHL	COL_I	COL_P	ECU	MEX	PER_I	PER_P	PRY	URY_C	URY_O
RA<PA	-0.0167	0.0094	0.0109	-0.0143	0.0014	-0.0078	-0.0001	-0.0119	-0.0051	-0.0105	-0.0533	0.0007	0.0046
RA>PA	-0.0050	(*)	0.0167	0.0248	(*)	-0.0001	0.0016	0.0122	0.0313	0.0007	0.0087	0.0124	0.0239

Notes: RA stands for retirement age. PA stands for pensionable age. (*) omitted in the estimation due to collinearity. Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization. Suffix “I” stands IRA, suffix “P” stands for PAYG, in Uruguay suffix “C” stands for choice (mixed regime for everybody) and “O” stands for ordinary (PAYG for low income workers and mixed for the rest).
Source: Own computations.

3.2.2. Pooled estimation

Table 3 shows the ERR's response surfaces.[15]

Table 3. Pooled estimation.

VARIABLES	ERR
Wage	-0.0804***
	(0.0130)
Wage growth	-5.8709**
	(2.0332)
Wage growth X PAYG	5.6977**
	(2.2940)
Length of service	0.0161***
	(0.0018)
Length of service X PAYG	-0.0039
	(0.0023)
Real interest rate	4.0809***
	(1.0598)
Real interest rate X PAYG	-3.2394**
	(1.3314)
Subsidized	0.1430***
	(0.0416)
Contribution rate	2.6288***
	(0.5516)
Contribution rate X PAYG	-0.8467
	(1.1133)
GDP / 1000	-0.0196***
	(0.0063)
PAYG	0.2778
	(0.2643)
Observations	26,293
R-squared	0.9163

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
ERR: is the effective replacement rate, measured in proportion to one. Wage is the wage level in proportion to GDP per capita, in proportion to one. Wage growth is the rate of growth of real wages, in proportion to one. Length of service is measured in years. Real interest rate, in proportion to one

[15] Estimations using clustered OLS, GLS using sandwich estimator for variance and ML show very similar results and are available upon request.

Subsidized is a dummy variable equal one when the individual receives a minimum or a supplemented pension. Contribution rate is the insured plus employer contribution rate, in proportion to one. GDP/1000 is the country's GDP per capita in 2015 measured in US dollars divided by 1000. PAYG is a dummy variable equal one when the regime is PAYG (including Argentina and the ordinary scheme in Uruguay). Source: Own computations

Most scenario level variables show the same pattern between and within regimes. Wage level has a negative and highly significant impact. If wages increase 100 pp, other things equal, ERRs would decrease 8 pp.

The effect of the rate of growth of real wages is also similar to the within regimes findings. The impact is highly significant and strongly negative in IRA regimes. A 1 pp enlargement in the rate of growth of wages would reduce ERRs in around 6 pp in those regimes. As expected, the effect is smaller in the case of PAYG regimes, where ERRs would decrease around 0.2 pp per every pp increase in the growth of wages. Wage growth times PAYG dummy and PAYG dummy coefficients are jointly significant (95% confidence).

The length of service has a positive, highly significant, impact on ERRs in IRA regimes. For every additional year of contribution, ceteris paribus, ERRs increase 1.6pp. The impact is non-significant in PAYG regimes (joint significance of length of service times PAYG dummy and PAYG dummy coefficients was rejected at 95% confidence).

As expected, the real interest rate has very different impact on ERR in IRA and in PAYG regimes. In the former, the impact is bigger, positive and highly significant. For every 1 pp increment in the real interest rate, ERRs would raise 4 pp in IRA regimes. In PAYG regimes, I expected a null impact and I find a 0.8 pp increase in ERRs for every1 pp increment in real interest rate. The real interest rates times PAYG dummy and PAYG dummy coefficients are jointly statistically different from zero at a 90% confidence level. That fact is explained entirely by Uruguay, where the "PAYG" regime is actually full PAYG for low income workers who do not choose to take part in the mixed regime and mixed for everyone else. If I exclude Uruguay from the regression, the effect of 1 pp increment in the real interest rate would be 5 pp higher ERRs in IRA regimes and zero in PAYG schemes.

The different kind of pension that individuals can access to, also affect their ERRs. For instance, being a recipient of a minimum or supplemented pension raises ERRs almost 14 pp.

GDP per capita has a negative impact on ERRs. The effect is highly significant but small. For every 1000 increase in GDP per capita, ERR would decrease 2 pp.

Contribution rate has a strongly significant and positive effect in IRA regimes, as expected. A one pp increment in contribution rate would increase ERRs in 2.6 pp. The effect has no statistical significance in PAYG regimes. This result is driven by the nature of the simulations, the impact of contribution rate in PAYG regimes cannot be separated from other institutional/environmental aspects.

There is no additional statistically significant impact between PAYG and IRA regimes.

While some variables in the simulations relays on individual choices or luck, contribution rate seems to be the crucial policy variable in determining pensions. I further analyze the effect of contribution rate in the next section, performing some counterfactual analysis, changing contribution rate in IRA regimes.

3.2.3. The effect of the contribution rate: counterfactual analysis in IRA regimes

As has been argued, many Latin American countries have comparatively low contribution rates. Chile seems to be the most notorious example. Chile has a global contribution rate of 15 percent of the insured wage, including employers and employees' contributions. This figure is relatively low if compared it with countries in the region with similar GDP per capita. Argentina and Uruguay both have contribution rates over 20 percent of the insured wage.

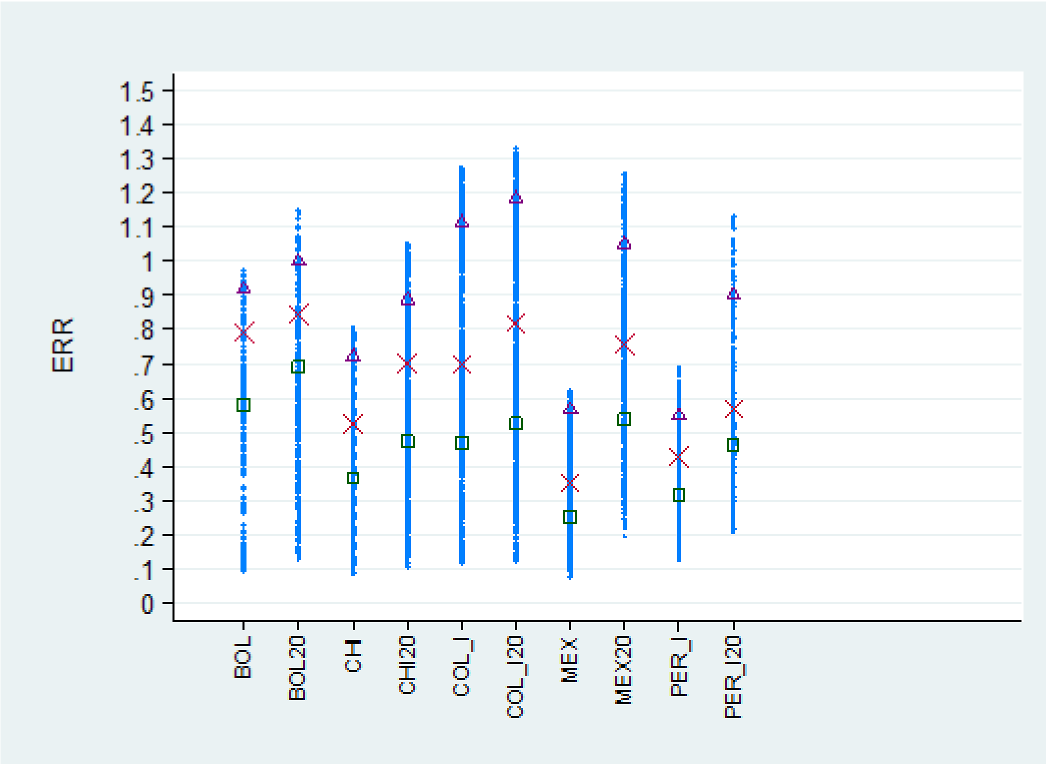
To further analyze the effect of contribution rates, I perform a counterfactual analysis changing contribution rates in IRA regimes. Contribution rates affects pensions in both type of regime, but it is better appreciated in IRA regimes given the nature of my simulations.

I examine how simulated ERRs would change if contribution rate increases to 20 percent of the insured wage, of which 15 percent go to individual accounts.[16]

[16]Labor cost is exogenous in this framework, so there is no point of distinguishing if the augmented contributions are employers or employees' contributions. The effect on the net wage would be exactly the

Figure 6: Simulated ERRs in IRA regimes with different contribution rates

(All individuals)



Notes: Countries are identified using ISO 3166-1 alpha-3 codes published by the International Organization for Standardization. Suffix "I" stands for IRA. Suffix 20 stands for scenarios where contribution rate is 20 percent of the insured wage. In all cases, median ERRs by regime and subgroup are marked with a red x, p25 with a green square and p75 with a purple triangle.
Observations above p85 were excluded in all cases due to presentation purposes.
Source: Own computation.

As Figure 6 and Table 4 show, such increase in individual accounts contributions would have a sizeable effect on ERRs. Median ERR would increase 30 pp in Mexico, around 20 pp in Chile, 10 pp in Colombia and Peru, and lower effect in Bolivia.

In absolute numbers, the greatest effect is found in Mexico, where an almost 9 pp increase in contribution rate result in a 40 pp increase in median ERR. Mexico currently has the lowest rate of contribution to individual account among Latin American countries. But the biggest impact is in Chile, where a 4 pp increase in the contribution rate, leads to almost a 20 pp increment on the median ERR. On the other extreme, a 5 pp increment in contribution rate in Bolivia leads to a 5 pp increment in median ERR. In

same. Also, in terms of the accumulated fund, it is not relevant if contributions are made by employers or employees.

Bolivia annuities are staggered by lower and upper bounds according to years of contribution, possibly diminishing the impact of the rate of contribution.

Table 4: Original and counterfactual contribution rates and median ERR.

	Original individual account contribution rate	Original Median ERR	New individual account contribution rate	New median ERR
Bolivia	0.10	0.79	0.15	0.84
Chile	0.11	0.52	0.15	0.70
Colombia	0.115	0.70	0.15	0.82
Mexico	0.06275	0.35	0.15	0.75
Peru	0.10	0.43	0.15	0.57

Source: own computations

It seems there is room to significantly improve ERRs increasing contribution rates, in particular in Chile and Mexico.

(v) Concluding remarks.

In the last decade, concerns about pension amounts and pension adequacy have been plastered in social security forums and laws throughout Latin America. In this paper I assess Latin American contributory pension schemes in terms of their role in replacing earnings after retirement, one of social security objectives from the individual perspective and one way to evaluate pension amounts. Since earnings are the main source of income before retirement and pensions are the main source of income after retirement, I choose to measure such role through the ERR, defined as first pension to last net wage ratio.

My analysis is based on microsimulations of work histories and pension rights in 10 Latin American countries according to current norms and controlled scenarios. I use response surface analysis to summarize the results, performing regression analysis to assess the impact of changes in control variables on the ERR. The effects of covariates at scenario level and at regime level are considered.

There is substantial variation in ERRs within and between regimes. I look for key elements that can explain such differences, resulting in useful policy recommendations.

Some differences are explained by individual choices, other by luck. There also are some institutional and policy variables that affect ERRs.

In the first group of variables, two are usually targeted in social security: length of service and retirement age. Findings go in line with incentives to work literature: postponing retirement increase ERRs, especially if one has already become eligible for pensions.

There are two variables that are related to luck and have big impact on ERR: the rate of grow of real wages and the real interest rate. Both affect in a greater extent to IRA regimes. In that case, flatter wage profiles are associated with lower contributions early in work life. Those contributions are the ones capitalized for a longer period, being pension and ERRs lower than in the case of steeper wage profiles. The real interest rate directly affects the return of the accumulated fund, determining pension amounts and ERRs in IRA schemes. The big impact of these variables in these regimes may turn the attention to risk distribution under different regimes.

The most relevant policy variable is the contribution rate. I show it can have a huge impact on ERRs in countries as Chile and Mexico, where there is margin to further increase contributions rates and improve pensions. It seems obvious, but it is usually overlooked, if you want to receive higher pensions you must contribute more throughout your active life.

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APENDIX

1. Brief description of old age contributory regimes applied in the simulations (individuals born in 2016)[17]

ARGENTINA

Type of program: Social insurance.

Funding: Insured person contributes 11 percent of covered earnings (up to a certain ceiling), employer contributes between 10.17 and 12.71 percent of covered earnings (no ceiling), Government with general revenue and certain taxes.

Qualifying conditions: In the general regime, minimum retirement age is 65 (60 to 65 for women) and vesting period condition is 30 years. The is no sharp jump, insured can delay in two years retirement for every year falling short of minimum requirement. In the advanced-age program, the minimum retirement age is 70 and 10 years of contribution are required.

Benefits: A basic flat old-age pension plus a compensatory pension based on years of contributions before July 1994 plus an additional pension based on years of contributions since then is paid. The basic pension is fixed. The compensatory and additional pensions are 1.5 percent of the insured's average earnings in the last 10 years multiplied by the years of contribution before and after July 1, 1994 (in both cases the ceiling is 35 years). Advanced-age benefits are 70 percent of the regular pension. There is a minimum pension in both types of benefits, which is a fixed amount.

BOLIVIA

Type of program: Mandatory individual account.

Funding: Insured person contributes 12.21 percent of covered earnings (up to a certain ceiling) of which 10 percent goes to IRA, also contributes progressively with wages from 0.5 to 10 percent of insured earnings to solidarity pension (there is a ceiling); employer does not contribute to IRA but contributes 3 percent of the payroll to solidarity pension (no ceiling).

Qualifying conditions: There are no age or vesting period requirements if the insured person can finance a pension "sufficiently" high (60 percent of average earnings in the last 2 years plus expenses). If not, minimum retirement age is 58 (56 for women) and vesting period condition is 10 years.

Benefits: The insured must purchase an annuity. Solidarity pension is the difference between the individual account balance and the legally defined threshold corresponding to the years of contribution of the insured. So minimum pension is not a fix amount, it varies with years of contribution.

BRASIL

Type of program: Social insurance.

Funding: Insured person contributes between 8 and 11 percent of covered earnings (up to a certain ceiling), employer 20 percent of covered earnings (no ceiling), Government contributes with certain taxes to cover administrative cost and any deficit.

Qualifying conditions: In the length of service pension, there is no minimum retirement age, vesting period is 35 years (30 for women). In the age pension, the minimum retirement age is 65 (60 for women) and vesting period condition is 15.

Benefits: In the length of service pension, 100 percent of the insured's average earnings is paid. In the age pension, 70 percent of the insured's average earnings plus a 1 percent for each year of contribution up to 100 percent, is paid. Average earnings used to calculate benefits are based on the best 4/5 of total earning history, multiplied by the Factor Previdenciario (an actuarial coefficient based on contribution rate, contributions period, retirement age and life expectancy). There is a fix minimum pension.

CHILE

Type of program: Mandatory individual accounts.

Funding: Insured person contributes 12.55 percent of covered earnings (up to a certain ceiling) of which 10 percent goes to IRA (there is a ceiling); employer contributes with 2.5 percent of the payroll (up to the same ceiling). Government finances the total cost of the minimum pensions.

17 Based on Social Security Programs Throughout the World: The Americas, 2017 (Social Security Administration)

Qualifying conditions: Insured person account balance is enough to purchase an annuity greater than 70 percent of the insured's average earnings in the last 10 years and 80 percent of the PMAS, or age 65. The PMAS is the lowest value of the old-age pension before qualifying for the old-age social security top-up benefit.

Benefits: The value of the pension is based on the insured's contributions plus accrued interest, minus administrative fees. At retirement, the accumulated capital can be used to provide an immediate life annuity, temporary income with a deferred life annuity, programmed withdrawals, or an immediate life annuity with programmed withdrawals. There are minimum benefits, which are not fixed values.

COLOMBIA

Type of program: Parallel systems social insurance and individual accounts, the insured may choose between them and may switch membership every 5 years up to the last 10 years before retirement.

Funding: Insured person contributes with 4 percent of covered earnings (up to a certain ceiling), there is an additional contribution ranging from 1 to 2 percent according to insured's wages. The employer contributes with 12 percent of covered earnings (up to the same ceiling), the Government contributes as an employer and finances the value of the accrued rights under the social insurance system.

Qualifying conditions: In social insurance, minimum retirement age is 62 (57 for women) and vesting period is 25 years. In individual accounts, insured person account balance is enough to purchase an annuity greater than 110 percent of the minimum wage or can access a minimum pension at 62 (57 for women) or older having contributed for 25 years. If insured person does not fulfill the requirements, a lump sum benefit is paid in both cases.

Benefits: In individual account, the pension is based on the value of the insured's contributions plus accrued interest. At retirement, the insured may make periodic withdrawals from the individual account to guarantee income for the expected lifespan, buy an annuity from a private insurance company, or a combination of the two. In social insurance, pension is equal to between 55 and 65 percent of the basic monthly wage, plus 1.5 percent for each 50-week period of contributions, up to a maximum of 80 percent of the basic monthly wage. The basic monthly wage is based on the insured's average earnings in the last 10 years before receiving the pension. There is a fix minimum pension.

ECUADOR

Type of program: Social insurance.

Funding: Insured person contributes 9.64 percent of covered earnings (there is no ceiling), employer contributes with 1.1 percent of the payroll, and Government contributes as an employer (at higher contribution rates) and finances 40% of the cost of old-age, disability and survivor pensions.

Qualifying conditions: Access is staggered; insured person can claim benefits at any age with 40 years of contribution, at age 60 with 30 years of contribution, at 65 with 15 years of contribution and at 70 with 10 years of contribution.

Benefits: A percentage of the insured's average monthly earnings in the five best years of earnings is paid, according to the total number of years of contributions (50 percent for 10 years, 75percent for 30 years, 81.25 percent for 35 years, and 100 percent for 40 years). The pension is increased by 1.25% for each year exceeding 40 years. There are minimum and maximum fix benefits.

MEXICO

Type of program: Mandatory individual accounts.

Funding: Insured person contributes 1.75 percent of covered earnings (up to a certain ceiling) of which 1.125 percent goes to IRA (there is a ceiling); employer contributes with 6.9 percent of the payroll (up to the same ceiling) of which 5.15 percent goes to IRA; Government 0.225 percent of covered earnings plus an average flat-rate daily amount to the individual account for insured persons with earnings up to 15 times the legal monthly minimum wage (old age); 0.125 percent of covered earnings (disability and survivors); and the total cost of the guaranteed minimum pension.

Qualifying conditions: Insured person account balance is enough to purchase an annuity greater than 30 percent of the minimum pension plus survivor pension; or age 65 with 25 years of contribution. If insured person does not fulfill the requirements, a lump sum benefit is paid.

Benefits: The insured has two different payment options: make programmed withdrawals or purchase an annuity. There is a fix minimum pension, the difference between the account balance and the legal monthly minimum pension is paid.

PARAGUAY

Type of program: Social insurance.

Funding: Insured person contributes 9 percent of covered earnings (up to a certain ceiling), employer contributes with 14 percent of the payroll (there is no ceiling), and Government contributes as an employer.

Qualifying conditions: Insured person can claim benefits at 55 with 30 years of contribution (early); or at age 60 with 25 years of contribution (ordinary); or at age 65 with 15 years of contribution (partial).

Benefits: Ordinary pension pays 100 percent of the insured’s average monthly earnings in the last three years of earnings. Early pension pays 80 percent of the insured’s average earnings plus a 4 percent for each year postponing retirement up to age 59. Partial pension pays 60 percent of the insured’s average earnings. There is a fix minimum pension.

PERU

Type of program: Parallel systems social insurance and individual accounts, the insured may choose between them.

Funding: Insured person contributes with 13 percent (12.48 percent in IRA) of covered earnings (there is no ceiling); employers do not contribute; and the Government contributes as an employer and finances the value of the accrued rights under the social insurance system.

Qualifying conditions: In social insurance, minimum retirement age is 65 and vesting period is 20 years, or insured person can access an early pension at 55 (50 for women) with 30 (25 for women) years of contribution. In individual accounts, insured person account balance is enough to purchase an annuity greater than 40 percent of the insured’s average earnings in the last 10 years, or age 65.

Benefits: In social insurance, pension is equal to 30 percent of the insured's average earnings in the last 5 years, plus 2 percent for each additional year of contribution exceeding 20, up to 100 percent. The early pension reduces benefits by 4 percent for each year that pension is claimed before 65. There are fixed minimum and maximum pensions. In individual account, the pension is based on the value of the insured's contributions plus accrued interest. At retirement, the insured may make periodic withdrawals, buy a personal annuity, buy a joint survivor life annuity, a deferred annuity with temporary periodic withdrawals or a lump sum. There is a fix minimum pension.

URUGUAY

Type of program: Mixed system social insurance plus mandatory individual accounts, low income workers may choose between full social insurance and mixed scheme.

Funding: Insured person contributes with 15 percent of covered earnings (up to a certain ceiling); employers contribute with 7.5 percent of covered earnings financing exclusively the social insurance scheme (up to the same ceiling); and the Government finance any deficit in the social insurance program and contributes as an employer.

Qualifying conditions: In social insurance, minimum retirement age is 60 and vesting period is 30 years, or insured person can access a staggered old-age pension at 65 with 25 years of contribution, requirements decrease by 2 years of contribution for each year postponing retirement. In individual accounts, for a full pension (social insurance plus annuity) insured person must fulfill social insurance requirements but can also purchase an annuity at age 65 with no contribution requirement.

Benefits: In social insurance, pension is equal to 45 percent of the insured's average earnings in the last 10 years or 105 percent of the insured’s average earnings in the best 20 years of contribution, plus 1 percent of reference earnings for each year of contributions from 31 to 35 years plus 0.5 percent of reference earnings for each year of contributions from 36 to 40 years is paid. Also, pension is increased by 3 percent for each year of contributions after the normal retirement age with at least 35 years of contributions, up to 30 percent; 2 percent for each year of contributions after the normal retirement age if the insured has less than 35 years of contributions. There are fixed minimum and maximum pensions. In individual accounts, the insured must use the total account balance to purchase an annuity from an insurance company.

2. Complete estimations by regime

ERR	ARG	BOL	BRA	CHL	COL_I	COL_P	ECU	MEX	PRY	PER_I	PER_P	URY_C	URY_O
w	-0.239***	0.006	0.040***	0.017	-0.057**	0.001	-0.016***	-0.046***	-0.034***	-0.000	-0.116***	-0.053***	-0.025***
	(0.009)	(0.012)	(0.009)	(0.012)	(0.024)	(0.002)	(0.004)	(0.007)	(0.007)	(0.006)	(0.010)	(0.007)	(0.008)
w^2	0.034***	-0.003	-0.040***	-0.023***	0.010*	-0.001***	0.002**	0.003**	0.005***	0.000	0.006***	-0.006***	-0.009***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.005)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
$w \times Dsub$	0.330***	-0.069***	-1.538***	-0.197***	1.004***	6.565***	0.453***	6.174***	-0.087***		-0.148***	-1.771***	-2.374***
	(0.031)	(0.013)	(0.104)	(0.019)	(0.092)	(0.078)	(0.029)	(0.360)	(0.030)		(0.020)	(0.096)	(0.106)
$w^2 \times Dsub$	-0.337***	-0.011***		0.044***	-1.208***	-9.786***	-0.562***	-9.763***	0.003		0.022***		
	(0.018)	(0.003)		(0.005)	(0.070)	(0.108)	(0.027)	(0.514)	(0.007)		(0.005)		
$\hat{w}$	2.938***	-15.843***	-5.734***	-8.752***	-10.689***	-2.779***	-1.437***	-7.455***	0.560**	-7.524***	-0.155	-3.095***	0.236
	(0.394)	(0.469)	(0.368)	(0.474)	(0.940)	(0.105)	(0.189)	(0.290)	(0.275)	(0.251)	(0.434)	(0.317)	(0.350)
$\hat{w} \times Dsub$	6.792***	16.620***	10.953***	5.128***	24.497***	5.288***	4.843***	9.325***	1.307		1.457**	2.869***	5.569***
	(0.674)	(0.522)	(0.915)	(0.639)	(1.483)	(0.179)	(0.299)	(0.791)	(1.229)		(0.687)	(0.777)	(0.856)
los	0.054***	-0.006**	0.060***	0.001	-0.015**	0.048***	0.012***	-0.017***	0.094***	-0.004***	0.054***	0.046***	0.050***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.006)	(0.002)	(0.001)	(0.004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
los^2	-0.001***	0.001***	-0.001***	0.000***	0.001***	-0.001***	0.000***	0.001***	-0.001***	0.000***	-0.001***	-0.000***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$los \times Dsub$	-0.075***	0.062***	-0.062***	0.012***	0.017	-0.049***	-0.024***	0.029**			-0.028***	-0.093***	-0.119***
	(0.008)	(0.003)	(0.005)	(0.004)	(0.020)	(0.003)	(0.002)	(0.014)			(0.010)	(0.005)	(0.006)
$los^2 \times Dsub$	0.001***	-0.001***	0.001***	-0.000***	-0.001***	0.001***	0.000***	-0.001***	-0.002***		0.000	0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
ra	-0.017***	0.009***	0.011***	-0.015***	0.004***	-0.008***	-0.000	-0.012***	-0.053***	-0.005***	-0.010***	0.001	0.005***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
$ra \times Dpen$	0.012***	-0.002***	0.006***	0.042***		0.008***	0.002**	0.025***	0.062***	0.036***	0.017***	0.012***	0.019***
	(0.002)	(0.000)	(0.002)	(0.002)		(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
$Dpen$	-0.745***		-0.538***	-2.754***		-0.477***	-0.105*	-1.628***	-4.012***	-2.364***	-1.091***	-0.920***	-1.418***
	(0.133)		(0.125)	(0.133)		(0.037)	(0.054)	(0.123)	(0.118)	(0.095)	(0.130)	(0.086)	(0.094)
rir	-0.000	20.732***	0.000	12.911***	14.515***	0.000	0.000	10.583***	0.000	11.008***	-0.000	5.649***	2.234***
	(0.377)	(0.483)	(0.350)	(0.462)	(0.916)	(0.100)	(0.177)	(0.280)	(0.263)	(0.242)	(0.411)	(0.303)	(0.334)
$rir \times Dsub$	0.000	-20.454***	-0.000	-4.081***	-17.340***	-0.000	-0.000	-10.067***	-0.000		0.000	-0.065	-2.234***
	(0.644)	(0.532)	(0.844)	(0.623)	(1.445)	(0.169)	(0.284)	(0.820)	(1.175)		(0.657)	(0.743)	(0.819)
$Dsub$	1.096***	0.222***	1.581***	0.091	0.796**	0.248***	0.358***	-0.789***			0.787***	2.079***	2.758***
	(0.080)	(0.043)	(0.086)	(0.063)	(0.326)	(0.044)	(0.024)	(0.221)			(0.136)	(0.090)	(0.099)
$Constant$	0.883***	-0.831***	-0.617***	0.890***	-0.181	0.280***	0.340***	0.955***	2.922***	0.289***	0.131	-0.222***	-0.489***
	(0.069)	(0.052)	(0.095)	(0.099)	(0.120)	(0.036)	(0.048)	(0.133)	(0.103)	(0.070)	(0.108)	(0.062)	(0.069)
Obs	2,160	2,160	2,160	2,160	1,669	1,512	2,160	1,512	2,160	2,160	2,160	2,160	2,160
$Adj\ R^2$	0.789	0.915	0.836	0.804	0.707	0.974	0.898	0.844	0.794	0.863	0.787	0.806	0.793

Where:
ERR: is the effective replacement rate, measured in proportion to one
w: is the wage level in proportion to GDP per capita, in proportion to one
$\hat{w}$: is the rate of growth of real wages, in proportion to one
los: is the length of service in years
ra: is the retirement age, age at which individuals opt out the labor market, in years
rir: is the real interest rate, in proportion to one
$Dpen$: is a dummy variable equal one when retirement age is equal or greater to pensionable age
$Dsub$: is a dummy variable equal one when the individual receives a minimum or a supplemented pension