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Abstract: We present a new database of social security indicators for eleven Latin American countries designed to assess pension schemes in terms of the payments they promise in return to contributions. Based on this data, we analyze inequality, insurance and incentives to work, using the replacement rates and the internal rates of return implicit in the flows of contributions and pensions. Our results indicate that most programs analyzed are progressive in the sense that, other things equal, they yield higher returns to low than to high income workers. Poor workers, notwithstanding, often have flat age-earnings profiles and lower life expectancy, both of which reduce the rates of return received from social security. The Argentinean and (the pre-2008) Uruguayan programs severely punish short contribution careers, providing strong incentives for workers in the programs to continue contributing until they reach minimums that vary between 30 and 35 years of contributions. The counterpart is that these programs do not hedge workers against the risk of having short working careers; quite the opposite, they raise the uncertainty workers face. The very low rates of return that the Argentinean and Uruguayan main pension programs pay to workers with short working careers are likely to impact strongly on low income workers, as the probability they experience interruptions is higher. The Brazilian, Chilean and Mexican programs show a better balance between insurance against the risk of short working careers and incentives to work. The defined benefit programs of Argentina, Ecuador and Uruguay strongly discourage early retirement; the Chilean and Mexican programs are more neutral. Argentina, Chile and Uruguay passed reforms to their main pension programs in 2008. Unlike the Argentinean reform, the Chilean and Uruguayan 2008 reforms strengthened the social protection that programs provide, shifting the balance towards more insurance and less incentives to work.

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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. 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 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 of their contributions. 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 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 (2008), who present a similar analysis for the Caribbean.

In the following section, we present the methodology. In Section 3 we present the estimated IRRs and RRs in a base case scenario in each country. In Sections 4 and 5 we analyze income inequality, insurance and incentives using these same indicators with different simulations. Section 6 concludes. The appendix contains a brief description of the pension programs.

I. 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 internal rates of return (IRRs) and the replacement rates(RRs) are synthetic indicators that summarize the interactions between all these ingredients and provide the basis for meaningful comparisons across programs and time.

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, p 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. In this document, the RRs will be used primarily to better-understand what is driving the estimated IRRs, but also to assess the income-smoothing goal of pension schemes.

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.

We simulate the cash flows of contributions and pensions and compute the IRRs and the RRs 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.

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 receive in the IRRs and the RRs 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).[1] In this scenario, workers start working at 30 and contribute without interruptions until they retire at 65 in all countries. Individuals live until they reach the "age of death", which is 20 plus life expectancy at 20. With this choice we are approximating the expected life length at the earliest age at which simulated workers are assumed to start working and contributing. Our indicators are hence conditional on having survived until age 20. Life expectancy was taken from WHO (2008), which presents data for the year 2006. The WHO tables represent the whole country's population rather than the population that contribute to the social security systems. It is possible that these statistics underestimate the life expectancy of contributors to pension programs because in Latin America the

[1] 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).

pool of contributors are relatively better off and are likely to have higher life expectancy than the excluded. Because of this, the IRRs that actual contributors are receiving might be higher than reported in this study.

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.

The flows over which we compute the IRRs include both the insured and the employers' contributions. 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 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), 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 (see the appendix for the details).

All the flows are before taxes, so we computed gross IRRs. All the IRRs we present are real. The basic rules and parameters of each pension scheme were taken from Social Security Administration (2008) and complemented with local sources in most countries. We present a summary of the main provisions in each program in the appendix.

We performed sensitivity analysis in five dimensions, namely: (i) the average wage level, (ii) the age-earnings profile, (iii) life expectancy, (iv) the enrollment age, and (v) 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.[2] 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 percent per year in real terms. The *age of death* was set at 20 plus life expectancy at 20 in the base scenario and reduced in 1 and 2 years in other two scenarios. We assessed the impact of the *length of the period of contributions* on the IRRs simulating different enrolment ages, keeping the retirement ages as in the base scenario. In turn, we analyzed the impact of the *age of retirement* changing this variable and keeping constant the enrolment age. It should be noted that this approach implies that the length of the period of contributions is being changed in parallel to the age of retirement.

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

II. Results in the Base Case Scenario

We provide in this section a relatively detailed description of the results in each pension program in the base case scenario. We hope readers familiar with Latin American pension programs will find this description useful to assess our results. Readers unfamiliar with these programs might not find this description particularly useful and we suggest they skip this section. In the following sections, we focus on stylized facts that are probably more interesting for all readers.

The middle column in Table 1 presents the real internal rates of return (IRRs) we got in our base case scenario. Other columns present IRRs for workers whose average labor incomes differ from that in the base scenario. The table shows much diversity across countries, programs and labor income levels, with IRRs ranging from -2.5 to 8.1 ppa.

In the Argentinean PAYG pillar, workers in the base case scenario would receive basically a zero IRR. These workers would start their working career at 30 (in 2037) paying a contribution of about US$ 2,700 per annum, would continue paying contributions that would gradually increase up to a maximum of about US$ 5,300 when they reach 64 (in 2071), and would receive a pension of US$ 16,900 at 65 until they die at 73.[3] Their initial pension would represent about 80 percent of their final wage. This pension would be composed of two terms, the basic (US$ 3,221) and the additional (US$ 13,680) pension. The additional pension is computed as the average wage of the last 10 years times a technical replacement rate that positively depends on the number of years of contribution (with a minimum of 52.5 percent). As expected, the representative worker in our simulations would be receiving neither the minimum nor the maximum pension, so the IRR we get for this worker is not driven by these provisions.

Opting for the individual account pillar, this same worker would receive about 0.9 ppa. With the same contributions as in the PAYG pillar, this worker would receive a pension of about US$ 20,300 per annum, composed of the same US$ 3,221 basic pension plus an annuity of about US$ 17,100. The striking fact about this result is that this IRR is much smaller than the rate of return of the pension funds that we assumed to run these simulations (3.5 ppa). The reason is that only insured

[3] The cash flows are expressed in 2007 US dollars. Remember that this flow corresponds to a worker whose average lifetime labor income equals Argentina's GDP per capita during his working time (2037-2071). Given the assumption that real GDP per capita grows at an annual average rate of 2 percent and that 2007 GDP per capita was about US$ 6,600, this worker's average labor income turns out to be approximately US$17,180.

contributions go to the pension fund while the employer contributions finance the basic pension. The rate of return of the insured contributions to the accounts is 3.5 ppa in this simulation by assumption, but the rate of return of the employer contributions is negative, so that the total IRR in the pillar turns out to be much smaller than the assumed 3.5 ppa.

Bolivian workers in the base case scenario would receive an IRR of 3.5 ppa. They would start working at 30 paying a contribution of about US$ 303 per annum and would continue paying contributions that would gradually increase up to a maximum of US$ 595 when they turned 64. They would receive a pension of US$ 7,345 at 65 until they died at 69. Since this is not the minimum pension, and the individual contribution is not affected by the floor or the ceiling, it is not surprising that the IRR is exactly the interest rate assumed to be earned by the pension funds and the insurance companies. Workers would not receive any subsidy in this scenario. Their initial pension would represent about 172 percent of their final wage.

Brazilian workers would receive an IRR of about -1.1 ppa in this scenario. They would start paying a yearly contribution of about US$ 3,500 at the age of 30, would continue paying contributions that would gradually increase up to a maximum of about US$ 6,900 when they reach 64, and would receive a pension of about US$ 23,900 at 65 until they die at 71. Therefore, their initial pension would represent about 110 percent of their final wage.

Chilean workers would receive an IRR of about 3.5 ppa in the base case scenario. They would start paying about US$ 2,245 in contributions at the age of 30, would continue paying contributions that would gradually increase up to a maximum of US$ 4,400 when they reach 64, and would receive a pension of about US$ 22,180 at 65 until they die at 76. In this case the initial pension would represent around 72 percent of their final wage. As in the Bolivian case, these workers are not being benefited with any subsidy, therefore the IRR equals the interest rate pension funds are assumed to get.

In the base case scenario, Colombian workers would receive an IRR of about 3.5 ppa if they opted for the individual account pillar. They would start paying contributions of about US$ 1,080 at age 30, their maximum contributions would round the US$ 2,120 at 64 and their first pension would be of about US$ 14,000, which represents 110 percent of their final wage. They would keep receiving this amount of pension until they die at 73. Colombian workers would receive a worse deal in this scenario if they opted for the PAYG pillar rather than for the individual account pillar. For the same

amount of contributions in their lifetime, they would receive a pension of about US$ 9,900 at age 65, which represents 78 percent of their last wage. They would receive an IRR of only 2.2 ppa.

The Ecuadorian PAYG system promises one of the highest IRRs in the base case scenario in our sample of countries: 4.9 ppa. Workers would start contributing at 30 about US$ 580 per annum and at 64 the contributions would have increased up to US$ 1,145. At age 65 they would receive their first pension of about US$ 10,370 and would continue earning that amount (in real terms) every year until they die at 73. Given the amount of their last real wage (US$ 11,760), this implies a replacement rate of 94 percent.

Mexican workers would receive 4.1 ppa (i.e., more than the 3.5 ppa assumed rate of return of the pension fund and despite this program being an individual account system) because of the contributions the Mexican government pay to each individual account, the so-called "social contribution" (*cuota social*).They would start their working career paying a contribution of about US$ 1,330 per annum at 30, would continue paying contributions that would gradually increase up to a maximum of US$ 2,600 when they turned 64, and would receive a pension of US$ 16,290 at 65 until they died at 75. Their initial pension would represent about 55 percent of their final wage.

The minimum wage is larger than per capita GDP in Paraguay. Since we cannot assume that workers contribute by less than the legal minimum, we built this scenario with workers earning the minimum wage. They would start contributing about US$ 1,200 per annum at 30 and would continue paying increasing contributions up to a maximum of about US$ 2,400 at 64. They would receive a pension of US$ 10,133 at 65 until they died at 75. Their initial pension would represent 108 percent of their last wage and they would receive an IRR of 2.4 ppa.

Table 1: Internal Rates of Return and Average Wages (IRRs in %)

	Average Wage in Simulations Relative to Per Capita GDP				
	One-Quarter	One-Half	One	Two	Four
Argentina (Ind. Account)	2.8	1.7	0.9	0.5	0.0
Argentina (PAYG)	3.1	0.9	0.0	-0.5	-1.1
Bolivia	3.5	3.5	3.5	3.5	3.5
Brazil	-0.6	-1.1	-1.1	-1.3	-1.4
Chile b/	3.5	3.5	3.5	3.5	3.5
Colombia (Ind. Account)	4.1	4.1	3.5	3.5	3.5
Colombia (PAYG)	3.6	3.6	2.2	1.7	1.7
Ecuador	4.9	4.9	4.9	4.9	4.5
Mexico	6.7	4.5	4.1	3.9	3.8
Paraguay	2.4	2.4	2.4	2.4	2.4
Peru (Ind. Account)	3.5	3.5	3.5	3.5	3.5
Peru (PAYG)	4.6	4.4	2.2	1.1	-2.5
Uruguay (Opting for mixed DB-DC) a/ b/	2.6	1.6	1.6	0.4	1.0
Uruguay (Ordinary regime) a/ b/	1.5	-0.5	-0.5	0.4	1.0
Venezuela	8.1	7.8	6.7	6.0	6.0

Note: a/ Workers earning less than US$5,000 of may 1995 per month (approximately US$ 8,900 per annum, in 2007 US dollars) participate only in the PAYG-DB pillar –the "ordinary regime"–, unless they explicitly opt to deposit half of their personal contributions to the savings account pillar. b/ Computed with current norms, which are in the process of being modified by laws passed in 2008.

Assumptions: Real wages growing at 2% per year, 35 years contributing, retirement at 65, age of death is 20 plus life expectancy at 20, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

Peruvian workers opting for the individual account regime would receive an IRR of 3.5 ppa, which is to be expected given that this is a pure savings regime with no interference of subsidies in the cash flow. They would contribute about US$ 900 at 30, would continue paying contributions that would gradually increase up to a maximum of US$ 1,770 when they reached 64, and would receive a pension of about US$ 10,500 at 65 until they died at 74.

If they chose the PAYG program the deal would be clearly worse under our assumptions since the contributions are slightly higher and the benefits are clearly lower than in the individual account program. Peruvian workers would receive an IRR of 2.2 ppa, a difference of 1.3 ppa. They would contribute about US$ 920 at 30, would continue paying contributions that would gradually increase up to a maximum of US$ 1,800 when they turned 64, and would receive a pension of about US$ 8,000 at 65. Workers opting for the individual account program replace 87 percent and for the PAYG program replace 66 percent of their last net wage.

Uruguayan workers earning the country's per capita GDP may get very different results depending on whether they opt to contribute only to the PAYG or to both the PAYG and the individual account pillars. In the Uruguayan program workers earning less than a certain threshold (currently about US$ 8,900 per annum) will by default contribute only to the PAYG pillar, unless they explicitly opt to split their personal contributions between the two pillars. Workers earning the country's per capita GDP will belong to this category during most of their working career. According to our results, these workers will receive a much higher IRR if they opt for the mixed PAYG-individual account scheme (1.6 ppa) than if they stay with only the PAYG program (-0.5 ppa). Not surprisingly, most workers opted for the mixed scheme.

Uruguayan workers in the base case scenario would start their working career at 30 paying a contribution of about US$ 2,800 per annum, and would continue paying contributions that would gradually increase up to a maximum of US$ 5,560 when they turned 64. If they did not choose to participate in the two pillars, they would receive an initial pension of about US$ 15,100. This pension would grow in real terms, reaching a maximum of US$ 17,400 at 72. Pensions grow in our Uruguayan simulation, unlike in other cases, because pensions are by constitution indexed to the average wage and we assumed the real wages grow at 2 ppa. The initial pension would represent about 72 percent of the final wage. Workers would receive a much better result if they opted to split their contributions between the two pillars. With the same total amount of contributions as in the other regime (but with a different distribution between pillars), these workers would receive an initial pension of US$ 22,800 per annum, distributed almost in halves between the DB pension and the annuity.

Finally, in the base case scenario, Venezuelan workers receive the highest IRR of the entire region with 6.7 ppa. They would start contributing about US$ 1,015, and would reach the maximum contribution of about US$ 1,990 at age 64. At 65 they would receive a pension of about US$ 25,200 until they died at age 74. The first pension would represent about 87 percent of the final wage net of contributions. This replacement rate is not unusually large, but the IRRs are nevertheless comparatively high because of the low contribution rates this program charges (less than 7 percent).

All the simulations were run with the same 3.5 interest rate earned by the pension funds and the insurance companies and yet only the Bolivian, the Chilean, and the individual account pillars of the Colombian and Peruvian social security systems would yield that rate of return. It is natural that the DB schemes in PAYG pillars and the Uruguayan mixed program do not yield the assumed interest

rate, but it is less obvious why the individual account pillar in Argentina and Mexico yield something different. The reason lies with the non-DC ingredients present in these schemes. In the case of Argentina, there is the already mentioned basic pension, financed with the employers' contributions. Because of this, the Argentinean workers earn in the individual account pillar much less than the assumed 3.5 ppa. The Mexican representative worker benefits from a government contribution to the individual account (*cuota social*). This is a flat amount equal to 5.5 percent of the minimum wage.

III. Impact of Pension Programs on Income Inequality

Pension schemes generate redistribution, not only in terms of redistributing towards those workers who were negatively affected by shocks, which is the typical insurance function of social security, but also in expected terms. The implicit internal rates of return (IRRs) indicate the type of redistribution that takes place through the pension system: beneficiaries of the redistributive process will have higher expected IRRs.

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. But workers with steeper age-earnings profiles often receive higher rates of return as well, and these workers tend to have high income. Also workers with high life expectancy tend to benefit from the system, as they will likely receive pensions for longer periods of time than workers with low life expectancy, and poorer workers usually have lower life expectancy. There are winners and losers between generations as well. We summarize in this section the results of simulations that we ran to specifically analyze the impact of pension schemes on income inequality.

3.1. Impact of the Average Wage

The public pension schemes analyzed in this study provide in principle higher IRRs to low than to high income workers. We compared the implicit IRRs paid by the pension schemes to workers whose lifetime average income lies between one-quarter of and four times the country's per capita GDP (Table 1).[4]

In most simulations in this series, high income workers received lower IRRs than low income workers. The equalizing redistribution is generally performed in the DB-PAYG programs through minimum and maximum pensions. For example, the Argentinean PAYG pillar has a maximum pension that is about seven times the minimum. The Argentinean system also performs redistributions through the basic pension. This benefit, which covers workers who opted for either regime, does not depend on contributed amounts and therefore is pretty flat across income levels.

[4] The range of simulated wages is in some cases actually narrower than one to sixteen, because when the country's minimum wage is larger than one or more of these thresholds, we imposed the minimum.

This is why the computed IRRs in the Argentinean individual account pillar decrease with income levels.

The Ecuadorian and Paraguayan programs do not look very progressive according to our simulations, despite being DB-PAYG programs. In the case of Paraguay, the range of average lifetime labor incomes used turned out to be narrower than initially planned because 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.[5] A similar issue arises in the case of Ecuador. The minimum wage is in this case 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 same. The simulated wages in Ecuador range 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.

The Colombian PAYG program looks moderately progressive, according to our simulations. Whereas workers earning four times per capita GDP receive an IRR of only 1.7 ppa, those in the quarter-of-per-capita-GDP scenario receive 3.6 ppa. The latter actually earn the minimum wage and receive the minimum pension. Their comparatively high IRR is partly driven by the minimum pension.

The Peruvian PAYG is the most progressive program in the region, if we measure progressiveness by the difference between the IRRs received by the richest and the poorest worker in our simulations. This result is mostly driven by the relatively small difference that exists in this program between minimum and maximum pensions (the maximum is about twice the minimum). Because of this, workers earning two and four times the country's per capita GDP are both capped by the maximum pension, with the former paying half as much as the latter in contributions. At the other end of our simulated wage range, all workers earning half of per capita GDP or less receive the same minimum pension in this scenario even though workers earning half of per capita GDP contribute more than their poorer counterparts.

[5] 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).

The Uruguayan pension program has a minimum and a maximum pension in its DB-PAYG pillar. Nevertheless, as the results in Table 1 show, this program may well yield lower IRRs to workers who earn less (see, for example, the cases of workers earning one and two times the country's per capita GDP). This is because of a composition effect: The annuity (which yields a higher return than the DB pension in these simulations) represents a greater share of the total pension for high than for low income workers. In fact, workers whose annual income does not surpass US$ 8,900 will only receive the DB pension (i.e., a negative IRR) unless they explicitly opt to contribute to both pillars.

The Venezuelan system delivers higher IRRs to low than to high income workers for the whole wage range we considered in the simulations. The program has a highly redistributive ingredient in the basic pension, which is a flat benefit independent of the insured's wages.

The Bolivian, Chilean and Peruvian individual account schemes yield the same IRRs for a wide range of income levels. In fact, in all the simulations presented in Table 1 for these regimes, the IRR is the same for all workers. All these programs, save the Peruvian individual account pillar, have some redistributive ingredients, but they do not show up in any of the simulations presented in the table. The Bolivian program has minimum pensions. In the Chilean case, the government provides a supplement to workers who contributed at least 20 years but whose accumulated funds do not self-finance a pension above the "minimum pension guarantee". This provision obviously departs from actuarial fairness since workers with sufficiently low contributions receive IRRs above the assumed (net) rate of return of pension funds and insurance companies. Be that as it may, none of the workers simulated in Table 1 profit from this minimum.

A reform passed in the Chilean parliament in January 2008 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). Another important difference, there is no minimum number of contribution periods required to receive the solidarity contribution. The reform will be fully effective in about 15 years. In the reformed system and with the same assumptions used in Table 1, workers earning a half and a quarter of Chile's per capita GDP would receive IRRs of 4.5 and 5.3 ppa, respectively. The reformed system will thus be more redistributive than the current one.

The Colombian individual account pillar looks slightly redistributive in our simulations. Low income workers receive a moderately high IRR thanks to the minimum pension.

The Mexican system has a guaranteed minimum pension, about US$ 1,960 a year in 2007, which is financed by the government. It also has, as mentioned above, the singularity of a flat contribution made by the government 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. The guaranteed minimum pension becomes operative for workers earning a quarter of the country's per capita GDP and that is why the IRR is remarkably higher in this case.

The practical relevance of these different IRRs may be better gauged after noting that one percentage point difference in the IRR represents an approximately 27 percent difference in the pension, keeping contributions constant.[6] Therefore, with a difference in the IRR like the 4.0 percentage points obtained in the Argentinean PAYG pillar between a worker earning a quarter of and a worker earning four times the country's per capita GDP, the pension-wage ratio of the poorer worker would more than double that of the richest worker in this simulation.

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. However, some redistributive effects of the systems are not captured by this analysis. 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 significant government transfers to social security might end up undoing the redistribution that pension programs were supposed to achieve by design.

[6] The semi-elasticity of pensions to the IRR depends on the enrolment, retirement and death ages. It is approximately 27percent when enrolment is at 30, retirement at 65 and death at 73.

3.2. Impact of the Age-Earnings Profiles

In order to isolate the impact of average earnings, we held other characteristics equal in the set of simulations presented above, but low income workers tend to have flatter age-earnings profiles than high income workers and this might impact on the IRRs. Many pension schemes provide pensions that depend on the average insured wages during the last years of the working careers. As mentioned, 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 results in Table 1 suggest. We therefore analyzed the sensitivity of the results to workers age-earnings profiles.

We simulated in each country three different age-earnings profiles, which are associated with three different rates of growth of wages and the same average wage along the lifecycle. In several but not all cases, the IRR increased with the rate of growth of wages (Table 2).

Table 2: Internal Rates of Return and Age-Earnings Profile (IRRs in %)

	Annual Rate of Growth of Wage		
	One	Two	Three
Argentina (Ind. Account)	1.0	0.9	0.8
Argentina (PAYG)	-0.4	0.0	0.4
Bolivia	3.5	3.5	3.5
Brazil	-1.8	-1.1	-0.4
Chile b/	3.5	3.5	3.5
Colombia (Ind. Account)	3.5	3.5	3.5
Colombia (PAYG)	2.1	2.2	2.4
Ecuador	4.1	4.9	5.7
Mexico	4.1	4.1	4.1
Paraguay	2.4	2.4	2.4
Peru (Ind. Account)	3.5	3.5	3.5
Peru (PAYG)	1.5	2.2	2.8
Uruguay (Opting for mixed DB-DC) a/ b/	1.8	1.6	1.8
Uruguay (Ordinary regime) a/ b/	0.0	-0.5	0.1
Venezuela	6.1	6.7	7.4

Note: a/ Workers earning less than $5,000 of may 1995 per month (approximately US$8,900 per annum, in 2007 US dollars) participate only in the PAYG-DB pillar –the "ordinary regime"–, unless they explicitly opt to deposit half of their personal contributions to the savings account pillar. b/ Computed with current norms, which are in the process of being modified by laws passed in 2008.

Assumptions: Average wage in the simulation equal to per capita GDP, 35 years contributing, retirement at 65, age of death is 20 plus life expectancy at 20, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

The Argentinean PAYG pillar displays the typical pattern. The individual whose wage grows faster receives a higher rate of return because the pension is computed on the last 10 years of contribution rather than on the whole working career. The steeper the worker's age-earnings profile, the higher the wages in the last 10 years relative to his own lifetime average and the higher the pension. The same effect is present in all the other PAYG programs in the region. This effect is stronger in programs that use shorter periods of contribution to compute the pension.

The IRRs delivered by purely individual account programs should not depend on the profile of lifetime wages, and this is what our simulations show in the cases of the Bolivian, Chilean, Colombian, Mexican and Peruvian individual account programs. Some non-pure individual account programs, however, have non-actuarial ingredients that make the return sensitive to the age-earnings profile. The Argentinean individual account pillar, for example, yields lower IRRs the steeper the age-earnings profile (i.e., just the opposite as the Argentinean PAYG pillar). This rather unexpected result is due to the impact of the age-earnings profile on the composition of pensions in terms of the annuity and the basic pension. Workers with steeper age-earnings profile have a larger proportion of their final pension served by the basic pension, which yields a lower rate of return than the individual account. To understand this result, it is important to recall that in this set of simulations, the average wage was kept constant, which means that flatter profiles imply lower wages at the end but higher at the beginning of the working career. In the individual account pillar, contributions made at the beginning of the working career count more to the final pension because these contributions are being capitalized at a rate of return that surpasses that of the pension program. It is thus important to have relatively good wages from the beginning.

3.3. The Impact of Life Expectancies

Workers with a shorter life expectancy receive lower IRRs because pensions are paid for fewer periods; and given that pension schemes provide insurance against the "risk" of living too long, this is understandable. But this insurance function turns into redistribution when different groups of workers with varied life expectancy are covered under the same rules. In particular, low income workers are likely to live on average fewer years than high income workers. Once this factor is brought to the fore, pension systems look less pro-poor.

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 (1999) 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.

Unfortunately, we do not have estimations of life expectancy by income levels in Latin America. To assess the possible magnitude of this effect, therefore, we computed the IRRs for the average citizen in each country and for workers who live one and two years less than the average citizen (Table 3). As expected, the IRRs of workers who live fewer years are smaller.

Table 3: Internal Rates of Return and Life Expectancy (IRRs in %)

	"Age of Death" = 20 + Life Expectancy at 20		
	- 0	- 1	- 2
Argentina (Ind. Account)	0.9	0.3	-0.6
Argentina (PAYG)	0.0	-0.7	-1.6
Bolivia	3.5	2.1	-0.2
Brazil	-1.1	-2.2	-3.8
Chile b/	3.5	3.2	2.7
Colombia (Ind. Account)	3.5	3.0	2.3
Colombia (PAYG)	2.2	1.6	0.8
Ecuador	4.9	4.4	3.8
Mexico	4.1	3.7	3.3
Paraguay	2.4	2.0	1.5
Peru (Ind. Account)	3.5	3.0	2.5
Peru (PAYG)	2.2	1.6	1.0
Uruguay (Opting for mixed DB-DC) a/ b/	1.6	0.9	0.1
Uruguay (Ordinary regime) a/ b/	-0.5	-1.2	-2.2
Venezuela	6.7	6.3	5.9

Note: a/ Workers earning less than US$5,000 of may 1995 per month (approximately US$8,900 per annum, in 2007 US dollars) participate only in the PAYG-DB pillar –the "ordinary regime"–, unless they explicitly opt to deposit half of their personal contributions to the savings account pillar.

b/ Computed with current norms, which are in the process of being modified by laws passed in 2008.

Assumptions: Average wage in the simulations equal to per capita GDP, wages growing at 2% per year, 35 years contributing, retirement at 65, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

IV. 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 actuarial 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 and opens a window to opportunistic behavior. So too, some design characteristics constitute an invitation to gamble, like the benefit formulas based on last salaries. 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. We separately analyze enrolment and retirement ages, which are two key determinants of the length of working careers – as are the number and duration of interruptions in the histories of contributions (Bucheli et al. 2008; Forteza et al. 2009). While we do not explicitly model interruptions in this document, the analysis of enrolment ages provides insightful information: Late enrolment works as a proxy for short contribution histories due to interruptions in the periods of contribution.

4.1. Late Enrolment

The impact of the enrolment age on the IRRs varies widely across the region (Table 4). The Argentinean and Uruguayan programs punish individuals who have short histories of contribution as a result of late enrolment. The DC individual account programs are mostly neutral, yielding the same IRRs irrespective of the enrolment ages, although the Chilean program after the 2008 reform and the Mexican program represent interesting exceptions to this rule. These programs are not totally neutral despite being based on the individual account pillar. Finally, the third and largest group of programs pays higher IRRs to individuals with short working careers. This group includes the Brazilian, Chilean (after the 2008 reform), Ecuadorian, Mexican, Paraguayan, Peruvian PAYG and Venezuelan programs. We briefly comment on each group in what follows.

Workers participating in the Argentinean PAYG pillar receive similar IRRs whether they contribute 30 or 40 years whereas much lower IRRs are received if they contribute less than 30 years. Working 40 rather than 30 years, individuals receive higher replacement rates (Table 5), which means bigger pensions, but the number of contributions is higher too. The trade-off is roughly actuarially fair in this range; therefore the IRRs are similar (-0.4 ppa when contributing 40 years and -0.1 ppa for 30 years' contribution). In turn, workers who contribute 25 years or less are constrained to receiving a pension five years later (i.e., age 70) than the ordinary age. They also receive lower replacement rates (Table 5) and smaller pensions than workers who contribute 30 years or more. According to the IRRs that we get for the last two cases (Table 4), the reduction in benefits is (much) more than actuarially fair, suggesting that the "punishment" for having short contribution histories is too harsh.

In principle, a defined contribution individual account pillar should be actuarially fair. Fewer contributions should be balanced by smaller pensions and the IRRs should be the same irrespective of the length of the contribution period. However, the Argentinean individual account pillar departs from actuarial fairness, as it seems to punish workers who contribute little. Indeed, as the first row in Table 4 shows, the Argentinean individual account pillar yields higher IRRs the longer the contribution period. This is because the replacement rates drop very fast as the number of years of contribution decrease (Table 5). This unexpected result stems from the non-actuarial component of this program, that is, a basic pension that is very sensitive to the number of periods of contribution.

Table 4: Internal Rates of Return and Length of Contribution Period (IRRs in %)

	Number of Years Contributing				
	40	35	30	25	20
Argentina (Ind. Account)	1.1	0.9	0.7	-0.5	-1.0
Argentina (PAYG)	-0.4	0.0	-0.1	-7.5	-8.2
Bolivia	3.5	3.5	3.5	3.5	3.5
Brazil	-1.5	-1.1	-1.9	-0.9	0.7
Chile. Post-2008	3.5	3.5	3.7	4.2	5.0
Chile. Pre-2008	3.5	3.5	3.5	3.5	3.5
Colombia (Ind. Account)	3.5	3.5	3.5	3.5	3.5
Colombia (PAYG)	1.6	2.2	3.1	2.5	a/
Ecuador	4.4	4.9	5.6	6.6	8.3
Mexico	4.0	4.1	4.2	4.3	4.4
Paraguay	1.8	2.4	3.2	4.5	a/
Peru (Ind. Account)	3.5	3.5	3.5	3.5	3.5
Peru (PAYG)	2.2	2.2	2.2	3.1	4.9
Uruguay (Optional DB-DC) Post-2008	1.6	1.6	1.6	1.7	-0.1
Uruguay (Optional DB-DC) Pre-2008	1.6	1.6	0.1	-0.1	-0.2
Uruguay (Ordinary regime) Post-2008	-0.5	-0.5	-0.4	-0.1	-3.6
Uruguay (Ordinary regime) Pre-2008	-0.5	-0.5	-4.5	-4.5	-4.4
Venezuela	6.0	6.7	7.8	9.3	11.7

Note: a/ Not eligible for pensions.

Assumptions: Average wage in the simulations equal to per capita GDP, real wages growing at 2% per year, retirement at 65, age of death is 20 plus life expectancy at 20, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

Table 5: Replacement Rates and Length of Contribution Period (%)

	Number of Years Contributing				
	40	35	30	25	20
Argentina (Ind. Account)	113.0	96.9	81.8	53.9	41.5
Argentina (PAYG)	81.3	80.5	70.5	47.3	40.1
Bolivia	204.2	171.7	141.5	113.4	87.3
Brazil	106.8	106.8	86.8	90.0	93.4
Chile Post-2008	86.0	72.3	62.3	53.9	46.2
Chile Pre-2008	86.0	72.3	59.6	47.8	36.8
Colombia (Ind. Account)	130.8	110.0	90.6	100.4	94.4
Colombia (PAYG)	78.0	78.0	78.0	62.0	
Ecuador	103.0	94.4	85.8	77.2	68.7
Mexico	65.4	55.0	45.3	36.3	36.3
Paraguay	107.7	107.7	107.7	107.7	
Peru (Ind. Account)	103.3	86.9	71.6	57.4	44.2
Peru (PAYG)	77.4	66.3	55.3	51.2	51.2
Uruguay (Optional DB-DC) Post-2008	123.3	108.5	94.4	81.0	27.7
Uruguay (Optional DB-DC) Pre-2008	123.3	108.5	200.7	169.5	139.2
Uruguay (Ordinary regime) Post-2008	78.0	72.0	66.0	60.0	50.1
Uruguay (Ordinary regime) Pre-2008	78.0	72.0	84.8	79.5	72.9
Venezuela	93.3	87.2	81.1	74.9	68.8

Notes: a/ Not eligible for pensions.

Assumptions: Average wage in the simulations equal to per capita GDP, real wages growing at 2% per year, retirement at 65, age of death is 20 plus life expectancy at 20, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

The Brazilian pension system does not seem to reward–in an actuarial sense–contributions made above the 35 years that are statutorily required to receive the ordinary pension (also referred to as the contributory or length of service pension), as workers would receive higher IRRs contributing 35 rather than 40 years. They would receive the same pension whether contributing 40 or 35 years (Table 5). Even if they would contribute more, they receive the same. In any event, the required 35 years of contributions is an already-long period in the Brazilian context, so lacking incentives to contribute more than this threshold does not seem to be an issue.

More interesting is to look at the provisions in the Brazilian pension scheme designed to deal with shorter contribution histories. The so-called "advanced-age pension" sets the minimum age and years of contributions at 65 and 15, respectively. Individuals contributing 30 years or less in our simulations are not eligible for the ordinary (length of service) pension, thus receive the age pension. This latter program requires fewer contributions and provides smaller benefits (Table 5) so that in our simulations workers contributing 25 and especially 20 years receive higher IRRs than workers contributing over longer periods.

The Uruguayan ordinary program before the 2008 reform strongly punished short working careers. As Table 4 shows, the IRRs are much smaller if workers contribute 30 or fewer years than 35 years. Workers who fail to contribute 35 years are not eligible for the ordinary pension, and they have to wait until they are 70 to receive an advanced-age pension. The IRRs are smaller basically because they receive the pension for a shorter period and, to a lesser extent, because the PAYG-DB pension is smaller.[7] Under these rules, workers who worked 30 years or so in the formal sector would have strong incentives to continue contributing. These high-powered incentives would probably work fine if contributing was just a matter of choice, but contributions depend on chance as well. Hence, these rules could be too extreme.

The 2008 reform smoothed these characteristics, shifting the balance of the scheme from incentives to insurance. Workers no longer face significant drops in the IRRs when they contribute less than 35 years, unless they fall short of 25. Changes in both the ordinary and the advanced-age pension programs are behind these results. The minimum number of years of contribution required to

[7] Before the 2008 reform, Uruguayan workers get a higher replacement rate contributing 30 rather than 35 years (Table 5). This high replacement rate is due to the annuity which increases as the worker with less than 35 years of contribution starts collecting only at 70. This rise of the annuity does not impact on the IRRs though, for the annuity by construction is actuarially fair. In turn, the DB component of the Uruguayan mixed pension falls when workers contribute 30 rather than 35 years.

access an ordinary pension was reduced from 35 to 30. In turn, the advanced-age pension is now granted at 65 (rather than at 70) with 25 years of contribution. If the worker contributed less than 25 and more than 15 years, he could still access the advanced-age pension but at older ages: at 66 with 23 years of contribution, at 67 with 21 years of contribution and so on up to age 70 with 15 years of contribution.

The purely DC individual account programs comprise a second group characterized by neutrality in the sense that the IRRs are the same irrespective of the enrolment age. By their very structure, these programs are actuarially fair so that shorter contribution histories are exactly compensated with lower annuities. In this sense, short contribution histories are neither punished nor rewarded. This group is represented in the region by the Bolivian, Chilean (pre-2008 reform), Colombian and Peruvian individual account programs.

The third group is composed of programs that provide relatively high IRRs to workers with short working careers. As mentioned, two interesting cases in this group are the Chilean (post-2008) and Mexican programs, which depart from actuarial fairness despite being based predominately on the individual account program. When the 2008 reforms become effective in Chile, the program will provide a subsidy to workers who cannot self-finance a pension above a certain threshold, hence fewer contributions pay higher IRRs.[8] In Mexico, the government makes a flat contribution to the program. As the number of worker contribution periods falls and the amount of total contributions lowers, the government contribution represents a higher proportion of the individual account.

According to our results, the Ecuadorian and Venezuelan programs strongly discourage long working careers, with IRRs decreasing steadily as the careers extend. The same happens in the Colombian and Peruvian PAYG programs, although to a lesser extent. In these programs, the replacement rates rise in tandem with the years of contributions; the gains, however, do not actuarially offset the added years. The flat benefit paid to all Venezuelan retirees irrespective of their contributions partially accounts for the insufficient rise in pensions relative to individual concerted efforts to increase contributions. Yet, this is not the only explanation. We performed simulations ignoring this provision and still obtained important differences in IRRs: 8.5 ppa for workers with 20 years of contributions versus 4.8 ppa for workers with 40 years of contribution.

[8] The current Chilean program has redistributive non-actuarial ingredients as well. However, our representative worker would not benefit from these ingredients even if he contributed only 20 years.

This occurrence of higher IRRs paid to shorter careers is found in the Paraguayan program as well. But unlike other programs in this group, the Paraguayan program does not have any actuarial compensation for more years of contribution: The pension is exactly the average wage in the last three years, no matter the number of years of contribution. Pensions may still grow as workers contribute more years if wages in the last years are higher than in previous years, but this is a rather indirect and small effect that does not actuarially compensate for the longer period of contributions. The only incentive to contribute seems to be that below 25 years, workers receive no benefits.

In summary, Argentina and Uruguay seem provide stronger incentives to pursue long contribution careers; their IRRs are increasing functions of the length of the contribution periods. The counter side of these strong incentives is the weak protection against the risk of having short working careers. The relatively tough pension eligibility conditions in Argentina and Uruguay play a significant role in this result, as workers with short contribution histories are not entitled to ordinary pensions and must work beyond the ordinary retirement age to receive smaller pensions.[9] These rules are being softened in Uruguay, as the 2008 reform put in place a phased loosening of the eligibility conditions. At the other extreme, Ecuador and Venezuela, according to our computations, provide weaker incentives to pursue long contribution careers and better protection against the risk of having short careers. Somewhere in towards the middle are the defined contribution individual account programs in several Latin American countries (e.g., Chile and Mexico); they are in principle actuarially neutral. That being said, some of these programs are not pure schemes, so the IRRs are not totally inelastic to the length of the contribution period. A clear example, the Argentinean individual account pillar.

[9] There is some evidence that this toughness in the legal norms has been "accommodated" through weak enforcement, so that many workers receive pensions even though they do not fulfil the eligibility conditions (Bucheli et al. 2008; Forteza et al. 2009).

4.2. Retirement Ages

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.

According to our estimations, some Latin American pension programs strongly discourage retirement before pension eligibility while others are relatively neutral. As expected, the defined contribution programs are mostly neutral: They yield basically the same IRR irrespective of the retirement age. This is the case of the Bolivian, Chilean, Colombian, Mexican and Peruvian individual account programs (Table 6).[10] In contrast, the defined benefit programs in Argentina, Ecuador and Uruguay discourage retirement before pension eligibility ages.

[10] The comparatively high IRR and low RR that Colombian workers would receive in the individual accounts pillar if they retired at 60 is due to the minimum pension. They receive a lower RR retiring at 60 than at 55 or 65 because their first pension is a minimum pension. If they retired either at 55 or at 65, their first pension would be an annuity, which is larger than the minimum pension. In turn, they receive a higher IRR retiring at 60

Even in the simple examples presented in Table 6 several forces are at work, so the IRRs do not monotonically increase or decrease with the retirement age. Other things equal, a worker who retires later contributes more periods. Unless the worker is compensated with a sufficiently larger pension, the extension of the contribution period will obviously reduce the IRR. In principle, the postponement of retirement will also raise the age at which workers start collecting pensions, which also reduces the IRRs (e.g., Colombian PAYG program). This effect can be very large, particularly when life expectancy is short, as the example of Brazilian workers retiring at 70 shows. However, in some cases the opposite occurs: If the worker is close to but has not fulfilled the minimum number of years required to receive an ordinary pension, he may postpone retirement to complete the minimum required periods of contribution. By doing so, the worker accesses an ordinary pension rather than an advanced-age pension. In this case, later retirement implies earlier pension claim, which positively impacts on the IRRs (see more on this below in the cases of Argentina and Ecuador). Finally, the rules included in benefit formulas to reward late retirement with higher pensions usually do not actuarially compensate the insured for working additional years and, thereby, abbreviating pension spans.

Despite these general findings, it should be noted that retirement ages impact on the IRRs through several channels, some of them rather indirect; precluding any simple relationship between the two. Moreover, it is not always the retirement age per se that impacts on the IRRs but the way the retirement decision impacts on variables such as the length of the contribution period, the pension eligibility age, the age at which the pension is effectively claimed (if it happens after first eligibility age) and the average wage on which pensions are computed. Because of this, the impact of the retirement age on the IRRs depends on other variables, like the enrolment age and the density of contributions. Someone retiring at 60 in Uruguay, for example, is not eligible for an ordinary pension if he enrolled in the system at 35, but he is eligible if he enrolled at 25 (and contributed without interruption). The results summarized in Table 6 and Table 7 should be read with these remarks in mind, avoiding the temptation to draw too general a conclusion from the few cases presented. We next turn to further-analyzing several programs to arrive at a better understanding of what is driving our results.

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because in this case they receive the pension at 62, while if they retired at 55 or 65 they would only receive a pension at 65.

In the Argentinean PAYG pillar, the pensionable age for males is 65 (with 30 years of contribution and over 65 with fewer). Individuals have the choice to stop working sooner, with the caveat of waiting until they turn 65 or older to start collecting.[11] The second row of Table 6 is illustrative of how severe the fall in the rate of return can be for an Argentinean worker retiring before the pensionable age. The fall is due to the drop in the RR and the postponement of the pensionable age that is associated to a shorter period of contributions (Table 7). This case is a clear example of how the impact of retirement ages on the IRRs crucially depends on the enrolment age. At the other end of the spectrum, if a worker delays retirement until 70 and—based on our assumptions—dies at 71, only one year of pension is received thus yielding a strongly negative IRR.

The pre-2008 Uruguayan rules severely punish early retirement. Workers who start contributing at 30, retire at 60 and contribute only to the PAYG pillar receive–3.1 ppa in return. This IRR is 2.6 percentage points smaller than the return when they retire at 65. Because 35 years of contributions are required to access an ordinary pension, a worker retiring at 60 is five years short of the ordinary pension but 10 years away from the other entitlement, the advanced-age pension. The IRR is lower retiring at 60 than at 65 because the period collecting pensions is shorter (individuals start receiving pensions at 70 and die at 73). And this is so despite RRs being higher when workers retire at 60 compared to 65 (Table 7). The increase in the annuity derived from late retirement drives this result: the annuity is large, but only because workers are expected to collect for a short period. With the same work history, the IRRs would be higher if workers opted to direct half of their personal contributions to each pillar, although the IRR would still drop if workers retired at 60 rather than 65.

The reform passed in 2008 smoothed out the impact of early retirement because the minimum number of years of contribution to access an ordinary pension was reduced to 30 and the eligibility age for the advanced-age pension was reduced from 70 to 65. Today, someone who starts contributing at 30 and retires at 60 accumulates the 30 years of contribution that are required to access an ordinary pension. Even if he receives a smaller pension retiring at 60 than at 65, the IRR is higher because of the combined effect of less years contributing and more years collecting the pension. There is still a punishment for early retirement, but it is smaller and takes place at a

[11] To receive the pension at 65 they must have at least 30 years of contribution. The pensionable age rises if the number of periods of contribution reduces. For example, the individual who retires at 55 (first column and row in the Table 6) has 25 years of contribution and only get the pension at 70

younger age. Under the conditions assumed to run the simulations presented in Table 6, the fall in the IRR takes place if the worker now retires at 55 rather than at 60.

Chile and Mexico are two of the cases where programs do not seem to provide strong incentives to retire at any definite age. In the Chilean system, workers are entitled to an annuity or to programmed withdrawals at 65, with no requirement regarding years contributing. Alternatively, workers have the option of an early-pension at any age if the accumulated funds adequately finance pensions that surpass both an absolute minimum and a certain proportion of their final wages. The 2008 reform did not change these provisions. The Mexican program grants the ordinary pension at 65 with 25 years of contribution. It also provides an early-pension with no requirements of age or contribution, if the accumulated fund suffices to finance a pension that surpasses a certain threshold (which is the same for everybody). In the base case scenario, workers have enough funds accumulated to retire before 65 in both countries, and because of the actuarial fairness of the schemes, the IRRs are the same for all retirement ages. The Argentinean individual account pillar is not completely neutral because of the DB ingredients involved in the basic pension.

Table 6: Internal Rates of Return and Age at Which Individuals Stop Working (IRRs in %)

	Age at Retirement			
	55	60	65	70
Argentina (Ind. Account)	1.0	1.3	0.9	0.4
Argentina (PAYG)	-3.9	0.3	0.0	-6.9
Bolivia	3.5	3.5	3.5	a/
Brazil	-0.7	-1.4	-1.1	-21.1
Chile Post-2008	3.9	3.6	3.5	3.5
Chile Pre-2008	3.5	3.5	3.5	3.5
Colombia (Ind. Account)	3.5	4.5	3.5	3.5
Colombia (PAYG)	3.0	4.3	2.2	-4.0
Ecuador	3.3	7.2	4.9	0.3
Mexico	4.0	4.1	4.1	4.1
Paraguay	4.3	4.7	2.4	-1.4
Peru (Ind. Account)	3.5	3.5	3.5	3.5
Peru (PAYG)	4.6	4.1	2.2	-1.6
Uruguay (Optional DB-DC) Post-2008	2.1	2.5	1.6	-0.2
Uruguay (Optional DB-DC) Pre-2008	1.0	0.7	1.6	-0.2
Uruguay (Ordinary regime) Post-2008	0.7	1.3	-0.5	-6.3
Uruguay (Ordinary regime) Pre-2008	-2.1	-3.1	-0.5	-6.3
Venezuela	7.4	8.0	6.7	3.9

Note: a/ Simulated workers die at 69 in Bolivia.

Assumptions: Average wage in the simulations equal to per capita GDP, real wages growing at 2% per year, age of enrolment is 30, age of death is 20 plus life expectancy at 20, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

Table 7: Replacement Rates and Age at Which Individuals Stop Working (%)

	Age at Retirement			
	55	60	65	70
Argentina (Ind. Account)	76	96	97	254
Argentina (PAYG)	58	78	81	81
Bolivia	74	78	172	
Brazil	86	87	107	107
Chile Post-2008	67	72	72	145
Chile Pre-2008	61	71	72	145
Colombia (Ind. Account)	119	94	110	321
Colombia (PAYG)	62	81	78	78
Ecuador	60	86	94	103
Mexico	37	33	55	121
Paraguay	95	108	108	108
Peru (Ind. Account)	47	55	87	214
Peru (PAYG)	57	55	66	77
Uruguay (Optional DB-DC) Post-2008	106	69	108	234
Uruguay (Optional DB-DC) Pre-2008	228	233	108	234
Uruguay (Ordinary regime) Post-2008	73	54	72	90
Uruguay (Ordinary regime) Pre-2008	97	94	72	90
Venezuela	58	65	87	112

Note: a/ Simulated workers die at 69 in Bolivia.

Assumptions: Average wage in the simulations equal to the average insurable wage of the system, real wages growing at 2% per year, age of enrolment is 30, age of death is 20 plus life expectancy at 20, single male.

Sources: Own computations based on Social Security Administration (2008), WHO (2008), World Bank Development Indicators, and decrees and laws listed in the references section.

The Colombian PAYG program does not provide incentives to work beyond 60 years of age in the base case scenario. A higher pension could be received retiring at 65 or even at 70 than at 60, but this rise in the monthly pension would not suffice to compensate the additional contributions and fewer months receiving the pension. These workers would not be eligible for an ordinary pension if they retired at 55 for lack of the required 25 years of contributions.

The Ecuadorian worker presented in Table 6 has strong incentives to work until 60, as the IRRs are considerably smaller if he retires before or after that age. This worker is assumed to enroll at 30. If he stops working at 55, he will only be eligible for a pension at 65; if he continues working until 60, he will be eligible for a pension at 60. This is because the Ecuadorian program's eligibility age is 60 if the worker contributed 30 years, but 65 if the worker contributed only 15 years. Contributing five more years reduces the IRR, but receiving the pension five years earlier increases the IRR. The second effect dominates the first in this case and the simulated worker benefits postponing retirement until 60. This is a clear example of how the impact of postponing retirement on the IRRs

depends on the whole history of contributions. If the worker had enrolled in the system earlier, for example, the retirement age that maximizes his IRR would likely be smaller.

The Paraguayan program delivers maximum IRRs if the simulated worker retires at 60, a bit less if he retires at 55, and much less if he retires later. Retirement at 60 is contingent upon accumulating at least 25 years of contributions and at 55 upon 30 years of contributions. In either case, based on our assumption of enrolment at 30, he will be eligible for a pension at 60. The number of years accumulated (i.e., 25) would not suffice to access an early pension at 55, while retiring five years later (i.e., at 60) does provide the needed number of contributions but increases the pension. The end result is similar IRRs. In turn, no additional benefits are derived for working beyond age 60; pensions do not rise despite contributing additional years and collecting pensions fewer years. Pensions do not rise because the replacement rate is constant at 100 percent. This lack of actuarial adjustment naturally leads to declining IRRs as workers compound years; therefore, the Paraguayan program provides strong incentives against contributing beyond the minimum required to access the ordinary pension.

Peruvian workers in the PAYG system have incentives to retire at 55. Workers who enrolled at 30 will have accumulated only 25 years of contributions if they retire at 55. They will not be eligible for early retirement (55 years of age and 30 of contribution are the qualifying conditions for this benefit) and will have to wait until they turn 60 to receive the pension. The eligibility age in this case is the same whether workers choose to retire at 55 or at 60. Retiring at 60 rather than 55,more contributions are paid yet higher pensions are not yielded because these workers receive the minimum pension.[12] In turn, if workers choose to retire at 65 rather than at 60, they pay more years of contributions and receive higher pensions over fewer years. Our simulations show that the rise in pensions does not offset the additional contributions and the reduced pensionable years, hence the IRR is significantly lower if workers retire at 65 rather than at 60. Similar effects occur if workers postpone retirement even further beyond 65.

The Venezuelan workers have incentives to retire at 60. The IRRs are smaller if they retire either at 55 or at 65. In the Venezuelan program, the ordinary pension requires 60 years of age and 15 years of service, but people who retire younger can receive an old-age grant if they have contributed for

[12] It may look surprising that the replacement rate is actually a bit smaller retiring at 60 than at 55. This is only because the wage in the denominator is larger at 60 than at 55, while the pension is in this case the same.

at least two whole years in the last four. Workers who enroll at 30 and retire at 55 obtain this grant until they comply with the ordinary pension requirements, which in this case occur when they turn 60. From then on, these workers receive the ordinary pension. Workers retiring at 60 receive larger pensions, contribute more years and receive pensions fewer years than workers retiring at 55. The first effect dominates the last two and hence the IRR is higher when workers retire at 60 rather than at 55. In turn, postponing retirement even further is not profitable. Even though pensions rise when workers retire at 65 rather than at 60, the combination of more periods contributing and fewer periods receiving pensions make this option unappealing.

In general, the programs do not provide incentives to retire at 70 or later. In the defined contribution programs the IRRs do not vary with the retirement age, and in the PAYG and mixed schemes the IRRs are much smaller when workers retire at 70 than at 65.

V. Conclusion

We present in this paper estimations of the internal rates of return (IRR) and replacement rates (RR) that formal workers in eleven Latin American countries receive from social security. We first use these indicators to assess the programs in terms of the return workers receive in a base case scenario. We then move to the analysis of diversity: we want to know 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.

Our analysis of inequality is based on simulations run for hypothetical workers who differ in terms of (i) wage level, (ii) age-earnings profiles and (iii) life expectancy. All the defined benefit programs analyzed in this study are in principle progressive in the sense that they provide higher returns to low than to high income workers. This result should be qualified, however. Several of these programs yield higher IRRs to workers with steeper age-earnings profiles, usually representative of the better-off, and all of these programs yield lower IRRs to workers with lower life expectancies, generally attributed to low income workers.

In Argentina and Uruguay, pension programs punish short contribution careers with very low IRRs. This is probably an intended result, with the idea being to provide incentives for making contributions. Short working careers, however, can be the result of the unforeseen circumstances, like the onset of debilitating diseases or simple bad luck, and these pension programs compound the income loss suffered. While it is perfectly natural for an insurance program to look at its provision of incentives, our results suggest excessive incentives at the sacrifice of insurance. Recent analysis about the histories of contribution to social security show that most Argentinean and Uruguayan contributors to social security are not in the way of accumulating the number of years of contribution required to access pensions at the ordinary retirement ages (Bucheli et al. 2008; Forteza et al. 2009). According to our results, these workers would receive very low IRRs from the system if the rules were strictly enforced. These findings suggest that the incentives these low IRRs represent have not been effective in inducing longer histories of contribution in these countries. One possible reason is weak enforcement: Workers expect to receive pensions even if they do not fulfill formal conditions.

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 the number of periods of contribution. 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 reduce pensions by more than that look unnecessarily harsh. Rather than providing insurance, these programs create risk.

In Chile (when the 2008 reform is fully operational) and Mexico, pension programs provide some insurance against the risk of short contribution careers. Individuals with few years of contributions receive larger IRRs than individuals with long contribution histories. The RRs are nevertheless increasing functions of the length of the contribution period (i.e., workers with short contribution histories receive low RRs in both countries). Therefore, these programs provide some protection against the risk of short working careers and also address incentives by providing partial insurance against this risk.

The Ecuadorian and Venezuelan pension programs also deliver larger IRRs to workers with short contribution careers, but they seem to go much further than the Chilean and Mexican programs. In the base case scenario, while in Chile and Mexico workers would lose 1.5 and 0.4 percentage points per annum respectively if they contributed 40 rather than 20 years, in Ecuador and Venezuela workers would lose as much as 3.9 and 5.7 percentage points per annum respectively under the same scenario. As in other countries, the RRs in Ecuador and Venezuela are increasing functions of the length of the contributions period and, thus, do not provide full insurance against the risk of short working careers. Yet, the striking losses in the rates of return that Ecuadorian and Venezuelan workers suffer if they continue contributing beyond 20 years suggest that the incentives to contribute are too weak in these cases.

While we cannot say what the optimal insurance contract in each country should look like, our results suggest that the Brazilian, post-2008 Chilean and Mexican programs engineered a better balance between insurance and incentives than the other programs. While the Argentinean (PAYG) and the Uruguayan programs seem to have shifted the balance too far towards incentives, submitting workers to excessive risk, the incentives provided by the Ecuadorian and Venezuelan programs are probably too weak.

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. 2008; Forteza et al. 2009). The very low IRRs that the Argentinean and Uruguayan pension programs yield to workers with short contribution histories impact thus primarily on low income workers. Ironically, two of the programs that provide better protection against this risk that is highly prevalent among the poor are built on individual savings accounts–the Chilean and the Mexican programs– and the two programs that impose very negative results on workers who do not manage to contribute long enough are to a large extent based on "intergenerational solidarity".

Argentina, Chile and Uruguay passed reforms to their main pension programs in 2008. The Argentinean reform basically eliminates the individual account pillar, so the results we present for the existing PAYG pillar would still hold. In turn, the Chilean and Uruguayan reforms are parametric, in the sense that they change parameters but do not modify the basic architecture of the programs. According to our simulations, the Chilean and Uruguayan reforms reinforced social protection as the balance shifted towards insurance and away from incentives.

This document is an intermediate product of a research line that is still in progress. We presented a relatively detailed discussion of several scenarios mostly to show the various effects at work even in relatively simple simulations. Our results suggest patterns, but the complexity of the involved effects necessitates that these results be taken with caution. In any event, we hope that the database that accompanies this document will serve other observers of Latin American pension systems to perform their own analysis.

Future steps involve the inclusion of more countries, the development of a more formal and explicit analytical framework and the presentation of a wider range of simulations. While the first point requires no justification, the other two merit a few remarks. Regarding the analytics, we have

borrowed some basic concepts from agency theory to illuminate our discussion of the empirical results in this paper. We have, on the other hand, made no attempt to present a formal elaboration of these concepts. At this stage of our research, we feel that we would greatly benefit from a more systematic integration of the rich and powerful concepts of agency theory in our analysis.

Regarding the set of simulations, we would like to explore several extensions of our current work. An obvious one is to include both genders, as the results in the present document refer exclusively to men. Inclusion of survivor benefits and focusing on families rather than on single individuals are also important extensions. 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. Another important extension is the inclusion of disability benefits.

Finally, the complexity of the systems suggests that running more simulations is advisable to confirm the robustness of some results. Consider for example the analysis of the impact of retirement ages on the IRRs. Since the IRRs depend on the whole histories of contribution, postponing retirement one year may have quite different impacts on the IRRs depending on the enrolment age, the densities of contribution, the average wage and the age-earnings profile. So too, as the impact of the retirement age on the IRRs is a non-monotone relationship, choosing only two or three points in each dimension may not be adequate to fully characterize these functions. A problem of dimensionality immediately arises. Therefore, a thorough understanding of the nature of these programs, educated with a more systematic use of formal analytical tools, seems necessary to pin down the appropriate set of simulation scenarios for future research.

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Annex: Description of Systems

Note: All amounts in this section are expressed on a monthly basis, in 2007 US dollars.

Argentina

<table>
<tr><th>Individual Account</th><th>Additional</th></tr>
<tr><td>Source of funds:
Insured person: 11% of covered earnings
Employer: 11.44% of gross payroll

Contribution wage floor = US$ 78 (3 MOPRES)
Contribution wage ceiling = US$ 1,954 (75 MOPRES).

Qualifying Conditions:
a) “Ordinary”: Age 65 with 30 years of contributions and service.
b) “Advanced Age”: Age 70 with 10 years of service
c) “Early Retirement”: the annuity surpasses 50% of the average wages (SBJ).

Benefits:
a) “Ordinary” = annuity
b) “Advanced Age” = 70% of the ordinary annuity
c) “Early Retirement” = annuity</td><td>Source of funds:
Insured person: 11% of covered earnings
Employer: 11.44% of gross payroll

Contribution wage floor = US$ 78 (3 MOPRES)
Contribution wage ceiling = US$ 1.954 (75 MOPRES).

Qualifying Conditions:
a) “Ordinary”: Age 65 with 30 years of service. The insured may substitute 2 years of age after the retirement age for 1 year of contributions.
b) “Advanced Age”: Age 70 with 10 years of service
c) “Early Retirement”: (Age 60 and 30 years of service. This program is being phased out since April of 2007)

Benefits:
a) “Ordinary”= (1.5/100) * average wages * t, where t= min(length of service, 35).[13]
Minimum pension (Additional + UBP) = US$ 173.
Maximum pension (Additional + UBP) = US$ 1,267.
b) “Advanced Age” = 70% of the “Ordinary additional”
c) “Early Retirement”: being phased out since April of 2007</td></tr>
<tr><td colspan="2">Universal Basic Pension

Source of funds: 10.17 or 12.71% for private workers and 16% for civil servants (employers contributions)

Qualifying Conditions:
a) “Ordinary”: Age 65 with 30 years of service
b) “Advanced Age”: Age 70 with 10 years of service

Benefits:
a) “Ordinary” = 2,5*MOPRE + 0.01*2.5*MOPRE*(t-30); $30 \leq t \leq 45$,
MOPRE = US$ 26
b) “Advanced Age” = 70% of the Ordinary UBP</td></tr>
</table>

where:
- covered earnings = 3*MOPRE < wage < 75 * MOPRE.
- average wages= average wages of the last 10 years.

Options: By default, the worker is covered by UBP + Individual Account. He may choose for the Additional at the beginning, and being there he can change pillars but with no return.
The average wage index is used to update the MOPRE and for the “valorisation” of wages for the computation of pension (Decree 1.306/00 and Law 24.241, art 24).

[13] The ordinary pension was (**0.85**/100)*SBJ*t until the 2007 reform.

Bolivia

Individual Account

Source of Funds:
Insured person: 12.21% of covered earnings
Employer: None
Government: None.

Floor = minimum wage
Ceiling=60 * minimum wage
With minimum wage= US$ 65.5

Qualifying Conditions:
a) "Ordinary" = At age 65 or at any age if the accumulated capital in the individual account, plus accrued interest, is sufficient to finance a monthly pension equal to 70% of the insured's average covered earnings in the last 5 years.

Benefits= individual account annuity.

Min: 70% of the insured's average covered earnings in the last 5 years.

All nominal variables are adjusted by the CPI.

Brazil

Contributory Pension

Source of fund (all amounts are expressed on a monthly basis):

Insured Person
8% of wage if wage < US$ 452
9% of wage if US$ 452 < wage < US$ 754
11% of wage if wage > US$ 754
floor = minimum wage = US$198
ceiling = US$ 1,507

Employer: 20% of payroll

Qualifying Conditions
a) "Ordinary": 35 years of service
b) "Advanced Age": Age 65 with 15 years of service

Benefits
a) "Ordinary"= average wages * fator previdenciario
b) "Advanced Age" =0.7 * average wages * (1+0.01*(length of service))

Max average wage = US$ 1,390
Max pension: average of the last 36 monthly contribution wages.

where:
- average wages = average of the 80% highest (updated) wages.
-fator previdenciario = (0.31 * (length of service) / life expectancy) *
((1 + (0.31 * (length of service) + retirement age) / 100).
-penalization = min (1 , (1 - 0.05 * max (0 , (35 - length of service)))).

All nominal variables are adjusted by the CPI. Also wages used to compute pensions are valorized according to CPI.

Chile

Pre-2008 Reform System

Individual Account

Source of funds: 12.55% of covered wages (Insured Person).
Floor = US$ 274.23 (if 18 ≤ age< 65) or US$ 204.74 (if 65 ≤ age)
Ceiling = 60*UF; where UF = US$ 35.46

Qualifying Conditions:
a) "Ordinary": Age 65
b) "Early Retirement": if individual account annuity surpasses the 70% of the average wage of the last 10 years and also surpasses the 150% of the minimum pension.
c)Guaranteed minimum pension: Age 65 with 20 years of service if annuity is less than a minimum pension

Benefits:
a) "Ordinary"=individual account annuity.
b) "Early Retirement" = individual account annuity.
c)"Guaranteed minimum pension"= US$170.85 if age<70 or US$186.82 if age≥70

PAYG

We haven't analyzed this pillar because it is being phased out since 1981.

All nominal variables are adjusted by the CPI.

Post-2008 Reform System

Individual Account

Source of funds: 12.55% of covered wages (Insured Person).
Floor = US$ 274 (if 18 ≤ age < 65) o US$ 204 (if 65 ≤ age)
Ceiling = 60*UF; UF = US$ 35

Qualifying Conditions:
a) "Ordinary": Age 65
b) "Early Retirement": if annuity surpasses 70% of the average wage of the last 10 years and also surpasses the 150% of the minimum pension.

Benefits:
a) "Ordinary"=individual account annuity.
b) "Early Retirement" = individual account annuity.

Solidarity

Source of funds:
a) "BSP-Advanced Age" (Basic Solidarity Pension): financed by the government
b) "Elderly-PSC" (Previsional Solidarity Contribution): financed by the government

Qualifying Conditions:
a) "BSP-Advanced Age": Age 65, no right to receive other pensions, and being a member of a low income household.
b) "Elderly-PSC": Age 65, with a self financed pension (the so-called base pension = BP) higher than cero and lower than or equal to a Maximum Pension (MP), and being a member of a low income household.
Maximum pension: US$133 from 07/2008 to 06/2009
with solidarity US$229 from 07/2009 to 06/2010
contribution (MP) US$286 from 07/2010 to 06/2011
US$381 from 07/2011 to 06/2012
US$486 from 07/2012

Benefits:
a) "BSP-Advanced Age": US$114 between 07/2008 and 06/2009; and US$143 from 06/2009.
b) "Elderly-PSC" = BSP - (BSP/MP)*BP if MP≥BP≥BSP

All nominal variables are adjusted by the CPI.

Colombia

Individual Account	PAYG a/
Source of funds: Insured person = 0,04 * ins_wage1 + 0,01 * ins_wage2 (if wage > 4* min_wage) + 0.002 * ins_wage3 + 0.004 * ins_wage4 + 0.006 * ins_wage5 + 0.008 * ins_wage6 + 0,01 * ins_wage7 Employer =12% wheremin_wage =floor = US$ 228 ceiling=25*min_wage=US$9927.2	*Source of funds:* Insured person = 0,04 * ins_wage1 + 0,01 * ins_wage2 (if wage > 4* min_wage) + 0.002 * ins_wage3 + 0.004 * ins_wage4 + 0.006 * ins_wage5 + 0.008 * ins_wage6 + 0,01 * ins_wage7 Employer =12% The government also contributes to this pillar pensions (partial subsidy). wheremin_wage =floor = US$ 228 ceiling=25*min_wage=US$9927.2
Qualifying Conditions: a) "Ordinary" =individual account annuity must surpass the 110% of a min_wage. b) "Guaranteed minimum pension" = Age 62 with 23 years of service	*Qualifying Conditions:* a) "Ordinary" = Age 62 with 26 years of service. b) "Guaranteed minimum pension" = Age 62 with 26.5 years of service
Benefits: a) "Ordinary" = individual account annuity.	*Benefits:* a) "Ordinary" = R * BMW + 0.015 * BMW * (years of service beyond the minimum) where: R= 0.655-0.05*(wage/minimum wage)
b) "Guaranteed minimum pension" = If the pension is less than the minimum pension set by law, the government makes up the difference. Min: US$ 228	b) "Guaranteed minimum pension" = If the pension is less than the minimum pension set by law, the government makes up the difference. Min: US$ 228 Max: 0.8 * BMW

a/ Parameters programmed to be operational from 2015 onwards, when our simulated workers will retire.

ins_wage1= wage if wage < 4*min_wage
ins_wage2= wage-(4*min_wage) if 4*min_wage ≤ wage < 16*min_wage
ins_wage3= wage-(16*min_wage) if 16*min_wage ≤ wage < 17*min_wage
ins_wage4= wage-(17*min_wage) if 17*min_wage ≤ wage < 18*min_wage
ins_wage5= wage-(18*min_wage) if 18*min_wage ≤ wage < 19*min_wage
ins_wage6= wage-(19*min_wage) if 19*min_wage ≤ wage < 20*min_wage
ins_wage7= wage-(20*min_wage) if wage ≥ 20*min_wage

All nominal variables are adjusted by the CPI.

BMW = The basic monthly wage is based on the insured's average earnings in the last 10 years before receiving the pension.

Ecuador

PAYG

Source of funds:
Insured person: 6.64%
Employer: 3.10%
Government: Finances 40% of the cost of social insurance pensions; the total cost of social assistance pensions; contributes as an employer.

Floor=min_wage=US$240
There is no ceiling.

Qualifying Conditions:
"Ordinary" = Paid at any age with at least 40 years of contributions; age 60 with at least 30 years of contributions; age 65 with at least 15 years of contributions; or age 70 with at least 10 years of contributions.

$$Benefits = \begin{cases} (0.5 + (x-10) * (1/60)) * avg\_wage & if \quad 10 \le x < 40 \\ (1 + (x-40) * 0.0125) * avg\_wage & if \quad x \ge 40 \end{cases}$$

where*x* = contributing years; and avg_wage= average monthly earnings in the best 5 years

Max: US$ 9720

All nominal variables are adjusted by the CPI.

Mexico

Individual Account

Source of fund:
Insured person: 1.75% of covered earnings.
Employer: 5.15% of covered earnings.
Government: social contribution (*cuota social*), equal to 5.5% of the minimum wage, plus 0.35% of the worker's wage

Contribution wage floor = minimum wage; where minimum wage = US$117.5 (we accounted 25 labor days per month)
Contribution wage ceiling = 25* minimum wage = US$ 2,937.5

Qualifying Conditions:
a) "Ordinary"= Age 65 with 25 years of service
b) "Early Retirement"= if the annuity surpasses by at least 30% the guaranteed minimum pension.
c)"Guaranteed Minimum Pension"= Age 65 with 25 years of service and the annuity is less than a minimum pension.

Benefits:
a) "Ordinary"=individual account annuity.
b) "Early Retirement" = individual account annuity.
c)"Guaranteed minimum pension"= US$163

PAYG

We haven't analyzed this pillar because it is being phased out since 1997.

All nominal variables are adjusted by the CPI.
We have not included the May 2009 reform in our analysis.

Paraguay

PAYG
Source of funds: Insured person: 9% Employer: 14% Government: 1.5% Floor=min_wage=US$ 242.5 There is no ceiling. *Qualifying Conditions:* a) “Ordinary” = Age 60 and 25 years of service. b) “Early pension”= Age 55 and 30 years of service. *Benefits:* a) “Ordinary” = avg_wage where avg_wage=average earnings in the last 3 years b) “Early pension”= 0.8* avg_wage + 0.04* avg_wage*(min(59 , age-55)) Max: US$ 2425 Min: US$ 60

All nominal variables are adjusted by the CPI.

Peru

Individual Account	PAYG
Source of funds: 12.72% of covered earnings (Insured Person). floor = US$ 157.7, and there is no ceiling *Qualifying Conditions* = Age 65; a pension is paid at any age if the individual account has accumulated assets that will replace at least 50% of average indexed earnings in the last 120 months. *Benefits* = individual account annuity.	*Source of funds:* 13% of covered earnings (Insured Person). floor = US$ 157.7, and there is no ceiling *Qualifying Conditions:* a) “Ordinary” = Age 60 with 20 years of service. b) “Early pension” = Age 55 and 30 years of service. *Benefits:* a) “Ordinary” = 0.3*avg_pen_wage + 0.02*avg_pen_wage*(contributing years exceeding 20, max 100%) where avg_pen_wage= average earnings in the last 60 months b) “Early pension” = The pension is reduced by 4% for each year that the pension is taken before the normal pensionable age. Minimum: $ 130 Maximum: $ 270 Constant-attendance supplement: A monthly amount is paid equal to the minimum wage (US$ 157.7).

All nominal variables are adjusted by the CPI.

Uruguay

Law 16713 (Passed in 1995)

Individual Account

Source of funds:

$$0.15 * \text{AC}; \text{where AC} = \begin{cases} \text{wage - US\$ 724}; & \text{if US\$ 724} \leq \text{wage} \leq US\$\ 1{,}449 \\ US\$ 1{,}449 - US\$ 724; & \text{if wage} > US\$\ 1{,}449 \end{cases}$$

Qualifying Conditions:
a) "Ordinary": Age 60 with 35 years of service
b) "Advanced Age": Age 70 with 15 years of service, and the individual doesn't have any pension.

Benefits:
a) "Ordinary" = individual account annuity.
b) "Advanced Age" = individual account annuity.

PAYG

Source of funds:

$$(0.075 + 0.15) * \text{AC}; \text{ where } \text{AC} = \begin{cases} \text{wage}; & \text{if wage} \leq US\$\ 724 \\ US\$\ 724; & \text{if wage} > US\$\ 724 \end{cases}$$

Qualifying Conditions:
a) "Ordinary": Age 60 with 35 years of service
b) "Advanced Age": Age 70 with 15 years of service

Benefits:
a) "Ordinary" = average wages * rr,
Where: rr = 0.5 + 0.005*(contributing years exceeding 35, max 2,5%) + 0.02*(years of postponing retirement after 60 if pension right wasn't configured yet, max 20%) + 0.03*(years of postponing retirement after 60, max 30%); and
average wages = average of the best 20*12 wages or average of the last 10*12 wages, whichever is greater.
b) "Advanced Age" = average wages * rr; where rr = 0,5 +0.01* (contributing years exceeding 15, max 14%)

Minimum: US$ 80
Maximum: US$ 598

Workers whose first wages lie below the US$ 724 threshold may opt to split their insured contributions by halves between the individual account and the PAYG pillars. Opting workers receive a special bonus of 50% of their PAYG pension.
The nominal amounts are updated using the average wage index.

Uruguay(Cont.)

Law 16713 Plus Amendments Passed between 1995 and 2008

Individual Account

Source of funds:

$$0.15 * \text{AC; where AC} = \begin{cases} \text{wage - US\$ 724; if US\$ 724} \leq \text{wage} \leq US\$\ 1{,}449 \\ US\$1{,}449 - US\$\,724;\ if\ \ wage > US\$\ 1{,}449 \end{cases}$$

Qualifying Conditions:
a) "Ordinary": Age 60 with 30 years of service
b) "Advanced Age": Age 65, and the individual does not have any pension.

Benefits:
a) "Ordinary" = individual account annuity.
b) "Advanced Age" = individual account annuity

PAYG

Source of funds:

$$(0.075 + 0.15) * \text{AC; where AC} = \begin{cases} \text{wage; if wage} \leq US\$\ 724 \\ US\$\ 724; \text{ if wage} > US\$\ 724 \end{cases}$$

Qualifying Conditions:
a) "Ordinary": Age 60 with 30 years of service
b) "Advanced Age": Age 70 with 15 years of service, or 69 and 17, or 68 and 19, or 67 and 21, or 66 and 23, or 65 and 25, and the individual does not have any pension.

Benefits:
a) "Ordinary" = average wages*rr;
Where: rr = 0,45 + 0,01*(contributing years exceeding 30, max 5%) + 0,005*(contributing years exceeding 35 when pension right is configured, max 2,5%) + 0,02 * (years of postponing retirement after 60 if contributing years are lower than 35, max 20%) + 0.03 * (years of postponing retirement after 60 if contributing years are higher than 35, max 30%); and
average wages = average of the best 20*12 wages or average of the last 10*12 wages, whichever is greater.
b) "Advanced Age" = average wages*rr;
Where: rr= 0,5 +0.01*(contributing years exceeding X, max 14%), and X=years of service required according to age.

Minimum: US$ 80
Maximum: US$ 598

Workers whose first wages lie below the US$ 724 threshold may opt to split their insured contributions by halves between the individual account and the PAYG pillars. Opting workers receive a special bonus of 50% of their PAYG pension.

The nominal amounts are updated using the average wage index.

Venezuela

PAYG

Source of Funds:

Insured person: 1.93% of gross earnings

Employer: 4.82% of payroll

Government: 1.5%

Ceiling= five times the minimum urban wage

There is no floor.

Qualifying Conditions:

a) “Ordinary” = Age 60 with 15 years of service

b) “Old-Age Grant”= 2 whole years of contribution in the last 4 years

Benefits:

a) “Ordinary” = US$ 138 + 0.3*avg_pen_wage + 0.01* avg_pen_wage* (years of contribution exceeding 15).

Where: avg_pen_wage= average earnings in the last five years or the average in the best five of the last 10 years, whichever is greater.

An additional 5% of the pension is paid for each year the pension is deferred after the pensionable age.

b) “Old-age grant” = 10% of the insured’s total covered earning.

Min: 40% of avg_pen_wage

Note: All nominal variables are adjusted by the CPI.

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Summary Findings

We present a new database of social security indicators for eleven Latin American countries designed to assess pension schemes in terms of the payments they promise in return to contributions. Based on this data, we analyze inequality, insurance and incentives to work, using the replacement rates and the internal rates of return implicit in the flows of contributions and pensions. Our results indicate that most programs analyzed are progressive in the sense that, other things equal, they yield higher returns to low than to high income workers. Poor workers, notwithstanding, often have flat age-earnings profiles and lower life expectancy, both of which reduce the rates of return received from social security. The Argentinean and (the pre-2008) Uruguayan programs severely punish short contribution careers, providing strong incentives for workers in the programs to continue contributing until they reach minimums that vary between 30 and 35 years of contributions. The counterpart is that these programs do not hedge workers against the risk of having short working careers; quite the opposite, they raise the uncertainty workers face. The very low rates of return that the Argentinean and Uruguayan main pension programs pay to workers with short working careers are likely to impact strongly on low income workers, as the probability they experience interruptions is higher. The Brazilian, Chilean and Mexican programs show a better balance between insurance against the risk of short working careers and incentives to work. The defined benefit programs of Argentina, Ecuador and Uruguay strongly discourage early retirement; the Chilean and Mexican programs are more neutral. Argentina, Chile and Uruguay passed reforms to their main pension programs in 2008. Unlike the Argentinean reform, the Chilean and Uruguayan 2008 reforms strengthened the social protection that programs provide, shifting the balance towards more insurance and less incentives to work.

HUMAN DEVELOPMENT NETWORK