Preliminary steps for projecting public pensions' sustainability: calibrating a dynamic microsimulation model for the prospective and retrospective simulation of Argentina's labour market (2003-2014).

LÉO

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Abstract

The aim of this paper is to lay the foundations of a prospective analysis that will draw perspectives on Argentina's Pay-As-You-Go pension system. After a brief description of the country's pension system, this paper develops a dynamic microsimulation model and calibrates it with a household-level quarterly survey data, the EPH[2]. The calibration is done both on a micro level (by modelling individual transition probabilities between labour-market states) and on a macro level (by trying to reproduce the levels of the different kinds of activity and inactivity of the working age population by age, gender and education as observed in the 2003-2014 period). In the end, we have obtained a model that makes a realistic projection of

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[2]"Encuesta Permanente de Hogares", which stands for "Permanent Household Survey". In its quarterly form, covers the 2003-2014 period.

the labour career of each individual in our survey up to the year 2040. Once our retrospective simulations are complete, we will be able to reconstitute their labour career, an information that is not present in our dataset. With this, we will be able to compute the total amount of contributive years each individual has validated once he reaches retirement age in the 2014 - 2040 period. This would lay the basic framework for future projections on Argentina's pension system's mid to long-term sustainability.

Introduction.

This paper is part of a broader project : to provide a reliable projection of Argentina's Unified Social Security System (SUSS), run by the "National Social Security Administration" (ANSES). We intend to simulate ANSES future income, expenses and ultimately financing needs, based on a set of different demographic, social and economic scenarios. This public agency manages social security benefits[3] as well as family and unemployment benefits. Its total non-figurative[4] expenses amounted to 8,2% of GDP in 2013[5]. In the context of this project, this paper aims to provide the general outlines of future simulations of pension rights of a sample population, which would mean reconstituting backwards its likely contribution years and forward its future contributions, given a set of demographic hypothesis and labour-market transition probabilities. Not only are contribution years essential to calculate contributive benefits paid by ANSES, they are also central for calculating its future contributive revenue. But before further expanding on this subject, let us briefly present why we chose to study Argentina's social security system.

In the past twenty years, Argentina's social security system has undergone various reforms. Starting from 1993, it has been run by ANSES, an autonomous agency that began functioning on that year in the midst of a constitutional reform. It was first meant to run a unified Pay-As-You-Go (PAYG)[6] pension system, as part of the two-pillars system that was implemented at that time, where the second pillar was a new fully funded pension system[7]. This PAYG pension system paid pension benefits to people that had retired in one of the previous existing PAYG systems and collected the contributions of the minority of workers that had explicitly opted for the public PAYG system. Apart from the predictable huge social security deficit this reform generated, the adequacy of retirement pension benefits decreased sharply for a number of reasons. On the one hand, since 1991 all indexation on inflation was banned as part of the "convertibility plan" that was launched in that year, in a move to establish a currency board to end with chronic hyperinflation outbursts. This was maintained throughout the 1990's, and meant for instance that the minimum retirement pension was frozen at 150 pesos (150 US$) a month from December 1995 to December 2001(DNPE , 2012, p 28). On the other hand, private pensions had a defined contribution scheme that made benefits rely on the profits of the funds. And finally, the requirements to benefit either

[3]Mostly retirement benefits and survivors pensions, but also unemployment benefits.

[4]Figurative expenses stem from programs run on behalf of other government agencies, and are balanced out by figurative contributions, which are transfers from the Treasury.

[5]Source: own calculus based on Contaduría General de la Nación's (CGN) Savings-Investment-Financing account of Social Security institutions, 2013.

[6]In a PAYG pension system, today's contributions to the system pay for today's pensions. By contributing, a worker acquires rights for future pensions, paid by future workers.

[7]Here, each person contributes to its individual account, that is invested by private pension funds. The return of the invested funds pays for that fund's current retirees, depending on the amount these had previously contributed.

from a private or a public pension were toughened, leading to a drop in pension coverage, which was also due to an unstable and, in the late 1990's, recessive economy. At the same time, private fully funded pensions had on average very high operative costs and although they had fewer retirees than ANSES, starting from 2002[8] the federal government had to subsidise some of the fully funded pensioners since their pensions did not reach the minimum retirement benefit.

ANSES' role became however increasingly important starting from the 2000's, first with the 2005 pension moratorium Law 25994 that came into effect in 2007 and raised coverage rates from approximately 50% of retirement-age population to almost full coverage in 2010. Together with a previous independent workers' moratorium Law 24476, these two moratoriums have a bigger coverage than PAYG pension plan's. Indeed, in 2013, 45,9%[9] of retiring age population had a retirement pension by moratorium, while 36,1%[10] of this population had a retirement pension through the regular PAYG pension plan. Furthermore, the Pension mobility Law 26417 was adopted on October 2008, and it indexed pensions and social security benefits on an average of the evolution of wages and ANSES revenue. But at the same time, following the outbreak of the global financial crisis that hit hard Argentinian private pension funds, the nationalisation of private pension funds was decided. The two pillars of the system were fused into a single PAYG pension system, the Argentinian Integrated Pension System (SIPA). This meant on the one hand that ANSES, through its national pension fund, the FGS, which was created the previous year, began administrating almost 10 GDP points worth of individual pension accounts and receiving most retirement contributions; but on the other hand it meant the federal PAYG system had to fully pay most pension benefits[11]. However, as it has been pointed out in the literature by the likes of Mesa-Lago, this reform "[was] not supported by actuarial studies and apparently they have not been done after the re-reform" (Mesa Lago , 2014, p 20). If we add to these considerable institutional changes a continued demographic transition, with a gradual ageing of Argentina's population, a middle to long-term projection of future Argentinian social security system's financing needs becomes all the more important.

The purpose of this paper is to lay the foundations of a forthcoming microsimulation of ANSES mid to long-term financing needs by preparing the simulation of contributed years at retirement. To do so, after doing a literature review and exposing our methodology, we will first describe Argentina's social security system and study Argentina's labour market, through descriptive statistics and the estimation of transition probabilities between labour market states. We will then expose

[8]Source: CGN's Evaluation of results by program and project, social security agencies, 2002.

[9]Source: own calculus from CGN's physical-financial follow-up and INDEC demographic data.

[10]Ibid.

[11]There are Provincial and municipal PAYG pension funds for some provincial workers, where around 15% of total contributing workers are affiliated.

the demographic data and projections we use in our simulations as well as the calibration of our model with our 2003-2014 dataset.

Literature review.

Dynamic microsimulation literature.

The microsimulation literature in economics is quite old, as it traces back to Orcutt's(Orcutt , 1957) seminal paper. As Li and O'Donoghue explain, "[(Orcutt et al. , 1961)] described the first dynamic microsimulation model following the inspiration of Orcutt's (1957) article. Most dynamic microsimulation models that have developed in the following decades trace a direct or indirect link back to this model." (Li and O'Donoghue , 2013, p 4). Basically, a microsimulation model simulates unit-level behaviour, accounting for the diversity of characteristics and of possible responses among the population. In the fields of economics and sociology, it is mostly used to analyse social economic policies. Static microsimulation models simulate an immediate response to a shock, without a time dimension[12] . Dynamic microsimulation models, on the other hand, model this behaviour over time. As explained by Li and O'Donoghue, "dynamic models (...) extend the static model by allowing individuals to change their characteristics due to endogenous factors within the model (...) and let individual units to progress over time"(Li and O'Donoghue , 2013, p 4). These are the most common in the economic field, since they make it possible to generate synthetic micro-level data useful for prospective analysis (typically, social security and pension plans [13], but also for instance future income distribution[14]). In our case, we intend to carry out a dynamic microsimulation model about retirement and social security contributions and validated contributive years. We will hence study more closely the literature on social security and pension plans microsimulation models.

However, one of the major problems of the field has been its fragmentation. As Li and O'Donoghue explain, "microsimulation models are mostly developed in governmental or policy institutions, where developing a literature on which a wider group of scientists has built has been a lesser objective. Furthermore, the documents are mainly spread with limited books and conference presentations, which may not be easily available for researchers outside of the network. (...)Thus a

[12]Some examples of static microsimulation models are the EUROMOD(Sutherland , 2007) model and the IZAΨMOD(Peichl et al. , 2010) model.

[13]"Models such as LIAM(O'Donoghue et al. , 2009), PRISM(Kennell and Sheils , 1990), the Belgian dynamic model(Joyeux et al. , 1996), the SfB3 population model(Galler and Wagner , 1986), LIFEMOD(Falkingham and Johnson , 1993), SESIM(Flood , 2007; Klevmarken , 2010) and Belgium MIDAS(Dekkers et al. , 2010; Dekkers and Belloni , 2009) have all been used to look at pension reform"(Li and O'Donoghue , 2013, p 6)

[14]Li and O'Donoghue (2013, p 7) mention, among others, the DESTINIE1/2(Bonnet and Mahieu , 2000; Blanchet , 2009), APPSIM(Harding , 2007), SESIM(Klevmarken and Lindgren , 2008) or SADNAP(Van Sonsbeek , 2010) models.

significant proportion of the extensive methods used in the field are not formally codified, meaning that to a large extent new models have had to reinvent the wheel and redevelop existing methods over and over again. This has made it very difficult to work in the field"(Li and O'Donoghue , 2013, p 34). In addition to the intrinsic complexity of microsimulation models and of their high computing power needs, these aspects hamper the transfer of knowledge and know-how in the field and make it very difficult to replicate previous results using the same methodology. It also meant entry costs in the field were for a long time particularly high. Moreover since a microsimulation model cannot be properly explained in a standard paper, most of the available literature are working papers or reports from organisations describing their microsimulation model. As such, this work is based mostly on working papers about existing microsimulation models for given pension systems.

Our main inspiration for the general outlines of our project comes from various pension-related dynamic microsimulation models. Direct references are INSEE's model Destinie 2(Blanchet et al. , 2011), CNAV's dynamic microsimulation model PRISME(Poubelle et al. , 2006; Albert et al. , 2009) and DREES' TRAJECTOIRE(Duc et al. , 2013) model, among others. These are the leading models for microsimulation of pension policy in France, and although there are many others that currently exist [15]we chose to focus on these as the basis of our microsimulation framework. Since none of these models are open source nor directly applicable to Argentina's pension system, our aim is to follow some of their methodological choices in our study of Argentina's social security system. This aspect is further discussed in our methodological section.

Literature on labour market transitions.

Our work has required we compute transition probabilities between labour market states for the individuals in our data set. Indeed, having a dynamic microsimulation model implies simulating transitions over time of single individuals between different states. So be it regarding demographic or labour-market characteristics, we have to specify for the states we will study a transition rule between them. Our demographic transition sources come from recent demographic projections from the INDEC. [16]

Regarding labour-market transitions, we have mobilised a wide array of economic literature to compute these from the EPH data set. On the one hand, a part of the literature calculates empirical transition probabilities between labour-market states, usually from individuals followed in household surveys. Most of these papers compute empirical transition probabilities at least

[15] Li and O'Donoghue (Li and O'Donoghue , 2013, p 9) provide an exhaustive list of existing dynamic microsimulation models and of their uses.

[16] Both conditional probabilities of dying and probabilities of giving birth have been computed by INDEC from 2008-2010 life tables computed from the 2010 national Census. The data is available at INDEC's website http://www.indec.gov.ar, in the "projections and estimations" section of the "population" thumbnail.

for the sake of descriptive statistics. Some use a quarterly step, for instance, Silva and Vázquez-Grenno "obtain the gross labor market flows by calculating the quarter-on-quarter transitions made by individuals workers between different labor market states"(?, p 162). Others have a yearly or bigger step, such as Theodossiou and Zangelidis (2009), Zissimopoulos and Karoly (2007) or Bradley et al. (2003) . Finally, others compare quarterly and yearly transition rates, such as Güell and Petrongolo (2007)and Gomes (2012). Usually these papers use these transition rates as the input for some econometric analyses, such as cross-correlation analysis Silva and Vázquez-Grenno (2013), multinomial logit models (Zissimopoulos and Karoly , 2007), multinomial probit models (Theodossiou and Zangelidis , 2009) or duration models(Güell and Petrongolo , 2007). In general, this literature focuses on some specific transitions, such as transitions in and out of unemployment, into retirement or between types of employment. It provides interesting methodological possibilities, which we will further analyse in our methodological section.

Methodology.

The choice of a dynamic microsimulation framework.

We have made two major methodological choices in order to carry out the retirement and social security projections of ANSES. The first is to opt for a microsimulation approach, starting from available individual data, instead of simulating a model at the macro level. Because this approach builds upon an existing population sample, we have chosen as our main data set the quarterly "Permanent Household Survey" (EPH), which is available at the micro level and covers the 2003-2014 period. This survey studies a randomised sample of the urban population of 31 Argentinian cities and metropolitan areas. These represent most of Argentina's urban population, and hence most of its total population, since about 91% of Argentinians live in towns of 2000 and more inhabitants[17]. Each household is surveyed four times all in all: two consecutive quarters first, then after a break of six months two other consecutive quarters. This allows for a rotation in the studied population while still making it possible to study quarterly as well as yearly transitions. An average of around 50000 individuals are interviewed each quarter.

The choice of a microsimulation framework follows a number of reasons, the main one being that "microsimulation models (. . .) differ from (semi-) aggregate budgetary models in that they simulate the impact of policy measures and schemes on real people, and not on averages or representative agents. (. . .) Where macro simulation considers averages, a micro simulation model attempts to take into account the heterogeneity behind the average."(Dekkers et al. , 2012, p 4). Since a number of conditions come into play when considering both benefits granted and the amount

[17]Source: own calculus from INDEC, 2010 Argentinian Census (Censo Nacional de Población, Hogares y Viviendas, 2010).

a given individual must contribute, it was only by going down to the individual level that we deemed possible to precisely study and project ANSES benefits and contributions. Moreover,while these projections will take into account aggregated expected evolutions such as growth rates, productivity gains or activity rates in their scenarios, they should also account for the effects of expected structural changes on Argentina's population due to ageing and to changes in the productive structure of the country. Given the significant economic changes the country has experienced since it defaulted on its debt in early 2002, it is not possible to assume that the labour career of generations about to retire today will be similar to younger generations' when they retire some decades from now.

The descriptive statistics on the EPH all show unemployment but also informal labour have sharply decreased since 2003, implying a rise in contributing workers as we can see in Annex 1. Also, prior to the 1998-2002 crisis, there had been throughout the 1980's and 1990's a very unstable economic situation, with huge fluctuations in employment and formal employment that have not faced younger working generations. Wages have also risen sharply in the last ten years, although it is difficult to measure exactly how much they have since official inflation figures have been mired in controversy since 2007[18]. Given this, we can expect that cohorts that will retire in the coming years will be structurally different from cohorts that have recently retired, will less often benefit from moratorium retirement or family benefits but will on the other hand be entitled to higher benefits. It is hence necessary to take into account this change in structure in working-age population in our social security financing needs' projections, meaning for instance that it is highly likely that in the future most pension benefits will no longer be moratorium or minimum retirement benefits as it is the case today in Argentina.

Here is where the methodological advantages of this technique for our particular problem are relevant. As described by Li and O'Donoghue: " In order to evaluate certain impacts of public policies (...) it is necessary to utilise a long panel data set. In general, such data sets are not available, either because the analysis relates to the future, as in the case of pension forecasts, or because collected data sets do not cover sufficiently long time periods; therefore, analysts use dynamic microsimulation models to assist in their analysis (...). Essentially, microsimulation is a tool to generate synthetic micro-unit based data, which can then be used to answer many "what-if" questions that, otherwise, cannot be answered." (Li and O'Donoghue , 2013, p 4). This synthetic population can hence give detailed consequences on the adoption of different hypothesis for our

[18]This has resulted for some years in gaps of ten percentage points between the consumer price index and the GDP deflator, that before then did not exist with such a magnitude. The implementation, starting from February 2014, of a new National Price Index developed with the support and the monitoring of the IMF however solved this problem, returning significantly higher monthly inflation figures.

scenarios, both demographic and macroeconomic. With this population, we can precisely gauge the structural changes that would derive from an ageing of present-day young cohorts.

One of the methodological challenges this method however entails is the handling of weights. Indeed, as is the case of the EPH dataset, most household surveys are weighted so that the interviewed population is representative of a larger partly surveyed population, whose overall characteristics (age group and gender structure for instance) are known from external sources. Without these, the dataset is simply no longer representative of this broader population that interests the modeler in the first place. The simplest solution from a methodological point of view would be to expand the dataset: if an individual represents n individuals, then we clone it n times and assign a weight of 1 to each of these clones. However, larger datasets imply longer computation times. Although there is an incipient literature of alternative solutions to expanding the dataset[19], in this paper we have chosen to expand the dataset in a limited way. Instead of reaching a weight of 1 for each clone, we create a limited amount of clones with lower weights[20]. In the end we get an expanded dataset, where clones with lower weights behave independently from one another, but which does not require large computation capacity or time.

The software that has been chosen for this is LIAM2. This is an open-source and free microsimulation package recently developed by the Belgian Federal Planning Bureau. They state in their user manual that "the goal of the project is to let modelers concentrate on what is strictly specific to their model without having to worry about the technical details. This is achieved by providing a generic microsimulation toolbox which is not tied to a particular model. By making it available for free, our hope is to greatly reduce the development costs (in term of both time and money) of microsimulation models" (Bryon et al. , 2013, 1). It is also capable of making simulations with very large datasets in a limited time. This choice was hence driven for practical reasons.

The choice of empirical transition rates for modeling transitions between labour-market states.

Among different available methods, we have decided to use the simplest and least theoretically demanding one of inputting transition matrices. As Li and O'Donoghue explain, "microsimulation models could use structural behavioural models, reduced form statistical model or simple transition matrix to simulate changes. Behavioural models are grounded in economic theory, in the sense that changes to institutional or market characteristics result in a change in the behaviour of agents within the model. In contrast, reduced form statistical models aim to model the transition probabilities of individual characteristics using related variables. (...) Reduced form models usually (...) assume a stable policy environment implicitly. (...) It is the easiest way to model potential

[19]For instance,Dekkers and Cumpston (2012) propose a method to assign weights to newborns and immigrants.
[20]We warmly thank M. Dekkers, who provided us the code we used for expanding our dataset.

changes with least theoretical considerations"(Li and O'Donoghue , 2013, p 25). We should keep in mind though that "[as] reduced form models and transition matrices (...) usually do not depend on policy parameters, they are not suitable for reform analysis, and are often restricted to simulating status quo only. " (Li, 2013, p. 26). The first version of our model will hence be with an unchanged legislative framework, since we will not for now include individual decision making concerning labour states, the most interesting of which could be retirement decision modeling or transitioning in and out of the informal workforce.

We have defined five distinct activity and inactivity states, in which all our working-age population can be categorised. These are contributing salary workers, contributing independent workers[21], undeclared workers, unemployed, and inactive people. Unfortunately, the EPH does not contain information about registered independent workers: indeed, the questions "for this work, do you have a retirement contribution" or "do you on your own contribute to any retirement system"INDEC (2003, p 22) are only asked to wage-earners. In order to avoid having all independent workers be counted as undeclared workers, we have used methodology from Maurizio (2012) to measure informality among independent workers. Indeed, based on "ILO's 15th and 17th International Conference of Labour Statisticians" recommendations, she assumes that "in the case of independent workers, only those with no professional skills are considered as part of the [informal sector], as an operational way to leave only independent workers with low productivity in this sector"(Maurizio , 2012, p 6). Furthermore, "Also on the ILO's recommendation, given the lack of enough information from household surveys, in the case of independent workers, their formal/informal character is directly determined by the characteristics of their enterprises: informal own-account and employers are those working in enterprises of the [Informal Sector]."Maurizio (2012, p 7). She applies this method to the EPH data set for Argentina and finds "4,4%" of the urban labour market in 2006-2007 was comprised of formal non-wage earners Maurizio (2012, p 11), a figure close to the one we got for that period. We have hence defined independent contributing workers as those working in firms with five or less individuals of the private sector and whose job was not qualified or required only an operative qualification[22].

The computation of these transition matrices will be first made, for descriptive statistic's sake, across different sub-populations categorised by gender, age and education, as seen in Duc et al. (2013) concerning the TRAJECTOIRE microsimulation model. For our prospective simulations past year 2014, we will use an average of transition probabilities since the onset of the international financial crisis, that is starting from transitions between the third and fourth quarters of 2008. We

[21] These pay comparatively less contributions than salary-men and women, but also receive less generous retirement pensions.

[22] As defined in Argentina's 2001 "Clasificador Nacional de Ocupaciones", or National Occupation Classifier.

are taking an average over several years instead of only the last available quarters because labour-market transition probabilities, as will be seen in Section 1.2, are surprisingly stable over the whole period. We also have failed to reject the non-stationarity null hypothesis of the Phillips-Perron test for quarterly transition rates between labour market states between the years 2003 and 2013, after controlling for seasonality. We are not however taking into account transition probabilities previous to the 2008 international financial crisis since, as will be seen in Section 1.2, there are huge changes in the labour-market structure of our population in the 2003-2008 period. This entailed a structural mobility of the workforce out from unemployment and unregistered employment to registered dependent employment, which although did not affect transition probabilities at the aggregate level in a significant way, it may have done so at a more disaggregated level when studying sub-samples that depend on age, gender and level of education. We will hence use the 2008-2014 as our benchmark for prospective transition probabilities as well as for establishing our scenarios regarding the occupation of working-age population. However, even when simulating within the 2003-2014 period with empirical quarterly transition probabilities, we get different simulated population structures than the observed ones. We have hence calibrated our transition probabilities to get a simulated population closer in the 2003-2014 period closer to the actual one, as will be seen in Section 2. We will present further in this paper our calibration methodology, as well as the resulting transition probabilities and simulated labour-market frequences.

1 Transitions in Argentina's labour market: descriptive statistics and transition probabilities.

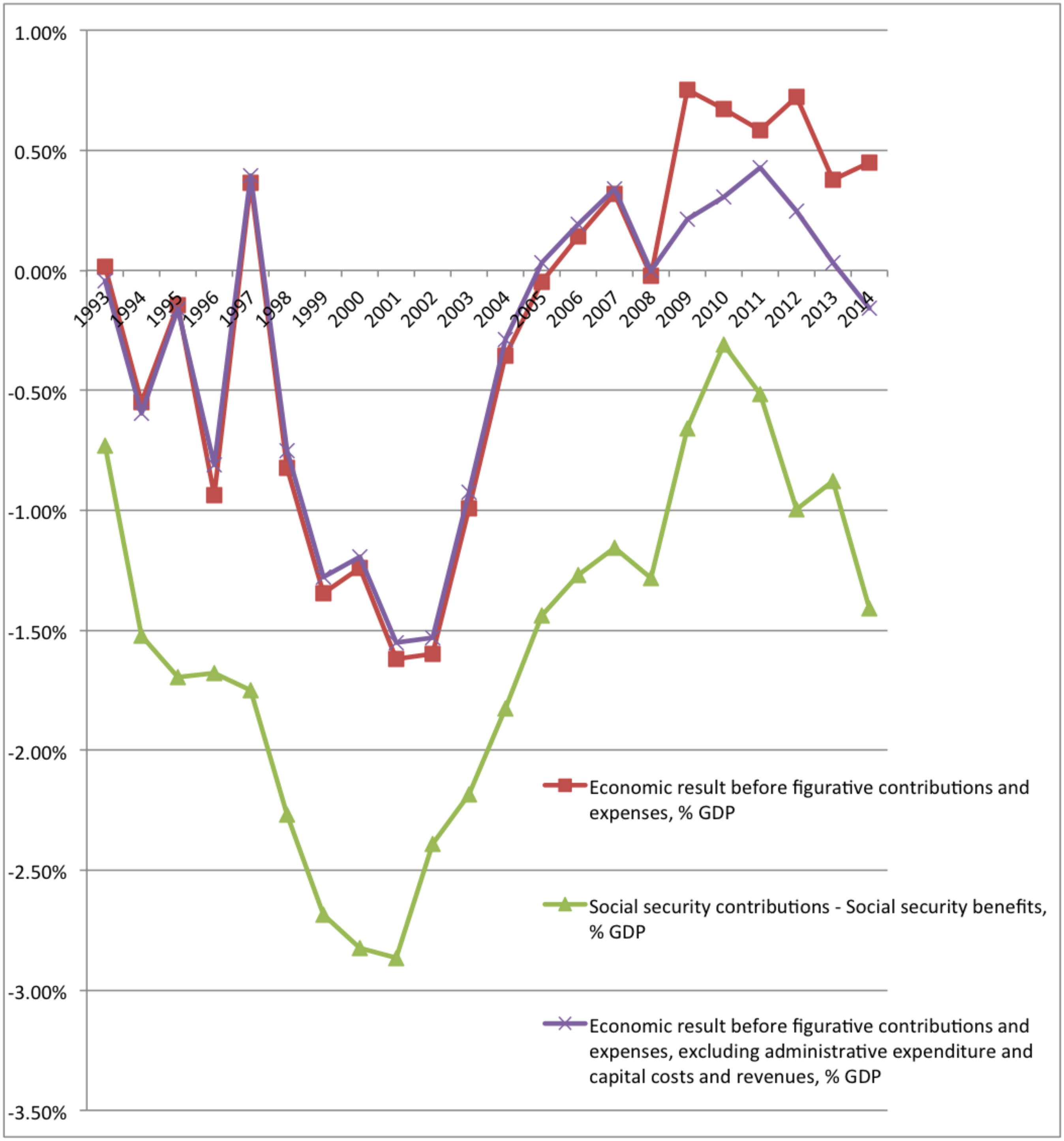
1.1 A brief description of Argentina's social security system.

As we have already said in the introduction, Argentina has a federal Pay-As-You-Go pension system, the SIPA, run by ANSES.

Its story is summarised in Figure 1, which expresses different measures of ANSES economic results. We have a purely social-security balance (that is social security contributions minus social security expenses), ANSES' economic result before contributions (that is, non-figurative revenues minus non-figurative expenses) and finally this same economic result excluding capital expenses and resources, mainly FGS revenues starting from 2008 (which are currently reinvested in the Fund, and as such do not finance ANSES current expenditures), as well as functioning expenses.[23]

[23]Source: own calculus based on CGN data. Data on expenses come from budgetary implementation reports for social security institutions, and data on revenues come from CGN's Savings-Investment-Financing account of Social Security institutions. 2014 data are interim Savings-Investment-Financing scheme evaluations.

Figure 1: ANSES economic result in GDP points.



In the beginning ANSES was the 'poor parent' of a two-pillars system where the fully-funded pillar got most of the contributions and paid the least retirement benefits, with chronic deficits that substantially worsened when the economy entered a recession in 1998. When the recession ended in late 2002, and a substantial economic recovery started only to be interrupted by the 2008 financial crisis, this deficit was gradually curbed, reaching sizeable surpluses of up to 0,5% of GDP in 2007. The onset of the crisis in 2008 together with an acceleration of social security expenses[24]that year lead to a near equilibrium in 2008. From the nationalisation of private pension funds in 2008, if we consider the economic result before figurative contributions and excluding FGS' costs and revenues, we have a surplus of almost 0,5% of GDP in 2011, despite the implementation of new benefits such as the Universal Child Benefit (AUH) in 2010. This surplus was reduced until it nearly reached the equilibrium in 2013, and a slight deficit is projected for 2014. An important point is that ANSES revenues are not all explicitly allocated for the payment of a given benefit, since in any case total contributions to social security have never been enough to pay for social security benefits[25]. That is why it is not possible to exclusively study the sustainability of retirement pensions: it cannot be dissociated from the sustainability of the social security system as a whole.

We believe these figures summarise well the history of ANSES, and help understand better the motivation of the whole project of providing a meaningful projection on this agency's future current balance, given how this balance has strongly fluctuated over time. Now let's focus on the core of our paper: labour-market transition probabilities and the empirical bases for our future projections.

1.2 Empirical vs. calibrated transition probabilities: how do we reproduce the changes in the labour-market structure?

Following the guidelines we established in our methodological section, we first calculated the quarterly labour-market transition rates of the population of working age. A worker can earn a contributive retirement pension if he has reached retirement age (60 for women, 65 for men) and has contributed at least 30 years. He can get a better replacement ratio[26] by contributing more years, until he reaches 35 years of contributions. Since in order to validate a contribution year a worker has to contribute two trimesters in a year, we have chosen to retain a quarterly step in our

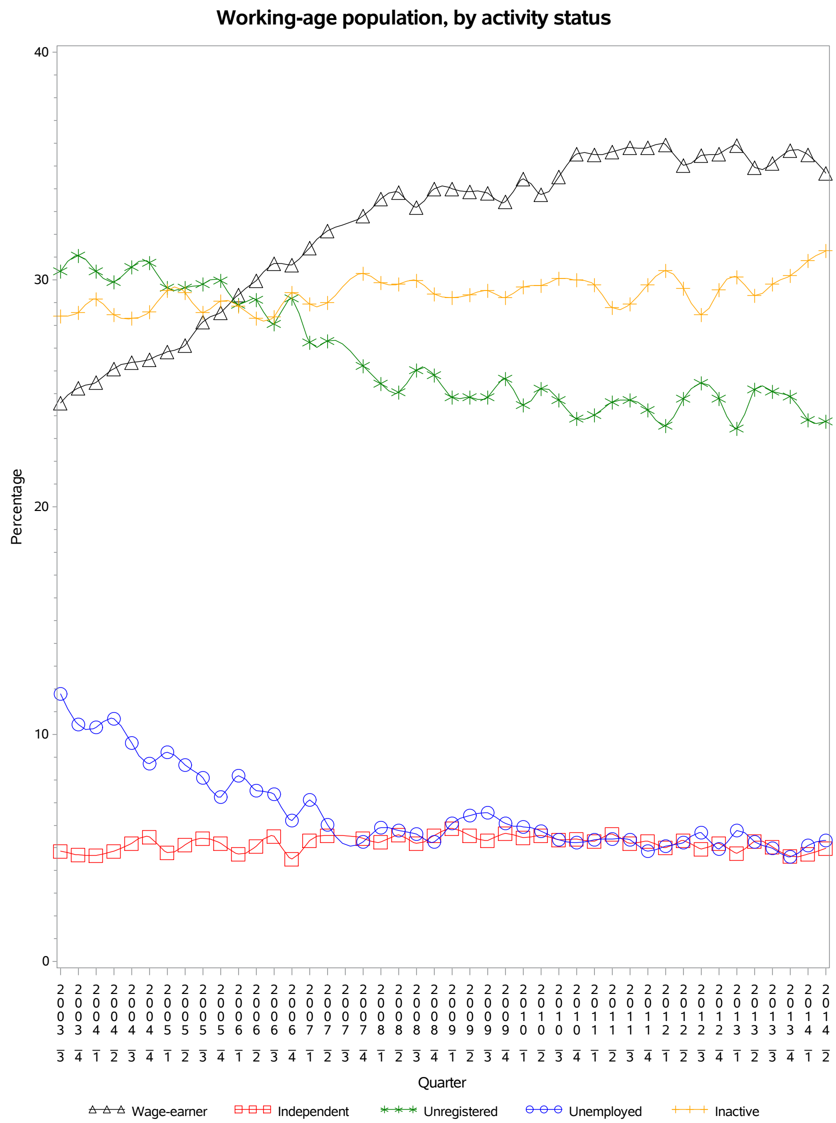
[24] This stems from a combination of factors. The private pension funds nationalisation transferred to ANSES the payment of pensions from the fully-funded system, but mostly the indexation of pensions on wages and ANSES income variation in 2008, as well as the pension moratorium that came into place the same year, highly increased retirement expenses. This was however offset by the rise in contributions stemming from the end of the fully-funded system in 2008.

[25] In 2011, 68% of ANSES revenues excluding government transfers came from social security contributions, 55% including these. Source: own calculus from the Savings-Investment-Financing Account of Social Security Organisms (Contaduría General de la Nación, CGN).

[26] That is, the pension / reference wage ratio.

simulations. After taking into account weightings, we have arrived to the conclusion that these transition rates were surprisingly stable over our 10 year period despite the considerable changes in the occupation status of our working age population. Figure 1 shows the evolution in structure of Argentina's labour market, which has been significant in the 2003-2014 period.

Figure 1: labour-market states as a percentage of working-age population. Argentina, 2003-2013. Source: EPH dataset



We can see that the inactivity rate remained stable at around 30% of working-age population, increasing slightly in the most recent quarters. However, the structure of the active population changed, and Argentina witnessed a significant increase in contributors to social security. Indeed unemployed and unregistered workers as a percentage of working-age population fell respectively from 11,1%[27] to 4,8% and from 30,6% to 24,9% between 2003 and 2013. Hence, contributors to

[27] These figures are taken from Annex 1, which compares the labour market structure of Argentina in the last

social security as a percentage of working-age population rose from about 30% to about 40%, and it increased from 42% to 57% as a percentage of active population in that decade.

Seeing this considerable change in the occupation of Argentinians of working age over time, we were expecting transition probabilities between labour-market states to reflect this and change. However, not only have we measured transition probabilities that were surprisingly stable throughout our dataset, but also the transition probabilities we have estimated ourselves are also remarkably stable, although sometimes quite different from the ones we observed in our dataset. Before we comment their shape as can be seen in Figure 2, let us explain how we adjusted our transition probabilities, which lead us to a better fit of our simulated labour market frequencies with the observed ones in the 2003-2014 period. We used the following alignment routine: using these empirical transition probabilities, as well as a command in our LIAM2 code to align our simulated population to the empirical quarterly labour market frequencies in the 2003-2014 period, we simulated each quarter of our dataset for only one period. Then, we calculated the transition probabilities between the observed population and that same population but aged by one quarter. For instance, we took the population interviewed in the third quarter of 2003 and simulated it for one period, that is, up to the fourth quarter of 2003. We then used these two datasets (the population interviewed in the third quarter of 2003 and this population simulated to the fourth quarter of 2003) to calculate new transition probabilities. Theoretically, we can begin an infinite loop with this routine: we could input these adjusted transition probabilities in our simulations, simulate again our model for one period for each period of our dataset and calculate new adjusted transtition probabilities over and over again. We did this once more, but the readjusted transition probabilities we obtained resulted in a less efficient calibration of our model, as will be seen later, so we sticked with the adjusted probabilities that can be seen in Figure 2.

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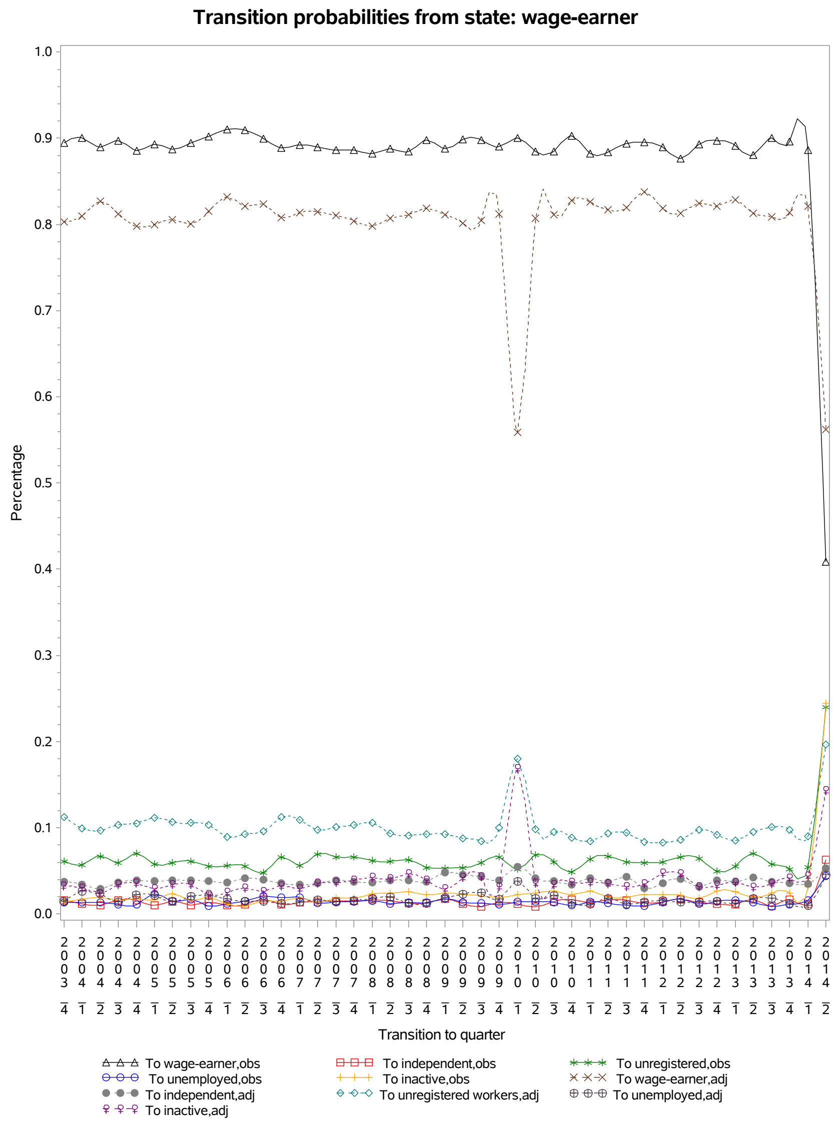
semester of 2003 and of 2013.

Figure 2: Quarterly transition probabilities from the states “wage-earner” and “unemployed” for people of working age, 2003-2014.



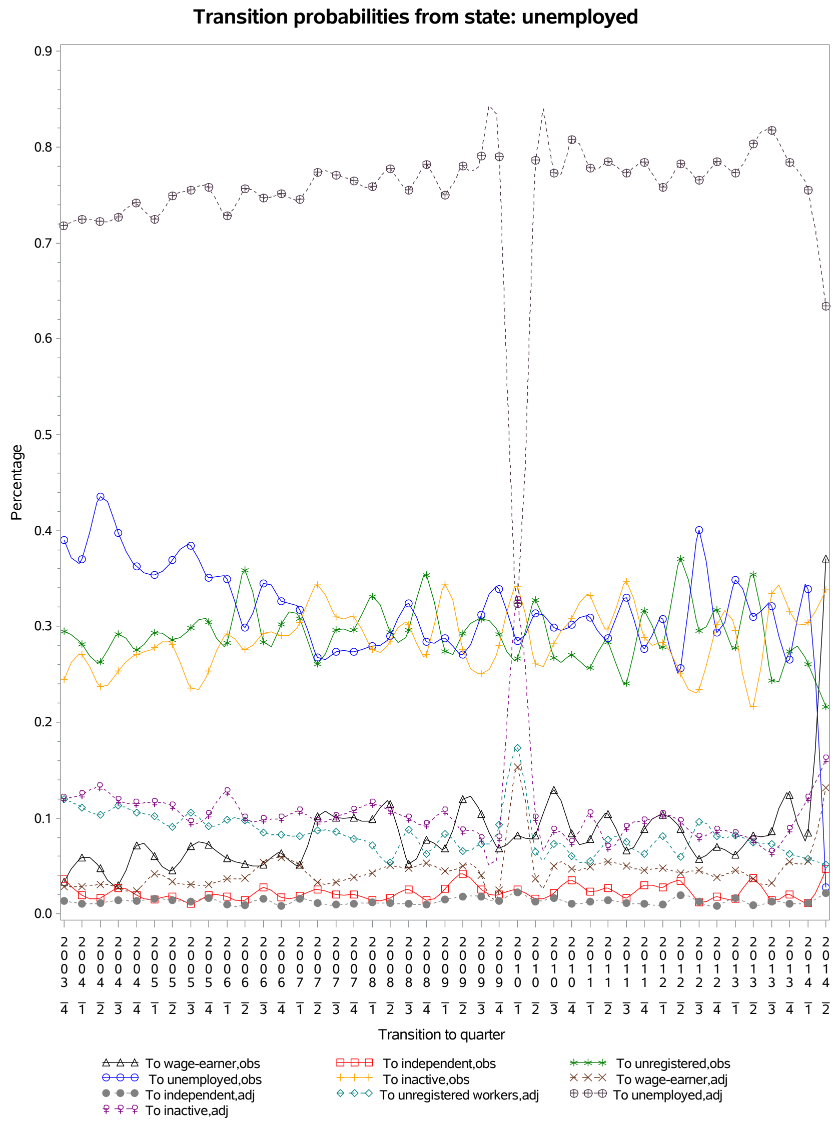


Figure 2 compares measured and adjusted quarterly transition probabilities from the «wage-earner» and «unemployed» status to all five possible labour market statuses. There are a number of conclusions we can draw from these figures. First, we can see that our last period, the second quarter of 2014, is an outlier: both with observed and with adjusted transition probabilities, we see these behave abnormally when studying the first quarter of 2014 / second quarter of 2014 transition. For instance, the observed quarterly transition probability of staying a wage-earner plunges from a value close to 90% to one close to 40% between the penultimate and the last observation. For this reason, we have decided to exclude the second quarter of 2014 from our analysis. Secondly, our adjusted transition probabilities result in a probability of not transiting to a different state that ranges between 75 and 90%, the most absorbent state being inactivity (a stable 90%, not shown here) and our least absorbent state being unemployment (an average of 75%). Usually, the second most common state an individual tends to transit to is unregistered employment, with for instance a 10% probability for wage-earners and the unemployed, with the probabilities of reaching other states being negligible. These adjusted transition probabilities look hence realistic, although they may overestimate transitions out of formal employment for instance.

And finally, both measured and simulated transition probabilities are remarkably stable over the whole period, and furthermore, simulated transition probabilities are even more stable than observed ones (if we exclude the first quarter of 2010 outlier, for which we have not found an explanation for now). We can for instance see that the observed quarterly probability of staying a wage-earner is stable at 90%, while the adjusted one is at 80%. Transition probabilities from the unemployed state do fluctuate more, but the ones we ended up using in our projections are more stable than the ones we measured. An explanation could be that adjusted transition probabilities are computed on a larger population, since on the one hand we have expanded our dataset for our calibrations, and on the other hand we observe the near totality of our dataset in two consecutive quarters. This is not the case for observed transition probabilities because only some of our individuals in a given period are surveyed again in the following period, both because of our dataset's erosion (some individuals are simply not present in the household when they should have been interviewed for a second time) and because of the rotative nature of the EPH dataset, which we previously explained. But in the case of observed transition probabilities, and even when we took into account each sub-sample that resulted from combining gender, education and age group variables, we ruled out the null hypothesis at the 5% threshold on the existence of a trend in these transitions through a Phillips Perron test after taking into account seasonality.

This stability would advocate for averaging our transition probabilities across the whole period. However, we have desisted on doing so because, on the one hand, the transition probabilities that are actually taken into account in our model, that is those computed by sub-samples that depend on age groups, gender and level of education, are more volatile than the ones we present here simply because they are computed with less observations than the ones we show in Figure 2. And on the other hand, it corresponds to a relative stagnation in the repartition of the labour force across different labour market states, as can graphically be seen in Figure 1. We hence find, like Duc et. al., that "descriptive statistics by generation show us a quite important evolution in behaviour between generations". We therefore "avoid using older generations for calibrating the model, since their behaviour does not necessarily mirror more recent generation's" (Duc et al. , 2013, p 17), and use an average of transition probabilities from the second half of our database, where labour-market behaviour seems to have stabilised since the onset of the 2008 international financial crisis. That is, the average of transitions to the fourth quarter of 2008 to transitions to the first quarter of 2014, excluding the outliers we observe in Figure 2.

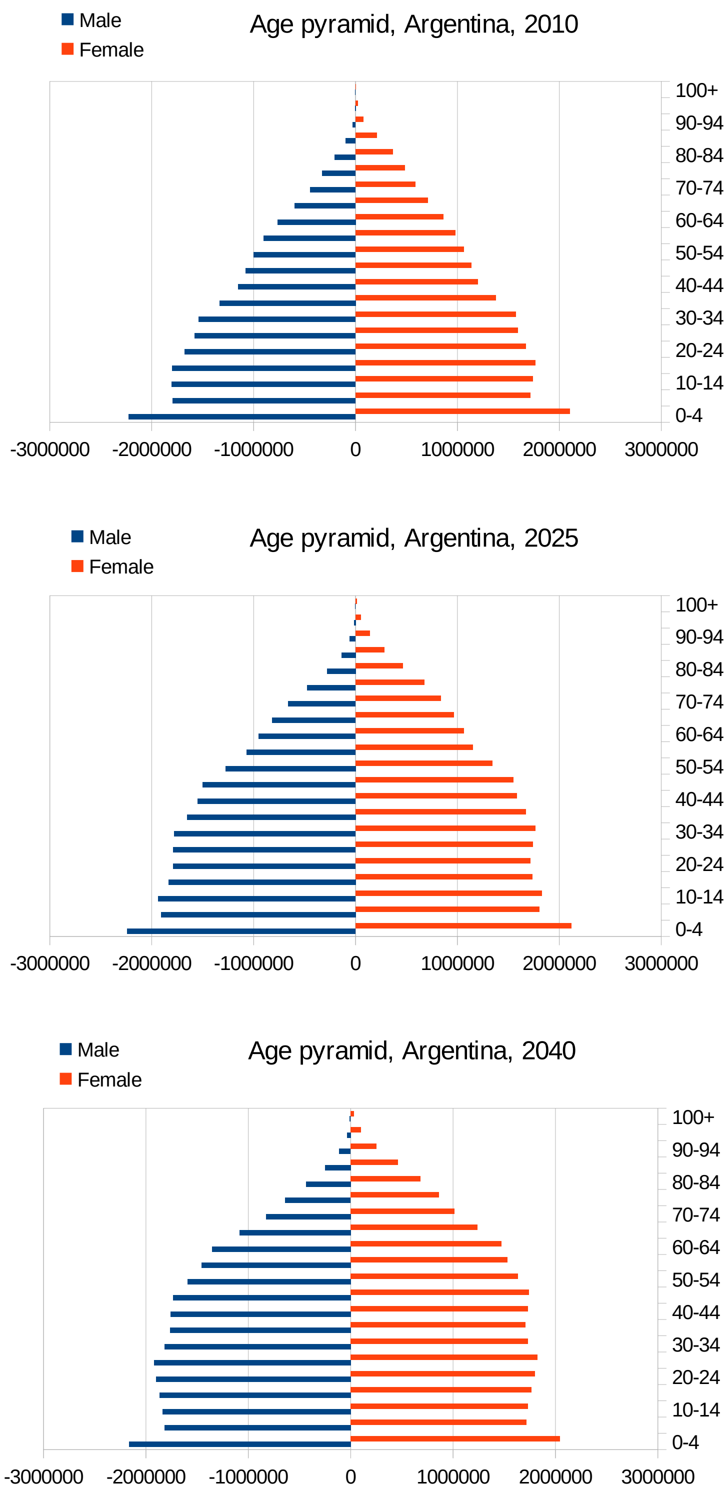
In the end, we have obtained the transition probabilities we need for our prospective and retrospective simulations. The precision with which we reproduce the labour-market frequencies of our dataset's working-age population, that will be seen in Section 2.2, advocates for their use for our projections beyond our available dataset. The second half of this paper lays out the basis for these simulations, leaving us at the threshold of establishing realistic labour force projections for Argentina.

2 Laying the basis for a microsimulation analysis: computing demographic transitions and identifying and correcting discrepancies between the data and simulations.

2.1 An ongoing demographic transition: INDEC's projections on Argentina's population.

The other key input for our future microsimulation are demographic transition rates. The most important ones are conditional probabilities of dying, depending on age and gender, and probabilities of giving birth conditional to the age of the mother. We computed the first ones based on demographic projections from INDEC until 2040, reconstituting year by year the death rates with deaths by age data that the INDEC kindly provided us on demand. The second ones were directly available at INDEC's website, although a possible sophistication could be making these probabilities vary depending on the existing number of children and the civil state of each woman. This will be our baseline demographic scenario, which will result in the following demographic structure of the simulated population, as can be seen in figure 3's demographic pyramids.

Figure 3: Demographic pyramids in 2010, 2025 and 2040.



The estimated population will have undergone a demographic transition, with a progressive drop of fertility and increasing longevity. For instance, The INDEC supposes that by 2040 the fertility rate will be slightly below the population replacement level of 2.1 children per woman. The crucial question that remains out of the scope of this work is whether we should expect it to stabilise at that value or continue falling to levels akin to those of Southern Europe. Our demographic scenarios will be derived from this baseline projection, and we expect them to have a huge impact on the estimated overall sustainability of the pension system, probably bigger than the macroeconomic scenarios we will later on develop.

2.2 Testing the methodology in our data: comparing backwards simulation, forward simulation and actual data in the 2003-2014 period.

As a result of these methodological considerations, and before simulating up to the 2040 horizon, we have run some simulations on the period covered by our database. On the one hand, backwards microsimulation is made using the last available survey excluding the outlier we pointed previously, that is the 2014 first quarter wave, up until the beginning of our database in the third quarter of 2003, supposing there is no migration. Labour-market transitions are determined by reversed transition probabilities: if we know at time t a given individual is in a given state, these are the probability of having been at time t-1 in a given state. On the other hand, we simulate forward the first available surveyed population, that is the 2003 third quarter wave, up until the end of our database. We have computed life tables using data on population and death by age and gender issued by Argentina's Ministry of Health [28], obtaining conditional probabilities of death for the 2003-2009 period, which we complete with the ones we computed for the 2010-2040 projection. From these reports we have also obtained conditional probabilities of giving birth by age.

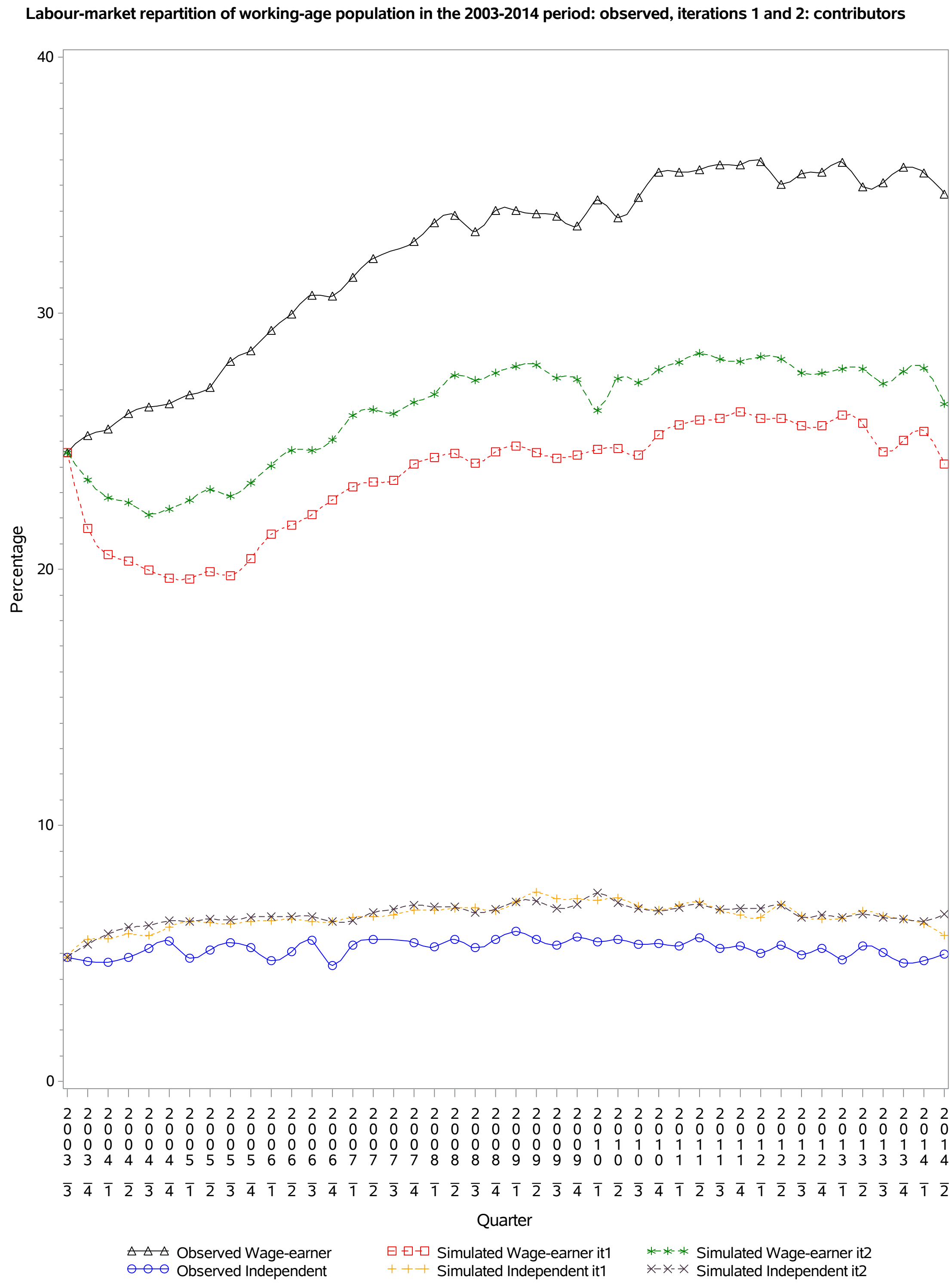
The overall structure of our simulation routine is the following: we start with sub-samples by gender and education level. For instance, let us suppose we want to simulate the transition of men that have not finished high school by agegroup to the state «wage-earner». In that case, we start by assigning to each working-age male individual without high-school level education (let's say it's sub-sample 1) a random score A between 0 and 1, and a score of -1 to any individual outside of this sub-sample. Then we apply to this population the transition probabilities depending on the state they currently are in (the transition probability will be different for unskilled men that already are wage-earners than for men that are, for instance, inactive). The procedure LIAM2 uses for selecting individuals is alignment by sorting: depending on a score variable we input in our code, the program will select the n individuals with the highest score in order to respect the frequencies we tell LIAM2 to align to. That is why we give individuals which we do not want to be selected a

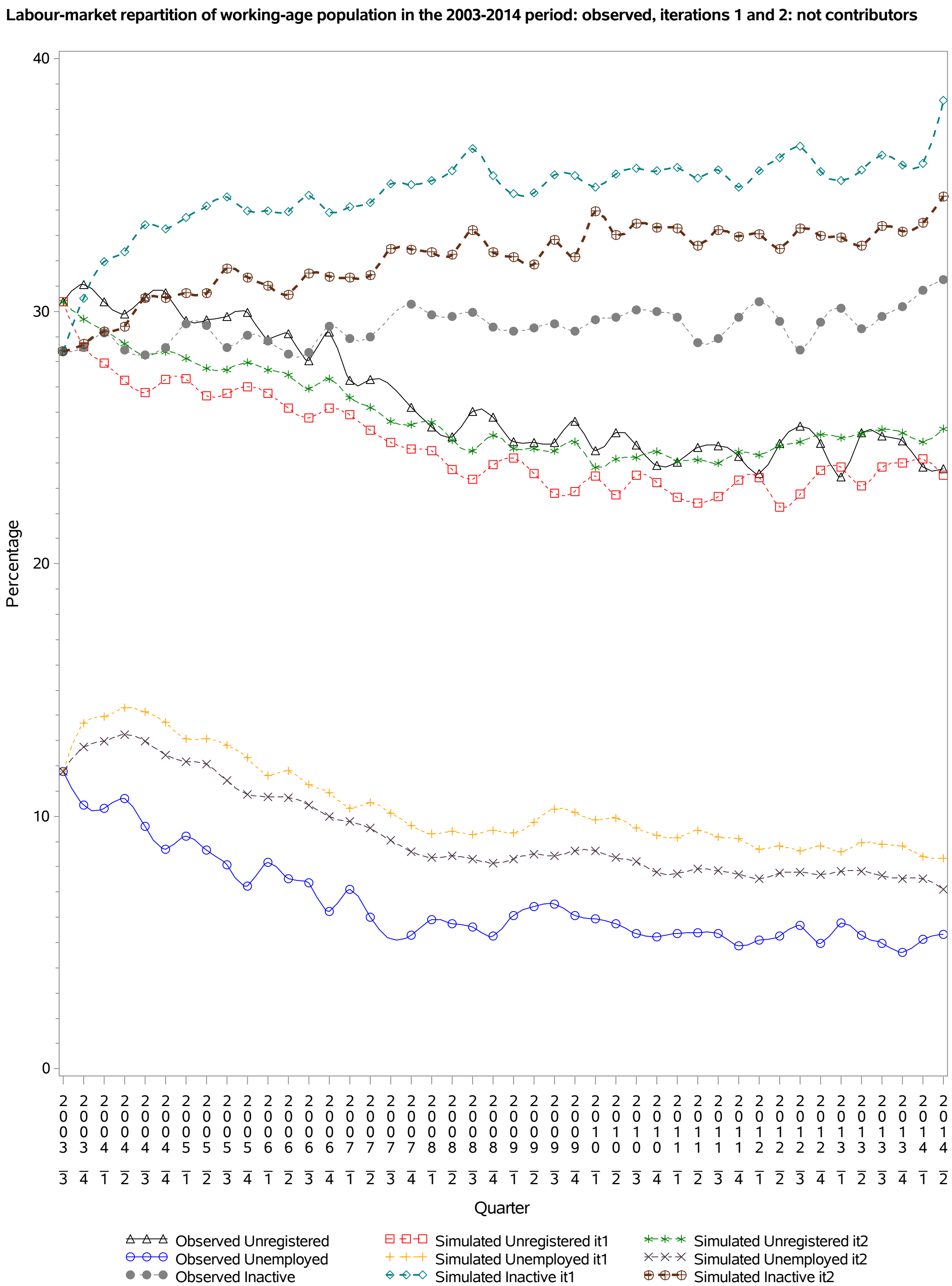
[28]The data is compiled in yearly reports issued by the "Dirección de Estadísticas e Información de Salud" in their "Anuario de Estadísticas vitales" series. These can be downloaded in the following URL: http://www.bvs.org.ar/php/level.php?lang=es&component=31&item=19 .

score A of -1. For individuals that are indeed selected after the alignment to transition probabilities has been done, we give them a random score B_{sal1} comprised between 1 and 2: it indicates which individuals of sub-sample 1 should in priority transit to the wage-earner status. We then align these individuals to the macro frequencies of male wage-earners with the lowest level of education we want to reproduce in an aggregate level. Individuals selected in this alignment process are given a random score C_{sal} comprised between 1 and 2. This score indicates which individuals across any of the sub-samples should in priority transit to the wage-earner status. Once we have given random scores to all individuals depending both on the sub-sample they belong to and on the labour-market state they are transiting to, we align individuals according to score C_{sal} in order to reproduce an overall frequence of wage-earners for all sub-samples (say, 33% of population of working age). We do the same thing for all the other four possible labour-market states (those would be C_{ind}, C_{unr}, C_{une} and C_{ina}). This means that our individual of sub-sample 1 gets a score for transiting to all five possible labour-market states. In the end, we align all individuals according to C_{sal},C_{ind}, C_{unr}, C_{une} and C_{ina}: those selected for C_{sal} are considered to have transited from whatever state they used to be to the wage-earner status. The same thing is done for the other scores, but in such a way that we have at the same time only one selected transition per individual and an aggregate amount of transitions that reproduce the desired labour-market frequencies for the simulated period both at the sub-sample level and at the aggregate level. This way, we model labour-market transitions both in a micro-level by applying labour-market transition probabilities and in different aggregate levels in order to get a plausible overall population.

The result of both the adjustment of transition probabilities as seen in Figure 2 and of this simulation routine as described in the above paragraph results in Figures 4 and 5. Figure 4 compares the evolution of n Figure 4, we have graphed the gap between observed frequencies and forward simulated frequencies, both calibrated and non calibrated for population of working age. In Figure 5 we have done the same thing for backward simulation.

Figure 4: Forward simulations from 2003 compared to 2003-2014 data: first and second iteration.

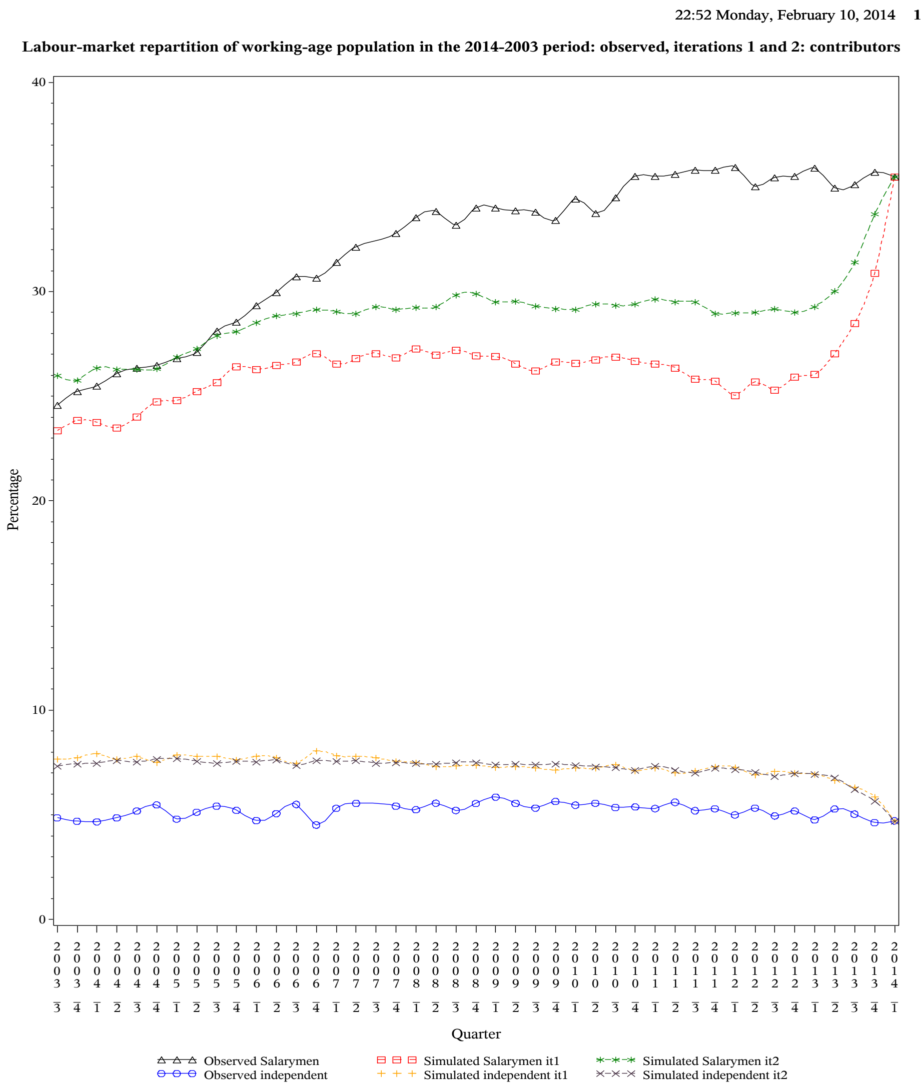


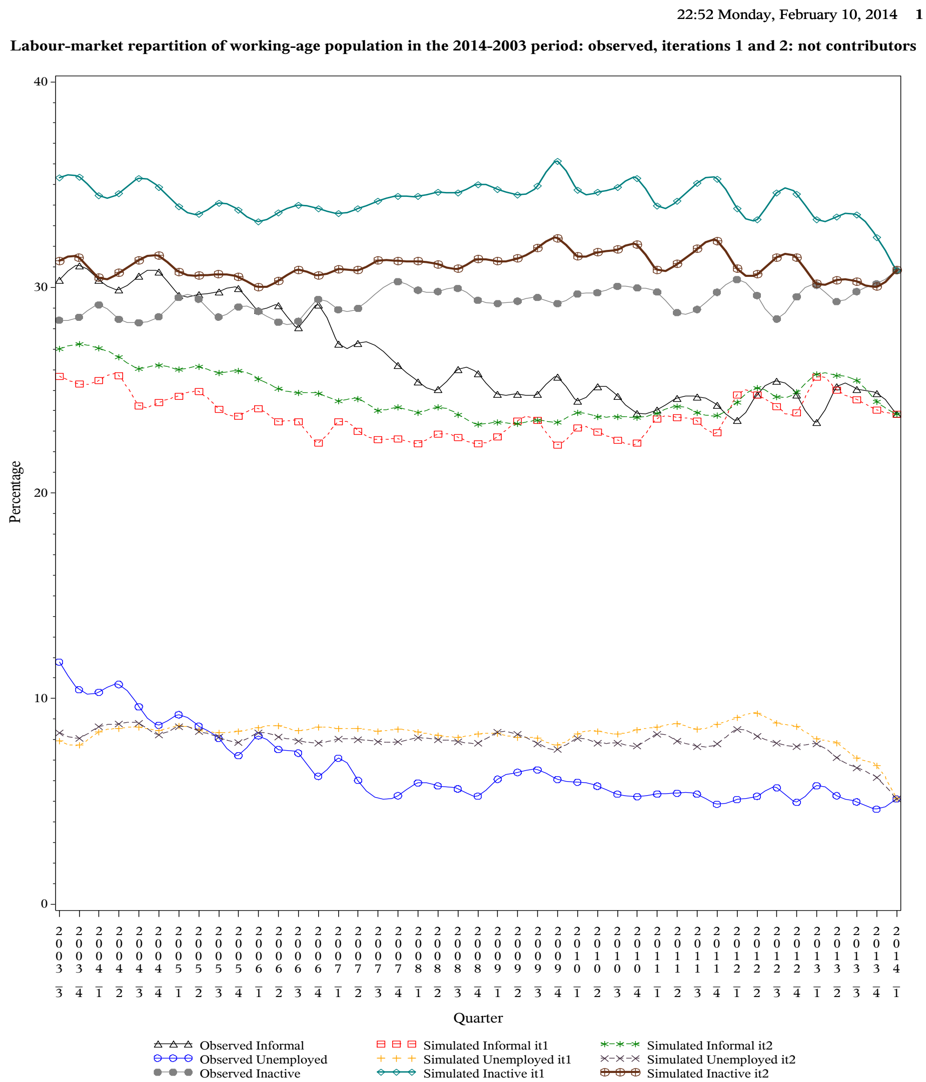


The calibration is satisfactory, and is better with the second iteration (that is, when we make our calibration routine as described above with the adjusted transition probabilities) for all frequencies. The labour-market state that is worse reproduced is wage-earner, with an underestimation of at worst ten percentage points, but the other states are well reproduced, in particular the unregistered worker state. The main explanation we can find for this here is that we have taken the first available period (2003 third quarter) and have simulated it forward up until 2014. However, this comprises the first half of our dataset, the 2003-2008 period where the changes in the activity of the labour force were drastic, particularly a sharp increase in wage-earners as a percentage of the working age population. We will not have this problem for our prospective simulations: indeed, we are not assuming in our scenarios a rapid change in labour-market frequencies, and so far have been able to proprerly reproduce a pessimist scenario where economic stagnation such as the one expeirenced during this crisis results in stables labour-market frequencies, with a slight rise in unregistered labour at the expense of registered dependent employment, as can be seen in Annex 2. The persisting gap between our simulations and our dataset may come from two contradictory objectives: on the one hand, simulating labour market transitions that are realistic at the micro level, and on the other hand, obtaining plausible aggregate employment levels. We have concluded our misreproduction of the wage-earner labour market status is not a big problem, and hence can continue with our prospective simulations on the basis of these calibrations. Since we have not yet carried out the corresponding retrospective simulation that would make it possible to simulate plausible labour careers in our population, we cannot conclude for now regarding to what retirement benefits upcoming generations upon retirement will be entitled. Annex 2 however illustrates how our model can reproduce a realistic, stable scenario with moderate labour force occupation changes over time (apart from a significiant initial drop in wage-earners as a percentage of working age population), and serves as an illustration of our future work.

Regarding backwards microsimulation, crucial for reconstituting a contributing record of each individual in our database compute their pension, we get a similar problem, as pictured in Figure 5.

Figure 5: Backward simulation from 2014 compared to 2003-2014 data.





We get a similar discrepancy between simulated and actual labour market frequencies: wage-earners are underestimated, while other categories are quite well matched. However, the frequency of wage-earners is correctly estimated at the end of the period. This discrepancy between our retrospective simulations and the actual data is problematic, although it remains within acceptable limits. Even though it should result in less favourable careers for our simulated individuals than the ones they most likely actually expierienced, it should not pose too big a problem, and if it does we can always calibrate differently our model to make it better reproduce our dataset.

Conclusion

All in all, in the current state of our work, we have obtained all the input necessary for carrying out a basic forward microsimulation in order to study the social security system of an emerging country, Argentina. We have estimated empirical transition rates that depend on age, gender and formation, and inputted conditional death and birth rates as part of our centra demographic scenario. We then calibrated these empirical transition rates with our dataset in the 2003-2014 period and achieved to better reproduce the labour-market structure of our dataset, through adjusting our quarterly labour market transition probabilities. Since we have achieved a satisfactory calibration of our labour-market structure at the aggregate level while at the same time keeping a realistic behaviour at the micro level, we have been able to make a plausible forward simulation of our surveyed population up to 2040, which basically reproduces a pessimistic scenario of stagnation and progressive deterioration of Argentina's labour market, as can be seen in Annex 2. Once we have made a backward simulation to reconstitute past contributed years, we will have reconstituted for each individual in our dataset retiring in the 2014-2040 period a plausible labour career and hence the replacement ratio he will be eligible to at retirement.

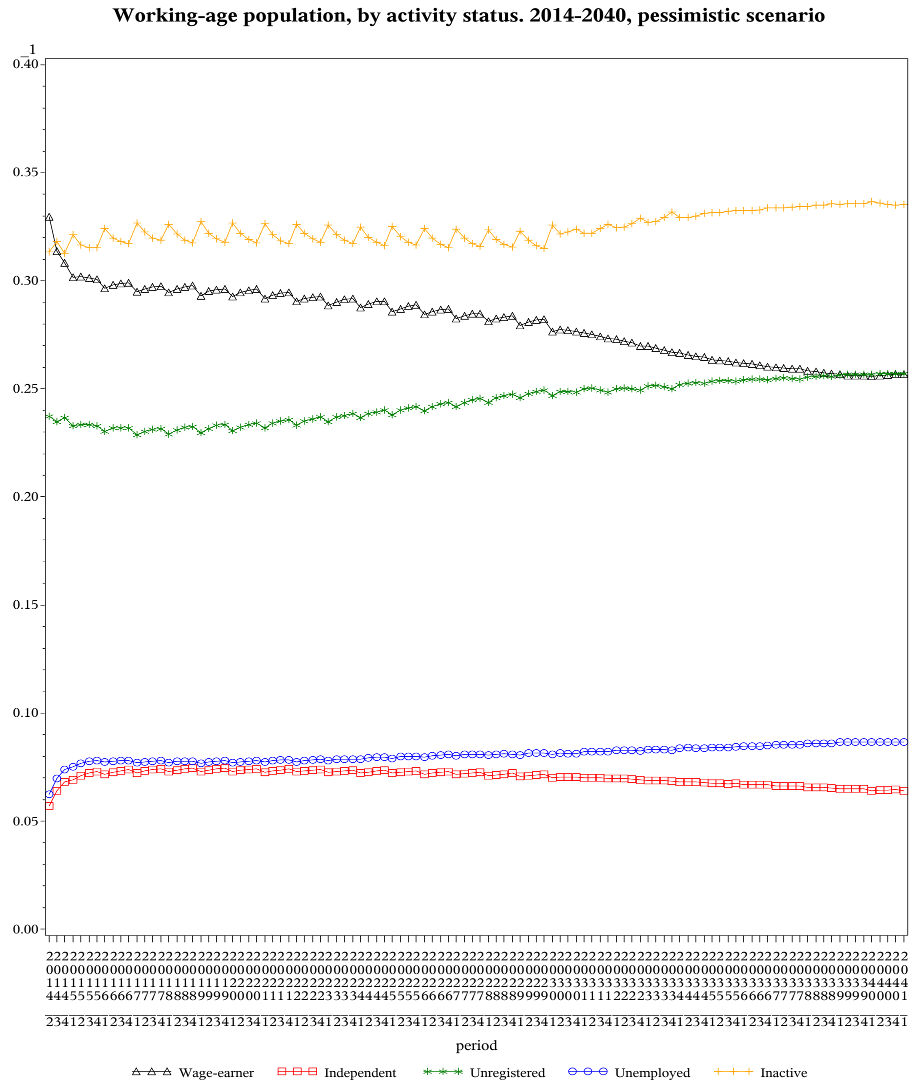
Future developments will include wage functions to simulate future and past wages in order to calculate the reference wage and hence determine the retirement pension each individual is entitled to at retirement. It will also compute total contributions by individual, helping us simulate total contributions to social security. On the other hand, we intend to carry out a civil state modelisation, with matching functions for simulating marriage and divorce. This should help us simulate the beneficiaries of non-retirement benefits, such as survivors pensions, but also contributive and non-contributive family benefits. These objectives are bound to take time to achieve, but we are, nevertheless, quite confident we will ultimately build a comprehensive microsimulation of social security expenses and contributions, producing reliable forecasts for Argentina's social security system evolution and future financing needs.

Annex 1:Labour-market states in working-age population in the last semester of 2003 versus the last semester of 2013. Source, EPH data set.

Table of Gender by Workstate : working-age population, 2003						
Gender	Workstate					
Percent Row Pct Col Pct	Unregistered worker	Unemployed worker	Inactive	Independent worker	Wage-earner	Total
Men	17.23 35.25 56.27	5.53 11.32 50.10	8.19 16.75 28.50	3.13 6.40 65.61	14.81 30.29 59.62	48.89
Women	13.39 26.20 43.73	5.51 10.78 49.90	20.54 40.18 71.50	1.64 3.21 34.39	10.03 19.63 40.38	51.11
Total	30.62	11.05	28.72	4.77	24.84	100.00

Table of Gender by Workstate : working-age population, 2013						
Gender	Workstate					
Percent Row Pct Col Pct	Unregistered worker	Unemployed worker	Inactive	Independent worker	Wage-earner	Total
Men	14.98 30.04 60.15	2.30 4.62 48.37	9.15 18.35 30.28	3.23 6.48 66.80	20.21 40.52 57.31	49.88
Women	9.93 19.81 39.85	2.46 4.91 51.63	21.07 42.04 69.72	1.61 3.21 33.20	15.06 30.04 42.69	50.12
Total	24.91	4.76	30.22	4.84	35.27	100.00

Annex 2: Aggregate labour-market frequencies as simulated for the 2014-2040 period, pessimistic scenario



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