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Demographic Changes in Latin America—The Good, the Bad and …

by Santiago Acosta-Ormaechea, Marco Espinosa-Vega and Diego Wachs

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Demographic Changes in Latin America—The Good, the Bad and …[1]

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Abstract

The paper develops a simple, integrated methodology to project public pension cash flows and healthcare spending over the long term. We illustrate its features by applying it to the LAC5 (Argentina, Brazil, Chile, Colombia and Mexico), where public spending pressures are expected to increase significantly over 2015-50 due to demographic trends and rising healthcare costs. We simulate alternative pension reforms, including the transition from a defined benefit to a defined contribution pension system and the fiscal burden of a minimum guaranteed pension under the latter. We also analyze public healthcare outlays in the LAC5, which is likewise expected to increase significantly over 2015-50 due to aging and the so-called excess cost growth factor of healthcare services, showing that curbing the evolution of the latter (e.g., through enhanced competition in the healthcare sector) could aid in containing spending pressures. Despite its simplicity, the methodology yields projections that compare well with other approaches. It therefore provides a good benchmark for assessing alternative reform scenarios, particularly in data-constrained countries.

JEL Classification Numbers: H51; H55; H68

Keywords: public pension spending, public healthcare spending, aging, pension system reforms.

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I. INTRODUCTION

Increases in life expectancy over the last decades have been GOOD for societies' wellbeing. Rising income levels, technological advances in medicine, and increases in public healthcare systems' coverage, have all contributed to a longer life span and better health for the average citizen in emerging and advanced economies. For example, the average life expectancy at birth for the five Latin-American economies analyzed in this paper (LAC5: Argentina, Brazil, Chile, Colombia and Mexico) increased from 58 years in 1960 to 76 years in 2014 (Saad, 2009).[2]

However, there is a BAD aspect of this increase in life expectancy when combined with the ongoing reductions in fertility rates (which decreased from 5.6 children per woman in 1960 to 2.0 in 2014 for the LAC5): public finance pressures. Public pension systems have generally been designed at times when the ratio of working to pension age population was particularly benign—a large contributing base with a significantly smaller beneficiary population. However, the ongoing demographic changes have resulted in growing old-age dependency ratios with a concomitant increase in public pension spending. Moreover, the costs associated with the development of new healthcare technologies, tapped intensively by older cohorts, are also adding substantial pressures to the public coffers.

The public finance pressures associated with these demographic trends can become unpleasant for some countries, in the absence of prompt measures to correct pension and healthcare funding gaps, given the typical long lags associated with reforms to social security systems.

In this paper we develop an integrated methodology to project long-term public pension cash flows and healthcare spending, which we illustrate by applying it to the LAC5. To this end, we first estimate pension funding (from workers' contributions) and pension and healthcare expenditures under a baseline scenario, namely one with no policy changes. An important contribution of the paper is the development of a user-friendly toolkit to estimate the fiscal implications of alternative reforms in both defined benefits (DB) and defined contribution (DC) pension systems, including the assessment of the fiscal cost of a minimum guaranteed pension under the latter. The toolkit also allows to quantify the fiscal implications of a migration from a DB to a DC system, and the effects on the government budget of a stylized public healthcare system reform.

Turning to our illustrative results, we show that among the LAC5, the negative impact of demographic changes on the public pension system will be most pronounced in Argentina and Brazil—both have maintained their defined-benefit pay-as-you-go (PAYGO) systems. We then discuss how alternative parametric reforms can mitigate these negative spending trends. We find that, in the absence of significant increases in pension contributions, countries will have to rely on increases in the retirement age and reductions in the indexation of benefits (among the most effective cost cutting measures) to mitigate public pension liabilities.

Healthcare spending is also expected to grow substantially in all these countries; the result of aging and the associated healthcare expense growth—resulting from technological innovation in

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[2] Figures represent unweighted averages and are taken from World Banks' World Development Indicators Dataset available at: http://data.worldbank.org/indicator/SP.DYN.LE00.IN

healthcare outpacing output per capita growth—the so-called excess growth factor. We also show how reforms that can help curb the excess growth factor (e.g., enhanced competition in the healthcare sector) could aid in containing healthcare spending.

Finally, we compare the projections produced by our methodology with those of the International Monetary Fund's Fiscal Affairs and the Western Hemisphere Departments (IMF, 2016; IMF, 2017). We show that our methodology is versatile enough to incorporate country-specific features and can be applied to a broad set of countries, providing adequate ballpark estimates of age-related public spending that can help shade light on emerging fiscal vulnerabilities with relatively low data requirements. However, our approach does not replace the need for more granular, country-specific analysis to choose among alternative social security system reforms.

The rest of the paper is organized as follows. Section II presents a pension primer, Section III discusses demographic trends in the LAC5 and Section IV provides an overview of our proposed methodology. Then, Section V discusses key stylized facts about pension systems in the LAC5 and summarizes our main results on pensions. Likewise, Section VI introduces key stylized facts about healthcare systems in the LAC5 and summarizes our main results on healthcare. Section VII compares our projections with those currently available at the IMF and, finally, Section VIII provides concluding remarks.[3]

II. BACKGROUND—A PENSION SYSTEM PRIMER

A key distinction across social security systems is between "pay-as-you-go" (PAYGO) systems and "fully funded" systems. Under a PAYGO system, the pool of current workers' contributions is used to fund the benefits to current retirees.[4] Under a fully funded system, the contributions of current workers are used to purchase assets, and the accumulated stock and return on these assets are used to pay the future social security benefits of the individual workers who made those contributions.

Another relevant distinction is the relationship between the amount of a worker's current social security contributions and the amount of the same worker's future social security benefits. Under a defined contribution system (DC), a worker's contributions are used to purchase assets, and the worker's pension benefits depend on the stock of the accumulated assets and the rate of return. Under a defined benefit system (DB), the social security benefits paid to a retired worker are determined by a fixed formula based on factors like the total contributions to the system, the total number of years worked, the pension base which is based on the salary during the last few years before retirement, the age at retirement, etc. Workers' social security contributions may be used to purchase assets or to finance direct transfers to retirees, but in either case the workers' retirement benefits do not depend on the accumulated stocks and returns on any asset, but rather on a pre-defined benefit.

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[3] A discussion on how demographic uncertainty affects our projections and a detailed description of our methodology to undertake public pension and healthcare projections are left to the appendix.

[4] The pooling process of current contributions could be carried out by government agencies or pension funds where contributions are accumulated over time.

A public DB system gives rise to significant risks to be borne by the government, which usually finances the future benefits out of the revenue from current social contributions and other taxes, elements which depend on future economic conditions and demographic trends. If the promised benefits turn out to be larger than the amount received in the form of social contributions, then the government has to obtain supplementary funds through borrowing, an increase in taxes or through reallocations of government budgeted expenses from other uses. Under a funded DC system, the uncertainty about the future benefits (a function of individual contributions, economic conditions and realized returns) is instead directly borne by the individual worker.

Historically, PAYGO social security systems have featured DB, and fully funded systems have usually featured DC. However, other combinations are possible. Under a PAYGO DC the benefits associated with a worker's current contributions could be directly linked to the savings in the so-called notional accounts, allowing the level of benefits to vary with the country's economic performance and its demographic changes. Also, a pension system could be a DC/DB hybrid, whereby the government could specify a minimum benefit for a subset of workers and/or beneficiaries for a particular pillar, and cover any shortfall in the accrued benefits of pensioners as needed.

Pension systems can also be either privately or publicly managed. In practice, most PAYGO systems are publicly managed whereas most funded systems are privately managed. A pension system can also consist of multiple pillars, of which usually only one is mandatory, and the rest constitute voluntary saving options to increase future pension benefits and economy-wide savings (World Bank, 2006).

Although the paper focuses on five Latin-American countries, our sample contains a diverse structure of pension systems. Two of them (Argentina and Brazil) feature a pure DB system, two of them feature a full DB–DC transition (Chile and Mexico), while the last one features a hybrid system with a DB and DC structure that coexist (Colombia).

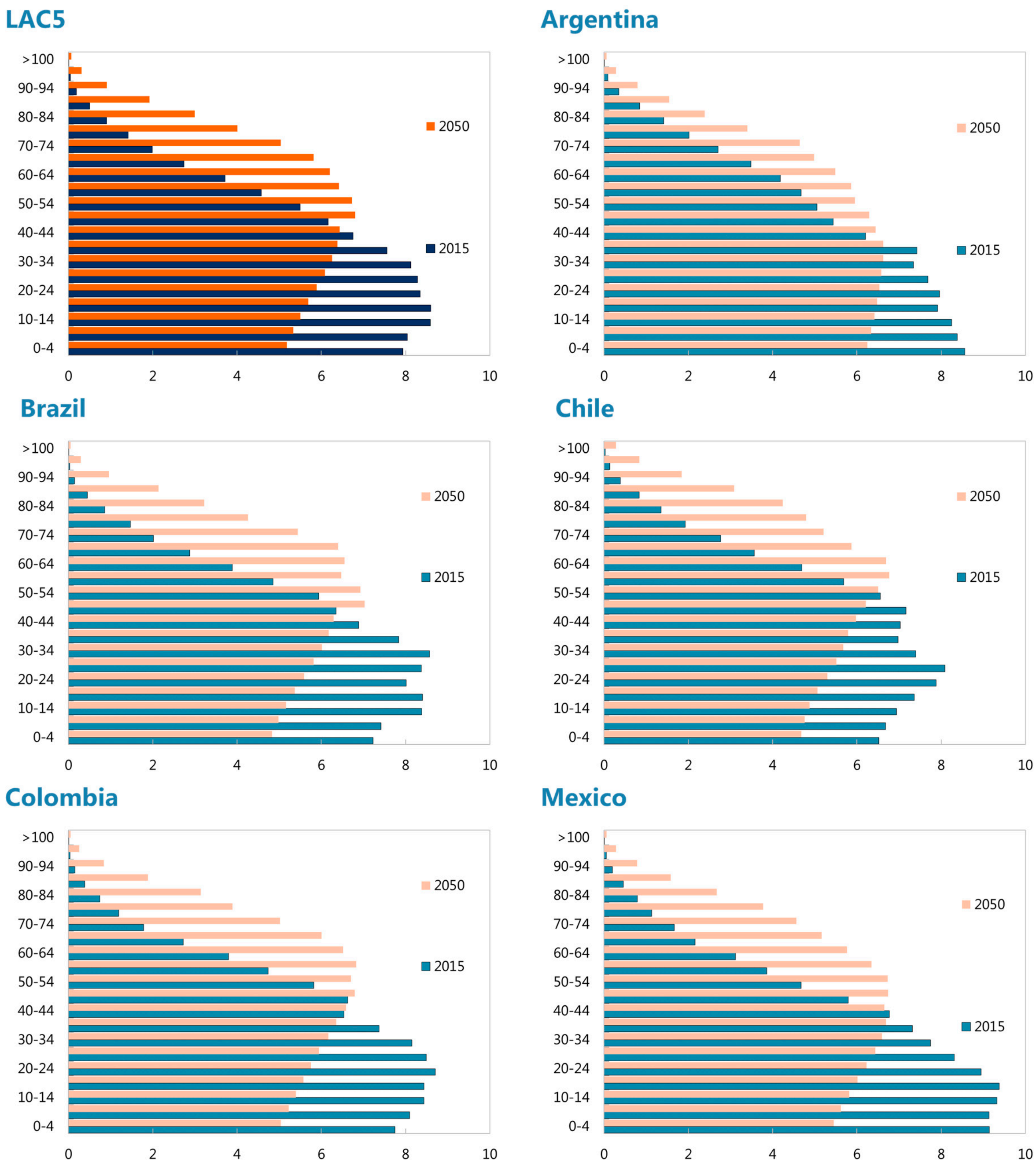
III. Background—Demographic trends

Demographic trends in the LAC5 are likely to experience significant shifts over the medium term: falling fertility rates and rising life expectancy (Figure 1). As the population distribution transitions from high to low levels of fertility and mortality rates, a country can enjoy the so-called 'demographic dividend' (Bloom, Sevilla, & Canning, 2003), i.e., the result of a temporary, proportionately higher labor force growth relative to the growth of the economically-dependent population.

However, as the process continues, falling fertility rates may impact negatively on the future growth of the labor force. Moreover, advances in medical technologies reduce the mortality rate of old-age cohorts and cause a shift to an older-age population distribution, contributing to sovereign pension and health spending pressures over time (Mason & Lee, 2006).

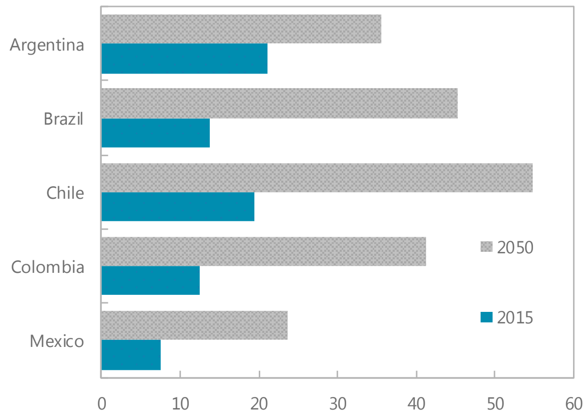
Factors that can limit these effects include households' behavioral responses such as: increases in labor force participation, savings rates and human capital investment. Policy reforms could include the creation of incentives to raise labor force participation, by promoting better health and female participation, and increasing the retirement age (Bloom, Canning, & Fink, 2010). In the absence of prompt action on these fronts, the ratio of beneficiaries to contributors, which broadly measures pressures on the economically active population, will likely increase substantially. This fact is broadly captured by the increase in the old-age dependency ratio illustrated in Figure 2.

Figure 1. Changes in Population Distributions between 2015-50
(percent of total population)



Source: Staff calculations based on UN World Population Prospects, 2015 Revision, medium fertility variant

Figure 2. Old-age dependency ratios[5]
(percent)



Source: Staff calculations based on UN World Population Prospects, 2015 Revision, medium fertility variant

IV. An Integrated Methodology to Assess Public Pensions Cash Flows and Healthcare Spending

The projections presented in this section are obtained through a newly-developed and standardized methodology (Appendix 1). This methodology is available in a companion Excel-based toolkit to project public pension system cash flows and healthcare system spending. In addition to old-age pensioners, our methodology also considers survivors and disabled pensioners.[6] The toolkit is highly stylized, a necessary condition for it to remain simple, yet it provides flexibility to assess different country-specific needs. In fact, the toolkit can be applied to diverse countries with varied pension and healthcare systems.

We acknowledge that more detailed and complex models may produce more accurate results, particularly over the short run. However, a larger set of variables at the projection stage adds complexity and uncertainty, lessening the advantages of data-intensive models over the longer run relative to those that require fewer variables to project—a problem known as data overfitting (Goldstein & Gigerenzerb, 2009; Miller & Castanheira, 2013). Since our goal is mostly to assess long-term trends, our simplified approach suffices for our purposes. Moreover, we show that our projections compare well with other approaches used at the IMF (Section VII).

A key advantage is that our approach allows users to model government's pension-related cash flows under either a DB or DC system, or a transition from the former to the latter, through a fully integrated toolkit that allows users to consider either systems. Calculations are performed on the basis of the following data inputs and assumptions.

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[5] The old-age dependency ratio is calculated as the fraction of population aged 65 + years over working-age population (defined as economically active population (between 20 years and the retirement age).

[6] Other pensioners, such as non-contributory, can also be included to match any specific value of total spending observed in each particular country.

(continued…)

The first building block for our analysis is the *medium fertility variant* of the United Nation's (UN) total population projections on annual basis divided by five-year age groups.[7] Total pension beneficiaries and contributors under a DB or DC scheme are then calculated using population projections, labor force participation rates, the size of the formal sector and disability and survivor rates. Disability and survivor rates, labor force participation rates, the size of the formal sector and contribution rates under the DC and DB systems (when applicable) are assumed to remain constant at the latest known value, unless a particular reform affecting either of these parameters is to be analyzed (see Appendix for details).[8]

Pension benefits and contributions under a DB system are calculated using the average wage and the replacement rate. The replacement rate for new pensioners is assumed to stay constant at the latest known value, while the average wage evolves in line with nominal GDP. However, for current pensioners, their average pension to the average wage ratio (i.e., the benefits ratio, a measure akin to the replacement rate), could change with pension benefits' indexation (see below).

The inflation rate (assumed equal to the GDP deflator) and real GDP per capita growth are assumed constant from 2020 onwards at the average of 2016-20.[9] In the no-policy change scenario the age and gender patterns of employment remains the same over the projection period, thereby assuming an average age of retirement across genders fixed at each country's current level.[10] The indexation of pension benefits at the individual level is tied to the inflation rate, the growth rate of the average nominal wage, or any arbitrary indexation parameter depending on country-specific rules[11]. In the no-policy change scenario, existing individual pensions are indexed to the CPI inflation rate, an assumption that is relaxed in one of the reform scenarios presented below.

To estimate government's expenditures under a DC scheme, it is also assumed that the income shares of the different population quintiles stay constant throughout the projection horizon.[12] The

[7] Available at: https://esa.un.org/unpd/wpp/Download/Standard/Population/

[8] The size of the formal sector is defined as the share of employees contributing to the pension system.

[9] Macroeconomic data are obtained from IMF's World Economic Outlook but, to obtain GDP per capita figures, UN population projections are also used for consistency with our demographic variables.

[10] In case of differing official retirement ages for male and female we take the average.

[11] There are many alternative indexation reforms to the more standard reform analyzed in the paper. For instance, in the case of Brazil, although pension benefits are indexed to inflation, these cannot be below the minimum wage (Karpowicz & Mulas Granados, 2016). However, analysis of more intricate indexation schemes requires assumptions about income distribution by cohorts of pensioners, making our toolkit extremely complicated, detracting from its simplicity and broad application. For simplicity, we assume that indexation in the case of Brazil is only to inflation (but the user could modify the toolkit to tailor alternative indexing reforms).

[12] An interesting extension would be to relax the assumption of constant income shares, as these may change over time, including through policies associated with the social security systems analyzed here.

(continued…)

minimum pension is assumed to evolve in line with wages.[13] Life expectancy after retirement and the average number of contributions per year are also assumed to stay constant at the latest country-specific value. The return of paid contributions under a DC scheme is assumed to equal an implied interest rate obtained from a combination of a fixed discount factor and GDP growth, which may change over time (see Appendix for details).

Healthcare costs account for a significant portion of age-related public spending. Key drivers include demographic dynamics (i.e., age-specific healthcare spending and the population age distribution), and the so-called excess cost growth factor. The latter is defined as the per capita real healthcare spending growth above per capita real GDP growth, after controlling for the effects of population growth. To a large extent, excess cost growth is driven by technological innovation in healthcare, but reflects also institutional factors and healthcare policies (Clements, Coady, & Gupta, 2012).[14]

The aim of Section VI. below is to summarize the projections of pension cash flows under a no-policy change scenario beyond recently implemented legislatives. These projections are the basis for the analysis of alternative reform scenarios. We then discuss results for healthcare spending projections under a no-policy change and reform scenarios.

V. Key Stylized Facts About Pension Systems in LAC5

This section introduces some country-specific LAC5 pension features to better tailor our projections, which are discussed in the next sections.

Argentina and Brazil are the only two countries among the LAC5 where the only mandatory pillar of the system is a PAYGO DB public scheme. In 2007, Argentina launched *Moratoria Provisional* a program that allowed workers over the statutory retirement age, who had not met the minimum required pension contributions, to pay their outstanding payments—to be deducted from their accrued pension benefits—in order to be eligible to obtain their corresponding pension. The budget implications of this reform are subsumed in what we call other beneficiaries (including non-contributory) in our toolkit, as explained in the Appendix. A reform to switch to a

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[13] This assumption may not represent well the Brazilian case, since the minimum pension grows in line with the minimum wage in that country (which is indexed to previous year CPI and real GDP from two years before, Domit, et al., (2016). For simplicity and consistency with the other cases, we assume that the minimum pension in Brazil is indexed to the average wage (which given our assumptions, grows in line with GDP). According to our estimations results would be about the same under these alternative indexation rules.

[14] We do not account for the so-called demographic dividend from a healthy economically active aging population, which may involve a positive relationship between health status and longevity gains: a healthy aging would lower the average cost per individual in older-age groups. To the extent that this is not incorporated in the model, healthcare spending projections might be upward biased. This is an important extension left for future research, which could build on Maisonneuve and Oliveira Martins (2014).

(continued…)

DC system was introduced in Argentina in 1994, but it was reversed in 2008, when the system returned to the DB scheme that was in place before the 1994 reform.

In the case of Brazil, pension reforms have focused on strengthening the redistributive characteristics of the system and the gradual creation of a complimentary pillar: voluntary pension saving accounts (ABRAPP, 2014). Brazil's compulsory PAYGO DB pension system consists of separate sub-schemes for private sector workers and civil servants, but for simplicity we analyze them together. Given the fiscal pressures of the pension system, the country has recently introduced a number of legislated reforms (1999, 2003, 2012 and 2015) to reduce the generosity of the scheme both in the short and long run. Because of this, we consider a no-policy reform scenario in which the most recent reforms are partially implemented along the lines of Miller and Castanheira (2013) (for instance, to account for the effects of the 2015 reform which modified the benefit formula to provide incentives for a delay in retirement, we set the retirement age to 60).[15]

In Chile the reform switching from a PAYGO DB to a fully-funded DC scheme was introduced in 1980—the implementation started in 1981. However, when the reform took place the cohorts who contributed to the DB system in the previous five years were allowed to choose between the DC and the DB systems, and were granted "recognition bonds" in case they switched to the new DC system (Arenas de Mesa, Benavides, Castillo, & Gonzáles, 2009). In this context, we then assume in our projections that the first contributing cohort to the DC system is that of 1976, which then retires after 40 years in 2016. Individuals who contributed to the previous DB system before 1976 were not switched to the new DC system, implying the need to account for the coexistence of both systems throughout the whole projection period. In 2008 another reform took place in Chile aiming at reducing poverty through the introduction of a "solidarity pillar" targeted at the poorest 60 percent of the population. The goal was to finance the benefits of those who never contributed, or those whose contributions were "too low" to result in a minimum pension (Berstein, 2010), a fact that needs to be accounted for when doing the projections.

In 1997, Mexico undertook a pension reform introducing a defined contribution system (OECD, 2016b). Active workers, at the time of the reform, had the option to receive pension benefits under the prevailing DB or the new DC scheme, upon retirement. For simplicity, we assume that the first pensioners under the new DC scheme will start retiring at age of 65 (entering the labor market at the age of 20 and after 45 years of contributions). In addition, we also assume that all pension system participants who contributed to the old DB scheme remain in that system, and that only new cohorts enter the new DC scheme, along the lines of what is assumed in the Chilean case. In addition, to deal with old-age poverty, Mexico introduced *Pension Universal* in 2015. Under this program, retirees 65 years of age or older could be entitled to a minimum guaranteed pension (MGP) (IMSS, 2016). We thus tailor our template to the specific cases of

[15] In fact, these authors consider only a partially-implement reform scenario, since according to them the modeling of all the most recent rules introduced with the latest reforms would require information on wage distributions, a forecast of future life expectancy and predictions of the future minimum wage relative to the average wage, in combination with an assessment of contributors' behavioral responses to the new rules, all elements which are extremely cumbersome to estimate.

Mexico (and Chile), whereby pensioners belonging to the DC system whose accumulated savings do not provide enough funds to meet a monthly pension above a MGP threshold, will receive the later, even if the person has never contributed to the pensions system.

A major reform took place in Colombia in 1993, aiming at replacing the fragmented, inefficient DB system with a public DB and a private DC. The reform allowed the population with at least 15 years of contributions in 1994 to stay in the old DB scheme, whereas the rest of the labor force, as well as the new cohorts entering the labor market, had to choose between the new public DB and the new private DC schemes (OECD, 2016a). Since the old DB system was more generous than the current one, we assume that those entitled to stay in the old system choose to do so. Therefore, since the last cohort in the labor force that was entitled to stay in the old DB system paid its first contribution in 1979, we assume that the effective year of the reform is 1978. This means that individuals who entered the labor market after 1978 had to choose between the two new DB and DC pension schemes. Then, to divide contributors between the two new systems we use the fraction of contributors below the age of 35 that choose either the public or the private system.[16] Contributors may switch between schemes every five years up until 10 years before retirement, but for simplicity we disregard this aspect of the system.

In contrast with Mexico and Chile, where every retiree is entitled to a MGP even if the person has never contributed to the system, in Colombia, under their private account regimes, a person that has never contributed will not be entitled to a government pension (Asofondos, 2016). Thus, our template does not need to be tailored in this case, since we do not need to account for any additional spending.

A. Pensions Baseline Results

This section presents the baseline estimation for the LAC5's public pension cash flow projections over the long term, based on the methodology we develop in detail in the Appendix. According to this methodology, between 2015-50 Argentina and Brazil's net cash flows are projected to worsen to close -4 and -22 percent of GDP, respectively, on the back of the demographic changes. For the other LAC5, the balance is projected to stay constant or even improve (Table 1).

It is worth noting that revenues are expected to grow continuously in Argentina, while exhibiting an inverted U-shape in Brazil. As shown in the Appendix, this concavity is due the dynamics of the working-age population. Colombia, with its hybrid DC/DB system, exhibits constant revenue flows as share to GDP during the projection period. In the case of pure DC systems, these elements are not relevant. Thus, revenue flows as share to GDP are either negligible for Chile, since the system was introduced a while ago, or showing a declining trend in the case of Mexico, as the transition to the DC system is completed.

[16] We assume that these values amount to 10 and 90 percent, respectively, which are the proportion of the pension system participants below the age of 35 affilliated with the public and private pension schemes in 2013, respectively.

Table 1. Baseline pension cash flow projections
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050	PDV 2015 - 2050
				Argentina			
revenue (pension contributions)	4.8	5.1	5.6	5.9	6.1	1.2	168.6
spending (pension benefits)	7.8	7.9	8.6	10.7	12.9	5.0	286.2
balance	-3.0	-2.8	-3.0	-4.8	-6.8	-3.8	-117.6
				Brazil			
revenue (pension contributions)	8.0	8.4	8.7	8.6	8.1	0.1	258.6
spending (pension benefits)	11.2	13.5	19.5	26.2	33.4	22.2	634.6
balance	-3.2	-5.1	-10.7	-17.5	-25.3	-22.1	-376.1
				Chile			
revenue (pension contributions)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
spending (pension benefits)[1]	3.6	3.0	2.6	3.0	3.8	0.2	91.9
balance	-3.6	-3.0	-2.6	-3.0	-3.8	-0.2	-91.9
				Colombia			
revenue (pension contributions)	0.2	0.2	0.2	0.2	0.2	0.0	5.7
spending (pension benefits)[1]	5.1	4.5	3.1	2.7	3.0	-2.1	105.3
balance	-4.8	-4.3	-2.9	-2.5	-2.8	2.1	-99.6
				Mexico			
revenue (pension contributions)	0.4	0.3	0.2	0.0	0.0	-0.4	5.3
spending (pension benefits)[1]	1.7	1.9	2.6	3.9	3.0	1.4	83.3
balance	-1.3	-1.5	-2.4	-3.9	-3.0	-1.7	-78.0
revenue average change						0.2	
spending average change						5.3	
balance average change						-5.2	

1/ Includes DB spending and DC government liability given by to the minimum guaranteed pension payments
Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

Nevertheless, in all cases even where there is no projected worsening of the balance over time, the present discounted value (PDV) of the system's cash flows throughout the projection horizon is negative and substantial.[17] Thus, these pension systems still involve substantial pressures on the budget over time, a fact that may require a careful assessment of alternative reform scenarios.

B. Pensions Reform Scenarios

The significant increase of public pension spending in countries with DB systems and aging societies will require reforms to guarantee the sustainability of their pension systems. Avoiding corrective measures or postponing them could jeopardize substantially public finances over the

[17] PDV calculations assume that the discount factor remains constant throughout the projection horizon. We follow the related literature and set the discount factor at 1 percent (see Appendix for details).

medium term. The significant lags involved in the introduction of these measures and the need to legislate and implement them, calls for a timely assessment of plausible reform alternatives.

Possible reforms include policies that affect the age distribution of the population (e.g., through incentives to increase fertility or immigration) and policies that directly modify the pension scheme itself.[18] Reforms aim at adjusting the scheme's 'parameters', include changes to the retirement age, the replacement rate and the contribution rate, without a complete overhaul of the system. Broader reforms affecting the design of the system, involve switching from a DB to a fully funded DC system or the introduction of individual accounts as an additional element of a system based mainly on the DB public scheme (Coudouel & Paternostro, 2006).

The reforms analyzed with our methodology take the population distribution as given, focusing initially on parametric reforms only. Specifically, the pension system reforms analyzed are the following: increase in the retirement age; indexation of the retirement age; decrease in the generosity of the pension system through a reduction in the replacement rate; reductions in the indexation of benefits; and increases in the contribution rate.

Moreover, an important contribution of our methodology is the possibility of analyzing the transition from a DB to a DC scheme, or the introduction of individual accounts to complement a DB system, and the fiscal burden of offering a minimum guaranteed pension under a DC system.

Increase in Retirement Age

One of the most popular pension reforms consists of increasing the retirement age. This reform improves the balance of the system by simultaneously affecting the number of contributors and beneficiaries. Specifically, the reform evaluated here consists of a onetime increase in the retirement age of the DB system by 5 years, assuming that the transition is spread out over 10 years, namely between 2016-25.[19] Results are presented in Table 2.

On average, the increase in the retirement age reduces pension spending in 2050 by 2.2 percent of GDP relative to the baseline scenario. The biggest reduction is observed in Brazil, amounting to 7.5 percent of GDP, followed by Argentina, yielding a reduction of 3 percent of GDP. The smaller improvements in the cases of Chile and Mexico are attributed to the shift to the DC schemes that these countries underwent—in these cases the DB expenditure amounts to a small

[18] A useful distinction between policies that affect demographics and labor market and policies that directly affect pension benefits can be found in Clements et. al (2015).

[19] An increase in the retirement age in a DC system will also lead to an increase in the number of years in which pension system participants contribute to their individual accounts, thereby increasing the annuities received after retirement. This in turn decreases government spending, since a lower number of beneficiaries will have annuities below the MGP. However, we disregard such effects and instead assume that the reform affects the retirement age only under DB systems because under DC systems the effects on the budget are difficult to quantify. A more comprehensive estimation would require, for instance, keeping track of those cohorts affected by the change in retirement age throughout the period in which the reform takes place, making it cumbersome to estimate the overall impact. Yet a back-of-the-envelope calculation suggests that expenditures in 2050 would be lower relative to those of Table 2 by 0.5, 0.6 and 0.1 percentage points of GDP for Chile, Colombia and Mexico respectively.

and falling fraction of GDP and the DC public expenditure is only connected with the government contribution to the minimum pension, which has a low value.

Table 2. A onetime increase in the retirement age by 5 years
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
revenue (baseline)	4.8	5.1	5.6	5.9	6.1	1.2
revenue (increase in retirement age)	4.8	5.3	6.0	6.5	6.7	1.9
spending (baseline)	7.8	7.9	8.6	10.7	12.9	5.0
spending (increase in retirement age)	7.8	6.8	6.5	7.8	9.9	2.1
			Brazil			
revenue (baseline)	8.0	8.4	8.7	8.6	8.1	0.1
revenue (increase in retirement age)	8.0	8.7	9.5	9.6	9.2	1.2
spending (baseline)	11.2	13.5	19.5	26.2	33.4	22.2
spending (increase in retirement age)	11.2	11.3	14.1	19.4	25.9	14.7
			Chile			
revenue (baseline)	0.0	0.0	0.0	0.0	0.0	0.0
revenue (increase in retirement age)	0.0	0.0	0.0	0.0	0.0	0.0
spending (baseline)	3.6	3.0	2.6	3.0	3.8	0.2
spending (increase in retirement age)	3.6	3.0	2.6	3.0	3.7	0.1
			Colombia			
revenue (baseline)	0.2	0.2	0.2	0.2	0.2	0.0
revenue (increase in retirement age)	0.2	0.2	0.2	0.2	0.2	0.0
spending (baseline)	5.1	4.5	3.1	2.7	3.0	-2.1
spending (increase in retirement age)	5.1	4.1	2.9	2.5	2.7	-2.3
			Mexico			
revenue (baseline)	0.4	0.3	0.2	0.0	0.0	-0.4
revenue (increase in retirement age)	0.4	0.4	0.3	0.1	0.0	-0.4
spending (baseline)	1.7	1.9	2.6	3.9	3.0	1.4
spending (increase in retirement age)	1.7	1.5	1.7	2.7	3.0	1.3

Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

Indexation of Retirement Age

The indexation of retirement age is another option to increase the retirement age on a more sustainable basis. In our scenario the reform starts in 2026 (during 2016-26 it remains at the current statutory level), and it involves automatic increases in the retirement age as population's life expectancy rises. Specifically, every year the retirement age is augmented by the increase in the average age of those retired. The effects of introducing this reform are presented in Table 3.

The average reduction of public pension expenditure amounted to 1.1 percent of GDP. Again, the largest gain from this reform is projected for Brazil at 4.2 percent of GDP. In contrast, for

Chile and Mexico there are almost no gains when introducing such reform. Since in this scenario the retirement age is increased by a smaller value and more gradually than the onetime increase evaluated previously, the gains in term of spending reductions are also more moderate.

Table 3. Indexation of retirement age
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
revenue (baseline)	4.8	5.1	5.6	5.9	6.1	1.2
revenue (indexation of retirement age)	4.8	5.1	5.6	6.0	6.3	1.4
spending (baseline)	7.8	7.9	8.6	10.7	12.9	5.0
spending (indexation of retirement age)	7.8	7.9	8.5	10.0	11.9	4.1
			Brazil			
revenue (baseline)	8.0	8.4	8.7	8.6	8.1	0.1
revenue (indexation of retirement age)	8.0	8.4	8.8	9.0	8.7	0.7
spending (baseline)	11.2	13.5	19.5	26.2	33.4	22.2
spending (indexation of retirement age)	11.2	13.5	18.9	23.7	29.2	18.0
			Chile			
revenue (baseline)	0.0	0.0	0.0	0.0	0.0	0.0
revenue (indexation of retirement age)	0.0	0.0	0.0	0.0	0.0	0.0
spending (baseline)	3.6	3.0	2.6	3.0	3.8	0.2
spending (indexation of retirement age)	3.6	3.0	2.6	3.0	3.8	0.2
			Colombia			
revenue (baseline)	0.2	0.2	0.2	0.2	0.2	0.0
revenue (indexation of retirement age)	0.2	0.2	0.2	0.2	0.2	0.0
spending (baseline)	5.1	4.5	3.1	2.7	3.0	-2.1
spending (indexation of retirement age)	5.1	4.5	3.1	2.6	2.8	-2.2
			Mexico			
revenue (baseline)	0.4	0.3	0.2	0.0	0.0	-0.4
revenue (indexation of retirement age)	0.4	0.3	0.2	0.0	0.0	-0.4
spending (baseline)	1.7	1.9	2.6	3.9	3.0	1.4
spending (indexation of retirement age)	1.7	1.9	2.5	3.5	3.0	1.4

Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

Reduction of Replacement Rate

Another possible reform to improve the cash flow of the pension system is to ratchet down the generosity of the system through a reduction in the replacement rate. For simplicity, we assume that in the DB scheme the average level of the pension benefit for new beneficiaries in the year of retirement is determined by the average wage multiplied by the replacement rate, which is constant through the projection horizon in the baseline. Thus, this reform assumes that the replacement rate is decreased in DB systems for new pensioners, namely that it falls by 0.5 percentage points every year for 10 consecutive years, i.e., from 2016 to 2025, so that from 2025 onwards its level is 5 percentage points lower than in the baseline scenario. Results are shown in Table 4. On average, the reduction of pension spending equals 0.7 percent of GDP.

Table 4. Reduction of replacement rate
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
spending (baseline)[1]	7.8	7.9	8.6	10.7	12.9	5.0
spending (reduction of replacement rate)	7.8	7.9	8.3	10.0	12.0	4.2
			Brazil			
spending (baseline)[1]	11.2	13.5	19.5	26.2	33.4	22.2
spending (reduction of replacement rate)	11.2	13.4	18.7	24.6	31.1	19.9
			Chile			
spending (baseline)[1]	3.6	3.0	2.6	3.0	3.8	0.2
spending (reduction of replacement rate)	3.6	3.0	2.6	3.0	3.8	0.2
			Colombia			
spending (baseline)[1]	5.1	4.5	3.1	2.7	3.0	-2.1
spending (reduction of replacement rate)	5.1	4.5	3.1	2.6	2.9	-2.2
			Mexico			
spending (baseline)[1]	1.7	1.9	2.6	3.9	3.0	1.4
spending (reduction of replacement rate)	1.7	1.8	2.3	3.2	2.5	0.9

1/ Revenue is not shown because in our template it is assume to be unaffected by this reform
Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

Reduction in the Indexation of Benefits

The dynamics of the average pension can be modified through changes in the indexation of benefits. In this exercise it is assumed that the indexation coefficient of individual pensions will decrease such that pensions of existing pensioners are indexed at fourth-fifths of the inflation rate of the period (the baseline assumed that pensions of existing pensioners are fully indexed to inflation). This reform is assumed to take place in 2016 and lasts until the end of the projection period. The effect of this reform is summarized in Table 5. The average reduction in pension spending equals 1.7 percent of GDP. As in the case of the other reforms, the more significant gains take place in Argentina and Brazil, whereas the gains for those countries with DC systems are rather moderate.

Table 5. Reduction in the indexation of benefits
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
spending (baseline)[1]	7.8	7.9	8.6	10.7	12.9	5.0
spending (reduction in the indexation of benefits)	7.8	7.0	6.7	8.1	9.6	1.7
			Brazil			
spending (baseline)[1]	11.2	13.5	19.5	26.2	33.4	22.2
spending (reduction in the indexation of benefits)	11.2	12.8	17.4	22.6	28.4	17.2
			Chile			
spending (baseline)[1]	3.6	3.0	2.6	3.0	3.8	0.2
spending (reduction in the indexation of benefits)	3.6	2.9	2.5	3.0	3.8	0.2
			Colombia			
spending (baseline)[1]	5.1	4.5	3.1	2.7	3.0	-2.1
spending (reduction in the indexation of benefits)	5.1	4.4	2.9	2.5	2.9	-2.2
			Mexico			
spending (baseline)[1]	1.7	1.9	2.6	3.9	3.0	1.4
spending (reduction in the indexation of benefits)	1.7	1.8	2.5	3.7	2.8	1.1

1/ Revenue is not shown because in our template it is assume to be unaffected by this reform
Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

Increase in Contribution Rate

Another way of improving the public pension balance is by increasing the contribution rate. In this exercise, the increase in the contribution rate is assumed to be permanent, takes place in 2016, and equals 1 percentage point.[20] The results of implementing such reform are shown in Table 6. By construction, for countries with a pure DB system the impact of the reform will be on the revenue side whereas for countries with a pure DC system the impact will be on the spending side.[21] As Table 6 shows, the effect is most significant for Argentina and Brazil, but rather small for Chile, Colombia and Mexico.

In addition to a onetime increase in contribution rates, we analyze a reform consisting of a self-correcting contribution formula to fend against underfunded PAYGO systems. This hypothetical

[20] Our calibration of a 1 percentage point increase in the contribution rate is roughly a third of the increase necessary to contain pension spending in a set of advanced economies absent changes in pension benefits or the retirement age, discussed in a relevant IMF policy paper (IMF, 2011, pp. 25-26). Political feasibility and other considerations such as the effects on the labor market would of course have to be taken into account when designing any specific reform on contribution rates.

[21] For countries that introduced a pure DC system, contributions are not part of government revenue, as these are allocated directly into individual accounts. However, the increase in contributions will rise the accumulated savings in individual accounts, thus reducing the number of beneficiaries which will end up with a pension (calculated as annuity) below the MGP. This in turn reduces public spending in the DC system as shown in Table 6.

contribution is explained in Furman (2007) and has been proposed for countries such as Germany. Accordingly, we calculate a dependency-indexed contribution that would vary proportionately with changes in the dependency ratio. This reform can be interpreted as the contribution rate required to close the pensions system underfunding such that it becomes fully balanced over time. These estimates are only done for countries with only PAYGO systems (i.e., Argentina and Brazil).

Table 6. Increase in contribution rate
(percent of GDP)

	2015	2020	2030	2040	2050	change 2015 - 2050
			Argentina			
revenue (baseline)	4.8	5.1	5.6	5.9	6.1	1.2
revenue (increase in contribution rate)	4.8	5.3	5.8	6.2	6.3	1.5
spending (baseline)	7.8	7.9	8.6	10.7	12.9	5.0
spending (increase in contribution rate)	7.8	7.9	8.6	10.7	12.9	5.0
			Brazil			
revenue (baseline)	8.0	8.4	8.7	8.6	8.1	0.1
revenue (increase in contribution rate)	8.0	8.7	9.0	8.9	8.4	0.4
spending (baseline)	11.2	13.5	19.5	26.2	33.4	22.2
spending (increase in contribution rate)	11.2	13.5	19.5	26.2	33.4	22.2
			Chile			
revenue (baseline)	0.0	0.0	0.0	0.0	0.0	0.0
revenue (increase in contribution rate)	0.0	0.0	0.0	0.0	0.0	0.0
spending (baseline)	3.6	3.0	2.6	3.0	3.8	0.2
spending (increase in contribution rate)	3.6	3.0	2.5	2.9	3.6	0.0
			Colombia			
revenue (baseline)	0.2	0.2	0.2	0.2	0.2	0.0
revenue (increase in contribution rate)	0.2	0.2	0.2	0.2	0.2	0.0
spending (baseline)	5.1	4.5	3.1	2.7	3.0	-2.1
spending (increase in contribution rate)	5.1	4.5	3.1	2.7	2.9	-2.1
			Mexico			
revenue (baseline)	0.4	0.3	0.2	0.0	0.0	-0.4
revenue (increase in contribution rate)	0.4	0.4	0.2	0.0	0.0	-0.4
spending (baseline)	1.7	1.9	2.6	3.9	3.0	1.4
spending (increase in contribution rate)	1.7	1.9	2.6	3.9	3.0	1.3

Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

As shown in table 7, relying *exclusively* on this reform would require an unfeasible increase in contributions. For instance, to achieve a pension system balance in 2015, the contribution rates in Argentina and Brazil would have to increase from 21 and 28 percent, respectively, to 39 and 34 percent of their average wage. As the old age dependency ratio increases over time, contribution rates would need to increase in both countries, reaching 45 and 115 percent of average wage in Argentina and Brazil, respectively, by 2050.

Table 7. Dependency indexed contribution rate
(percent of average wage)

	2015	2020	2030	2040	2050	increase 2015 - 2050
	Dependency indexed contribution rate					
Argentina	34	33	33	38	45	11
Brazil	39	45	62	85	115	76

Source: Staff calculations.

Cumulative Impact of Introducing All Reforms Simultaneously

In this section, we contrast the cumulative effect of piecemeal parametric reforms, against their simultaneous adoption (Table 8).[22] (As expected, the impact is especially large in those countries that did not switch from a DB to a DC system, namely Argentina and Brazil). Importantly, the net impact of these two experiments may differ because, by interacting with each other, some policies may offset or reinforce each other. We report this difference under the category of 'second-round effects' (Table 8).[23]

For example, the effects of a onetime increase in the retirement age and the impact of a reduction in the indexation of benefits, are quite substantial for those countries with a pure DB system. The decrease in the level of expenditure in 2050 relative to 2015 amounts to, accordingly, 3.0 and 3.3 percent of GDP in the case of Argentina and 7.5 and 5.0 percent of GDP in the case of Brazil. The sum of these two reforms equals 6.3 for Argentina and 12.5 percent of GDP for Brazil. However, under our methodology, when these two reforms are introduced simultaneously, the cumulative impact equals to only 5.5 and 11.3 percent GDP, respectively. The reason is that when the increase in the retirement age reform is introduced, there is a smaller number of pension system participants obtaining a pension benefit at each point in time (since workers stay longer in the labor market). Therefore, the introduction of the reform on the reduction in the indexation of benefits affects a smaller number of pensioners relative to the baseline, implying that the total effect on pension spending will be lower than what could have been achieved if the number of pensioners was not reduced by the concomitant retirement age reform.

[22] To be specific, the reforms that are introduced simultaneously are: (i) the increase in the retirement age; (ii) the indexation of the retirement age; (iii) reduction of replacement rate; (iv) the reduction in the indexation of benefits; and (v) a onetime increase in the contribution rate.

[23] The opposite is also possible. The effect of an increase in the contribution rate over the revenues will be boosted if the retiring age is increased at the same time.

Table 8. Introduction of all reforms simultaneously
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
spending (baseline)	7.8	7.9	8.6	10.7	12.9	5.0
spending (all reforms)	7.8	6.1	4.8	5.2	6.3	-1.5
sum of the impact of separate reforms						-8.1
second-round effects						1.5
			Brazil			
spending (baseline)	11.2	13.5	19.5	26.2	33.4	22.2
spending (all reforms)	11.2	10.7	11.6	14.4	17.7	6.5
sum of the impact of separate reforms						-19.0
second-round effects						3.3
			Chile			
spending (baseline)	3.6	3.0	2.6	3.0	3.8	0.2
spending (all reforms)	3.6	2.9	2.4	2.8	3.5	-0.1
sum of the impact of separate reforms						-0.1
second-round effects						-0.2
			Colombia			
spending (baseline)	5.1	4.5	3.1	2.7	3.0	-2.1
spending (all reforms)	5.1	4.0	2.7	2.3	2.5	-2.6
sum of the impact of separate reforms						-0.5
second-round effects						0.0
			Mexico			
spending (baseline)	1.7	1.9	2.6	3.9	3.0	1.4
spending (all reforms)	1.7	1.5	1.4	1.9	2.2	0.5
sum of the impact of separate reforms						-0.7
second-round effects						-0.1

Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

Transition from a PAYGO DB to a Funded DC System

Here we describe one of the main contributions of our analysis. Two main forces compel countries to migrate from PAYGO DB to funded DC systems: concerns about budgetary pressures arising from economic and demographic trends; and a desire to boost savings which might induce additional investment and eventually economic growth.

However, this reform presents challenges, particularly during the transition period. The biggest problem is how to finance the benefits to workers who have already retired or who will retire in the near future but belong to the old system. Our methodology allows us to assess key transition costs and the evolution of public sector cash flows once the DC system is fully in place.

Another challenge illustrated by recent protests in Chile (FT, 2016) is related to the fact that privately funded DC systems could result in low retirement benefits. In such cases, the government may feel compelled to step in and introduce a minimum pension guarantee. Our methodology also allows us to estimate the fiscal burden of alternative minimum pension guarantees.

The impact of the transition to a DC system can be illustrated with the examples of Brazil and Argentina, the only cases with a public PAYGO DB systems. Two variants are analyzed–a total shift to a private DC system and the introduction of a pension system where participants can choose between the DB and DC system, where the share that opts for each option can be calibrated.[24,25] Since the full impact of the total shift to a DC system on pension expenditure will take place only after the first cohorts who enter the new system start retiring, we extend the projection horizon until 2100. In both scenarios, we assume that the reform takes place in 2020. In the case of a full transition to a DC system, the new cohorts entering the labor market starting in 2020 will contribute only to the new funded private DC system; whereas in the partial transition fifty percent of newcomers to the labor market contribute to the old DB system while the remainder fraction contributes to the new DC system. When they start retiring in 2060, those participants of the new DC system get an annuity (i.e., their benefits) depending on the accumulated stock of contributions and the market rate of return.[26] Additionally, we assume that the contribution rate in the new DC system will be the same as in the old DB system for each country.

It can be seen that in the short run, balances of pension systems worsen, but the effect is temporary (Table 9). In the long run introducing a DC system, in either of the two variants presented above, has a positive and substantial impact on the sustainability of the pension system. Moreover, private savings increase as the total accumulated stock of funds in individual accounts increases over time, more than compensating the higher public sector pension deficit during the transition period.

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[24] The full-shift option is consistent with the reforms introduced in Chile and Mexico.

[25] A variant of a chosen share opting for a DC system is consistent with the reform introduced in Colombia.

[26] For this projections we assume that in order to access a MGP, any pension system participant should have contributed to the system (i.e., we rule out a non-contributory MGP). This is similar to the case of Colombia (see Section VI).

Table 9. Transition from a DB to a DC system
(percent of GDP)

	2015	2030	2050	2080	2100	increase 2015 - 2100	PDV 2015 - 2100
				Argentina			
				baseline			
spending	7.8	8.6	12.9	18.6	20.7	12.9	761.6
revenue	4.8	5.6	6.1	6.0	5.6	0.8	334.6
balance	-3.0	-3.0	-6.8	-12.6	-15.1	-12.1	-427.0
				partial shift			
spending	7.8	8.6	12.9	12.1	11.8	4.0	642.8
revenue	4.8	4.7	3.7	3.0	2.8	-2.0	223.4
balance	-3.0	-3.9	-9.2	-9.2	-9.0	-6.0	-419.4
Individual accounts total stock	0.0	2.6	21.2	55.7	69.2	69.2	1517.8
				total shift			
spending	7.8	8.6	12.9	5.7	2.9	-4.9	523.9
revenue	4.8	3.9	1.3	0.0	0.0	-4.8	112.1
balance	-3.0	-4.7	-11.6	-5.7	-2.9	0.1	-411.8
Individual accounts total stock	0.0	5.2	42.5	111.4	138.4	138.4	3035.5
				Brazil			
				baseline			
spending	11.2	19.5	33.4	43.8	42.4	31.2	1774.6
revenue	8.0	8.7	8.1	6.5	5.8	-2.2	449.6
balance	-3.2	-10.7	-25.3	-37.3	-36.6	-33.4	-1325.0
				partial shift			
spending	11.2	19.5	33.4	30.4	22.9	11.7	1523.9
revenue	8.0	7.5	5.0	3.3	2.9	-5.1	315.8
balance	-3.2	-12.0	-28.4	-27.2	-20.0	-16.8	-1208.1
Individual accounts total stock	0.0	3.9	29.0	67.8	67.8	67.8	1872.5
				total shift			
spending	11.2	19.5	33.4	17.0	3.4	-7.8	1273.3
revenue	8.0	6.3	1.9	0.0	0.0	-8.0	182.0
balance	-3.2	-13.2	-31.5	-17.0	-3.4	-0.3	-1091.2
Individual accounts total stock	0.0	7.8	58.0	135.7	135.6	135.6	3745.0

Source: Staff calculations.
Note: In the baseline, real GDP per capita growth, inflation and unemployment rates are assumed constant from 2020 onwards at the 2016-20 average as projected in WEO. The replacement rate for new pensioners is assumed to remain constant at the latest known value, while the average wage evolves in line with nominal GDP. See Section IV and the Appendix for details on the key assumptions and sources for the baseline projections.

VI. Key Stylized Facts About Healthcare Systems in LAC5

Healthcare services are provided by a combination of private and public subsystems in the LAC5 countries. However, our methodology focuses only on the public spending subcomponent. According to the World Bank, this subcomponent accounts from about 46 percent of total healthcare spending in Brazil to about 75 percent in Chile (World Bank, 2016).[27] Importantly, the majority of the population in the LAC5 countries relies on the public healthcare system, varying from 46 percent of total population in Argentina to close to 100 percent in Mexico (see Appendix II for details).

[27] The other LAC5 countries analyzed here are in between this range according to the World Bank.

Regarding healthcare cash flows, it is extremely cumbersome to cover diverse systems within a common framework, as we have done in the case of pension systems. This is to a large extent due to the significant heterogeneity of the funding sources, ranging from contributions and payroll taxes, to general taxes and copayments. For instance, in Chile the system is funded with mandatory contributions, two different forms of co-payments, and general taxes (Becerril-Montekio, de Dios Reyes, & Annick, 2011).[28] In contrast, Argentina's public healthcare sector is mostly financed through general taxes (Becerril-Montekio B. M., 2011). In Mexico, there are two main types of public institutions providing healthcare services. The first (IMSS) draws financing from the government, employers and employees' contributions. The second relies mainly on the government for its financing, and in some cases, with out-of-pocket payments (Gómez Dantés, et al., 2011).[29] Finally, in the cases of Colombia and Brazil, funding is a mixture of contributions and resources form the public budget.[30]

A. Healthcare Baseline Results

Our healthcare cost projections are based on total numbers of beneficiaries in the system, an age specific spending index assumed equal to that of the OECD average for all LAC5 (de la Maisonneuve & Oliveira Martins, 2013) and the so-called excess cost growth factor.

Assuming a 1 percent constant excess cost growth ((Clements, Coady, & Gupta, 2012)), our projections show that public sector healthcare costs in LAC5 are expected to increase, on average, by 4.1 percent of GDP, during 2015-50 (Table 10). Roughly, half of this increase is estimated to be due to the excess cost growth factor and half due to pure demographics. Although there is variability in the overall spending pressures across countries, the increase is substantial in all cases throughout the 2015-50 projection period, ranging from an increase of 3.1 percent of GDP in the case of Mexico to 5.3 percent of GDP in the case of Colombia.

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[28] The two different forms of co-payments are *modalidad de atención institucional* (MAI), in which beneficiaries contribute 10 to 20 percent of the service price according to their income level, and *modalidad de libre elección* (MLE), in which the copayment is equivalent to the difference between the price set by providers and the fixed amount determined by the government.

[29] To be precise, Mexico's public sector healthcare system is divided in more than 7 institutions with very different funding sources. Social security institutions like the *Instituto Mexicano del Seguro Social* (IMSS), the *Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado* (ISSSTE) or *Petróleos Mexicanos* (PEMEX) are financed with contributions covered by employers, employees, and the government. The *Secretaría de Salud* (SSa), *Servicios Estatales de Salud* (SESA), the *Programa IMSS-Oportunidades* (IMSS-O) and the *Seguro Popular de Salud* (SPS) cover the population without social security. SSa, SESA and IMSS-O are funded by the government, although the later collects also out-of-pocket payments. The SPS is funded through contributions from the government and individuals, although low-income households are exempted.

[30] Further details on the different LAC5 healthcare systems, including their structure, funding, and spending can be found in Becerril-Montekio B. M. (2011); Becerril-Montekio, Medina, & Aquino (2011); Becerril-Montekio, de Dios Reyes, & Annick (2011); Guerrero, Becerril-Montekio, Vásquez, & Gallego (2011); Gómez Dantés, et al. (2011).

Table 10. Baseline projections of public sector healthcare expenditure
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
spending	6.1	6.5	7.5	8.8	10.3	4.2
spending increase explained by ECG						2.8
spending increase explained by aging						1.4
			Brazil			
spending	4.6	5.1	6.2	7.6	9.1	4.6
spending increase explained by ECG						2.3
spending increase explained by aging						2.2
			Chile			
spending	3.8	4.2	5.1	6.2	7.4	3.6
spending increase explained by ECG						1.9
spending increase explained by aging						1.7
			Colombia			
spending	5.5	6.1	7.4	9.0	10.8	5.3
spending increase explained by ECG						2.7
spending increase explained by aging						2.6
			Mexico			
spending	3.3	3.6	4.3	5.3	6.4	3.1
spending increase explained by ECG						1.6
spending increase explained by aging						1.5
average increase in expenditure						**4.1**

Source: Staff calculations.

B. Healthcare Reform Scenario

Reductions in excess cost growth

The baseline scenario assumes an excess cost growth factor equal to 1 percent. However, multiple reforms can be introduced with the goal of curbing public healthcare spending. Those can include setting caps on certain services or treatments, or moving parts of the healthcare system to the central level to limit the autonomy of hospitals in terms of their control over budgets. The government can also promote competition between health service providers, in case a public contract healthcare system is in place. Finally, incentives for private insurers to offer varied medical plan insurances to increase competition in the sector can be fostered (Clements, Coady, & Gupta, 2012).[31] To illustrate the effect of a public healthcare reform targeted to limit

[31] Although the effects of an increase in the funding of public healthcare systems on the public healthcare system balance are worth considering, for instance through changes in healthcare contributions, we do not project healthcare funding and the associated reform scenarios because it becomes cumbersome to assess the diversity in the funding sources of the different public healthcare systems within a common framework.

expenditure growth, we show a scenario where the excess cost growth factor is reduced by 0.5 percentage points starting in 2016 for all countries.

Since the initial level of public healthcare spending is not so different in all the analyzed countries in 2015, the impact of the introduction of the reform is alike. That is, the average reduction of healthcare spending equals 0.8 percentage points of GDP, with point estimates ranging from 0.5 to 1.0 percentage points of GDP depending on the country (Table 11).

Table 11. A reduction in the excess cost growth factor
(percent of GDP)

	2015	2020	2030	2040	2050	increase 2015 - 2050
			Argentina			
spending (baseline)	6.1	6.5	7.5	8.8	10.3	4.2
spending (decrease in ecg)	6.1	6.5	7.2	8.2	9.3	3.2
			Brazil			
spending (baseline)	4.6	5.1	6.2	7.6	9.1	4.6
spending (decrease in ecg)	4.6	5.0	6.0	7.1	8.3	3.7
			Chile			
spending (baseline)	3.8	4.2	5.1	6.2	7.4	3.6
spending (decrease in ecg)	3.8	4.2	4.9	5.8	6.7	2.9
			Colombia			
spending (baseline)	5.5	6.1	7.4	9.0	10.8	5.3
spending (decrease in ecg)	5.5	6.0	7.2	8.4	9.8	4.3
			Mexico			
spending (baseline)	3.3	3.6	4.3	5.3	6.4	3.1
spending (decrease in ecg)	3.3	3.6	4.2	4.9	5.8	2.5

Source: Staff calculations.

VII. Comparison with Other Projections

In this section we compare our baseline projections (AEW) against those currently available at the International Monetary Fund, namely those of the Fiscal Affairs department (FAD) and the Western Hemisphere Department (WHD).[32],[33] The FAD cross-country projections are based on a

[32] Other well-known cross-country projection reports and methodologies, include the European Commission's Aging Report (constructed from a set of common assumptions and methodologies agreed between EU member countries to project pensions and healthcare spending) and the World Bank's Pension Reform Options Simulation Toolkit (PROST), which is an Excel-based toolkit that simulates pension expenditure over the long term, allowing users to run pension system diagnosis and the assessment of different reform options.

[33] AEW stands for Acosta-Ormaechea, Espinosa-Vega and Wachs.

(continued…)

common methodology using primarily public spending, macroeconomic and pension related indicators, and demographic identities (Amaglobeli & Shi, 2016; IMF, 2011; Clements, Dybczak, Gaspar, Gupta, & Soto, 2015). In contrast, projections prepared by WHD largely incorporate detailed country-specific information provided by authorities, thereby introducing elements which may not be straightforward to incorporate under a more standardized methodology.[34] To facilitate comparisons, the levels of public pensions and healthcare expenditure as a share to GDP in 2015 in our projections equal those of WHD (IMF, 2017).[35]

Figure 3. Baseline comparisons for public pension expenditure
(percent of GDP)

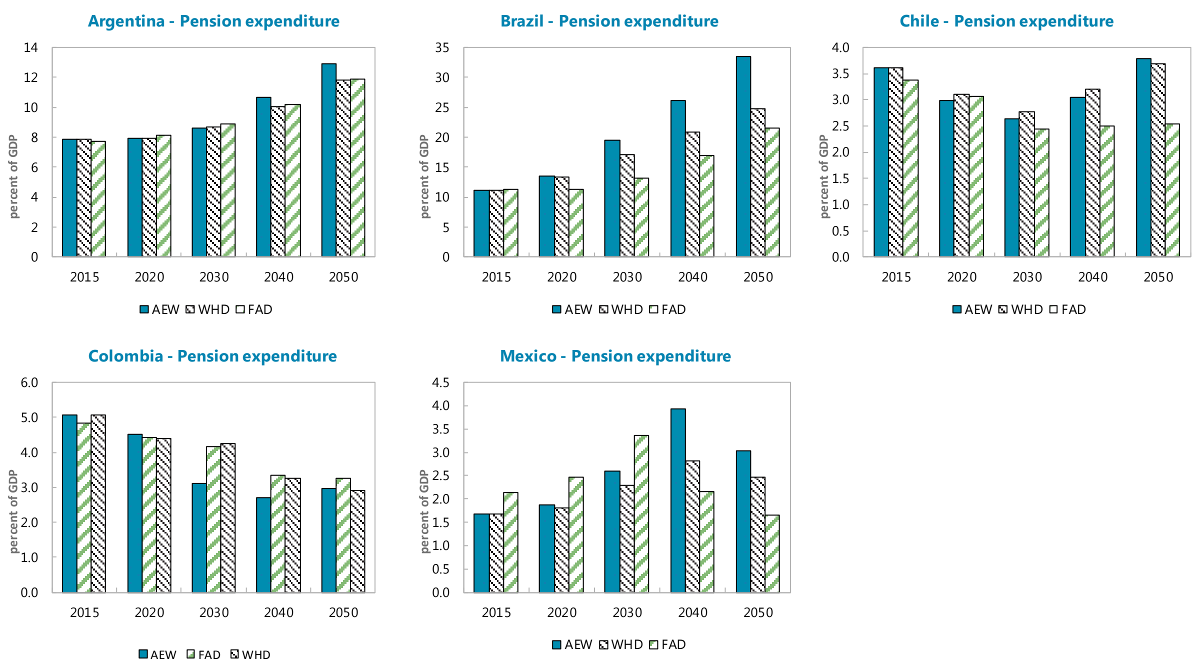


Figure 3 shows public pension expenditure projections across the three approaches. As can be seen in the chart, the general trend is similar in most countries, yet with caveats. Although our projections for Brazil are noticeably higher than either WHD or FAD starting in 2030, about 60 percent of the difference is due to differences in pensions' indexation parameters. In fact, if we set real GDP growth rate exactly equal to the one used by WHD, then the difference in pensions expenditure projections by 2050 drops to only 4 percent of GDP. The remaining difference is explained by the higher number of beneficiaries projected in our model (which depends purely on demographics), and possibly differences in the behavior of replacement rates for new

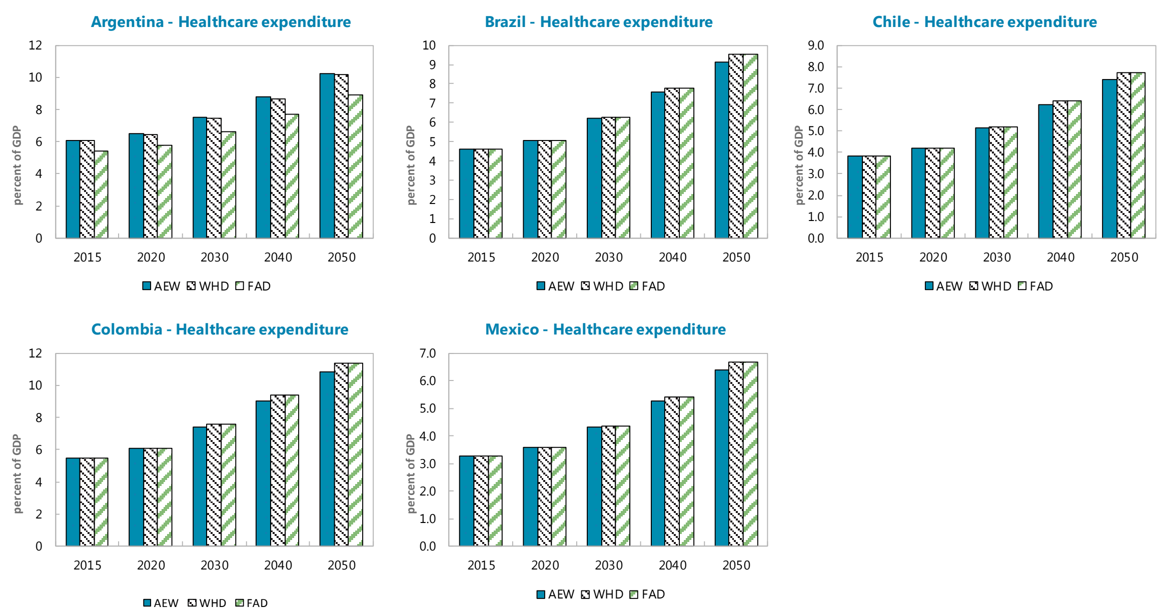
[34] Projections for Brazil and Argentina are also available in two recent IMF Selected Issues Papers (Karpowicz & Mulas Granados, 2016; Dudine, 2016). As in the cases displayed above, our baseline compares well also against the baseline projection in these papers.

[35] In all our projections discussed previously, the 2015 levels of either pensions or healthcare spending as share to GDP have been calibrated to match the figures of WHD, as we continue to do in this section.

pensioners (assumed constant in our framework). Likewise, in Chile and Mexico discrepancies in the evolution of beneficiaries explain most of the divergences in projections in outer years.

In the case of public healthcare expenditure projections are much closer (Figure 4). The underlying reason being that projections are not affected by differences in macroeconomic parameters, but rather on the evolution of the excess cost growth factor and on the number of beneficiaries. It follows that in all cases beneficiaries evolve in line with demographic projections, rather than discretionary healthcare policy assumptions, and that the excess cost growth factor remains constant over time.

Figure 4. Baseline comparisons for public healthcare expenditure
(percent of GDP) [1]



1/ In most countries WHD health care projections are the same as in FAD

VIII. Concluding Remarks

Demographic shifts are likely to have significant fiscal implications for a number of countries in the coming years, including in the LAC5 discussed in this paper. We discussed three aspects of this shift. The good aspect is connected with the longer and healthier lives of these countries' citizens. The bad aspect has to do with the increasing burden of age-related rising costs on public finances—many pension and healthcare systems have not been designed to deal swiftly with rising dependency ratios. Furthermore, healthcare costs are projected to outpace economic growth, adding to the government balance pressures. These trends can become unpleasant for some countries, the longer governments postpone implementing reforms to curb increasing age-related spending, with likely negative implications for the public sector's balance and, more generally, the economy as a whole.

The paper presents an integrated deterministic methodology to project public pensions cash flows and healthcare spending. Innovations include the development of a user-friendly toolkit to estimate the fiscal implications of alternative reforms in both DB and DC pension systems, including the assessment of the fiscal cost of a minimum guaranteed pension under the latter. The toolkit also allows to quantify the fiscal implications of a migration from a DB to a DC system, and the effects on the government budget of a stylized public healthcare system reform. The paper also describes the companion Excel-based toolkit to implement this methodology.

We apply the methodology to LAC5 countries and find that the projections compare well with other approaches. Furthermore, we show that the projected increases in pension spending is especially pronounced for Brazil and Argentina—the only two cases with a pure DB PAYGO system. Meanwhile, countries that have at least partially introduced DC systems, like Colombia and Mexico, are expected to face less severe public spending pressures over the long run.

All in all, to tackle the negative impact of societies' aging on these economies' fiscal balance, some reforms appear necessary. Argentina and Brazil might consider an increase in the retirement age and a reduction in the indexation of benefits, which appear to be very effective reforms to address the rising level of pension spending in our estimations, or a shift to a DC system (either total or partial), following other Latin-American examples. More generally, governments will also have to deal with healthcare expenditure pressures associated with aging and the rapid growth in healthcare costs stemming from technological innovation (as reflected in the so-called excess cost growth factor), requiring careful but expedient evaluation of alternative reform options.

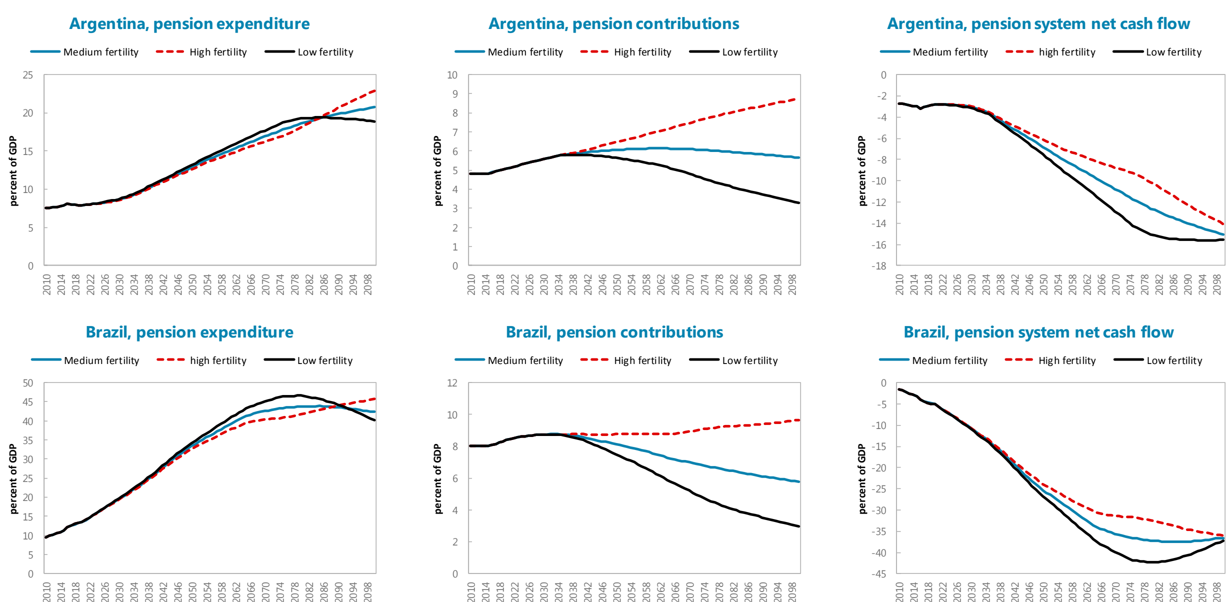
APPENDIX I. ADDRESSING DEMOGRAPHIC UNCERTAINTY

To account for demographic uncertainty we present two alternative scenarios of pension expenditure, considering the high and low fertility variants of the UN population projections. Because the effect of different fertility rates on pension spending will be observable only when new cohorts begin to retire, we extend the projection horizon until 2100. Since the higher or lower fertility rates will have a more pronounced effect on the countries with higher pension spending, we show the impact of demographic uncertainty only in the cases of Argentina and Brazil.

In this exercise, we assume that new cohorts enter the labor market at the age of 20 and start retiring at the age of 60. Thus, the impact of any modification in the fertility rate assumption affects the level of contributions and the balance of the system only starting in 2036 (when new cohorts enter the labor market). Moreover, the expenditure side is affected only after 2076, when the bigger or smaller cohorts start to retire.

Importantly, the positive (negative) impact of the increased (decreased) fertility rate on the cash flow of the pension system peters out over time for both Argentina and Brazil (Figure 5). For instance, the effect of a higher number of contributors gets offset by the higher number of pensioners in the future, as the cohorts reach the retirement age in either the high or low fertility rate scenarios.

Figure 5. Effects of alternative demographic scenarios on the pension system (percent of GDP)



Source: Staff calculations, UN, World Population Prospects: The 2015 Revision, Medium fertility variant.

APPENDIX II. METHODOLOGY FOR PUBLIC PENSION AND HEALTHCARE PROJECTIONS

This annex develops a methodology to calculate public pensions cash flows and healthcare spending projections over the long term, through a fairly simple yet comprehensive Excel-based toolkit. This framework provides accurate short- to medium-term deterministic projections, and is flexible enough to accommodate cross-country features across time as needed. It is worth noting that public pension systems projections can be applied to both DB schemes—assumed to be public PAYGO—and DC schemes—which can either be private or public. If relevant, a reform involving a change from a DB to a DC system can be considered, and the dynamics of the transition period can be accordingly taken into account. The methodology can also assess the effects of different reform scenarios, automatically producing summary tables and charts to compare any baseline with those scenarios where reforms take place.

A. Defined benefit public pension scheme

The Number of Estimated Pensioners

The number of pensioners is obtained through population age distribution projections. The pension age population is obtained for each country as the cohorts whose age equals or exceeds the country-specific retirement age, where the effective retirement age is used instead of the official one, because it allows to estimate the retired population more accurately.

There are three population groups receiving government pension benefits (beneficiaries): retirees, their survivors and those permanently disabled workers in the formal sector. In addition, a correction can be included between 2010-15 to better match any observed figure in the initial year of the projections as explained below. Thus, the number of pensioners receiving government benefits is estimated as follows:

$$Bnf\_p_t = Pen\_Pop_t * lp * fs * (1 + dr + sr) + Bnf\_corr_t,$$

where Bnf_p_t is the total number of beneficiaries, Pen_Pop_t is the population exceeding the average retirement age under the pension system in place, lp is the labor force participation rate, fs is the size of the formal sector, dr is the rate of permanently disabled workers in the formal sector, sr is the survivor rate of pensioners qualifying for retirement benefits, and Bnf_corr_t is the correction to the number of pensioners. The subscript *t* refers here to time (years in this case). The objective of including such correction to the number of beneficiaries is to calibrate pension spending to any actually observed incurred spending. The term is included both in the DC and DB systems and is based on the latest known value of the total pensions spending of a particular country.

To assess the transition or coexistence of the DB and DC systems, the share of old age pensioners who participate in each of them are calculated. If the DC system is mandatory, the share of old age pensioners is calculated taking into account the year when the reform that transforms the system from a DB to a DC takes place. Namely, in case of a total shift, those employees who already started contributing to the DB system and are not shifted to the DC scheme remain in the DB system until the end of their lives. However, new cohorts entering the labor market start contributing directly to the DC scheme. Therefore, a full shift to the new regime takes place only after the death of all the participants of the DB scheme, but the coexistence of the two systems in parallel is taken into account during the transition.

However, if the DC system is not mandatory, the population is divided between the DC and the DB systems using constant shares. That is, if the individual is already retired or has already contributed to the old DB system, she will remain on it, but the new cohorts which have not contributed yet will be divided between the two systems according to these constant shares that can be calibrated as needed.

Cash Flows Under a DB System

To obtain aggregate values for pension spending, a number of steps need to be followed. First, we calculate the average monthly pension per person in local currency for new beneficiaries in the year of their retirement under the DB system, $Av\_Pen\_db\_nb_t,$ is calculated as follows:

$$Av\_Pen\_db\_nb_t = rr * \frac{Av\_wage_t}{12},$$

where *rr* is the replacement rate for new retirees and Av_wage_t is the average wage in year *t*. For $t < 2016$, the average wage is calculated as

$$Av\_wage_t = \frac{GDP\_n_t * ws}{Empl_t}$$

where GDP_n_t is nominal GDP in local currency, *ws* is the share of compensation of employees to GDP and $Empl_t$ is total employment, where the latter is calculated as follows:

$$Empl_t = (1 - u) * lp * Work\_Pop_t,$$

where *u* is unemployment rate and $Work\_Pop_t$ is the total working-age population.

For t ≥ 2016 we assume that average monthly wage grows in line with the nominal GDP growth rate, g_n_t:

$$Av\_wage_t = Av\_wage_{t-1} * (1 + g\_n_t),$$

Where the nominal GDP growth rate is the product of real per capita GDP growth, gpc_t, population growth, g_pop_t, and inflation π_t:

$$g\_n_t = (1 + gpc_t) * \left(1 + g_{pop_t}\right) * (1 + \pi_t) - 1.$$

Second, the average pension in local currency at the individual level for existent beneficiaries (excluding new beneficiaries) $Av\_Pen\_db\_eb_{t_c}$, is in turn obtained by cohorts, by indexing the previous year average pension according to a country-specific rule, e.g. the inflation rate, the nominal wage or any other arbitrary indexation parameter that can be calibrated as needed.

$$Av\_Pen\_db\_eb_{t_c} = Av\_Pen\_db_{t-1_c} * (1 + \pi_t * \alpha) * (1 + w_t * \beta) * (1 + \gamma)$$

where α is the coefficient that determines the level of indexation to inflation, w_t is the nominal wage growth rate, where β determines the level of indexation to nominal wages and γ is a coefficient to account for any other country-specific rule. For instance, if existing pensions are to be indexed only to current inflation, then $\alpha = 1, \beta = 0$ and $\gamma = 0$.

Third, the average pension for all beneficiaries (new and existent) Av_Pen_db is calculated as a weighted average of their corresponding pensions, and their weights are determined by the amount of beneficiaries in each cohort as indicated below:

$$Av\_Pen\_db_t = Av\_Pen\_db\_nb_t * \frac{nb_t}{Bnf\_p_t} + \sum_{c=1}^{n} Av\_Pen\_db\_eb_{t_c} * \frac{eb_{t_c}}{Bnf\_p_t}$$

Where $\frac{nb_t}{Bnf\_p_t}$ is the ratio of new beneficiaries to the total number of beneficiaries and $\frac{eb_{t_c}}{Bnf\_p_t}$ is the ratio of existent beneficiaries by cohort to the total number of beneficiaries.

Finally, total benefits under the DB system, $Tot\_Benef\_db_t$, are equal to:

$$Tot\_Benef\_db_t = Av\_Pen\_db_t * Bnf\_p\_db_t * 12,$$

where $Bnf\_p\_db_t$ is the total number of pensioners under the DB scheme in year *t*. In case that both the DB and DC systems are in place, $Tot\_Benef\_db_t$ will constitute the share of total beneficiaries, Bnf_p_t.

Contributions Under a DB System

The number of formal sector workers who contribute to the DB pension system is given by:

$$Contr\_db_t = Work\_Pop\_db_t * lp * fs,$$

where $Contr\_db_t$ is the number of pension system participants who are in the DB system and $Work\_Pop\_db_t$ is the working-age population of those cohorts assigned to the DB system. The average monthly contribution per person in local currency, $Av\_Contr\_db_t$, is then calculated as:

$$Av\_Contr\_db_t = cr\_db * \frac{Av\_wage_t}{12},$$

where cr_db is the total contribution rate under the DB system, and the other variables stay as before.[36] The, the total contributions, $Tot\_Contr\_db_t$, are equal:

$$Tot\_Contr\_db_t = Av\_Contr\_db_t * Contr\_db_t * 12.$$

[36] The total contribution rate can be divided between the contribution rates of the employee cr_db_ee, of the employer cr_db_er, and the contribution rate of the government cr_db_g, namely:

$$cr\_db = cr\_db\_ee + cr\_db\_er + cr\_db\_g$$

Net Government Cash Flow Under a DB System

The net cash flow is then defined as the difference between total contributions and total benefits.

B. Alternative Pension Reforms on Government's Cash Flows Under a DB System

We analyze five pension reforms, either as a stand-alone or combined.

Onetime Increase in the Retirement Age

This reform consists of increasing the retirement age by $incr$ years (in our case 5 years) and it is phased in over 10 years, namely between 2016-25. The reform affects only the number of old-age pensioners and the working age population, by impacting when the population of a certain age shifts from contributors to beneficiaries of the system. Under the reform, the pension age population, ${Pen\_Pop\_db_t}^r$, equals:

$${Pen\_Pop\_db_t}^r = Pen\_Pop\_db_t - \frac{(t-t0)}{10} * \frac{Reform\_Age_t}{5} * incr$$

and the working age population, ${Work\_Pop\_db_t}^r$, equals:

$${Work\_Pop\_db_t}^r = Work\_Pop\_db_t + \frac{(t-t0)}{10} * \frac{Reform\_Age_t}{5} * incr,$$

where $t0$ is the year preceding the reform, in our case 2015, $Reform\_Age_t$ is the fiver-year age cohort of the population that is affected by the reform and $incr$ is a variable that indicates by how many years the retirement age is increased. If $incr$ exceeds five years the formulas have to be adjusted accordingly to take into account that more than one fiver-year-wide age group is affected by the reform.

A Permanent Indexation of the Retirement Age

In this reform at every year *t*, the official retirement age is increased by the difference between the average age of those who reached and exceeded the initial retirement age in year *t* and the average age of those who reached and exceeded this age in year $t-1$. This scenario assumes that the effective retirement age, which is used for the calculations, is equally affected by the reform as the official retirement age changes. This reform is assumed to enter into effect in 2026, implying that it would have an impact only after any rise in the retirement age takes place, in case that reform is triggered. The working age and pension age population are given by:

$${Work\_Pop\_db_t}^r = Work\_Pop\_db_t + \frac{Reform\_Age_t}{5} * (ra_t^r - ra) \text{ and}$$

$${Pen\_Pop\_db_t}^r = Pen\_Pop\_db_t - \frac{Reform\_Age_t}{5} * (ra_t^r - ra)$$

where ra is the initial effective retirement age (including the onetime increase in retirement age if appropriate) and ra_t^r, the indexed effective retirement age in year *t,* is given by:

$$ra_t^r = ra_{t-1}^r + (av_{t-1} - av_t),$$

meaning that the indexed effective retirement age in year *t* amounts to its value in year *t-1* plus the difference between the average age of those retired, av_t, between years *t* and *t-1*. The other variables stay as before, but in relation to the reform indexing the retirement age. Namely, $Pen\_Pop\_db_t$ and $Work\_Pop\_db_t$ relate to the pension and working age populations before the introduction of the reform, but these also take into account the reform of the increase in the retirement age, if relevant.

Reduction in the Generosity of the Pension System

This reform, which affects only DB systems, assumes that the replacement rate of new pensioners is reduced linearly by a constant value, red, every year throughout the chosen horizon, which is assumed to be equal to 10 years. Therefore, if the reform is implemented, in years 2016-25 the replacement rate equals:

$$rr_t = rr_{t-1} - red$$

and then, namely for $t > 2025$,

$$rr_t = rr_{t-1},$$

meaning that after the reform of the replacement rate stays at a lower level through the projection horizon.

Reduction in the Indexation of Benefits

This reform assumes that the indexation coefficient of the average pension for existent beneficiaries will decrease by a chosen amount according to the formula.

$$Av\_Pen\_db\_eb_{t_c} = Av\_Pen\_db_{t-1_c} * (1 + \pi_t * \alpha) * (1 + w_t * \beta) * (1 + \gamma),$$

where α, β and γ are chosen such that the indexation of pensions is reduced relative to the baseline scenario. For instance, if in the baseline scenario existing pensions are to be indexed only to current inflation, namely $\alpha = 1$, $\beta = 0$ and $\gamma = 0$, and the reduction in indexation of benefits is such that pensions will be update at four-fifths of the inflation rate, then the reduction in the indexation of benefits would require setting $\alpha = 0.8$, $\beta = 0$ and $\gamma = 0$.

Notice that we assume this reform starts in 2016 and affects only current pensioners. New pensioners are assumed to receive benefits in the DB scheme according to a replacement rate and the average wage, factors that remain unaffected by this reform.

An Increase in the Contribution Rate

The increase in the contribution rate is assumed to take effect in 2016 and it comprises a permanent, immediate, and onetime increase in the total contribution rate. The assumed increase equals 1 percentage point, which means that the contribution rate for 2016 equals:

$$cr\_db_{2016} = cr\_db_{2015} + 1\%$$

and stays at that level until the end of the projections, namely:

$cr\_db_t = cr\_db_{t-1}$

for $t > 2016$.

C. DC Pension Scheme

Per Capita Account Balance Under a DC System

First, the working-age population is divided into quintiles by their income levels, q, and into age cohorts, *c*, of five years each. The contribution per capita, $Av\_Contr\_dc_{t_q}$ of quintile q in year *t* is calculated as follows:

$$Av\_Contr\_dc_{t_q} = is_q * Av\_wage_t * cr\_dc,$$

where is_q is the income share of quintile q and cr_dc is the contribution rate of the DC system. The per capita balance in the private account of quintile *q* and cohort *c*, $Account\_balance_{q_c}$, equals each year:

$$Account\_balance_{q_c} = Account\_balance_{q_c} * (1 + i_t) + Av\_Contr\_dc_{t_q} * cy/12,$$

where i_t is the interest rate, and cy is the number of contributions to the individual account per year. The inclusion of the cy index aims to capture unemployment periods and other factors resulting in temporary interruptions in contributory periods. The account balance grows each year until it reaches its maximum level the year before retirement. Using the balance of the private account, an annuity is calculated for the life expectancy after retirement of the individual, $Av\_Pen\_dc_{q_c}$, assuming a constant interest rate and payment flows as follows:

$$Account\_balance_{q_c} = \frac{Av\_Pen\_dc_{q_c}}{(1+df)^1} + \frac{Av\_Pen\_dc_{q_c}}{(1+df)^2} + \cdots + \frac{Av\_Pen\_dc_{q_c}}{(1+df)^n},$$

where $Av\_Pen\_dc_{q_c}$ is the average yearly pension per capita received by the person of the quantile q and cohort *c* who retires in year *t+1*, df is the discount factor, assumed to be constant, and n is the country-specific expected life span after retirement.

Government Spending, Revenue and Net Cash Flow Under a DC System

Public pension expenditure under a DC scheme consists of either total pensions, in case the system is a public notional DC, or only the contribution of the government to cover a minimum pension, in case of a private system.

In both private and public pension systems the government will have to take responsibility for a contingent liability, given by the minimum guaranteed pension. To estimate this liability, the average annual pension of quintile q and cohort *c* is compared with the minimum guaranteed pension. The total government contribution in year *t*, Gov_Contr_t, equals the sum of the average per capita government contributions in that year for all quantile q and cohort *c* times the number of beneficiaries for the same year, quantile and cohort:

$$Gov\_Contr_t = \sum_{q=1}^{5} \sum_{c=1}^{s} \left(Min\_Pen_t - Av\_Pen\_dc_{t_{q_c}}\right) * d_{t_{q_c}} * Bnf\_p\_dc_{t_{q_c}},$$

where $d_{t_{q_c}}$ equals 1 when the average pension $Av\_Pen\_dc_{t_{q_c}}$ is lower than the minimum pension, Min_Pen_t, or zero otherwise, and $Bnf\_p\_dc_{t_{q_c}}$ is the number of beneficiaries under the DC system, all evaluated for time *t*, quantile *q* and cohort *c*.

In a public notional DC pension system the government obtains the contributions collection and is responsible of the payment of the pension benefits. In this case, total benefits, $Tot\_Benef\_dc_t$, equal:

$$Tot\_Benef\_dc_t = \sum_{q=1}^{5} \sum_{c=1}^{s} Av\_Pen\_dc_{t_{q_c}} * Bnf\_p\_dc_{t_{q_c}} + Gov\_Contr_t,$$

And total contributions, $Tot\_Contr\_dc_t$, equal:

$$Tot\_Contr\_dc_t = \sum_{q=1}^{5} \sum_{c=1}^{s} Av\_Contr\_dc_{t_{q_c}} * Work\_Pop\_db_{t_{q_c}},$$

and the balance of the system in year *t* is defined as the difference between total contributions and total benefits.

D. Total Public Expenditure of Pension Systems

Depending on the country-specific design of the pension system, the public liabilities of the pension system will amount to one of the components of the expenditure explained above or to a sum of them.

In particular, in case of a country where a transition takes place from a public DB PAYGO to a private, fully-funded DC scheme, total expenditure, Tot_Benef_t, is the spending under the DB PAYGO system and the part of DC spending resulting from the minimum guaranteed pension:

$$Tot\_Benef_t = Tot\_Benef\_db_t + Gov\_Contr_t,$$

and in case where a transition takes place from a public DB PAYGO to a public notional DC scheme, total expenditure will be higher because it also includes the payment of all regular pensions, resulting from the accumulated contributions:

$$Tot\_Benef_t = Tot\_Benef\_db_t + Tot\_Benef\_dc_t.$$

E. Healthcare Projections

The building blocks for healthcare spending projections are the number of beneficiaries in the system and the value of the health cost index, which is a measure of the healthcare costs incurred for a certain age group relative to a base group, namely newborns. The number of healthcare system beneficiaries is assumed to grow in line with population as given by the medium fertility variant of the UN demographic projections. The average per capita health expenditure cost index relative to the reference group, $cost\_index\_av\_pc_t$, is calculated as the weighted average of the health cost index for all the 21 five-year-wide age groups:

$$cost\_index\_av\_pc_t = \sum_{c=1}^{21} \frac{Pop_{c_t} * cost\_index\_av_c}{\sum_{c=1}^{21} Pop_{c_t}},$$

where Pop_{c_t} is the population of age group c in time t and $cost\_index\_av_c$ is the arithmetic average value of the health cost index relative to the base group of the population in the ages included in age group c.

Real per capita spending for the reference group for the first year included in the calculations, equals the real health expenditure divided by the number of beneficiaries and the average per capita health expenditure cost index relative to the reference group:

$$Exp\_ref\_r_t = \frac{Health\_\exp\_r_t}{Bnf\_h_t * cost\_index\_av\_pc_t},$$

while $Health\_exp\_r_t$ is the value of the actually incurred real health expenditure. For the same period nominal public health expenditure, $Health\_exp\_n_t$, is calculated as the product of nominal GDP, total health expenditure as percent of GDP, het_t, and the share of public spending in total health expenditure, hep_t, for the year with the latest known value:

$$Health\_exp\_n_t = GDP\_n_t * het_t * hep_t.$$

Real per capita spending for the reference group is assumed to grow thereafter in line with the growth rate of real per capita spending, consisting of real per capita GDP growth, gpc_t, and the excess cost growth factor, ecg:

$$Exp\_ref\_r_t = Exp\_ref\_r_{t-1} * (1 + ecg) * (1 + gpc_t)$$

Total real public health expenditure for the following years is calculated as the product of the number of beneficiaries, Bnf_h_t, real per capita spending for the reference group, $Exp\_ref\_r_t$, and the average per capita health expenditure cost index, $cost\_index\_av\_pc_t$:

$$Health\_\exp\_r_t = Bnf\_h_t * Exp\_ref\_r_t * cost\_index\_av\_pc_t.$$

Nominal public health expenditure is then the value of real public health expenditure adjusted by inflation.

The growth in healthcare spending can be broken down into the share related to the excess cost growth and that related to population aging, which is assumed to equal the growth rate of the average per capita healthcare index relative to the reference group. The share of healthcare growth explained by the excess cost growth factor, s_ecg, is calculated as follows:

$$s\_ecg = \frac{\log(((1+ecg+g)/(1+g))^n)}{\log(\frac{Health\_\exp\_n_{t1+n}/GDP\_n_{t1+n}}{Health\_\exp\_n_{t1}/GDP\_n_{t1}})}$$

and likewise the share of growth explained by population aging is obtained as:

$$s\_cost\_index = \frac{\log(\prod_{t=t1}^{2015+n}(cost\_index\_av\_pc_{t+1}/(cost\_index\_av\_pc_t)))}{\log(\frac{Health\_\exp\_n_{t1+n}/GDP\_n_{t1+n}}{Health\_\exp\_n_{t1}/GDP\_n_{t1}})},$$

where n is the number of years between the year preceding the start of the projections, being usually the last known value (in our case 2015) and the last year of the projections (in our case 2050). The subscript *t1* refers to the last year with the known value, which in our case is 2015.

F. Analyzing the Impact of Reforms on Healthcare Expenditure

Reforms aiming at reducing healthcare expenditure can take various forms. For simplicity, all of them are assumed to take effect through the reduction in the excess cost growth factor. The decrease in this factor, $decr$, takes the value of 0.5 percent, starts in 2016 and takes 5 years. Therefore, between 2016-20 the excess cost growth, ecg, equals:

$$ecg_t = ecg_{t-1} - \frac{decr}{5}$$

and stays at that level from 2020 until the end of the projections.

G. Calibration to Implement Toolkit

This section describes the inputs used in our Excel-based toolkit. The first input is the United Nations Population Projections, which include the age distribution of the population broken down into five-year age groups until 2050 and until 2100 in some of the scenarios.

Macroeconomic variables (GDP and GDP deflator, assumed equal to inflation) are taken from WEO projections until 2020. This aspect is also mirrored in the values of the variables and in the way some of the variables are obtained. Namely, inflation and unemployment rate are fixed at the levels of the average value of WEO projections for 2016-20. Real GDP per capita is obtained from WEO data and population projections until 2020, and after 2021 is kept constant at the average 2016-20.

It will be assumed that the discount factor, denoted *d*, remains constant throughout the projection horizon.[37] We follow the literature and set the value of *d* at 1 percent. This is equivalent to the average interest rate-growth differential often discussed in the related literature, which is found to roughly equal 1 percent (Escolano, 2010; Kogan, Stone, DaSilva, & Rejeski, 2015).[38]

Then, the effective interest rate can be derived accordingly, which is given for each country by:

$$i_t = [1 + d * (1 + g_t) + g_t] * (1 + \pi_t) - 1.$$

[37] The discount factor *d* is assumed to be equal to $\frac{r-g}{1+g}$ where *r* and *g* are the net real interest rate and net real GDP growth rate, respectively (see Escolano (2010) for details).

[38] This calculation uses the interest paid in year t as a ratio to debt outstanding at the end of year t–1, which constitutes a safe proxy for the interest rate.

where π_t is inflation and g_t denotes real GDP growth (see below for country specific assumptions and data sources).

The excess cost growth factor (*ecg*) is assumed in the baseline scenario to be equal to 1 percent. However, especially in case of emerging markets, empirical estimations suggest large variability in this coefficient, which can be attributed to the diversity of countries and the limited time span of available series (Clements, Coady, & Gupta, 2012). The effect of the reform which reduces the level of *ecg* has been calibrated to a quarter of the standard deviation of the estimates for emerging economies found in (Clements, Coady, & Gupta, 2012), which roughly equals 0.5 percent.

The health cost index for each age group in relation to the base group is assumed to be equal for all countries, staying constant throughout the projection horizon and takes the average of the index reported by the OECD (de la Maisonneuve & Oliveira Martins, 2013). Other relevant variables used to obtain pension and healthcare spending projections for each country—most of them assumed to stay constant throughout the projection horizon—are described below in Table 10.

Table 11. Assumptions

	Argentina	Brazil	Chile	Colombia	Mexico	Source	Description/comment
Demographic parameters							
Labor force participation rate (2013)	61.00%	70.00%	62.00%	68.00%	62.00%	World Development Indicators, World Bank	The labor force participation rate is assumed to stay constant at the level of 2014.
Macroeconomic parameters							
Wage share (compensation of employees as percent of GDP) (average last 5 available)	39.20%	40.70%	37.99%	32.35%	27.53%	National Accounts Official Country Data, United Nations World Economic Outlook	Compensation of employees as percent of GDP is assumed to stay constant until 2020 at the level which equals the average of the last 5 known values, thereafter is obtained on the basis of the aggregate wages in the economy and GDP.
Size of formal sector (share of employees contributing to system) (last available)	54.00%	63.20%	67.40%	30.40%	46.10%	International Labor Organization	Size of formal sector, namely share of employees contributing to the system is assumed to stay constant at the level of the last known value.
Real GDP per capita growth rate (average last 5 available)	1.09%	-0.52%	1.52%	2.68%	1.53%	Staff calculations, World Economic Outlook and United Nations	Real GDP per capita growth rate is assumed to stay constant at the level calculated as the average of the last 5 values obtained on the basis of WEO and UN projections for years 2016-2020.
Inflation (GDP deflator, last 5 years average)	17.05%	7.11%	2.86%	3.54%	3.58%	World Economic Outlook	Inflation rate, assumed to be equal to the GDP deflator, is assumed to stay constant at the level calculated as the average of the last 5 values of WEO projections, 2016-2020.
Unemployment rate (average last 5 available)	7.12%	10.01%	7.02%	9.20%	3.85%	World Economic Outlook	Unemployment rate is assumed to stay constant throughout projection horizon at the level calculated as the average of the last 5 values of WEO projections, 2016-2020.
Income share held by highest 20%	50.01%	57.98%	57.34%	59.43%	53.51%	World Development Indicators, World Bank	The value equals the average of the last 5 observations.
Income share held by fourth 20%	22.38%	19.26%	18.38%	19.03%	19.84%	World Development Indicators, World Bank	The value equals the average of the last 5 observations.
Income share held by third 20%	14.41%	12.13%	11.81%	11.39%	13.05%	World Development Indicators, World Bank	The value equals the average of the last 5 observations.
Income share held by second 20%	9.07%	7.40%	8.07%	6.98%	8.76%	World Development Indicators, World Bank	The value equals the average of the last 5 observations.
Income share held by lowest 20%	4.13%	3.24%	4.41%	3.16%	4.84%	World Development Indicators, World Bank	The value equals the average of the last 5 observations.

Pensions parameters							
defined benefit system							
Replacement rate (average pension as share of average wage) (last available)	71.60%	69.50%	32.80%	64.10%	25.50%	OECD/IDB/TheWorld Bank (2014), Pensions at a Glance: Latin America and the Caribbean, OECD Publishing	Replacement rate is assumed to stay constant at the 2014 level.
Contribution rate (contribution rate of gross wage) (last available)	21.17%	28.00%	11.49%	16.00%	6.50%	OECD/IDB/TheWorld Bank (2014), Pensions at a Glance: Latin America and the Caribbean, OECD Publishing. USA Social Security administration, Social Security Programs Throughout the World: The Americas, 2011.	Contribution rate of is assumed to stay constant at the level of the last know value.
Disability rate (share of old age pensioners) (last available)	34.00%	19.00%	32.00%	7.00%	49.00%	Institutio Nacional de Estadsitica y Geografia, Mexico Instituto Nacional de Estadística y Censos, República Argentina Ministerio de Hacienda, Gobierno de Chile http://www.brasil-economia-governo.org.br/2015/02/24/pensoes-por-morte-por-que-e-preciso-alterar/ https://www.bbvaresearch.com/wp-content/uploads/migrados/Confianza_en_el_futuro_tcm346-219339.pdf	Disability rate as a share of old age pensioners is assumed to stay constant at the level of the latest known value.
Survivor rate (share of old age pensioners) (last available)	36.00%	44.00%	26.00%	29.00%	46.00%	Institutio Nacional de Estadsitica y Geografia, Mexico Instituto Nacional de Estadística y Censos, República Argentina Ministerio de Hacienda, Gobierno de Chile http://www.brasil-economia-governo.org.br/2015/02/24/pensoes-por-morte-por-que-e-preciso-alterar/ https://www.bbvaresearch.com/wp-content/uploads/migrados/Confianza_en_el_futuro_tcm346-219339.pdf	Survivor rate as a share of old age pensioners is assumed to stay constant at the level of the latest known value.
Retirement age	60	60	60	60	65	OECD/IDB/TheWorld Bank (2014), Pensions at a Glance: Latin America and the Caribbean, OECD Publishing	The retirement age is assumed to stay constant at the latest know value, rounded up to 5 years.

defined contribution system							
Year of reform (DB to DC)	-	-	1976	1978	1997	RAND Labor and Population	The year of reform is not necessarily the year of the introduction of the actual reform, but a specific year that will produce a match between the retirement of the first cohort in the new DC system and projections from other sources.
DC contribution rate (contribution rate of gross wage) (statutory)	-	-	11.49%	16.00%	8.88%	OECD/IDB/TheWorld Bank (2014), Pensions at a Glance: Latin America and the Caribbean, OECD Publishing	Contribution rate is assumed to stay constant at the level of the last know value.
Minimum pension (statutory)	-	-	1,685,978	7,732,200	25,587	A model for the pension system in Mexico: diagnosis and recommendations, Javier Alonso, Carmen Hoyo, David Tuesta, BBVA Ministerio del Trabajo y Prevision Social, Chile Ministerio del Trabajo y decretos del Gobierno nacional	Minimum pension of the latest known value that is annually adjusted by wage growth.
Average months of contributions per year (latest available)	-	-	6	6	6	Ministerio de Hacienda, Gobierno de Chile	The average number of contributions per year is assumed to equal 6 - the value reported for Chile.
Life expectancy after retirement (latest available)	-	-	25	20	18	OECD/IDB/TheWorld Bank (2014), Pensions at a Glance: Latin America and the Caribbean, OECD Publishing BBVA Confianza en el futuro, Propuestas para un mejor sistema de pensiones en Colombia	Life expectancy after retirement is assumed to equal latest known value.
Health parameters							
Number of beneficiaries of the system	18,962,523	144,988,372	13,612,038	44,770,148	118,617,542	Sistema de salud de Argentina, Belló and Becerril-Montekio, Scielo, 2011 Sistema de salud de Brazil, Becerril-Montekio, Medina and Aquino, Scielo, 2011 Sistema de salud de Chile, Becerril-Montekio, De Dios Reyes and Annick, Scielo, 2011 Sistema de salud de Colombia, Guerrero, Gallego, Becerril-Montekio and Vásquez, Scielo 2011 Sistema de salud de Mexico, Gómez Dantés et. al., Scielo 2011	The last known number of beneficiaries of the system is included in the calculations and assumed to grow in line with the population thereafter.
Health expenditure (percent of GDP, latest available)	4.17%	4.24%	3.31%	4.98%	3.10%	World Development Indicators, World Bank	The level of health expenditure in 2010 equals actually incurred spending.
Excess cost growth (annual growth rate)	1.00%	1.00%	1.00%	1.00%	1.00%	The Organisation for Economic Co-operation and Development (OECD)	The value of excess cost growth is assumed to be constant and equal the value obtained in the empirical literature.
Average per capita health expenditure cost index relative to reference group (latest available)	1.25	1.17	1.29	1.15	1.11	The Organisation for Economic Co-operation and Development (OECD)	The value of the indicators are assumed to be the same for all analyzed countiries and equal the average value of the indicators for OECD countries.

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