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Abstract

We present a new database of social security indicators for eleven Latin American countries designed to show how much they promise to pay in return to contributions. The indicators are based on micro-simulations according to existing norms. Our results indicate that most programs are progressive. In most programs, retirement ages do not have a sizeable impact on the rates of return, given the length of service. The length of service has a strong impact on the expected returns to contributions, mostly due to vesting period conditions. Because of this, several pension programs in Latin America may be exacerbating income risk.

Keywords: Latin America, Social Security, Internal Rate of Return.

Resumen

Se presenta una nueva base de datos con indicadores de seguridad social para once países de Latinoamérica, diseñados para mostrar cuánto ofrecen pagar en retribución a las contribuciones que las personas les hacen. Los indicadores se basan en mico-simulaciones que siguen las normas de los diferentes regímenes. Los resultados obtenidos indican que la mayoría de los programas son progresivos. En la mayoría de ellos, las edades de retiro no tienen un impacto significativo en las tasas de retorno, para un período de contribución dado. El período de contribución sí tiene un impacto importante en los retornos esperados de las contribuciones, debido a la importancia que tiene obre ellos, la satisfacción de los requerimientos de tiempo de contribución. Debido a esto, muchos programas de pensiones de América Latina pueden estar exacerbando el riesgo de ingresos.

Palabras clave: América Latina, Seguridad Social, Tasa Interna de Retorno.

JEL classification: H55, J14, J26

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1. Introduction

In this paper, we present a new database of social security indicators designed to assess pension schemes in terms of the payments they promise in return to contributions.[2] We use this data to assess several Latin American pension programs in terms of their impact on income inequality, insurance and incentives to work. The indicators are based on micro-simulations of lifetime contributions and pension rights according to existing norms. We provide two synthetic indicators: the expected internal rate of return (IRR) and the replacement rate (RR) implicit in the simulated cash flows of contributions and benefits. The current version of the database covers the main pension programs in eleven Latin American countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela.

The design of a pension scheme has important implications in terms of income inequality, insurance and incentives to work. These effects are difficult to assess because the outcome depends on the interactions between several parameters of the scheme as well as on characteristics of the population and the economy. The IRR and the RR are two synthetic indicators useful in this assessment. The IRR measures the benefit workers receive in return for their contributions, in terms of an implicit rate of return. The RR is the pension-wage ratio and provides a direct measure of the ability of the scheme to replace the wages that cease when a worker retires.

Our analysis focuses on the *design* of the schemes and hence on the *promises* they make rather than on actual performance. This acknowledgment/warning is important in a region where the gap between *de jure* and *de facto* policies is often wide. Most pension administrations cannot strictly abide by the law simply because they do not have the information they need to apply the rules. Also many workers who are legally covered by pension schemes are not covered in practice. Notwithstanding, the analysis of the design of the schemes and their adequacy to the local demographic and economic conditions is an important ingredient of a broader assessment of pension schemes in Latin America.

This paper and the accompanying database are part of a broader project to generate a new set of indicators of social security performance across the world. Using IRRs and RRs to

[2] The complete database is available as an Excel file named "Forteza_Ourens_Social_Security_Indicators_Version1.xls".

assess pension programs is of course not new (see, among many others, Duggan et al. 1995; Leimer 1999; Beach and Davis 1998; Gustman and Steinmeier 2001; Afonso and Fernandes 2005), but to the best of our knowledge there is no similar database that provides estimations of these indicators for Latin American pension programs on standardized and comparable conditions. The most direct antecedents of this contribution are Robalino (2005), who follows a similar strategy to assess incentives, redistribution and sustainability of the pension schemes in the Middle East and North Africa, and Dorfman and Forteza (2010), who present a similar analysis for the Caribbean.

In the following section, we present the methodology. In Section 3 we present our results, focusing first on income redistribution and then on insurance and incentives to work. Section 4 concludes.

2. Methodology

Social security programs involve pretty complex contracts between workers, employers and social security administrations. Workers and employers are supposed to contribute over several decades in exchange for pensions, some of which have to be paid until death, and often even beyond death (survivor benefits). Assessing the design of a program is not simple as the impact of each norm on the final result depends on other norms plus some demographic and socio-economic characteristics of the covered population. The IRRs and the RRs are two synthetic indicators that summarize the interactions between all these ingredients and provide the basis for meaningful comparisons across programs and time. While the analysis in this paper rests mostly on the IRRs and only subsidiary on the RRs, we comment on both here because both indicators were included in the database that accompanies this paper.

Replacement rates denote “the value of a pension as a proportion of a worker's wage during some base period, such as the last year or two before retirement or the entire lifetime average wage” (World Bank 1994: xxiii). In order to make the results comparable across countries, we standardized this measure choosing the last year as the base period. In the denominator, we compute all labor income (net of contributions), and not only insured wages, because we want to measure the proportion of worker’s labor income that is replaced with pensions. In a few cases, we will also refer to the replacement rates as they are defined in the norms of programs. To avoid confusion, we will refer to the latter as the technical replacement rates. Unlike the RRs, the technical replacement rates are not directly comparable across countries and programs because of different definitions of the reference wage. Notice that the RRs can be computed not only in defined benefit programs that have a well-defined technical replacement rate, but also in defined contribution and mixed social security programs, and the interpretation is the same: the percentage of the final wage that is replaced with the initial pension.

The literature has followed two different strategies to perform this type of analysis (Leimer 1999). One is to use surveys and social security records to gather data on contributions paid and benefits received by workers. The other strategy is to simulate flows of labor income of hypothetical workers and compute the contributions and benefits according to existing norms. We follow the second approach, partly dictated by data availability and partly by our goals. We want to build a database of social security indicators that can be used to assess the *design* of the systems and that allow for *cross-country comparisons*. In developing countries, the gap between design and actual implementation is usually large, hence contributions paid and benefits received may not accurately reflect the design of the programs. If our goal were instead to assess the performance of a program in a certain period or under specific circumstances that were observed in one or more countries, the first approach would probably be more appropriate. Regarding cross-country comparisons, it is usually difficult and risky to compare results provided in different studies because the assumptions are different. It is obviously easier to standardize conditions to facilitate comparisons using simulated working life histories than data from surveys and administrative records.

2.1. The simulations

We simulate the cash flows of contributions and pensions and compute the internal rates of return first in a "base case scenario" and then in other scenarios designed to perform sensitivity analysis. In all our simulations workers are born in 2007. Unless explicitly indicated, we assume they will be subject to the social security rules as of 2007.[3] The basic rules and parameters of each pension scheme were taken from Social Security

[3] In Chile and Uruguay we also simulate the reforms passed in 2008. The main change in Uruguay was the loosening of the vesting period conditions. In the case of Chile, the assistance and minimum pension provisions were better integrated and expanded and the 20 years of contributions previously required to access the minimum pension guarantee was dropped.

Administration (2008) and complemented with local sources in most countries. The list of these sources is included in the references section. We present a brief description of the pension programs in a related paper (Forteza and Ourens, 2009).

Our set of countries includes a considerable variety of pension program designs. Some countries have traditional pay-as-you-go defined benefit (PAYG-DB) programs: Brazil, Ecuador[4], Paraguay and Venezuela. Other countries introduced individual accounts defined contribution (DC) programs and phased out the traditional PAYG-DB programs: Bolivia, Chile and Mexico. Colombia and Peru introduced savings accounts, but without phasing out the PAYG-DB programs: contributors can choose program. The term “parallel model” has been coined to refer to this design (Mesa Lago 2006). Finally, a few countries introduced savings accounts and maintained the traditional PAYG-DB programs, like in the parallel model, but with the additional twist that each worker is covered by both schemes. This design has been called the “mixed model” and is represented in our study by Argentina[5] and Uruguay.

We present simulations for both the PAYG-DB and the individual accounts DC programs in the parallel model countries (Colombia and Peru). In the mixed models it is not possible to separate so neatly the DB and DC segments of the program, but some useful distinction can still be made. In the case of Argentina, workers can choose to contribute only to the PAYG or split contributions between both the PAYG and the individual accounts programs. So while some are covered exclusively by the PAYG program, no one is exclusively covered by individual accounts. We will refer to the former as PAYG and to the latter as individual accounts, even though the latter is actually mixed. Something similar happens in Uruguay, but in this case only low wage earners can make a choice: workers earning more than a certain threshold must participate in both DB and DC tiers. So in this case, we will use the label “individual accounts” to refer to simulations done for individuals who contribute to both tiers, either because they explicitly opted or because they had to participate in both. We will use the label “PAYG” to refer to the set of rules that applies to individuals who did not opt to contribute to individual accounts. Readers should keep in mind, though, that some of them, those earning sufficiently high wages

[4] In the nineties, Ecuador passed a reform law that would introduce savings accounts, but the constitutionality of this law was contested and the savings accounts were not introduced.

[5] In 2008, the individual accounts pillar was phased out in Argentina. We nevertheless include this case as a mixed model because we are simulating the 2007 rules.

have to contribute also to the individual accounts tier even if they do not explicitly opt to do it.

The only source of uncertainty in each scenario is the risk of death, which we evaluate using WHO 2006 mortality tables (WHO 2008).[6] Following Robichek (1975), we compute the expected internal rates of return as the rates that cancel the expected discounted cash flows. In our application, the expected cash flows are contributions and pensions flows times the survivor probabilities.

In the base case scenario, workers' lifetime average labor income is equal to their respective country's per capita GDP over their working life. In a few cases in which wages computed in this way would have been lower than the legal minimum wage, we imposed the legal minimum. Gross domestic product per capita was assumed to grow at the same constant rate in all countries and scenarios, so that the differences we get in the IRRs are not driven by different rates of growth.

Workers in the base case scenario have the same age-earnings profile across countries. Real wages grow at the same rate as real GDP per capita, equal to 2 ppa (percent per annum).[7] In this scenario, workers start working at 30 and contribute without interruptions until they retire at 65 in all countries.

In the current version of our database, simulated workers are single males, who do not generate survivor benefits or suffer disability, so the only benefit they effectively receive is the old-age pension. These workers are nevertheless covered by disability and survivor insurance as well, and therefore contribute to the old-age, survivor and disability programs. They simply are not eligible for survival and disability benefits because we assumed that they do not suffer disability and leave no survivors. Workers who do generate survivor benefits or receive a disability pension would receive higher IRRs than the set of workers simulated in the current version.

[6] It is possible that these statistics underestimate the life expectancy of contributors to pension programs for two reasons. First, in Latin America the pool of contributors are relatively better off and are likely to have higher life expectancy than the excluded. Second, WHO mortality tables are cross sectional, i.e. they are not cohort specific. It is reasonable, however, to expect lower mortality rates for recent cohorts. Because of this, the IRRs that actual contributors of the cohort born in 2007 would get might be higher than reported in this study, at least in DB programs.

[7] This assumption ensures that in our simulations the aggregate labor income to GDP ratio remains constant, which is one of the stylized facts of long run growth as first described by Kaldor (see, for example, Acemoglu, 2009).

The flows over which we compute the IRRs include both the insured and the employers' contributions.[8] Some might disagree with this choice, possibly arguing that only the insured contributions fall on workers shoulders. Most economists would argue however that this distinction is not economically meaningful since both the insured and the employers' contributions are part of the payroll taxes. What could be more relevant is to split the impact of contributions between lower after-tax wages and higher labor costs. Payroll taxes would reduce after-tax wages one-to-one in the long run in a neoclassical small open economy model. In this environment, contributions represent a burden on workers' shoulders and should be fully included in the simulated cash flows. In practice in a non-neoclassical world, the impact of payroll taxes on after-tax wages might be smaller than one-to-one even over relatively extended periods. If this is so, the burden of the system on workers would be smaller than assumed in our simulations. Nevertheless, computing the cash flows with total contributions would still be appropriate to assess the cost that the program imposes on the job position, which might be the most relevant approach in assessing incentive issues. In a non-neoclassical world, this assumption would be less appropriate for the assessment of the impact of pension programs on income inequality.

It should be noted that most pension programs have other sources of funds on top of contributions. Most governments partially finance these programs from general taxes. We made no attempt at computing the general taxes workers pay to indirectly finance pensions. The rates of return that workers receive from the pension programs are thus likely to be lower than what our simulations suggest. This is particularly true in the case of countries with mature pension programs, which usually have deficits that governments help to finance. If the payroll and general taxes were distributed similarly among workers, the results we got in terms of income redistribution would probably not differ qualitatively from what we would have gotten had we been able to compute all sources of pension funds. Under these conditions, the same workers who are net winners (losers) according to our analysis would continue being so in a more complete analysis that included these other sources of pension funds. In turn, the incentives to work should not hinge too much on general taxes that workers must pay independently of whether they participate in the social security system. Consider for example the case of Uruguay, where part of the value added

[8] Gruber (1999, p 90) makes the same assumption.

tax is earmarked to finance pensions. One could argue that the decision to participate in formal labor markets is relatively independent of the decision to pay the value added tax. Things might be less clear in the case of the income tax, for the decision to evade social security contributions could somehow be linked to the decision to evade the income tax.

In the spirit of Whitehouse (2007) and OECD (2009), we standardized some conditions to make the results more comparable across countries and to focus mainly on design issues. We assumed that all pension funds and annuity providers receive the same 3.5 ppa real interest rate (net of fees and other costs) across countries and programs. While it is possible that different programs get different real interest rates, we prefer at this stage to explore differences between programs that do not hinge on the divergent abilities of the pension funds to yield different net returns. We used the same interest rate for discounting.

The insurable wage ceilings, the minimum and maximum pensions, minimum wages, insured wage thresholds and all other system parameters that are set in nominal terms grow at the same rate as the average wage and the nominal GDP per capita. In all the simulations and countries these variables grow at 4.5 ppa. These assumptions ensure that these variables maintain a constant proportion over time, which looks like a sensible assumption in the long run.

The results are particularly sensitive to the assumptions made about the adjustment of pensions and, to a lesser extent, the "valorization" of wages for pension computation. In most countries, we did not find formal indexation rules. Failing to adjust pensions to prices has been a common practice in the region. Nevertheless, we assumed that all programs index pensions to the consumer price index, unless explicitly indicated otherwise. Analogously, we adjusted wages used to compute pensions in defined benefit programs ("valorization") according to inflation. Uruguay is an exception, since the constitution explicitly mandates indexation of pensions and valorization of wages to the average wage index. So too, in the Argentinean PAYG pillar, wages are "valorized" with the average wage index.

All the flows are before taxes, so we computed gross IRRs. All the IRRs we present are real.

We performed sensitivity analysis in four dimensions, namely: (i) the average wage level, (ii) the age-earnings profile, (iii) the length of service, and (iv) the age of retirement. The *average wage* along the lifecycle of the simulated workers was set at five different levels, corresponding to one-quarter, one-half, one, two and four times the country's average GDP per capita over their working life.[9] The *age-earnings profile* is the profile of earnings along the lifecycle. We generated three profiles setting the rate of growth of the real wage at 1, 2 and 3 ppa in real terms. The *length of service* is the number of years the individual is supposed to be effectively contributing. In our simulations, this is equal to the retirement minus the enrollment ages. So while we do not explicitly simulate interruptions in the contribution spells, we do consider the main effect of these interruptions, namely the reduction of the periods of contribution. We considered five enrollment ages (25, 30, 35, 40 and 45) and four retirement ages (55, 60, 65, and 70) so the length of service ranged between 10 and 45 years.

2.2. Response surfaces

Our simulations yield a wide range of IRRs, both across countries and scenarios, and hence the database has potentially interesting statistical variability. Having simulated thousands of scenarios, it is obviously impossible and not very enlightening to describe each and all of them in detail, so we will mostly appeal to regression analysis to characterize and summarize our simulation results. The regression model is a representation of the response of the outcome variable to the variation of the control variables across simulations. This representation is usually known as the response surface.

Response surface analysis has been used in many fields. In econometrics, for example, response surfaces have been extensively used to summarize and asses the outcomes of Monte Carlo simulations (Hendry 1984, provides a survey). In these applications, the usual goal of the analysis is to characterize the distribution of statistics when purely analytical characterization is not feasible. Response surface methodology is also extensively used in engineering to optimize processes (Myers et al. 2009). The outcome is usually an indicator of the efficiency of an industrial process and the control variables are conditions of the process that can be modified at will to get the most efficient result. The analysis involves characterizing the response surface and then using it to find the point at which the process is optimized. Our response surface analysis is close to the typical econometric use of the methodology and departs from engineering applications in that we do not pursue the

[9] As already mentioned, wages were set at the legal minimum whenever these rules yielded a wage below the minimum.

optimization of a process but the characterization of the impact on the response variable of changes in control variables. But we depart from typical econometric applications and come closer to some engineering applications of the methodology in that our simulations are deterministic.[10]

We run the following regressions:

$$IRR = \beta_{10} + \beta_{11} w + \beta_{12} w^2 + \beta_{13} \hat{w} + \beta_{14} los + \beta_{15} los^2 + \beta_{16}(1 - Dves1) + \beta_{17}(1 - Dves2) + \beta_{18} ra + \beta_{19} ra^2 \quad (1)$$

$$IRR = \beta_{20} + \beta_{21} w + \beta_{22} w^2 + \beta_{23} \hat{w} + \beta_{24} los \times (1 - Dves1) + \beta_{25} los \times Dves1 + \beta_{26}(1 - Dves1) + \beta_{27}(1 - Dves2) + \beta_{28} ra + \beta_{29} ra^2 \quad (2)$$

There are five sets of regressors in this equations: the wage level (in natural logs, w), the rate of growth of wages $(\hat{w})$, the length of service (los), dummies for vesting periods $(Dves1,\ Dves2)$, and the retirement age (ra).

The wage level is meant to capture the redistributive nature of the program. The pension schemes are supposed to be progressive in the sense that workers with low average income should receive higher returns than the well off, so $\beta_{i1} + 2\beta_{i2} w$ is expected to be negative in the relevant range values.

The rate of growth of real wages along the life cycle is meant to capture the impact of the age earnings profile on redistribution. Higher rates of growth of wages imply steeper earnings profiles. In DB programs the benefit formula is often based on the average of contribution wages in the last years of contribution, which tends to be higher the steeper the earnings profiles. Hence, we expect β_{i3} to be positive in these programs.

The length of service equals the years of effective contribution in our simulations. In most programs, pensions are supposed to be increasing functions of the periods of contribution, but other provisions like minimum and maximum pensions often interfere. Also, even when pensions increase with the number of periods of contribution, it is not a priori obvious whether the compensation is actuarially fair.

[10] Our simulation model is stochastic regarding death, but our statistics of interest, the expected internal rate of return, is not so. Hence, we only generate one replication for each “experiment”.

Many programs have vesting period conditions. In most cases, the impact of the length of service on the IRRs depends crucially on whether these conditions are being fulfilled. Interacting the length of service with dummies that capture this status is key to an appropriate characterization of the response surface in those cases. We also allow for different intercepts conditional on whether the vesting period conditions are fulfilled. Vesting period conditions may apply for ordinary pension eligibility, but also for minimum pension guarantees, special "advanced-age" benefits, and reimbursement of contributions. In a few cases, we had to include in the regression two vesting period conditions.

Response surfaces show discontinuities in the length of service when the contributor switches the vesting status. The impact on the IRRs of adding one more year of contributions when the additional year changes the vesting status can be computed as follows, where ves_1 and ves_2 are vesting period conditions 1 and 2:

The impact on the IRRs of changing the vesting status

Regression that applies	Vesting condition that is exactly fulfilled with the addition of an year of contributions	
	ves_1	ves_2
(1)	$\beta_{14} + \beta_{15}\left(ves_1^{\ 2} - (ves_1 - 1)^2\right) - \beta_{16}$	$\beta_{14} + \beta_{15}\left(ves_2^{\ 2} - (ves_2 - 1)^2\right) - \beta_{17}$
(2)	$(\beta_{25} - \beta_{24}) \times ves_1 - \beta_{26}$	$\beta_{24} - \beta_{27} \quad if \quad ves_1 > ves_2$ $\beta_{25} - \beta_{27} \quad if \quad ves_1 < ves_2$

Finally, the retirement age has in principle ambiguous effects on the rates of return. Most programs reward late retirement with higher pensions, but it is not obvious whether these rewards compensate workers for more periods contributing and fewer periods collecting pensions. A quadratic expression in the age of retirement provided the best fit in several cases.

The choice between the two specifications, i.e. equations (1) and (2), was dictated by both information on the characteristics of the programs and the goodness of fit.

3. Results

We organize our results in terms of the two main dimensions of Latin American pension programs we are assessing in this study, namely (i) income redistribution and (ii) insurance and incentives to work. The first two regressors are meant to capture redistribution and the last three to capture insurance and incentives to work. Table 1 in the Annex summarizes the regression results.

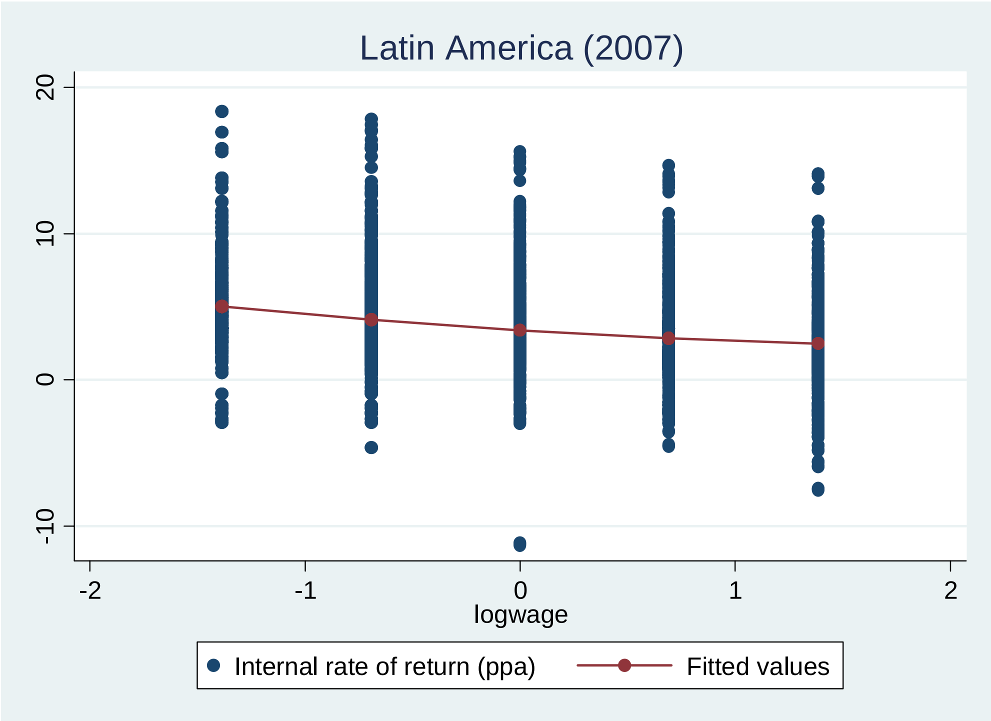
3.1 Redistribution

Results in Table 1 indicate that Latin American pension programs are mostly progressive: they are designed to provide higher IRRs to low than to high income workers. In no program did we find a positive slope of the response surface in wages and in most programs we did find negative slopes.

A quadratic function in (log) wages fitted the data significantly better than the (log) linear function in the Latin American pooled regression. The coefficient multiplying wages is negative and the coefficient multiplying the squared wage level is positive –highly significant both–, implying a convex function. The slope is negative within the simulated wage range (Figure 1). Our point estimation of the semi-elasticity of the IRRs to the average wage level is -0.91 when the wage level equals per capita GDP.[11]

[11] The semi-elasticity of the IRRs to wages evaluated at the GDP per capita wage level is β_{i1}, since wages are measured as a ratio to per capita GDP so that at this point the natural log of wages is zero $(w = 0)$.

Figure 1 Simulated and fitted IRRs in Latin American pension programs. The impact of the wage level. (Pooled regression)



Source: Authors' computations

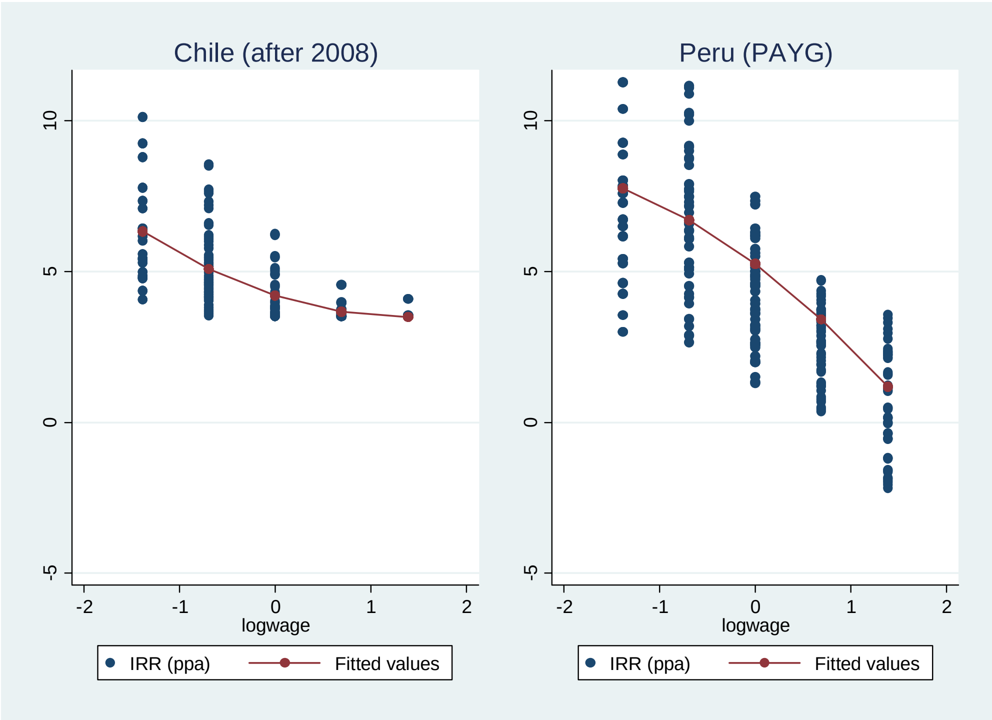
In most programs, the coefficients that multiply the natural log of wages turned out to be negative and highly statistically significant. In no program did we find a positive coefficient and in only three programs we could not reject the hypothesis that this coefficient is zero. These three programs are the Ecuadorian and Paraguayan DB-PAYG and the Peruvian individual accounts programs. It should be mentioned that in the cases of Ecuador and Paraguay, the range of wages in our simulations turned out to be narrower than initially planned, because of the minimum wage. In the case of Paraguay, we could not simulate workers earning GDP per capita or less since the minimum wage is larger than GDP per capita. Hence, rather than simulating wages ranging from one-fourth to four times per capita GDP we simulated Paraguayan wages ranging from about 1.5 to 4 times per capita GDP.[12] In Ecuador, the minimum wage is higher than one-half per capita GDP so that the first two scenarios (a quarter and a half of per capita GDP) are actually the

[12] We could have simulated richer workers to get the same wage spread in Paraguay as in other countries, but we preferred to build the base case scenario in all countries with workers earning per capita GDP (or the closest possible to that amount when minimum wages were above per capita GDP).

same. The simulated wages in Ecuador thus ranged from 0.6 to 4 times per capita GDP. In these wage ranges, contributions and pensions scale up proportionally in Paraguay and almost proportionally in Ecuador as wages increase. Hence, the IRRs are the same or almost the same in these scenarios. It remains to be seen whether, for other wage ranges and histories of contribution, the social security programs in Ecuador and Paraguay are more redistributive than what our simulations show.

Like in the Latin American pooled database, a quadratic function in (log) wages fitted the data significantly better than the (log) linear function in several programs. In all but two cases, the coefficient multiplying the squared wage level turned out to be positive, implying a convex function, while the slope continued being negative within the simulated wage range. A typical example is presented in Figure 2 for the Chilean program after the 2008 reform, but a similar pattern emerges for Argentina, Brazil, Chile, Mexico, Uruguay and Venezuela. In all these cases, the increase in the IRR that is associated to a decrease in wages is larger the lower the wages, reinforcing the redistributive nature of the programs. The Peruvian DB-PAYG is the only program that yielded a significantly negative coefficient multiplying the squared wage level. Hence, in this program, the IRRs are concave in the wage levels, implying that the increase in the IRRs that is associated to a decrease in wages is smaller the lower the wages.

Figure 2 Simulated and fitted IRRs in selected programs. The impact of the wage level.



Source: Authors' computations

Minimum and maximum pensions are two of the provisions that directly impact on redistributions. All the programs analyzed in this study have minimum pensions, but not all of them have maximum pensions. In some cases, there is a ceiling on insured wages, so that above this ceiling contributions are voluntary. In the case of DB designs, the ceiling on contributions indirectly generates a ceiling on benefits, but unlike maximum pensions, ceilings are not redistributive. The clearest example of the use of minimum and maximum pensions to redistribute is the Peruvian PAYG program, where the maximum is only about twice the minimum. The Argentinean program also performs redistributions through the basic pension, which does not depend on contributed amounts and therefore is flat across income levels. The Mexican government pays a flat contribution for every working person (*cuota social*). This flat contribution implies a greater subsidy, as a proportion of insured contributions, for people with lower earnings, and this makes the IRRs decrease with income. In the case of Colombia, workers earning four minimum wages or more have to pay an extra contribution.

It is interesting to notice that all the DC individual accounts programs, save the already mentioned Peruvian one, are progressive. Provisions like minimum pensions, government matching contributions and basic universal pensions complement these otherwise actuarially fair programs rendering them redistributive. The Bolivian and Chilean individual account schemes, for example, yield the same IRRs for a wide range of income levels, but low income workers get higher returns thanks to minimum pensions and government subsidies.

In the case of Chile, a reform passed in 2008 strengthened the redistributive ingredients in the benefit formula. Before the reform, Chilean workers who had contributed at least 20 years but whose accumulated funds do not self-financed a pension above the "minimum pension guarantee" were tapped to this minimum. The reform will gradually substitute the "solidarity contribution" (*Aporte Previsional Solidario*) for the "minimum pension guarantee" (*Pensión Mínima Garantizada*). The solidarity contribution is designed in such a way that pensions are always increasing functions of individual cumulative contributions (unlike the minimum pension guarantee which provides the same pension to all beneficiaries). Unlike the minimum pension, the solidarity contribution requires no minimum number of contribution periods to access the benefit. This is a key innovation, for many workers with small accumulations in their accounts were not eligible for the minimum pension guarantee because they had not contributed 20 or more years (Berstein et al. 2006). The reform will be fully effective in about 15 years. According to our estimations, the reform increased the degree of redistribution in the Chilean system as measured by the semi-elasticity of the IRRs to the wage levels. For a worker earning a wage equal to per capita GDP, the semi-elasticity changed from -0.58 to -1.32.

Low income workers tend to have flatter age-earnings profiles than high income workers and this might impact on pensions (Bosworth et al. 1999). Many schemes provide pensions that depend on the average insured wages during the last years of the working careers. These pension formulas benefit workers whose earnings profiles are steeper along the lifecycle, as their contributions are based on wages that are on average low relative to the wages used to compute their pension. Because of this effect, the programs might be less redistributive than what the previous analysis suggests.

Estimating age-earnings profiles for different income levels in the eleven countries covered in this study is well beyond the scope of this paper. We rather assessed the sensitivity of the IRRs to different profiles to see whether this effect is likely to be relevant in the region. To this end, we considered three age-earning profiles, associated with wage growth equal to 1, 2 and 3 ppa.

Considering the region as a whole, we do not find a large impact of the age-earning profiles on the returns to social security contributions (Table 1). The coefficient that multiplies the wage growth regressor is positive and significant at 5 percent level, but the amount of the effect is rather small: the IRR increases 0.09 ppa for each point of increase in the rate of growth of wages. Most programs do not show any clear correlation between the IRRs and the rate of growth of wages. Only the Colombian PAYG, Ecuadorian, Paraguayan, Peruvian PAYG-DB and Venezuelan programs show statistically significant coefficients. Not surprisingly, these programs use comparatively short spells of contribution to compute pensions. Ecuador, Peru and Venezuela base pensions on five and Paraguay on three years of contribution. Only the Colombian PAYG uses a longer period, 10 years, in this group. Other Latin American PAYG-DB programs currently use more years of contribution wages to compute pensions: the Argentinean PAYG pillar uses 10 years, the Uruguayan program uses the last 10 years or the best 20 and the Brazilian program uses wages belonging to the highest 80 percent of the whole period of contribution. In none of these cases, the wage growth regressor showed a significant impact on the IRRs. Similarly, this regressor was not significant in explaining IRRs in DC programs.

These results suggest that the fact that poor workers have comparatively flat age-earning profiles is not likely to have a major impact on the returns they get from social security in Latin America.

3.2 Insurance and incentives to work

Pension schemes are bound to distort *incentives*. Contribution rates are taxes that reduce the incentives to work, at least in the formal sector; and pensions reduce the incentives to save. The less than actuarially fair reduction in benefits that is usually associated to shorter working careers constitutes a hedge against negative shocks in the labor market; it also generates incentives to choose shorter careers. Singularly, it protects senior workers who lose their jobs, but it also opens a window to opportunistic behavior. So too, some design characteristics constitute an invitation to gamble, like the benefit formulas based on last salaries. In many developing countries, these elements are compounded by weak enforcement, which facilitates late enrolment and gambling. In this section, we use the IRRs to analyze both the incentives pension programs provide to work and the insurance they offer against shocks that negatively impact on the length of working careers.

There is a widespread concern in Latin America for the impact that low densities of contribution have on pension rights. Several studies have warned that large segments of the Latin American population contribute only for short periods and may not be eligible for pensions, because they do not fulfil vesting period conditions, or if they do, they may receive small pensions, because entitlements tend to be linked to contributions (Berstein et al. 2006; Bucheli et al. 2010; Forteza et al. 2009; among others). Some pension schemes provide insurance against this risk with benefit formulas that are relatively inelastic to the contribution history. However, this insurance is usually incomplete, probably because of moral hazard and adverse selection problems. We analyze the impact of the length of service on the expected IRRs to assess the degree of insurance pension programs provide against the risk of short working careers. A pension scheme that does not provide any insurance at all against this risk will effect an actuarially fair reduction in benefits when the length of service decreases. The expected IRR of this scheme will be inelastic to the length of service. The scheme provides insurance if the IRRs decrease as the length of service increases and exacerbates risk in the opposite case.

The age of retirement is another factor that may impact on the length of the contribution period, but it has a distinct component: early retirement provides protection against the risk of losing jobs at ages at which it is difficult to find a new job. Naturally, this insurance also provides incentives to retire early. The behavior of retirement and the incentives in social security to retire have been a major motive for concern in developed countries in recent years (Gruber and Wise 1999, 2004 and 2007). In this section, we analyze the impact of retirement ages on the IRRs response surfaces.

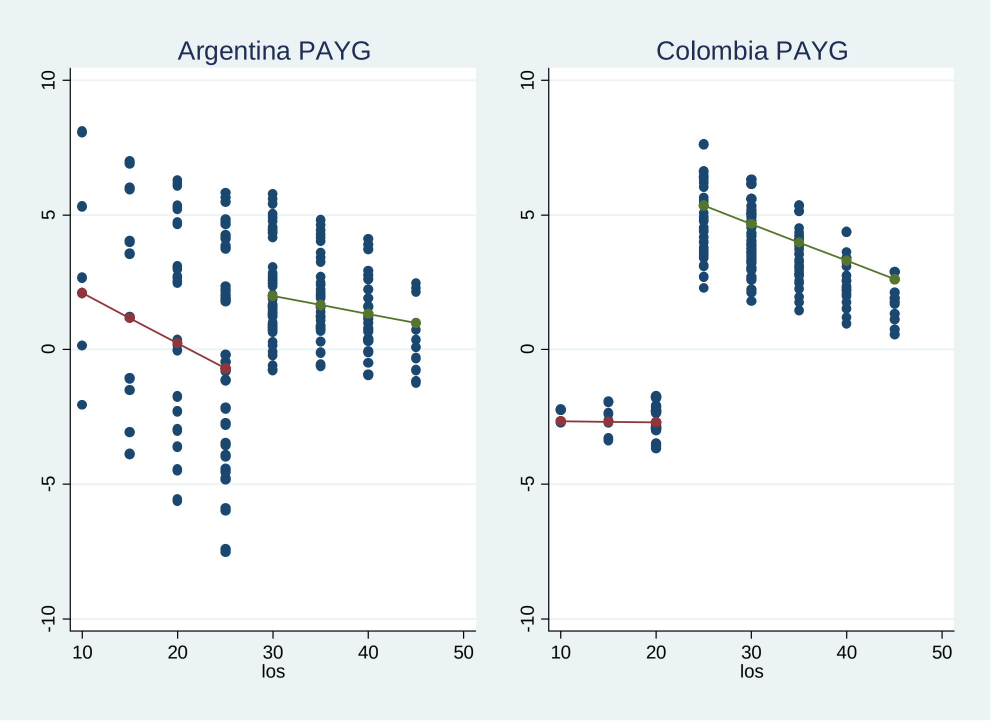
3.2.1 The length of service

A quadratic function in the length of service provides the best fit for the Latin American pooled database with a positive coefficient multiplying the length of service and a negative coefficient multiplying its squared value, both significant at the usual levels (Table 1). The IRRs response surface is thus concave in the length of service and exhibits a maximum at about 18 years of contribution.[13] The IRR increases by about 0.03 percentage points per additional year of contribution at 10 years of contribution, and decreases about 0.01, 0.05 and 0.10 percentage points at 20, 30 and 40 years of contribution, respectively (Table 2). The response surface of the Latin American pooled database is thus pretty flat in the length of service, suggesting that the IRRs are on average not very sensitive to the length of service. However, the analysis program by program and especially the analysis of some specific points at which the response surface exhibits discontinuities reveal a pretty different picture.

Vesting period conditions have a striking impact on the IRRs in most programs. Individuals who fall short of fulfilling those conditions tend to get much smaller IRRs. Two typical examples are presented in Figure 3. The Argentinean and Colombian PAYG programs require 30 and 25 years of contribution to access ordinary pensions. Workers who contribute one year less (29 and 24 respectively) are expected to suffer IRR losses of 3.6 and 8.1 percentage points, respectively.

[13] Using results in Table 1, the length of service at which the IRR is maximized can be computed as: $length\_service = -\frac{\beta_{14}}{2\beta_{15}} = \frac{0.078}{2 \times 0.002} = 18$.

Figure 3 Simulated and fitted IRRs in selected programs. The impact of vesting period conditions



Source: Authors' computations

Some programs require a minimum length of service to access to minimum pensions. Individuals who do not fulfil these conditions tend to get much smaller returns. The Bolivian, Chilean (before 2008) and Colombian individual account programs, for example, require 15, 20 and 25.5 years of contribution to access the minimum pension guarantee, respectively.[14] Workers contributing fewer periods would get the rate of return of pension funds net of fees. In turn, thanks to minimum pensions, Bolivian, Chilean and Colombian workers contributing exactly 15, 20 and 25.5 years to these programs would receive 7.5, 1.0 and 1.7 percentage points more each year, respectively. In Chile, the 2008 reform eliminated this gap by removing the vesting period condition.

In PAYG-DB programs, failing to comply with the eligibility conditions often lead to very negative IRRs. One of the most dramatic examples happens in Venezuela where

[14] The Colombian individual accounts program pays a minimum pension to individuals who have contributed at least 1,325 weeks (approximately 25.5 years). This threshold is currently lower, but it is gradually being increased to reach 1,325 weeks in 2015 (law 797/2003, article 65). Since we are simulating individuals who are born in 2007, we adopted this threshold for our simulations.

contributing 14 rather than 15 years implies an expected reduction in the IRR of 25 percentage points. Furthermore, workers often do not receive any payment in return for contributions in DB programs when vesting conditions are not fulfilled. When this happens, the IRRs are not even defined.[15]

It should be noticed that the discrete jumps in the IRRs mentioned above are only "average" impacts, smoothed out by the parsimonious regression representations of the response surface. We have observed many other sizeable discrete jumps in the IRRs of simulated individuals stemming from small variations in the length of service.

In most programs, the IRRs tend to be decreasing in the length of service, if the vesting period thresholds are not crossed. Indeed, adding years of contributions tends to reduce the IRRs, unless it implies a change in the vesting status (Table 2). When this happens the IRRs increase, often dramatically, as already shown. But once the vesting period conditions have been fulfilled, the programs tend to pay less than actuarially fair compensations for extending the length of service. Hence, the response surfaces tend to have maximums in the length of service at vesting periods.

There is an incentives rationale for the low IRRs we observe associated to short services in many programs, but this design implies that these programs exacerbate income risk, if short length of services is not entirely due to individual choices. In turn, the negative response of the IRRs to the extension of the length of service observed at longer lengths of service provides a hedge against the risk of interruptions. Therefore, these pension programs tend to provide incentives to contribute and to exacerbate risk when contribution histories are relatively short, and to provide insurance against the risk of interruptions when contribution histories are sufficiently long.

Departing from all other programs analyzed in this study, the Peruvian individual accounts program shows no significant effect of the length of service on the IRRs. This program is thus the only one that looks actuarially neutral in this respect.

[15] In several regressions in Table 1, the number of observations is less than 300, because of scenarios in which the IRRs are not defined.

3.2.2. Retirement age

Pension programs impact on workers' decision to stop working. There is a large literature that analyzes the relationship between social security provisions and labor force participation, mostly in developed countries. The main motivation for these studies is the steady decline in labor force participation of senior workers observed in recent decades in most developed countries precisely when life expectancies have risen dramatically. Gruber, Wise and collaborators have documented these trends and systematically explored the relationship between retirement ages and incentives inherent in social security programs in eleven developed countries (Gruber and Wise 1999, 2004 and 2007). They provide evidence that social security systems have contributed to reduce retirement ages in those countries. To the best of our knowledge, there is no comparable systematic effort to analyze the impact of social security programs on retirement in developing countries. While replicating Gruber and Wise's analysis for the Latin American region is well beyond the scope of the present document, we do provide some systematic comparable analysis of incentives to retire inherent in pension programs in the region using our estimations of internal rates of return.

As we have already mentioned, we are not only interested in the analysis of the incentives to retire, but also in the social protection that pension programs provide against the risk of short working careers. Programs that provide strong incentives to postpone retirement punish workers who retire early. From an insurance perspective, however, it seems desirable to protect workers who retire at relatively young ages due to adverse circumstances that are beyond choice. Hence, we will use our estimations of the IRRs to discuss the insurance that pension programs provide against this risk.

A quadratic function in retirement age provides the best fit for the Latin American pooled database (Table 1). The coefficients multiplying retirement age and its squared value are significantly different from zero at the usual significance levels, the former positive and the latter negative. The IRRs response surface is thus concave in retirement ages and exhibits a maximum at about 63 years. Postponing retirement one year brings about a 0.15 percentage points increase in the IRR at 55, and about 0.05 percentage points at 60 years (Table 3). In turn, IRRs fall 0.04 and 0.14 percentage points if retirement is postponed a year at 65 and 70, respectively.

According to these results, Latin American pension programs seem to be designed to disincentive retirement at early ages. The counterpart is that workers who lose jobs and cannot continue contributing at these ages tend to be punished with lower IRRs on their contributions to social security. At these retirement ages, pension programs are exacerbating risk. Notwithstanding, the response surface is pretty flat in a considerably wide vicinity of the maximum, so for these retirement ages Latin American programs are on average close to actuarially neutral to changes in retirement ages.

A similar pattern emerges in most pension programs in the region: like in the pooled database, individual programs exhibit concave but pretty flat response surfaces.[16] The retirement ages that maximize the IRRs range from 59 in the Colombian PAYG program to 77 in the Venezuelan one. This wide range of IRR-maximizing retirement ages is partly due to the flat response surfaces: small variation in the parameters may significantly shift these points. The incentives to retire at some specific ages are not sharp.

The sensitivity of the IRRs to the retirement age is also small in the few programs in which the response surface is not concave in the retirement age. The Argentinean individual account is the only program for which we find monotonically decreasing IRRs in the retirement age. The coefficient multiplying retirement age is negative and significantly different from zero, but the amount of the decrease is very small: 0.05 percentage points per year. The IRRs show no sensitivity to the retirement age in the Peruvian individual accounts program.

According to these results, the IRRs are basically inelastic to the retirement age in Latin American pension programs. In interpreting these results, it is important to keep in mind that we are controlling for the length of service. Therefore, we are not changing the length of service in parallel with the retirement age as it is normally done in studies of retirement. We do so to disentangle the effects on the IRRs of the length of service and the retirement age that are otherwise mixed.[17] The low elasticity of the IRRs to the retirement age we find

[16] This is the case of the Argentinean PAYG, Bolivian, Brazilian, Chilean (before 2008), Colombian PAYG, Ecuadorian, Mexican, Paraguayan, Peruvian PAYG, Uruguayan and Venezuelan programs.

[17] Studies of the incentives to retire implicit in pension programs usually analyze the impact of changing retirement ages and simultaneously changing the number of periods of contribution (Gruber and Wise, 1999, 2004 and 2007). Postponing retirement thus implies three main effects: (i) contributing one more period, (ii) receiving pensions one less period if the individual is already entitled to a pension, and (iii) receiving a different, probably higher, pension. In controlling for the length of service when we analyze changes in retirement ages, we are focusing on the last two effects. The first one is captured in our analysis of the length

in this study means that retirement ages do not have large *direct* impacts on the IRRs. This does not mean of course that a worker cannot materially modify his expected IRRs changing the age of retirement if he also changes the length of service. It rather means that the impact of retirement ages largely depends on the induced change in the length of service.

4. Concluding remarks

We present in this paper estimations of the expected internal rates of return (IRR) that formal workers in eleven Latin American countries receive from social security. We use this indicator to study how the programs treat both individuals of different standings and individuals of similar standings in different circumstances. Analyzing the return of the former, we assess whether social security programs in Latin America reduce income inequality. Analyzing the return of the latter, we assess insurance and incentives to work.

Our analysis of inequality is based on simulations run for hypothetical workers who differ in terms of wage level, and age-earnings profiles. Most programs analyzed in this study are progressive in the sense that they provide higher returns to low than to high income workers. This result holds both for DB and DC programs.

Some words of caution are in order here. As we mentioned above, we are simulating only single men. Things might be different for women and families. Gustman and Steinmeier (2001) show that, when analyzed at the individual level, the U.S. social security looks very redistributive, favoring low income workers, but it looks much less so at the family level.

Limited social security coverage is a second motive to be cautious. Our assessment of the progressiveness of the social security systems is based on the comparison of the IRRs received by covered workers with different average incomes. In Latin America, governments often contribute to the financing of social security with general taxes and significant swaths of the population are outside the system (i.e., not covered). The net effect, the government transfers benefit a populace generally comprised of the better-off (i.e., the covered worker). This caveat should be kept in mind when comparing the progressiveness of different programs in the region. Countries with very low coverage and

of service.

significant government transfers to social security might end up undoing the redistribution that pension programs were supposed to achieve by design.

Also, pension programs might be less redistributive than what our analysis suggests if poor workers had systematically lower life expectancies. Garrett (1995) compares the net U.S. social security returns of households with different average income taking into account varying mortality rates. He simulates U.S. workers of the 1925 birth cohort and finds that differences in mortality rates may eliminate the progressive spread in returns across income levels. Duggan et al. (1995) analyze the impact of differential mortality rates on the progressivity of the U.S. Social Security using actual work history records. They find that income-adjusted mortality rates affect the distribution of benefits across income levels, though not enough to undo the basic progressivity of the program. Beach and Davis (1998) report substantial reductions in the rates of return from the U.S. social security for low income workers when differential mortality rates are taken into account. We do not have income-adjusted mortality tables for the population covered by the pension programs analyzed in this study. Hence we could not take these effects into consideration.

We do not find sizeable impacts of the age earning profiles on the returns to social security contributions. The coefficient multiplying the regressor that captures earnings profiles –the rate of growth of wages– turned significantly different from zero in a few programs that tend to base pensions on relatively few years of contribution wages. But even in these cases, the effects were small. This does not mean that the age earnings profile is always irrelevant, though. We considered in this study only a limited set of profiles and we cannot extrapolate our findings to other profiles. We did not simulate, for example, working careers in which earnings fall in the last years.

In most programs, retirement ages do not seem to have a sizeable *direct* impact on the IRRs. Indeed, after controlling for the length of service, the effect of changing the retirement age was second order in most cases. Hence, it is mostly through changes in the length of service that retirement ages impact on the IRRs.

The length of service has significant and often dramatic effects on the returns to social security contributions in Latin America. The stylized response surfaces we used to summarize our simulation results tend to smooth out discontinuities and yet we did find some remarkable changes in the IRRs stemming from relatively minor changes in the length of service. In many cases, we found changes in the lifetime expected IRRs of more than 5 percentage points caused by a one-year-change in the length of service. These sizeable changes are invariably associated to vesting period conditions.

In a world of uncertainty in which workers may not be able to fulfill vesting period conditions because of bad shocks, the sharp changes in the IRRs that are associated to small changes in the length of service exacerbate risk. In the absence of moral hazard (e.g., if short contribution histories were just the result of bad luck) the optimal insurance would be to provide full protection against the risk of short working careers. Full insurance in this case means that pensions should be independent of the number of periods of contribution. But as individuals can materially modify the probability of getting a job in the formal sector making choices unobserved by the social security administrations, a full insurance program would severely distort incentives. Individuals would in this case avoid contributions. The standard solution to moral hazard in the insurance industry is to provide partial insurance. In pension programs, this means that pensions cannot be held constant irrespective of contributions. The optimal degree of risk the individual should be facing depends on parameters that are not directly observable, so we cannot easily determine such a rule. An actuarially fair reduction of the pension in response to shorter contribution histories would already be harsh (i.e., no insurance against the risk of short contribution careers), but the observed designs that at some points reduce pensions by more than that look unnecessarily harsh. Rather than providing insurance, these programs create risk.

Our results regarding the return workers with short contribution careers receive from social security also have a bearing on the income inequality issue. Low wage workers have more frequent and durable interruptions in their contribution histories than high wage workers (Bucheli et al. 2010; Forteza et al. 2009). The very low IRRs that several pension programs yield to workers with short contribution histories impact thus primarily on low income workers.

The IRR is a useful synthetic indicator, but it has an important drawback in our context: it is not defined when workers receive no benefits, and there are several scenarios in our simulations in which workers do not fulfill vesting conditions and receive no benefits. In these cases, alternative indicators, like the net present value of the cash flows or the ratio of discounted benefits over discounted contributions, could be more useful.

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Annex tables

Table 1: The IRRs regressions

	Latin America a/	Argentina Individual accounts	Argentina PAYG	Bolivia	Brazil	Chile (Before 2008)	Chile (Alter 2008)	Colombia Individual accounts	Colombia PAYG
Wage (Ln)	-0.906	-0.850	-2.479	-1.614	-0.978	-0.576	-1.318	-0.396	-0.806
	(0.032)**	(0.014)**	(0.075)**	(0.088)**	(0.029)**	(0.041)**	(0.048)**	(0.038)**	(0.039)**
Wage (Ln) squared	0.184	0.209	0.367		0.527	0.388	0.551		-0.111
	(0.039)**	(0.018)**	(0.092)**		(0.036)**	(0.050)**	(0.058)**		(0.048)*
Wage growth	0.093	-0.008	0.125	0.022	0.052	0.011	-0.071	0.004	0.139
	(0.038)*	(0.017)	(0.090)	(0.106)	(0.035)	(0.049)	(0.057)	(0.045)	(0.047)**
Length of service (LOS)	0.078			-0.700			-0.173		
	(0.026)**			(0.071)**			(0.028)**		
LOS squared	-0.002			0.009			0.002		
	(0.000)**			(0.001)**			(0.001)**		
LOS*(1- Dum_Vesting1) /b		-0.024	-0.188		-0.190			0.033	-0.004
		(0.004)**	(0.020)**		(0.007)**			(0.019)	(0.020)
LOS*Dum_Vesting1		0.016	-0.067		-0.034	-0.063		-0.074	-0.137
		(0.004)**	(0.013)**		(0.015)*	(0.007)**		(0.011)**	(0.008)**
(1- Dum_Vesting1)	-2.893	0.522		-7.981	6.126	-2.266		-4.469	-11.393
	(0.223)**	(0.164)**		(0.571)**	(0.571)**	(0.218)**		(0.616)**	(0.415)**
(1- Dum_Vesting2) /c								-1.010	
								(0.189)**	

Retirement age	1.202	-0.051	1.036	2.022	2.363	0.608	0.061	0.300	1.166
	(0.164)**	(0.003)**	(0.370)**	(0.453)**	(0.150)**	(0.204)**	(0.011)**	(0.193)	(0.198)**
Retir. Age squared	-0.010		-0.009	-0.016	-0.019	-0.005		-0.003	-0.010
	(0.001)**		(0.003)**	(0.004)**	(0.001)**	(0.002)**		(0.002)	(0.002)**
Constant	-34.431	4.356	-26.537	-44.140	-72.227	-13.906	3.950	-1.415	-25.427
	(5.068)**	(0.214)**	(11.495)*	(14.014)**	(4.818)**	(6.371)*	(0.678)**	(6.070)	(6.195)**
Observations	4341	300	300	300	285	300	300	300	300
Adjusted R-squared	0.56	0.93	0.81	0.73	0.95	0.57	0.78	0.73	0.96

* significant at 5% level; ** significant at 1% level

Notes: a/ Country dummies are not reported. b/ Dum_Vesting1 = 1 if LOS>= ves1, where ves1 = (i) 30, if Argentina or Ecuador; (ii) 35, if Brazil or Uruguay (before 2008); (iii) 20, if Chile; (iii) 25.5, if Colombian individual accounts; (iv) 25 if Colombian PAYG, Mexico or Uruguay (after 2008); (v) 15, if Venezuela. c/ Dum_Vesting2 = 1 if LOS>= ves1, where ves1 = (i) 25, if Colombian individual accounts; (ii) 15, if Ecuador or Uruguay (after 2008).

Source: Authors' computations

	Ecuador	Mexico	Paraguay	Peru (Individual accounts)	Peru (PAYG)	Uruguay (Before 2008)		Uruguay (After 2008)		Venezuela
						Individual accounts	PAYG	Individual accounts	PAYG	
Wage (Ln)	-0.011	-0.866	0.000	0.000	-2.374	-0.870	-0.520	-1.018	-0.785	-1.206
	(0.039)	(0.041)**	(0.029)	(0.000)	(0.048)**	(0.029)**	(0.027)**	(0.034)**	(0.034)**	(0.086)**
Wage (Ln) squared		0.536			-0.402	0.400	0.604	0.407	0.663	0.187
		(0.050)**			(0.058)**	(0.035)**	(0.033)**	(0.041)**	(0.042)**	(0.104)
Wage growth	0.309	0.053	0.245	0.000	0.148	0.026	0.036	0.037	0.050	0.285
	(0.047)**	(0.049)	(0.034)**	(0.000)	(0.058)*	(0.034)	(0.033)	(0.041)	(0.041)	(0.103)**

Length of service (LOS)	-0.166		-0.147	0.000	-0.490					-0.601
	(0.010)**		(0.005)**	(0.000)	(0.054)**					(0.069)**
LOS squared					0.005					0.004
					(0.001)**					(0.001)**
LOS*(1- Dum_Vesting1)						-0.058	-0.064			
						(0.007)**	(0.006)**			
LOS*Dum_Vesting1		-0.070				-0.043	-0.041	-0.079	-0.082	
		(0.008)**				(0.005)**	(0.005)**	(0.007)**	(0.007)**	
(1- Dum_Vesting1)	-0.931	-2.769				-4.332	-3.393	-2.033	-2.271	-25.266
	(0.146)**	(0.270)**				(0.162)**	(0.211)**	(0.226)**	(0.223)**	(0.553)**
(1- Dum_Vesting2)	-2.217							-4.015	-2.757	
	(0.212)**							(0.170)**	(0.249)**	
Retirement age	3.995	0.484	1.866	0.000	2.445	0.351	0.419	0.337	0.324	2.148
	(0.198)**	(0.202)*	(0.148)**	(0.000)	(0.242)**	(0.145)*	(0.136)**	(0.172)	(0.170)	(0.439)**
Retir. Age squared	-0.031	-0.004	-0.016		-0.021	-0.003	-0.003	-0.003	-0.002	-0.014
	(0.002)**	(0.002)*	(0.001)**		(0.002)**	(0.001)*	(0.001)**	(0.001)	(0.001)	(0.004)**
Constant	-116.764	-9.323	-47.436	3.500	-58.085	-7.291	-9.935	-6.283	-6.493	-56.770
	(6.204)**	(6.282)	(4.643)**	(0.000)**	(7.518)**	(4.530)	(4.244)*	(5.372)	(5.314)	(13.591)**
Observations	300	300	210	300	255	300	291	300	291	300
Adjusted R-squared	0.77	0.70	0.91	0.00	0.94	0.87	0.79	0.86	0.80	0.93

Table 2: Change in the expected IRRs from an additional year of contribution

Length of service	Latin America	Argentina Individual accounts	Argentina PAYG	Bolivia	Brazil	Chile (Before 2008)	Chile (Alter 2008)	Colombia Individual accounts	Colombia PAYG
10	0.03	-0.02	-0.19	-0.53	-0.19	0.00	-0.14	0.03	0.00
20	-0.01	-0.02	-0.19	-0.35	-0.19	1.01 a/	-0.11	0.03	0.00
30	-0.05	0.69 a/	3.63 a/	-0.18	-0.19	-0.06	-0.08	-0.07	-0.14
40	-0.10	0.02	-0.07	0.00	-0.03	-0.06	-0.05	-0.07	-0.14

Notes: a/ Vesting period conditions are exactly fulfilled at this lengths of service.

Source: Authors' computations

Length of service	Ecuador	Mexico	Paraguay	Peru (Individual accounts)	Peru (PAYG)	Uruguay (Before 2008)		Uruguay (After 2008)		Venezuela
						Individual accounts	PAYG	Individual accounts	PAYG	
10	-0.17	0.00	-0.15	0.00	-0.38	-0.06	-0.06	0.00	0.00	-0.52
20	-0.17	0.00	-0.15	0.00	-0.28	-0.06	-0.06	0.00	0.00	-0.44
30	0.76 a/	-0.07	-0.15	0.00	-0.17	-0.06	-0.06	-0.08	-0.08	-0.37
40	-0.17	-0.07	-0.15	0.00	-0.07	-0.04	-0.04	-0.08	-0.08	-0.29

Table 3: Change in the expected IRRs from retiring a year later

Retirement age	Latin America	Argentina Individual accounts	Argentina PAYG	Bolivia	Brazil	Chile (Before 2008)	Chile (Alter 2008)	Colombia Individual accounts	Colombia PAYG
55	0.15	-0.05	0.06	0.22	0.26	0.09	0.06	0.00	0.08
60	0.05	-0.05	-0.03	0.06	0.07	0.04	0.06	-0.02	-0.02
65	-0.04	-0.05	-0.11	-0.11	-0.12	-0.01	0.06	-0.05	-0.12
70	-0.14	-0.05	-0.20	-0.27	-0.31	-0.05	0.06	-0.08	-0.22

Source: Authors' computations

Retirement age	Ecuador	Mexico	Paraguay	Peru (Individual accounts)	Peru (PAYG)	Uruguay (Before 2008)		Uruguay (After 2008)		Venezuela
						Individual accounts	PAYG	Individual accounts	PAYG	
55	0.57	0.08	0.16	0.00	0.19	0.04	0.05	0.06	0.06	0.62
60	0.26	0.04	0.00	0.00	-0.02	0.01	0.01	0.03	0.03	0.48
65	-0.05	0.00	-0.16	0.00	-0.22	-0.01	-0.02	0.01	0.01	0.34
70	-0.36	-0.03	-0.31	0.00	-0.43	-0.04	-0.06	-0.02	-0.02	0.20