Effects of Legal and Unauthorized Immigration on the U.S. Social Security System*

Hugo Benítez-Silva† Eva Cárceles-Poveda‡ Selçuk Eren§
Yi Zhang¶

August 3, 2011

Abstract

Immigration is having an increasingly important effect on the social insurance system in the United States. On the one hand, eligible legal immigrants have the right to eventually receive pension benefits, but also rely on other aspects of the social insurance system such as health care, disability, unemployment insurance, and welfare programs, while most of their savings have direct positive effects on the domestic economy. On the other hand, undocumented immigrants contribute to the system through taxed wages, but they are not eligible for these programs unless they attain legal status, and a large proportion of their savings translates into remittances which have no direct effects on the domestic economy. Moreover, a significant percentage of immigrants migrate back to their countries of origin after a relatively short period of time, and their savings while in the US are predominantly in the form of remittances. Therefore, any analysis that tries to understand the impact of immigrant workers on the overall system has to take into account the decisions and events these individuals face throughout their lives, as well as the use of the government programs they are entitled to. We propose a life-cycle OLG model in a General Equilibrium framework of legal and undocumented immigrants' decisions regarding consumption, savings, labor supply and program participation to analyze their role in the financial sustainability of the system. Our analysis will help understand the effects of potential policy changes, such as giving undocumented immigrants legal status, on the future of the social insurance system, and the economy in the United States.

JEL Codes: J14, J26, J65

Keywords: Legal and undocumented immigration, Social Security, remittances, life-cycle models, OLG Models, GE models

*We gratefully acknowledge the support from the SSA through grant number UM11-07 of the Michigan Retirement Research Center, and the useful comments and suggestion of participants at the 2011 MRRC Research Workshop, and the applied micro workshop at Stony Brook. The usual disclaimer applies.

†SUNY at Stony Brook, hugo.benitez-silva@sunysb.edu

‡SUNY at Stony Brook, ecarcelespov@notes.cc.sunysb.edu

§Levy Economics Institute of Bard College, eren@levy.org

¶SUNY at Stony Brook

1 Introduction and Motivation

The effect of immigration on the social insurance system is a policy issue of growing importance, and it needs to be carefully analyzed and discussed by economists and policy makers. Immigration into the United States has grown rapidly for the last four decades. The foreign-born share of the U.S. population went up from 5 to 12.5 percent, between 1970 and 2007 (Borjas 2009). In fact, the foreign born population reached approximately 40.1 million by 2009 with almost 30 percent of the foreign born entering the United States within the last decade (American Community Survey 2009). Moreover, the immigrant population aged during the time period, and the share of immigrants older than age 65 went up from 8 percent during the 1990s to 12.5 percent by 2008.[1] While research on the effects of migrants on local labor markets has attracted considerable attention,[2] the importance of understanding the effect of immigration on public programs has only recently being recognized.[3]

In a Pay As You Go system, increased immigration has a positive effect on the health of the public pension system, at least in the short and medium run. Migrants who work pay their labor taxes, and given that these individuals are generally young, their taxes are used to support the benefits payments of the older generations.[4] The long run effects on the system, however, will depend on whether these immigrants are net contributors to the system given their wage paths, their labor histories, program participation, length of stay in the U.S. and their other needs likely to be covered by the social insurance system in place. To determine this, one needs to take into account several important dimensions. First of all, legal immigrants not only have the right to eventually receive pension benefits, but also disability, health care, and unemployment insurance. In fact, they may be more likely to receive some of these benefits given their characteristics and constraints when they arrive in the United States.[5] Second of all, undocumented immigrants (estimated to be around 11 to 12 million people with more than half of them coming from Mexico) pay taxes but are in principle not eligible, becoming net contributors to the system. However,

[1] In fact 17 percent of the legal immigrant adults is above age 65, but only 1.3 percent of the unauthorized immigrant adults is above that age, compared with 16.4 percent for U.S. native adults (Passel 2009).

[2] See Greenwood (1975, 1997), Borjas (1994) Friedberg and Hunt (1995), Lucas (1997), and Gallup (1997). HDR (2009) provides an illuminating discussion of current trends and possible policy reforms related to international migration.

[3] See Lee and Miller (1997, 2000), Bonin, Raffelhschen, and Walliser (2000), Storesletten (2000, 2003), Auerbach and Oreopolis (2000), Collado, Iturbe-Ormaetxe, and Valera (2004), Schou (2006), and Sand and Razin (2007).

[4] The statement is certainly true for legal immigrants. Moreover, as Porter (2005) reports, undocumented immigrants, working under Individual Taxpayer Identification Numbers or sometimes fake Social Security numbers, in many cases also pay Social Security taxes but are unlikely to receive the benefits from their withholdings, suggesting that at least in this dimension, undocumented immigration contributes positively to the financial health of the system.

[5] Borjas and Hilton (1996) document the differential usage of public programs by immigrants.

they may obtain legal status, in which case their characteristics and comparatively lower health investments will probably make them more costly for the social insurance system. Third, around 30 percent of immigrants migrate back to their countries of origin within 10 years of immigration (Duleep and Dowhan 2008a) possibly losing eligibility to the social programs due to short spell of work in the U.S.[6] We therefore conclude that any analysis that tries to understand the impact of immigrant workers on the overall system has to take into account the decisions and events different types of immigrants face throughout their lives, as well as the use of all the government programs they are entitled to. Empirically, when we look at individual programs, we find that 14 percent of immigrants older than age 25 were participating in Social Security compared to 20 percent of natives in the same age group. This is not surprising due to differences in age distribution as well as the differing rates in length of stay in the United States.

An important issue, and key aspect of our research, when considering possible reforms to the system is the tension between the decisions regarding domestic savings and remittances that immigrants make. In the General Equilibrium framework we present we make this explicit, and analyze the differential effects on the economy between resources saved in the host country vs. resources sent back to the country of origin is major. The former foster economic growth, while the latter do not improve the economic conditions of the country. If documented immigrants save more domestically, while undocumented immigrants send a higher proportion of their resources overseas, any reform might have a sizable positive effect on economic growth via savings, but the final effect is a function of the possible increase in the social insurance expenditures linked with creating a framework in which the number of undocumented immigrants who have lived in the US for a long time is minimized.

Regarding remittances, immigrants that are planning to stay longer are less likely to send money back home, in return save more money to increase their capital and future earnings. This is important information, and when coupled with the evidence from the Mexican Migrant Survey (2005), which indicates that 38 percent of those who do not have legal U.S. identification plan to return back to Mexico within a five year period, points in the direction of the differential savings vehicles we have mentioned above. In terms of orders of magnitude, according to the Mexican Migration Project, 65 percent of immigrants sent back remittances on a monthly basis with the average monthly remittance nearing 266 dollars in real terms.

The objective of the analysis is to understand the long term effects of legal and unauthorized immigration on the financial viability of the U.S. economy in general, and the

[6]Depending on the country of origin some legal immigrants might receive Social Security benefits after working for a period in their countries thanks to reciprocity agreements subscribed by the U.S. According to Passel (1999), only 25 percent of undocumented immigrants stay more than 10 years in the United States.

Social Security system in particular. We present an equilibrium model of the key decisions of immigrants. We analyze their decisions regarding labor supply, consumption, wealth accumulation, retirement and health investments, and we will account for the different incentive structures and eligibility rules faced by legal and undocumented immigrants regarding their retirement and disability application decisions, their health coverage, and their unemployment benefits and return migration probability. We propose the equilibrium setting to account for the macroeconomic effects of immigration, since the general equilibrium effects of migration are particularly important when studying the sustainability of social insurance programs, since changes in wages and interest rates affect directly the government budget through changes in tax revenues and government debt.[7] Additionally, as mentioned earlier, the differential savings strategies of documented and undocumented immigrants, and their effect on economic growth, makes this equilibrium framework a key aspect in order to understand the effects of possible reforms to the system.

The set up of the problem faced by legal and undocumented immigrants is a multi-period problem in which individuals start their careers in the host country around the age of entering the labor market. Given the empirical evidence, immigrants start with relatively low wages but within a decade legal immigrants can obtain levels of wages more in line with those of natives while undocumented immigrants continue to earn substantially less. From the ACS 2009, we find that immigrants and natives had the same rate of gainful employment at 78 percent, and immigrants (without distinction between legal and undocumented) were making approximately $3,200 less on salary and wage income compared to their native counterparts. In the model, immigrants are able to choose how much to work, consume and save. Their work, which can be full-time or part-time obtains wages which are uncertain, and also is subject to unemployment uncertainty, which we model following the empirical evidence on unemployment probabilities and durations. Individuals can also choose not to work, but in that case legal immigrants do not receive unemployment benefits. The wages are taxed independent of the legal status, and legal immigrants may receive a public pension when they reach a certain age, as well as be covered by disability insurance, and unemployment insurance if needed. Undocumented immigrants face deportation uncertainty, and also the possibility of becoming legal immigrants. The latter is an important feature of our model, given that legalized immigrants have access to the full array of social insurance programs, and their characteristics and choices up to then suggest that they will receive comparatively higher public support than natives and originally legal immigrants. Both legal and undocumented immigrants may

[7]Most research, including Storesletten's (2000) general equilibrium setting, does not account for the endogenous participation of immigrants in social insurance programs. Kemnitz (2003) does account for the presence of unemployment insurance but not other programs.

also choose to migrate back to their countries, but in that case legal immigrants might lose the eligibility for social insurance. A key aspect mentioned earlier is the savings behavior of these different types of immigrants. Legal immigrants save mostly through domestic accumulation of capital, which in our model is directly linked with economic growth. On the other hand, undocumented immigrants save approximately the same amount but this is mostly reflected through remittances back to their countries of origin. The key results of our model regarding reforms to the system come from the tension between the positive effects on economic growth of legalizing certain undocumented immigrants vs. the possible increased social insurance costs coming from those newly legal immigrants who now have the right to use the system without constraints.

As reflected in the discussion above, the model should distinguish between documented and unauthorized immigrants. We use Passel's (1999) residual approach to identify and assign status to immigrants in CPS data, the American Community Survey (ACS), and use intensively the Mexican Migrant Survey of 2005. Wages are separately modeled for legal and undocumented immigrants following the empirical evidence from the ACS and the Mexican Migrant Survey.[8]

The model we propose is computationally intensive but manageable given our experience with these types of models in the retirement and health literature.[9]

The first version of the model we present is a multi-period OLG model in which we have two types of immigrants, which differ in several dimensions. The two key dimensions have to do with savings and usage of the social insurance system. Legal migrants save a much larger proportion of their income domestically, which has a positive effect on economic growth, while undocumented immigrants choose remittances as their main way to save, which only affect positively the country of origin of those immigrants. Regarding usage of the social insurance system, legal immigrants are in this case the main users, with undocumented immigrants not been able to benefit from it almost at all. Additionally, these two groups face different return probabilities, different employment uncertainty, different wages, and in the case of undocumented immigrants, a small probability of becoming legal immigrants. Empirically (using the 2005 Mexican Immigrant Survey), undocumented immigrants are more likely to be single, and a majority of them has been in the US less than 5 years (while a majority of documented immigrants has been in the US for over a decade), but those who are married are more likely to have young children living back in their countries of origin, suggesting they are more likely to need to send

[8]We have benefited from recent work in the area of projecting earnings for immigrants by Duleep and Dowhan (2008a and 2008b).

[9]See Bentez-Silva, Buchinsky, and Rust (2003, 2011), Bentez-Silva and Heiland (2007), Bentez-Silva et al. (2008). Some of the parameters of those models will be useful in our analysis but in other cases we will need to re-estimate the models given the different characteristics of immigrants. We will only focus at this time on individual decisions, and leave the family decisions on labor supply and program participation for future research.

resources back to their countries to support their families.

This model allows us to exemplify a key aspect we believe should be part of the debate regarding immigration reform, which is the tension between the contribution to economic growth of legal and undocumented immigrants, vs. the costs they generate to the system through the usage of social insurance provisions. This trade-off is critical to successfully analyze the optimal type of reform, and also to take into account which variables to consider, when proposing a path to legalize undocumented immigrants.

The structure of the paper is the following. After presenting some empirical evidence on legal and undocumented immigration in Section 2, we describe our model in Section 3. In Section 4 we discuss some simulation results of the household problem, and Section 5 describes the policy experiments we propose and their likely consequences for the economy, and Section 6 concludes.

2 Immigration in the US

2.1 Data on Immigrants

The role of immigration on the Social Security System is two-fold: Legal immigrants contribute taxes to the Social Security Trust Funds. Some return to their country before they work long enough to become eligible for benefits whereas others eventually become beneficiaries of the system. Unfortunately, data is not available on the number of immigrants who emigrate back before becoming eligible to receive benefits from the system. The Social Security Administration, in its projections, assumes that 83 percent of emigrants (estimated to be 30 percent of legal immigrants annually) leave the United States before becoming eligible to receive benefits (Duleep, 1994). Undocumented immigrants, on the other hand, are not able to collect benefits unless they are legalized later while according to SSA actuaries about half of them are assumed to pay social security taxes.

Before discussing the key features of immigration data in our model, we discuss the main stylized facts regarding immigrant population in the United States using data from American Community Survey (2009). Foreign born population reached approximately 40.1 million by 2009 with almost 30 percent of the foreign born entering the United States within the last decade. More than a quarter of the foreign born population was born in Mexico, representing the largest source of immigration to the United States. Immigrant population cluster around prime working age as 79 percent of immigrants were between ages 18 to 65 while only 60 percent of natives were in this age group in 2009. Immigrants and natives had the same rate of gainful employment at 78 percent. Immigrants are slightly more likely to be unemployed with an unemployment rate of 6.4 percent compared to 6.1 percent of natives (Table 1). However, unemployment was more prominent among

recent immigrants as the rate goes up to 7.8 percent among immigrants who entered the United States within the last decade. The same trend holds when we restrict our attention to older individuals (age 40 and over) and differences are even larger with only 4 percent of unemployed among native population in this age group compared to 5.2 percent among immigrants. When it comes to social insurance programs, we observe the opposite trend as immigrants are less likely to be beneficiaries of Social Security Income that includes Old Age benefits as well as permanent Disability Insurance (20.1 percent among natives versus 13.7 percent among immigrants, see Table 1). The difference reflects not only differences in age compositions but also eligibility requirements given the trend hold for older individuals. On the other hand, immigrants are less educated than natives where nearly 27 percent of immigrants lack a high school diploma compared to only 8 percent of natives aged 18 or more lack the education (Table 2). Moreover, there is no increase in education attainment for recent immigrants suggesting that wage gap between immigrants and natives will result lower per worker contributions to social security among immigrants compared to natives.

For the analysis of role of immigration in the model, we need three measures. First is the remittances which reduce the available capital in the United States and varies between unauthorized and legal immigrants and will be further discussed in the next chapters. Unfortunately, there is no single data source available to measure the amount of remittances sent from the United States. We will rely on information from two companion data sets: the Mexican Migration Project (MMP) which started in 1982 to study the migration patterns of Mexicans within Mexico and the United States and the Latin American Migration Project (LAMP) which employs the same methodology to add Latin America and the Caribbean to the Analysis and is a more recent study. In both projects, interviewers gathered a complete life history for the household head that returned to his home country. Datasets include detailed information on past migration experiences in the United States including earnings, taxes paid as well as savings and remittances. Moreover, interviewers administered identical questionnaires to households In the United States from the same communities in these countries and no longer return home. Jointly these two datasets contain ten countries including Mexico, Puerto Rico, Dominican Republic, Nicaragua, Costa Rica, Peru, Haiti, Guatemala, Columbia, and El Salvador. While these datasets are far from complete to give us the whole picture of remittances, these communities correspond to countries that sent more than half of immigrants that are currently settled in the United States. Combining two datasets, we have 9,328 observations. Table 3 shows rates of remittances and savings as well as average monthly remittances and savings with positive values adjusted for inflation to 2010 prices. Nearly two-thirds of all households sent monthly remittances with the average remittance being 409 dollars per month among the households who sent remittances. Sending remittances is more common among unau-

thorized immigrants with nearly three quarters of households with unauthorized heads sent back money home compared to 55 percent among legal immigrants. Monthly average remittances are 12 dollars higher among legal immigrants who actually send home money but this translates into a lower unconditional amount (223 dollars among legal immigrants vs 290 dollars among unauthorized immigrants). When we look at the savings comparison between two groups, we observe that legal immigrants save 300 dollars more on average per month nearly doubling the savings of unauthorized immigrants. We can conclude that, at least on average, legal immigrants keep relatively more of their overall savings within the United States instead of sending them abroad. Similar trends are apparent when we look at educational attainment as well as years resided in the United States. More educated immigrants are less likely to send remittances back home and more likely to save with a higher average amount compared to less educated immigrants. Similarly, the longer an immigrant stays in the United Stated, the less likely that s/he sends money back home while saving more. An important contribution of our study is the introduction of remittances as a factor that reduces the available capital in the United States.

2.2 Focus on the Retirement Decision

Retirement is one key decision made by the agents in the model, so it is important to analyze some features of this decision in our economy. It is important to emphasize that GE OLG models rarely spend a lot of time on the details of the retirement decision, since it requires a great deal of attention to details, which translates into complexities, which are not always convenient to exemplify some of the features that this kind of macro-models usually choose to highlight.

The large retirement literature developed during the 1980s and 1990s in the U.S. focused on explaining the connection between retirement incentives and retirement behavior.[10] It concluded, quite convincingly, that the retirement peaks at age 62 and age 65 could be explained if the full set of incentives were included in the model. However, in the data used in those studies the majority of Americans were claiming benefits at age 65, while in the 1980s and 1990s the peak started to move towards age 62. By the end of the 1990s, around 60% of older Americans were claiming benefits at age 62, and it has stayed at that level, even with the implementation of the 1983 Amendments that penalize early claiming of benefits, and reward late claiming at a higher rate, along with the substantial increase in expected longevity since the 1970s. In fact, as of the end of 2009, 71.86% of men and 74.69% of women claimed Social Security benefits before the Normal Retirement Age (NRA), compared to 36% and 59% in 1970, respectively.[11] Clearly, the

[10]For a survey of this broad retirement literature see Lumsdaine and Mitchell (1999). Hurd (1990), Lumsdaine (1995), and Ruhm (1996) provide good discussions of the earlier literature.

[11]See the Annual Statistical Supplement to the Social Security Bulletin (2009), Table 6A4, and also

economic incentives seem to be insufficient to achieve the objective of prolonging average work lives, given the strong correlation between benefit claiming and labor supply.

In Table 4 we use a Public-Use microdata extract from the Master Beneficiary Record. This public data provided by Social Security allows us to overcome a problem with aggregate data; namely, that we could not separate individuals who claim on their own histories of earnings (workers) from those who claim as dependents. With the microdata we can do that, and in this new table we restrict attention to male workers, who represent the closest empirical counterpart of the agents in our dynamic model. Notice that the average benefits we show are adjusted by the Actuarial Reduction Factors and the Delayed Retirement Credit, which essentially mean that those benefit levels are now actuarially comparable and an approximation to the Primary Insurance Amount (PIA), instead of being in nominal terms like those reported in aggregate statistics. We have made the adjustments to show the striking trend in (actuarially adjusted) benefits in the last few years, in which the level of benefits of those receiving benefits early has increased while the level of those claiming late has decreased quite sharply. Benítez-Silva and Yin (2009) discuss this interesting issue in detail, arguing that has much to do with the elimination of the Earnings Test and the increases in the NRA.

In Table 5 we present the main stylized facts regarding labor supply of older workers, according to data from the Current Population Survey (CPS) in the 1996-2006 period. Firstly, it is quite remarkable that part-time is very stable at all ages: around 12-14% of them are observed working part-time (defined as working less than 35 hours per week). This fact likely reflects the considerable self-selection and labor demand factors that influence the possibility of working part-time, which makes quite challenging to try to match this within our model without relying on some ad-hoc assumption about part-time offer arrival rates which are hard to justify on empirical grounds. It is also important to note that the fraction of people working full-time at age 60+ has increased considerable (especially for those over 61) in the 10 years we present here, which corroborates the aggregate evidence that labor force participation of older workers is on the rise. Finally, the fraction of those not working increases substantially at age 62 and reaches 70% after age 67. More aggregate data, that from BLS, shows a similar and very interesting picture, for both males and females. The labor force participation rate for older Americans has been growing since the mid 1990s. The share of males aged 55-64 in the labor force has increased from 65.5% percent in 1994 to 70.2% percent in 2009 after three decades of decline. This is mainly driven by males aged 60-64, for whom participation rates have risen from around 52% to around 61% during that period. Notice that these are exactly the individuals who become eligible to claim retirement benefits, and are claiming them

the Social Security Bulletin, OASDI Monthly Statistics, 1970 - 2007. The latter statistics are no longer available but are comparable to the ones given in the Statistical Supplement.

predominantly early. At the same time, for males 65 and over the participation rate has also increased substantially, from close to 17% to around 22%. For females the participation rate has continuously increased in the last three decades, from around 40% in 1980 (48.9% in 1994) to 60% in 2009.

3 Methodology and the Model

3.1 Overview

We solve and simulate an extended version of the OLG Life-Cycle model in a General Equilibrium framework, in which individuals maximize expected discounted life-time utility, which in this case depends on consumption and leisure, and individuals face some of the key incentives from social insurance programs, such as retirement incentives, and unemployment insurance. We formally acknowledge that individuals face several sources of uncertainty, including life-time, wage, health, and employment uncertainty.[12] Individuals own the firms of the economy that produce output with constant returns to scale, and maximize profits leading to competitive factor prices, capital and labor. The government collects taxes to provide goods and services, including a Social Security system.

In terms of the role of migration in this model there are three key features, which we discuss in turn below.

First, both legal and undocumented immigrants differ from natives in that part of their savings is in the form of remittances. These remittances are very important in this model for reasons we hope will be obvious soon, and a feature rarely exploited in migration models. One interesting aspect of these remittances is that while immigrants think of them as savings, from the point of view of the US economy they are (strictly speaking) not, because they are not factor into the capital accumulation of the economy, and therefore do not help promote economic growth. In some sense, these savings disappear from the system, even as from the point of view of the agents they provide some instantaneous utility, because individuals care about their relatives in the home country. Remittances are a tough problem to tackle given the empirical evidence we have gathered so far, especially given the fact that we would need them measured for legal and undocumented immigrants. Therefore, we have made the assumption that legal immigrants remit a fraction g_1 of their resources to their home country, and undocumented immigrants remit a fraction g_2. During most of this research we will assume that the latter is larger than the former, but eventually these proportions can be estimated. A generalization of this set

[12]This latter type of uncertainty means in our model that individuals know that as they grow old, and their productivity declines, the probability of losing their jobs might be increasing. This can have a sizable effect on how they assess the benefits provided by early retirement provisions, and even disability benefits.

up would allow remittances to be a continuous choice similar to consumption, something we might consider when extending our already complex model. The key policy move we will discuss later would allow the conversion of some undocumented immigrants to legal immigrants, in our model that will mean that some individuals would switch from making remittances a fraction g_2, to making them a fraction g_1, which in turn would increase the capital stock in the economy, with the positive consequences (which we will describe later) that this has on the economy.

Second, both legal immigrants and undocumented immigrants can in principle decide at any time to move back to their countries. While ideally this should be modeled as a decision, this would require good information not only about whether individuals actually move back, but also about the opportunities that await for them in order to properly characterize this decision. Given how difficult is to trace the moves of immigrants, especially undocumented ones, for the moment we have chosen to model this return migration as a (exogenous) stochastic process. This means that immigrants face some probability of returning to their country, which is only a function of whether they are legal or not, with undocumented immigrants having a much larger probability of returning. If that event occurs, then individuals face a situation equivalent to having a ratio of remittances of 1, or say $g_3 = 1$. This means that in the year previous to the move individuals would still choose to consume optimally, but with some probability they would instantaneously obtain the utility of their full savings in the form of remittances, and otherwise from the point of the model they would have died, since we do not allow re-migration to the US. As a simplification, we are assuming for the moment that those who return to their countries lose any claims they have over their Social Security benefits. The latter should be a function of their experience (quarters of coverage), but short of increasing the complexity of the model by introducing experience as a state variable, we are considering the possibility of allowing older immigrants to return to their countries with the present value of their Social Security benefits, which would still capture the key feature, that those resources leave the economy.

Third, for undocumented immigrants only, bad health or disability have an extra cost not suffered by natives or legal immigrants in our model.[13] Since they do not have insurance, if they fall sick or disabled they face sizable out of pocket health expenditures. Empirically modeling this feature is extremely challenging given the lack of data, so we have chosen a simple (parameterized) setting in which, undocumented immigrants in bad health see a decline in their income in a fraction α_1 to account for the likely costs linked to their health deterioration. Similarly, if they become disabled the fraction they lose is α_2,

[13]In reality, of course, many natives and legal immigrants do not have health insurance, since it it is a choice, and many times linked to employment. A full analysis of health insurance and the consequences on out of pocket health expenditures is out of the scope of this research, but certainly a promising area of research in connection with migration.

which is larger than the previous one. In this General Equillibrium setting, these resources are paid to the government who is providing public goods and services. Therefore, when some undocumented immigrants become legal, the government ceases to receive these resources. Along with the savings in the form of Social Security entitlements not given to undocumented, and unemployment insurance not offered to undocumented, these are the consequences of the policy reform that legalizes immigrants.

The key result of our theoretical model regarding policy changes, comes from the tension between the *positive* effects of a move of some individuals to legal status, which leads to more real savings in the economy, and therefore more capital accumulation which leads to lower interest rates and higher growth, and the *negative* ones in the form of Social Security payments, unemployment insurance payments, and the lack of revenue due to not paying (or having access to certain programs that cover some of these costs) for their health problems. Making this trade-off explicit, is the main contribution of our work.

3.2 Individual Behavior

We assume that individuals maximize the expected discounted stream of future utility, where the per period utility function $u(c, l, h, im, t)$ depends on consumption c, leisure l, health status h, immigration status im, and age t. We specify a utility function for which more consumption is better than less, with agents expressing a moderate level of risk aversion. The flip side of utility of leisure is the disutility of work. We assume that this disutility is an increasing function of age. It is also higher for individuals who are in bad health and lower for individuals with higher human capital (measured by the average wage). In addition, we assume that the worse an individual's health is, the lower their overall level of utility is, holding everything else constant. Moreover, we assume that individuals obtain utility from bequeathing wealth to heirs after they die. This model assumes that individuals are forward looking, and discount future periods at a constant rate β, assumed fixed in our calibration exercises, and equal to 0.96. Individuals can accumulate balances and receive a fixed interest rate of 2%.[14]

We solve this individual part of the life-cycle model by backward induction, and by discretizing the space for the continuous state variables.[15] The terminal age is 100 and the age when individuals are assumed to enter the labor force is 21. Prior to their 62^{nd} birthday, agents in our model make a leisure and consumption decision in each period. At 62 and until age 70, individuals decide on leisure, consumption, and application for retirement benefits, denoted $\{l_t, c_t, ssd_t\}$, at the beginning of each period, where l_t denotes *leisure*, c_t denotes *consumption*, which is treated as a continuous decision variable, and

[14]Table A.1. in the Appendix shows a summary table with the values we use for the key parameters we use in the individual model.

[15]See Rust (1996), and Judd (1998) for a survey of numerical methods in economics.

ssd_t denotes the individual's Social Security *benefit* claiming decisions. We assume two possible values for ssd_t. If ssd_t equals 1 the agent has initiated the receipt of benefits. If the individual has not filed for benefits or is not eligible then ssd_t is equal to 0.

After age 70 it is assumed that all individuals have claimed benefits, and again only consumption and leisure choices are possible. Leisure time is normalized to 1, where $l_t = 1$ is defined as not working at all, $l_t = .543$ corresponds to full-time work, and $l_t = .817$ denotes part-time work. These quantities correspond to the amount of waking time spent non-working, assuming that a full-time job requires 2000 hours per year and a part-time job requires 800 hours per year.

The model allows for four different sources of uncertainty: (a) *lifetime uncertainty*: modeled to match the Life Tables of the United States with age and health specific survival probabilities; (b) *wage uncertainty*: modeled to follow a log-normal distribution function of average wages as explained in more detail below; (c) *health uncertainty*: assumed to evolve in a Markovian fashion using empirical transition probabilities from a variety of household surveys, including the NLSY79 and the HRS. And finally (d) *Employment uncertainty*: modeled following the empirical distributions using the CPS from 1989 to 2006. We will also use data on the 2008-2009 period to approximate the effect on the employment transition probabilities of the current economic crisis. Notice that here only legal immigrants get unemployment insurance.

Given that we allow for employment uncertainty and therefore the possibility of losing a job, it is quite important to model unemployment benefits, which in the United States, and until the current economic crisis, covered individuals during 26 weeks, and at a level of approximately 80% of their previous wage. We will model the latter as a function of the average wage of the individual, which in our framework plays the role of a permanent income measure.

Notice that we have three types of individuals in our model, natives, legal immigrants, and undocumented immigrants. The problem each group is solving is similar, but as we have already mentioned there are some differences, and we will emphasize them further. In the benchmark model the proportions in each group are fixed, but they are subject to change in the policy experiments that consider legalization of some of the undocumented immigrants.

The *state* of an individual at any point during the life cycle can be summarized by six state variables: (i) Current age t; (ii) net (tangible) wealth a_t; (iii) the individual's Social Security benefit claiming state ss_t; (iv) the individual's health status;(v) the individual's average wage, $\overline{w}_t$, and (vi) the individual's immigration status, im, which takes three values, native, legal immigrant and undocumented immigrant.

The legal status will affect the individual's savings decisions, since undocumented immigrants, given their stronger attachment to their country of origin will save a higher

proportion of their resources in the form of remittances, and will also affect the expected income they will keep given the possibility of facing large medical expenditures, with the uninsured facing larger out of pocket expenses due to their lack of insurance.

Another key variable in the model is the average wage, serving two roles: (1) it acts as a measure of *permanent income* that serves as a convenient *sufficient statistic* for capturing serial correlation and predicting the evolution of annual wage earnings; and (2) it is key to accurately model the rules governing payment of the Social Security benefits. In the U.S., an individual's highest 35 years of earnings are averaged and the resulting *Average Indexed Earnings* (AIE) is denoted as $\overline{w}_t$. The PIA is the potential Social Security benefit rate when retiring at the NRA. It is a piece-wise linear, concave function of $\overline{w}_t$, whose value is denoted by $P(\overline{w}_t)$.

In principle, one needs to keep as state variables the entire past earnings history for the computation of $\overline{w}_t$. To avoid this, we follow Benítez-Silva, Buchinsky, and Rust (2011) and approximate the evolution of average wages in a Markovian fashion, i.e., period $t+1$ average wage, $\overline{w}_{t+1}$, is predicted using only age, t, current average wage, $\overline{w}_t$, and current period earnings, y_t. Within a log-normal regression model, we follow Benítez-Silva, Buchinsky, and Rust (2011), such that:

$$\log(\overline{w}_{t+1}) = \gamma_1 + \gamma_2 \log(y_t) + \gamma_3 \log(\overline{w}_t) + \gamma_4 t + \gamma_5 t^2 + \epsilon_t. \tag{1}$$

The R^2 for this type of regression is very high, with an extremely small estimated standard error, resulting from the low variability of the $\{\overline{w}_t\}$ sequences. This is a key aspect of the model given the important computational simplification that allows us to accurately model the Social Security rules in our dynamic programming model with a minimal number of state variables.

We then use the observed sequence of average wages as regressors to estimate the following log-normal regression model of an individual's annual earnings:

$$\log(y_{t+1}) = \alpha_1 + \alpha_2 \log(\overline{w}_t) + \alpha_3 t + \alpha_4 t^2 + \eta_t. \tag{2}$$

This equation describes the evolution of earnings for full-time employment. Part-time workers are assumed to earn a pro-rata share of the full-time earnings level (i.e., part-time earnings are, say, $0.8 \cdot 800/2000$ of the full-time wage level given in equation (2)). The factor of 0.8 here incorporates the assumption that the rate of pay working part-time is 80% of the full-time rate. We actually use data from the CPS in the 1996 to 2006 period to estimate this part-time penalty.[16]

[16]Given the relatively small number of part-time workers at some ages, we had to aggregate across a wide range of ages. Interestingly the penalty decreases with age, likely due to self-selection. For individuals younger than 61 the penalty for part-time work is almost 40%, then decreases to about 25%

The advantage of using $\overline{w}_t$ instead of the actual Average Indexed Earnings, especially in the U.S., is that $\overline{w}_t$ becomes a sufficient statistic for the person's earnings history. Thus we need only keep track of $\overline{w}_t$, and update it recursively using the latest earnings according to (1), rather than having to keep track of the entire earnings history in order to determine the 35 highest earnings years, which the AIE requires.

The Appendix describes the key features of the model regarding retirement and retirement calculations.

3.3 The model

We assume that the individual's utility is given by

$$u_t(c, l, h, t) = \frac{(c)^\gamma - 1}{\gamma} + \phi(t, h, \overline{w}) \log(l) - 2h, \tag{3}$$

where h denotes the health status and $\phi(t, h, \overline{w})$ is a weight function that can be interpreted as the *relative disutility of work*We use the same specification for ϕ and the disutility from working as in Benítez-Silva, Buchinsky, and Rust (2011).[17]

The disutility of work increases with age, and is uniformly higher the worse one's health is. If an individual is in good health, the disutility of work increases much more gradually with age compared to the poor health states. The disutility of work decreases with average wage. We postulate that high wage workers, especially highly educated professionals, have better working conditions than most lower wage blue collar workers, whose jobs are more likely to involve less pleasant, more repetitive, working conditions and a higher level of physical labor.

Since we assume that immigrants send a (exogenous) portion g_i of their resources back to their home country as remittances every year (where i takes the value 1 for legal immigrants, and the value 2 for undocumented ones), after the optimization, which assumes that these resources are akin to savings, eventhough they do not enter the capital formation process of the economy, a term $im * (g_i) * (a_t - c_t)$ with the CRRA formulation as the consumption term above, is added to the utility function. Notice that this term im takes the value 0 for natives, the value 1 for legal immigrants, and the value 2 for undocumented immigrants.

We assume that there are no time or financial costs involved in applying for retirement benefits. The parameter γ indexes the individual's level of risk aversion. As $\gamma \to 0$ the utility of consumption approaches $\log(c)$. We use $\gamma = -.37$, which corresponds to a moderate degree of risk aversion, i.e., implied behavior that is slightly more risk

for those between 61 and 64, and finally declines to around 20% for those 65 and older.

[17] İnmohoroğlu and Kitao (2009a) discuss the role of different utility characterizations when using a an extended version of this kind of models to simulate Social Security reform.

averse than that implied by logarithmic preferences. This specification has been used and discussed by Benítez-Silva, Buchinsky, and Rust (2003, 2011), and also in Benítez-Silva and Heiland (2007).

Thus, the expected present discounted value of utility from age t onward for an individual with state variables $(a, \overline{w}, ss)$ where a stands for assets, is represented by the following two Bellman equations that correspond to the core of the model we are analyzing. We separate the value of being employed and the value of being unemployed. One of the keys of the model is that we are adding the probability of losing a job to a dynamic life cycle model of consumption, asset accumulation and retirement. In each case we first present the case for the natives, and then discuss how the formulation changes for immigrants.

The value of being employed

$$\begin{aligned} V_{1,\tau}^{t}(a, \overline{w}, ss) &= \max_{c_t, \tau, ssd} U(c_t, L_{\tau,t}) + \\ & \beta \left[(1-\delta)\ Emax\ (V_{1,\tau}^{t+1}(w_t), V_{1,\tau}^{t+1}(x)) + \delta\ V_{0,\tau}^{t+1}\right] \end{aligned} \tag{4}$$

subject to,

$$L_\tau = L(1 - I_\tau) + I_\tau$$

$$a_{t+1} = (1 + \overline{r})(a_t - c_t) + w_t(1 - I_\tau) + I_\tau P_t \tag{5}$$

For immigrants, the key differences come through the budget constraint. First of all, the asset accumulation equation is slightly different, because next period resources are affected by remittances, which we here model as exogenous, in the sense that legal and undocumented immigrants send a (different) portion of their savings back to their countries, and while we call it savings they enter in the constraint more as consumption. However, we have to be careful with the GE implications of this "quasi-consumption" nature of remittances, because for the economy as a whole they are neither savings, nor consumption, since they are not taken into account when computing the clearing market conditions required for equilibrium. Second, for undocumented immigrants, an event of either bad health, or a disabling condition has dire consequences compared with a native or a legal immigrant, because they have no choice but to pay the cost it generates out of their pocket. For simplification, at this stage we can think of this cost as a portion of their resources, call it α_1 when in bad health, and α_2 when disabled, and in the equation below (to simplify the algebra) we assume that the latter is twice as large as the former, and we collapse the concept into one α parameter.

The last equation for undocumented immigrants, for example, can be written as

$$a_{t+1} = (1 + \overline{r})((a_t - c_t) * (1 - g_2) * h * (1 - \alpha)) + w_t(1 - I_\tau) + I_\tau P_t \tag{6}$$

where it is key to notice that health (h) takes the value 0 for being in good health,

the value 1 for bad health, and the value 2 for disabled.

The tricky aspect of this strategy to model remittances is that while they are neither savings nor consumption from the point of view of the local economy, they are a source of utility of immigrants, since they use them to take care of their relatives back home. We solve this by making this kind of inconsistency explicit, and by allowing remittances to enter the utility function as we presented above, but not count as savings for the purposes of capital accumulation or as consumption for the purposes of equilibrium in the economy.

Formally, as we saw above, remittances enter additively to the consumption part of the utility function, making the utility function also a function of the legal status of the individual since it affects the fraction of resources send back to the country of origin.

The value of being unemployed

$$V_{0,\tau}^{t}(a,\overline{w},ss) \;=\; \max_{c_t,\tau,ssd} U(c_t,1)+\beta\; Emax\;(V_{1,\tau}^{t+1}(x),V_{0,\tau}^{t+1}) \tag{7}$$

$$L_\tau = L(1-I_\tau)+I_\tau$$

$$a_{t+1} = (1+\overline{r})(a_t-c_t)+b_t(1-I_\tau)+I_\tau P_t \tag{8}$$

Again, for immigrants this last equation changes as discussed in the case of the employed. Furthermore, for undocumented immigrants it changes further because no unemployment benefits can be received.

As explained before, unemployment benefits, b_t, are computed as a function of the average wage, with firing costs being the equivalent of two weeks pay, and unemployment benefits worth half of 80% of the previous period average wage. Thus, we define:

$$b_t = g(w_t,d_t) \tag{9}$$

The function $EV_{t+1}(a,\overline{w},ss,c,l,ssd,h)$ in each of the two labor status denotes the conditional expectation of next period's value function, given the individual's current state $(a,\overline{w},ss)$ and decisions (c,l,ssd). Specifically, we have

$$\begin{aligned} EV_{t+1}(.) \;=\; & \int_{y'}\sum_{h'=0}^{2}\sum_{ss'=0}^{n} V_{t+1}(wp_t(a,\overline{w},y',ss,ssd),awp_t(\overline{w},y'),ss') \\ & \times f_t(y'|\overline{w})k_t(h'|h)g_t(ss'|a,\overline{w},ss,ssd)dy', \end{aligned} \tag{10}$$

where the number of Social Security states, n, is eighteen for the United States, once we have to take into account the possibility of claiming early, and also the proper modeling of the earnings test, which results in early claimers who work above the earnings test

limit seeing their benefits increased by the time they reached the NRA (See Benítez-Silva and Heiland (2007) for a detailed description). Additionally, $awp_t(aw, y)$ is the Markovian updating rule that approximates Social Security's exact formula for updating an individual's average wage, and wp_t summarizes the law of motion for next period's wealth, that is,

$$wp_t(a, \overline{w}, y, ss, ssd) = R\left[a + ssb_t(\overline{w}, y', ss, ssd) + y' - \tau(y', a) - c\right], \tag{11}$$

where R is the return on saving, and $\tau(y, a)$ is the *tax function,* which includes income taxes such as Federal income taxes and Social Security taxes and potentially other types of state/local income and property/wealth taxes. The awp_t function, derived from (1), is given by

$$awp_t(aw, y) = \exp\left\{\gamma_1 + \gamma_2 \log(y) + \gamma_3 \log(aw) + \gamma_4 t + \gamma_5 t^2 + \sigma^2/2\right\}, \tag{12}$$

where σ is the estimated standard error in the regression (1). Note there is a potential "Jensen's inequality" problem here due to the fact that we have substituted the conditional expectation of w_{t+1} into the next period value function V_{t+1} over w_{t+1} and aw_{t+1} jointly. However, the R^2 for the regression of aw_{t+1} on aw_t is virtually 1 with an extremely small estimated standard error $\hat{\sigma}$. Hence, in this case there is virtually no error resulting from substituting what is an essentially deterministic mapping determining aw_{t+1} from w_{t+1} and aw_t.

Above, $f_t(y|\overline{w})$ is a log-normal distribution of current earnings, given current age t and average wage $\overline{w}$, that is implied by (2) under the additional assumption of normality in η_t. The discrete conditional probability distributions $g_t(ss'|a, \overline{w}, ss, ssd)$ and $k_t(h'|h)$ reflect the transition probabilities in the Social Security and health states, respectively.

The additional key aspect of the model with respect to immigration, is the introduction of return migration. We assume that with some exogenous probability, legal and undocumented immigrants go back to their countries. This probability is larger for undocumented immigrants, but for both groups it implies that Social Security will never pay their retirement benefits. We are aware of the lack of realism of this feature for some legal immigrants who work in the US for more than 10 years (40 quarters), so we hope to relax this assumption in the near future. The way this return migration works in the model is similar to death after remitting back to their countries all their resources, in the sense that with that given probability immigrants know they will get some utility as if all their resources were remittances. These resources never enter the economy of the US in the period after moving back to the country of origin.

Some additional assumptions implicit in our Dynamic Programming are:

- A period of employment (at least) follows the decision to work from unemployment or from the previous job (after accepting a job-to-job offer), if displacement does not occur.

- At least one job offer is received at the end of every period. Individuals decide to accept or not the offer, and even if they accept the offer, they could be displaced before they start to work that period. We do not differentiate here between someone who continues to work in a given job, and someone who changes jobs without a period out of the labor market. This assumes implicitly the portability of the accumulated tenure, a feature believed to be widely available to high skill individuals.

- There is, at least, a period of unemployment after displacement.

- The unemployment probability δ is a function of some characteristics of individuals like average wage and age, and given that it is logically also a function of the economic environment we use the higher empirical probabilities of the last couple of years to simulate the consequences for individuals of facing higher uncertainty.

- We do not model the institutional details of private pension schemes or disability insurance. However, we do model private savings.

- We assume an initial level of assets in the first period, $a(0) = a_0$, and assume they face borrowing constraints, $a(t) \geq 0$ for every $t \geq \tau$.

Demographics

Time is discrete. In each period, there are I overlapping generations of agents and population grows at the rate of n. Agents are born at age 1 and can live up to age I. Each agent faces a positive probability of early death which is exogenous and independent of other household characteristics. The probability of surviving from age $i-1$ to age i is denoted by $s_i \in (0,1)$, with $s_{I+1} = 0$. Due to the probability of death, there are bequests which give agents utility, and are distributed (as assets) among the members of all generations in the amount t_r.

Asset Structure

Households own financial assets a, which represent claims to capital and debts when they are negative. Capital depreciates at the constant rate δ_k. We assume that households face a borrowing limit of $A \geq 0$. This implies that financial assets must satisfy:

$$a \geq -A$$

Production Technology

There is a representative firm that produces output with the constant returns to scale technology:

$$Y = AK^{\alpha}L^{1-\alpha}$$

where A is total factor productivity (TFP), K is aggregate non-housing capital, $L = \gamma U + (1-\gamma) H$ is the total "labor" supplied, which is composed of aggregate raw labor U and the aggregate stock of skill H. The firm solves a static problem by hiring factors from the households to maximize period profits:

$$\max_{\{H,U,K\}} AK^{\alpha}L^{1-\alpha} - w_u U - w_h H - (r + \delta_k) K$$
$$where \;\; L = \gamma U + (1-\gamma) H$$

The optimality conditions determine the factor prices w_u, w_h and r competitively.

3.3.1 Government Policy

The government in its simplest form runs a pay-as-you-go social security program in order to provide retirement income, and also an independent unemployment insurance system. We assume that both systems are self-financed. In order to finance retirement benefits, the government collects payroll taxes τ_s from the labor earnings of workers, and similarly for unemployment benefits.

3.4 Recursive Competitive Equilibrium

In what follows we define the stationary recursive competitive equilibrium. To do this, let M be the space of individual state variables and let μ be the probability measure defined over the Borel $\sigma-$algebra generated by M. Households perceive that the distribution evolves according to the law of motion:

$$\mu' = \Gamma(\mu)$$

Definition. Given the social security tax τ_s and initial conditions K_0, μ_0, a recursive competitive equilibrium are value functions $V(s)$, optimal decision rules $g_c(s)$, $g_a(s)$, aggregate stocks of capital K, skills H and raw labor U, prices r, w_u and w_h, transfers t_r, social security benefits b_i and a measure μ such that:

1. The value function $V(s)$ is the solution to the household's problem defined above and $g_c(s)$, $g_a(s)$ are the associated policy functions.

2. The representative firm maximizes profits, leading to the competitive factor prices

$$r = \alpha Z \left(\frac{K}{L}\right)^{\alpha-1} - \delta_k$$

$$w_u = (1-\alpha)\,\gamma A \left(\frac{K}{L}\right)^{\alpha}$$

$$w_h = (1-\alpha)\,(1-\gamma)\,A \left(\frac{K}{L}\right)^{\alpha}$$

3. The following market clearing conditions are satisfied (all the integrals are over M):

$$1 = \int e d\mu$$

$$U = \int u d\mu$$

$$H = \int h_i d\mu$$

$$K = \int g_a(s) d\mu$$

4. The transition function Γ is generated by the optimal decisions for households and by the law of motion for the shocks.

5. All social insurance programs are self financed:

$$\tau_s \int w_i d\mu = \int b_i d\mu$$

6. The total amount of bequests is equal to the total amount of transfers plus the initial assets of the entering cohorts:

$$\int (1 - s_{i+1})\, g_x\,(s)\, d\mu = \int t'_r d\mu' + a$$

where a are the total initial assets distributed to the young cohorts.

Using the market clearing conditions, it is easy to show that the aggregate resource constraint of the economy is:

$$C + K' = (1-\delta_k)\,K + Y$$

$$\text{where } C = \int g_c(s) d\mu$$

3.5 Solving and Simulating the Model

Our interest in solving and simulating a model with the level of complexity we have described is twofold. On the one hand, the model will be able to provide a variety of predictions which we can then compare with the data, like the proportion of individuals claiming at different ages, their benefit levels, their consumption patterns, their labor

supply patterns, and their wealth levels. Additionally, the model will provide a set of structural parameters which are the foundations of the model even when we change the structure to analyze the effect of policy changes on the behavior of individuals and the economy.

As explained earlier, our model allows for four different sources of uncertainty. The random draws to simulate these sources of uncertainty, as well as the initial conditions regarding wealth levels and average wages, will be the same for all the models compared in the following. Thus, the differences presented in the results are only due to the changes in the incentive schemes. Underlying these characterization of uncertainty is the assumption that agents behave rationally given the information they have about the future (stochastic) evolution of these state variables.

For computational simplicity, we assume that decisions are made annually rather than monthly, but we allow for the benefit adjustments due to earnings above the Earnings Test limit to happen semi-annually following Benítez-Silva and Heiland (2007).

4 Benchmark Simulation Results

We are in the process of obtaining full results of this complex problem, which takes considerably longer given the GE-OLG structure of the problem. The individual life-cycle problem has given us some interesting results, which are close in nature to what we had obtained in similar individual level models that focused on the retirement decision. The main feature of those results we report in Table 3, is that the model does a good job in fitting retirement decisions, and also labor supply, especially before the retirement years, as compared with Table 2.

We are still not able to show the effects of the efforts we have made to model the consequences of accounting for migration in the model, but we are confident that the differences between different types of immigrants will be clear in terms of capital accumulation, and utilization of social insurance programs, which determines the main trade-off to take into account when considering possible legalization of undocumented immigrants.

Table 6 presents some simple results focusing on the retirement period. We find a distribution of claiming ages very close to the data reported by the U.S. Social Security Administration. In particular, we capture the sharp peak at age 62, with a simulated percentage almost identical to the males in the data, and we also capture the peaks at age 63 and 65 we see in the Public-Use microdata (and also the aggregate SSA data).

These findings are no small accomplishment given how elusive has been for researchers to explain the claiming behavior of Americans in the last decade and a half. Notice that we accomplish this excellent fit without relying on heterogeneous preferences (Gustman and Steinmeier 2005) or hard to test beliefs about the future. Regarding labor supply,

the qualitative results show a declining labor supply at older ages, especially at age 62 and then at age 63 and 64. The proportion of individuals working increases at age 65 and 66 mainly due to the phasing-out and eventual disappearance of the earnings test.[18]

This table also provides the average monthly retirement benefits (for those claiming at those ages), the average monthly consumption levels (for all individuals of that age), and the average wealth levels (for all individuals of that age) for the 10,000 simulations of the full model. The retirement benefit levels are also remarkably in line with what we observe in the aggregate Social Security data, giving us confidence that our modeling strategy regarding the average wage process and the wage process reflect quite closely the earnings histories of the individuals currently claiming Social Security retirement benefits.

Regarding average monthly consumption, the levels we find seem reasonable for a single individual, however, our model does not predict a significant decline in consumption around retirement (although a small decline is observed), as widely documented in the empirical literature. The latter is likely the result of our simplified structure which does not account for the complexities involved in the consumption decisions around the time of retirement as presented, for example, in Aguiar and Hurst (2005). We do not consider this a serious drawback of our model given the difficulty of finding data which could allow us to identify the different consumption objectives of older individuals. The last column also provides the average wealth level of individuals at different ages, and we can see the declining simulated wealth, which becomes steeper after age 63. Notice also the effect that increases in employment uncertainty have on wealth accumulation, with wealth monotonically declining at all ages when uncertainty increases.

It is worth emphasizing that the wealth averages shown in the last column of Table 4 hide a much richer relationship between wealth accumulation and claiming. If we focus in the regular uncertainty case, and for example in the average wealth at age 61, which is just below $103,000, we should emphasize that the average wealth level varies tremendously depending on whether those individuals eventually claim at age 62 or higher. For example, the average wealth level at age 61 for individuals who claim at age 62 is $66,845, while for those who end up claiming at age 63 is $96,482, and the levels for claimants at ages 64 to 66 are $134,433, $164,669, and $173,736, respectively. Interestingly, those who claim later end up consuming a lot of that wealth as they take advantage of the guaranteed

[18]The model does include a part-time labor supply choice and we assume that agents can freely choose to work part-time of full-time, which is not likely to be realistic and leads to a growing interest in part-time work once agents reach the ages in which labor supply is more costly in utility terms. As we saw in Table 6, a fairly stable (across time and across older ages) proportion of individuals actually works part-time, but since we do not model the mechanism that explains why some individuals might or might not receive part-time offers we have chosen not to modify the model in an ad-hoc way to match this proportion. We have experimented with a model in which individuals can only choose whether to work full-time or not to work at all, and in that case the proportion of those working at older ages does not increase. However, in such a model early claiming is much less attractive, suggesting a connection between access to flexible labor supply and the decision to draw retirement benefits.

(if they survive) adjustment factors offered by Social Security. This should not be very surprising in the model given that we are assuming that individuals obtain only a fixed 2% interest rate on savings, so conditional on surviving to the next period and accounting for a discount factor β, which is equal to 0.96, obtaining the return on their expected Social Security benefits offered by the actuarial adjustment can be optimal and therefore wealth de-accumulation can be a good strategy for some individuals. This is exemplified by the fact that by the time they actually claim, those who claim at age 65, have on average wealth level of $111,562, around $50,000 less than what they had accumulated by age 61.[19] These findings are somewhat sensitive to the assumptions regarding the interest rate and the discount factor, and are difficult to compare with the data due to the fact that we do not have housing in our model, which represents the large majority of the savings of individuals at older ages.[20]

5 Policy Experiments

The main policy experiment we have set ourselves to analyze has to do with the consequences of some form of legalization process that makes some undocumented immigrants eligible to become legal immigrants in our country. In our model the initial proportion of natives and the two types of immigrants are fixed, you can think of individuals facing a fixed diagonal unitarian transition matrix. The policy experiment can be understood as introducing the possibility of some flexibility in the transitions from undocumented to legal.

While we still do not have results of this, we do know that any move to legalization in this framework will have two consequences with different effects for the government and the economy. First, legalization translates automatically into higher savings because those legal immigrants remit a smaller proportion of their resources back to their countries. By definition in our model this is exogenous, and this larger capital in the economy has the positive consequence of lowering the interest rate, increasing the tax base and promoting

[19] Quite surprisingly, these results regarding the wealth holdings of early vs. late claimers is at odds with the results in İnmohoroğlu and Kitao (2009b) who find that less wealthy individuals claim later. Given how correlated early claiming is with bad health, previous unemployment, and lower longevity, in our model and the data, we believe our result is more intuitive. Additionally, our findings are very much in line with those of Gustman and Steinmeier (2005) in a related model. The two models are quite different since they do not have unemployment uncertainty or wage uncertainty, but they introduce uncertain health care costs. However, both models do replicate quite well the claiming behavior.

[20] If for example, we increase the interest rate to 4% the level of wealth accumulation increases by around 50% when individuals reach the 60s. However, the difference between the level accumulated, by age 61, by those who claim at 62 and those that claim at 65 is much smaller with this higher interest rate, which is what we could expect given the trade-offs faced by the agents in the model. Notice, however, that this higher (real) interest rate leads to a claiming hazard at the ERA that is too high (over 60%) compared with the data.

growth. The economic intuition between the remittances assumption has to do with the way legal immigrants perceive their attachment to the country, and the likelihood of using their new status to re-unite with some family members originally left in the country of origin. The empirical evidence points in the direction of higher remittances among those who have been in the US the least, and since legal immigrants usually stay much longer in the US the logic goes through.

Second, legalization will bring a higher usage of social insurance programs, including, but not limited, to unemployment insurance, retirement benefits, and disability benefits.

Whether legalization of some undocumented immigrants translates into a welfare improving strategy for the country will depend on the relationship between the decline in remittances (and their impact on the economy), and the increase usage of social insurance programs. This trade-off should be taken into account when discussing legalization policies, and the search for some kind of optimal path to solving the undocumented problem in our country.

6 Conclusions

It might seem relatively unimportant in comparison with some of the worries that have kept the country busy in the last three years (months, weeks), when the world economy has gone (and it is still going) through one of its worse periods in recent memory and widespread instability seems to have settled in financial markets, but immigration issues will continue to be present in our everyday lives, and the likely agenda of our policy makers.

The reality is that millions of individuals and families currently living in our borders came to our country searching for a better life, but did not necessarily followed the procedures established by our government for them to do so. These millions of undocumented immigrants contribute to our economy, but also maintain a weak attachment to it, so it is natural to ask whether some kind of legalization process, which seems fair given that we know some of them have been in the country for decades, should be considered.

Our research tries to bring to the forefront some of the economic consequences of legalization, mainly the likely increase in capital stock thanks to the fact that newly documented immigrants will probably invest a higher proportion of the resources now that their immigration status is no longer a major stigma for their economic behavior, but also the fact that this newly gained status will give them rights that will probably translate into a higher usage of our social insurance system.

A discussion of optimal immigration reform is likely to naturally emerge from the framework we are proposing, as long as we can measure with some level of confidence, some the key parameters we propose to analyze this interesting trade-off.

In summary, we hope our research provides a step in the direction of having a framework to evaluate and discuss the consequences of possible migration reform.

References

Aguiar, M., and E. Hurst (2005): "Consumption versus Expenditure," *Journal of Political Economy,* **113-5** 919–948.

Auerbach, Alan and Oreopolis, Philip (2000): "The Fiscal Impact of U.S. Immigration: A Generational Accounting Perspective," in James Poterba, ed., *Tax policy and the economy,* Vol. 14. Cambridge: MA. MIT Press.

Baker, M., and D. Benjamin (1999): "How do retirement tests affect the labour supply of older men?" *Journal of Public Economics,* **71** 27–51.

Benítez-Silva, H., and F. Heiland (2007): "The Social Security Earnings Test and Work Incentives," *Journal of Policy Analysis and Management,* **26-3** 527–555.

Benítez-Silva, H., and F. Heiland (2008): "Early Claiming of Social Security Benefits and Labor Supply Behavior of Older Americans," *Applied Economics,* **40-23** 2969–2985.

Benítez-Silva, H., M. Buchinsky, and J. Rust (2003): "Dynamic Structural Models of Retirement and Disability," manuscript, SUNY-Stony Brook, UCLA, and University of Maryland.

Benítez-Silva, H., M. Buchinsky, and J. Rust (2011): "Induced Entry Effects of a $1 for $2 Offset in SSDI Benefits," manuscript, SUNY-Stony Brook, UCLA, and University of Maryland.

Benítez-Silva, H., and N. Yin (2009): "An Empirical Study of the Effects of Social Security Reforms on Claiming Behavior and Benefits Receipt Using Public-Use Administrative Micro Data," *Social Security Bulletin- Perspectives*, **69-3** 77–95.

Benítez-Silva, H., D.S. Dwyer, F. Heiland, and W.C. Sanderson (2009): "Retirement and Social Security Reform Expectations: A Solution to the New Early Retirement Puzzle," manuscript submitted for publication.

Blau, D. (2008): "Retirement and Consumption in a Life Cycle Model," *Journal of Labor Economics*, **26-1** 35–71.

Bonin, Holger, Raffelhschen, Bernd, Walliser, Jan (2000): "Can Immigration Alleviate the Demographic Burden?" *FinanzArchiv: Public Finance Analysis,* Vol. 57-1, 1-21.

Borjas, J. (1994): "The Economics of Immigration," *Journal of Economic Literature,* Vol. 32-4, 1667-1717.

Borjas, George J., and Hilton, Lynette (1996): "Immigration and the Welfare State: Immigrant Participation in Means-Tested Entitlement Programs," *Quarterly Journal of Economics,* Vol. 111, 575-604.

Borjas, George J. (2009): "Economic Well-Being of the Elderly Population," NBER Eleventh Annual Conference of the Retirement Research Consortium, August 2009.

Bricker, J., B. Bucks, A. Kennickell, T. Mach, and K. Moore (2011): "Surveying the Aftermath of the Storm: Changes in Family Finances from 2007 to 2009," Staff Working Paper 2011-17, Board of Governors of the Federal Reserve System. Washington, D.C.

Chan, S., and A.H. Stevens (2004): "How Does Job Loss Affect the Timing of Retirement?" *Contributions to Economic Analysis & Policy,* Vol. 3-1, article 5.

Chai, J., R. Maurer, O.S. Mitchell, and R. Rogalla (2011): "Lifecycle Impacts of the Financial and Economic Crisis on Household Optimal Consumption, Portfolio Choice, and Labor Supply," NBER Working Paper No. 17134. Cambridge, MA.

Cheng, I.-H., and E. French (2000): "The effect of the run-up in the stock market on labor supply," *Economic Perspectives,* **24(4)** 48-65.

Coile, C.C., and P.B. Levine (2007): "Labor market shocks and retirement: Do government programs matter?" *Journal of Public Economics*, **91-10** 1902–1919.

Coile C.C. and P.B. Levine (2010): "Reconsidering Retirement. How Losses and Layoffs affect older workers," Brookings Institution Press, Washington, D.C.

Coile, C.C., P. Diamond, J. Gruber, and A. Jousten (2002): "Delays in Claiming Social Security Benefits," *Journal of Public Economics,* **84-3** 357–385

Collado, M. Dolores, Iigo Iturbe-Ormaetxe, and Guadalupe Valera (2004): "Quantifying the Impact of Immigration on the Spanish Welfare State," *International Tax and Public Finance,* Vol. 11, 335-353.

Coronado, J.L., and M. Perozek (2004): "Wealth effects and the consumption of leisure: Retirement decisions during the stock market boom of the 1990s" manuscript, Federal Reserve Board, Washington, D.C.

Diamond, P.A. (2007): "Top-Heavy Load: Trouble Ahead for Social Security Systems." *CES ifo Forum,* **8-3** 28–36.

Duleep, Harriet Orcutt and Dowhan, Daniel J. (2008a): "Adding Immigrants to Microsimulation Models," *Social Security Bulletin,* Vol. 68-1, 51–65.

Duleep, Harriet Orcutt and Dowhan, Daniel J. (2008b): "Incorporating Immigrant Flows into Microsimulation Models," *Social Security Bulletin,* Vol. 68-1, 67–76.

Fenge, R., and P. Pestieau (2005): *Social Security and Early Retirement,* MIT Press, Cambridge, MA.

French, E. (2005): "The Effects of Health, Wealth, an Wages on Labour Supply and Retirement Behaviour," *Review of Economic Studies,* **72** 395–427.

French, E., and J.B. Jones (2011): "The Effects of Health Insurance and Self-Insurance on Retirement Behavior," *Econometrica,* **79-3** 693–732.

Friedberg, L. (1998): "The Social Security Earnings Test and Labor Supply of Older Men," in *Tax Policy and The Economy,* Vol. **12.** MIT Press.

Friedberg, L. (2000): "The Labor Supply Effects of the Social Security Earnings Test," *Review of Economics and Statistics,* **82** 48–63.

Friedberg, Rachel M., and Hunt, Jennifer (1995): "The Impact of Immigrants on Host Country Wages, Employment and Growth," *Journal of Economic Perspectives,* Vol. 9, 23–44.

Frijters, P. and B. Van der Klaauw (2006): "Job search and nonparticipation." *The Economic Journal,* **116** 45–83.

Gallup, J. L. (1997): "Theories of Migration," Harvard Institute for International Development, Development Discussion Paper No. 569.

García-Pérez, J.I. (2006): "Job Separation in a Non-stationary Search Model: A Structural Estimation to Evaluate Alternative Unemployment Insurance Systems", *Journal of Applied Econometrics,* **21(2)** 245–272.

García Pérez, J.I. y A. R. Sánchez Martín (2010): "Social Security and the search behavior of workers approaching retirement," FEDEA Working paper no. 2010-26.

Gourinchas, P.O., and J.A., Parker (2002): "Consumption over the Life Cycle," *Econometrica,* **70-1** 47–89.

Greenwood, M. J. (1975): "Research on Internal Migration in the United States: A Survey," *Journal of Economic Literature,* 13-4, 397-433.

Greenwood, M. J. (1997): "Internal Migration in Developed Countries," in *Handbook of Population and Family Economics,* ed. by M. R. Rosenzweig, and O. Stark, Vol. 1B, pp. 531-552. North Holland.

Gruber J. and D.A. Wise (1999): *Social Security and Retirement around the World.* Editors. The University of Chicago Press.

Gruber J. and D.A. Wise (2004): *Social Security Programs and Retirement around the World.* Editors. The University of Chicago Press.

Gruber, J., and P. Orszag (2003): "Does the Social Security Earnings Test Affect Labor Supply and Benefits Receipt?" *National Tax Journal,* **56(4)** 755–773.

Gustman, A. L., and T.L. Steinmeier (1991): "Changing the Social Security Rules for Work after 65," *Industrial and Labor Relations Review,* **44** 733–745.

Gustman, A. L. and T. L. Steinmeier (2005): "The social security early entitlement age in a structural model of retirement and wealth," *Journal of Public Economics,* **89 (2-3)** 441–463.

Heiland, F., and N. Yin (2011): "Actuarial Fairness of Early Social Security Benefits: A Historical Assessment with Implications for the Optimal Timing of Retirement," manuscript, CUNY-Baruch College.

Human Development Report (2009): Overcoming Barriers: Human Mobility and Development. United Nations Development Programme. Palgrave, Macmillan. New York, NY.

Hurd, M. (1990): "Research on the Elderly: Economic Status, Retirement, and Consumption and Saving," *Journal of Economic Literature,* **28** 565–637.

Hurd, M. D., and M. Reti (2001): "The effects of large capital gains on work and consumption: Evidence from four waves of the HRS," RAND Working Paper 03-14.

Hurd, M. D., M. Reti and S. Rohwedder (2009): "The Effect of Large Capital Gains or Losses on Retirement." In *Developments in the Economics of Aging,* ed. David Wise. Chicago: University of Chicago Press.

İmrohoroğlu, S. and S. Kitao (2009a): "Labor supply elasticity and social security reform," *Journal of Public Economics,* **93 (7-8)** 867–878.

İnmohoroğlu, S. and S. Kitao (2009b): "Social Security, Benefit Claiming and Labor Force Participation: A Quantitative General Equilibrium Approach," manuscript. USC and New York Fed.

Iskhakov, F. (2010): "Structural dynamic model of retirement with latent health indicator," *Econometrics Journal,* **13-3** S126–S161.

Judd, K.L. (1998): *Numerical Methods in Economics*, The MIT Press.

Juster, T.F., and R. Suzman (1995): "An Overview of the Health and Retirement Study," *The Journal of Human Resources,* **30** (Supplement): S7–S56.

Kemnitz, Alexander (2003): "Immigration, Unemployment, and Pensions," *Scandinavian Journal of Economics,* Vol. 105-1, 31–48.

Laitner, J., and D. Silverman (2008): "Consumption, Retirement and Social Security: Evaluating the Efficiency of Reform that Encourages Longer Careers," manuscript, University of Michigan.

Lee, Ronald D., and Miller, Timothy W. (1997): "The Life Time Fiscal Impacts of Immigrants and Their Descendants: A Longitudinal Analysis," in Smith, James P., and Edmonton, Barry, (eds.) *The New Americans.* Washington: Nat. Acad. Press, 1997.

Lee, Ronald D., and Miller, Timothy W. (2000): "Immigration, Social Security, and Broader Fiscal Impacts," *American Economic Review Papers and Proceedings,* Vol. 90-2, 350-354.

Leonesio, M. V. (1990): "Effects of the Social Security Earnings Test on the Labor Market Activity of Older Americans: A Review of the Evidence," *Social Security Bulletin,* **53** 2–21.

Lucas, R. E. (1997): "Internal Migration in Developing Countries," in *Handbook of Population and Family Economics,* ed. by M. R. Rosenzweig, and O. Stark, Vol. 1B, pp. 531-552. North Holland.

Lumsdaine, R. (1995): "Factors Affecting Labor Supply Decisions and Retirement Income," NBER Working Paper No. 5223.

Lumsdaine, R., and O.S. Mitchell (1999): "New Developments in the Economic Analysis of Retirement," in Ashenfelter, O., Card, D. (Eds.), *Handbook of Labor Economics*, Vol. **3C.** 3261–3307.

Lutz, W., Sanderson, W., and S. Scherbov (2008): "The coming acceleration of global population ageing," *Nature*, **451-7** 716–719.

Passel, Jeffrey S. (1999): "Undocumented immigration to the United States: Numbers, trends, and characteristics." In Illegal immigration in America, David W. Haines and Karen E. Rosenblum, eds., 27-111. Westport, CT.: Greenwood Press.

Passel, Jeffrey S. (2009): "A Portrait of Unauthorized Immigrants in the United States," Pew Research Center Report, April 2009.

Porter, Eduardo (2005): "Illegal Immigrants are Bolstering Social Security with Billions," The New York Times, April 5.

Pissarides, C. (1976): "Job search and participation," *Economica*, **43(169)** 33–49.

Ruhm, C. J. (1996): "Historical Trends and the Future of Older Americans," in Crown, W.H. (Ed.), *The Handbook on Employment and the Elderly*, Greenwood.

Rust, J. (1996): "Numerical Dynamic Programming in Economics," in *Handbook of Computational Economics.* H. Amman et al. (eds.). Amsterdam: Elsevier.

Rust, J., and C. Phelan (1997): "How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets," *Econometrica,* **65** 781–831.

Sand, Edith and Razin, Assaf (2007): "The Role of Immigration in Sustaining the Social Security System: A Political Economy Approach," CESifo Working Paper Series No. 1979.

Schou, Poul (2006): "Immigration, Integration and fiscal sustainability," *Journal of Population Economics,* Vol. 19, 671-689.

Song, J.G., and J. Manchester (2007a): "New evidence on earnings and benefit claims following changes in the retirement earnings test in 2000," *Journal of Public Economics,* **91(3-4)** 669–700.

Song, J.G., and J. Manchester (2007b): "Have People Delayed Claiming Retirement Benefits? Responses to Changes in Social Security Rules," *Social Security Bulletin,* **67-2** 1–23.

SSA-S (various years): Annual Statistical Supplement to the Social Security Bulletin. `http://www.ssa.gov/policy/docs/statcomps/supplement/`.

SSA-H: Social Security Handbook. Online Version. `http://www.ssa.gov/OP_Home/handbook/ssa-hbk.htm`.

SSA-M: Program Operations Manual System (POMS). Public Version. `https://s044a90.ssa.gov/apps10/poms.nsf/aboutpoms`.

Storesletten, K. (2000): "Sustaining Fiscal Policy through Immigration," *Journal of Political Economy,* Vol. 108-2, 300-323.

Storesletten, K. (2003): "Fiscal Implications of Immigration-A Net Present Value Calculation," *Scandinavian Journal of Economics,* Vol. 105-3, 487-506.

Votruba, M. E. (2003): "Social Security And Retirees' Decision to Work," manuscript, Case Western Reserve University.

van den Berg, G.J. (1990): "Search behaviour, transitions to nonparticipation and the duration of unemployment," *The Economic Journal,* **100** 842–865.

van der Klaauw, W., and K.I. Wolpin (2008): "Social Security, Pensions and the Savings and Retirement Behavior of Low-income Households," *Journal of Econometrics,* **145** 21–42.

Appendix: Social Security Incentives for Early Retirement in the United States

Individuals who claim benefits before the NRA but continue to work or reenter the labor force can reduce the early retirement penalty by suspending benefit payments.[21] The Actuarial Reduction Factor, ARF, (or early retirement reduction factor), in turn, will be increased proportionally to the number of months without benefits, which will increase benefits permanently after the individual reaches the NRA.[22] This adjustment of the ARF allows those who become beneficiaries before the NRA to partially or completely reverse the financial consequences of their decision, averting being locked-in at the reduced rate. In the sequel of this section the exact details of these incentives are presented.

Benefit Calculation

Individuals aged 62 or older who had earned income that was subject to the Social Security payroll tax for at least 10 years since 1951 are eligible for retirement benefits under the Old Age benefits program (OA program). Earnings are subject to the tax up to an income maximum that is updated annually according to increases in the national average annual wage.[23] To determine the monthly benefit amount (MBA), the Social Security Administration calculates the Primary Insurance Amount (PIA) of a worker as a concave piece-wise linear function of the worker's average earnings subject to Social Security taxes taken over her 35 years of highest earnings. If the benefits are claimed at the NRA (66 for those born between 1943 and 1954, and currently at 65 and 8 months), the MBA equals the PIA. If an individual decides to begin receiving benefits before the NRA and exits the labor force or stays below the earnings limit, her MBA is reduced by up to 25%, assuming a NRA of 66. Under the current regulation of the OA program, the monthly benefit amount received upon first claiming benefits depends on the age (month) of initiation of Social Security benefits, in the following way,

$$MBA_t = \begin{cases} (0.75 + 0.05 * \frac{1}{12} * \text{MP3Y}) * PIA, \text{if claimed more than 3 years before NRA;} \\ (0.80 + 0.20 * \frac{1}{36} * \text{M3Y}) * PIA, \text{if claimed within the 3 years before NRA} \end{cases}$$

where MBA_t represents the monthly benefit amount before the NRA (see SSA-S 2005, p.18), MP3Y are the months not claimed in the period prior to 3 years before NRA, and M3Y are months not claimed in in the 3 years before NRA. Assuming that the individual continues to receive benefits, her MBA_t is permanently reduced. The Actuarial Reduction

[21] In this paper, we are not considering spousal benefits and joint decision making in the household. The complexities introduced by those considerations are out of the scope of this analysis. See Gustman and Steinmeier (1991), Coile et al. (2002), and Votruba (2003) for a discussion. By ignoring spousal benefits we are not taking into account the fact that approximately 5.96% of the individuals who receive some type of Old Age, Survivors, or Disability Insurance (OASDI) benefits receive them as spouses of entitled retirees. This percentage comes from the Public-Use Microdata File provided by the Social Security Administration and refers to a 1% random sample of all beneficiaries as of December of 2001.

[22] Given a NRA of 66, which will be the prevailing one for the cohort born between 1943 and 1954, the Actuarial Reduction Factor is a number between 0.75 and 1 depending on when the individual claims benefits, and how many months he or she earns above the Earnings Test after claiming benefits.

[23] As of 2010 this maximum is $106,800.

Factor (ARF) underlying this calculation is a permanent reduction of benefits by 5/9 of 1 percent per month for each month in which benefits are received in the three years immediately prior to the NRA. The reduction of benefits is 5/12 of 1 percent for every month before that. Thus, the maximum actuarial reduction will reach 30 percent as the NRA increases to 67 over the next few years (see SSA-S 2005, p.18).[24]

Actuarial Reduction Factor

One less-emphasized feature of the process of benefit reduction due to early retirement is the possibility to reduce the penalty even after initiating the receipt of benefits. The specifics of this adjustment to the Actuarial Reduction Factor are documented in the Social Security Handbook (SSA-H, §724. *Basic reduction formulas*, §728. *Adjustment of reduction factor at FRA*) and in the internal operating manual used by Social Security field employees when processing claims for Social Security benefits (SSA-M, RS00615. *Computation of Monthly Benefits Amounts*) but may not be well-understood by the retirees.[25] To illustrate this feature of the system, suppose the NRA is 66 years, and an individual claims benefits at age 62 and n months, where $n < 48$, receives checks for x months where $(n + x < 48)$, and suspends receiving checks after that until she turns 66 (after which she retires for good). In this case she receives x checks of

$$MBA_t = \begin{cases} (0.75 + 0.05 * \frac{1}{12} * n) * PIA & \text{if claimed more than 3 years before NRA,} \\ (0.80 + 0.20 * \frac{1}{36} * n) * PIA & \text{if claimed within the 3 years before NRA.} \end{cases}$$

After turning 66, her MBA will be permanently increased to

$$MBA_t = [0.75 + (0.20 * \frac{1}{36} * n) + (0.20 * \frac{1}{36} * (36 - n - x)) + 0.05] * PIA. \qquad (13)$$

It is important to note that the adjustment of the ARF is automatic and becomes effective only after reaching the NRA.

Earnings Test

The Earnings Test limit defines the maximum amount of income from work that a beneficiary who claims benefits before the NRA under OASI may earn while still receiving the

[24]The reductions in benefits for early claimers are designed to be approximately actuarially fair for the average individual. During the post-NRA period additional adjustments exist: Workers claiming benefits after the NRA earn the delayed retirement credit (DRC). For those born in 1943 or later it is 2/3 of 1 percent for each month up to age 70 which is considered actuarially fair. For those born before 1943 it ranges from 11/24 to 5/8 of 1 percent per month, depending on their birth year. For a discussion of the evolution of actuarial fairness in the last decades see Heiland and Yin (2011)

[25]The Social Security Administration does not use the term Actuarial Reduction Factor in their publications, but a number of the people we have talked to within the administration do use this terminology. In publications the related concept of "Reduction Factor(s)" (RF) which is simply the number of months in which benefits were received before the NRA is used. The RF maps into a "Fraction" that ranges between 0.75 and 1 (for an ERA of 62 and an NRA of 66). The latter corresponds to what we refer to as ARF. The ARF ("Fraction") is adjusted upwards at the NRA according to the number of months before the NRA in which benefits were withheld.

"full" MBA.[26] Earnings above the limit are taxed at a rate of 50 percent for beneficiaries between age 62 and the January of the year in which they reach the NRA, and 33 percent from January of that year until the month they reach the NRA (SSA-S 2005, p.19; SSA-S 2005, Table 2.A18). For the latter period, the earnings limit is higher, $34,680, compared with $14,160 for the earlier period as of 2010. Starting in 2000, the Earnings Test was eliminated for individuals over the NRA.

Individuals who continue or reenter employment after claiming Social Security benefits before the NRA, and whose earning power or hours constraints are such that their income from work is around or below the earnings limit, are mailed their full monthly check from Social Security and are locked-in at the reduced benefit rate permanently. Those with earnings above the limit will not receive checks from Social Security for some months and thereby adjust their ARF.[27] Individuals have the option of informing Social Security to suspend the monthly benefit payment at any time if they believe they will be making earnings high enough above the Earnings Test. However, during the first year after claiming benefits, the Social Security Administration performs a monthly test to determine whether the person should receive the monthly check. As a result an early claimer who is not working or earns below the limit in the months after claiming ("grace year") will receive all monthly benefits even if earnings for that calendar year exceed the Earnings Test limit due to high earnings before claiming.[28] After the first year, the test is typically yearly and it depends on the expected earnings of the individual. Given the scarce documentation of the functioning of the ARF, having earned above the earnings limit, and thus receiving fewer checks, may be a common way for beneficiaries to learn about the possibility of undoing the early retirement penalty.[29]

[26]Some sources of income do not count under the Earnings Test. For details see SSA-H §1812. Notice that retirement contributions by the employer do not count towards the limit, but additional contributions by the employee even if they are through a payroll deduction are counted. This means that individuals earning above the limit cannot just increase their retirement savings to avoid being subject to the limit. We thank Barbara Lingg and Christine Vance from the Social Security Administration for clarifying this point, which is rarely discussed in any publication.

[27]A beneficiary may receive a partial monthly benefit at the end of the tax year if there are excess earnings that do not completely offset the monthly benefit amount (see SSA-H, §1806).

[28]Social Security claim specialists emphasized to us that during the first year after claiming they do what is most advantageous to the claimer, the monthly or the yearly test, if they have enough information. However, they failed to clarify what that means. Some of them said the number of checks individuals receive is maximized, but we were unable to find documentation of such practices. In any case, the internal operating instructions used by Social Security field employees when processing claims for Social Security benefits state that the monthly earnings test only applies for the calendar year when benefits are initiated unless the type of benefit changes (see SSA-M, RS02501.030).

[29]See Benítez-Silva and Heiland (2008) for a numeric example of the streams of income resulting from these incentives.

Table A.1. Key Parametrizations of the Model

Parameter	Value	Use	Source
β	0.96	Discount Factor	Calibration
γ	-0.37	Risk Aversion	Utility Function Eq. (3)
Leisure of a FT Worker	0.54	Leisure	Utility Function Eq. (3)
Interest Rate	2%	Wealth Accumulation	Calibration
Maximum Taxable Earnings	94,200	Maximum Soc. Sec. Taxes	SSA 2006
Earnings Test ERA to 65	12,480	Work and Claim	SSA 2006
Earnings Test 65 to NRA	33,240	Work and Claim	SSA 2006
Part-time Penalty 1	0.61 on the $	Age 21 to 60	CPS 1986-2009
Part-time Penalty 2	0.75 on the $	Age 61 to 64	CPS 1986-2009
Part-time Penalty 3	0.8 on the $	Age 65+	CPS 1986-2009
g_1	10%	Remittances	Authors' Calc.
g_2	20%	Remittances	Authors' Calc.
α_1	5%	Health Expenditures	Authors' Calc.
α_2	15%	Health Expenditures	Authors' Calc.

Notes: When appropriate the sources are mentioned in some detail in the text.

Table 1: Participation in Social Insurance Programs of Immigrants by Period of Entry (American Community Survey, 2009

			age 25 and over			
Program	**Native**	**Immigrant**	**Prior to 1980**	**1980-1989**	**1990-1999**	**2000-2009**
Social Security	20.1	13.7	36.9	8.6	4.5	1.9
Welfare	1.4	1.5	1.2	1.7	1.7	1.3
Pensions	9.9	4.9	13.7	2.6	1.2	0.9
SSI	2.1	2.2	3.3	2.8	2.2	0.7
Percentage Unemployed	6.1	6.4	4.2	6.5	7.1	7.8
Not in Labor Force	33.1	31.7	45.2	23.1	25.3	31
			age 40 and over			
Program	**Native**	**Immigrant**	**Prior to 1980**	**1980-1989**	**1990-1999**	**2000-2009**
Social Security	31.7	23.0	40.4	12.1	9.6	5.2
Welfare	1.1	1.5	1.11	1.6	2.1	1.9
Pensions	15.9	8.2	15.0	3.5	2.4	2.6
SSI	2.6	3.6	3.4	3.7	4.6	2.0
Percentage Unemployed	4	5.2	4	5.9	5.9	7
Not in Labor Force	40.6	37.7	48.4	26.7	29.1	36.5

Table 2: Educational Attainment of Immigrants (and Natives) by Period of Entry (ACS 2009)

Educational Attainment	Native	Immigrant	Prior to 1980	1980-1989	1990-1999	2000-2009
6 Years or Less	1.0	13.8	12.2	15.2	14.0	13.6
7 to 12 Years	7.3	13.3	10.8	13.5	14.4	13.8
High School Graduate	61.5	43.0	46.1	43.6	43.1	40.1
More than High School	30.2	29.9	30.9	27.8	28.5	32.5

Table 3: Remittances and Savings of Immigrants from MMP and LAMP, in 2010 Dollars

	Remittances		**Savings**	
	Percentage	Amount	Percentage	Amount
All Immigrants	0.65	409	0.50	522
Immigration Status				
Unauthorized	0.74	405	0.49	382
Legal	0.55	417	0.51	682
Education				
Less than 12	0.67	401	0.49	499
12 and above	0.52	500	0.54	697
Years in the U.S.				
0-5 Years	0.73	389	0.47	387
5-10 Years	0.72	456	0.59	519
¿10 Years	0.55	419	0.54	671

Table 4: US Males Retirement Benefits Claiming Behavior. Public-Use Micro-data Files

	New Male claimants, proportions, 1994-2004 (w/o DI conversions)								
Age	**1994**	**1996**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
62	0.489	0.509	0.491	0.473	0.414	0.453	0.460	0.465	0.478
63	0.162	0.150	0.163	0.152	0.137	0.163	0.160	0.148	0.142
64	0.081	0.072	0.071	0.072	0.061	0.075	0.073	0.073	0.072
65	0.207	0.201	0.207	0.212	0.248	0.273	0.275	0.282	0.219
66	0.022	0.025	0.024	0.033	0.054	0.009	0.010	0.010	0.076
67	0.008	0.013	0.013	0.018	0.031	0.007	0.005	0.006	0.004
68	0.008	0.009	0.007	0.012	0.021	0.004	0.003	0.005	0.002
69	0.007	0.007	0.007	0.009	0.013	0.004	0.004	0.003	0.001
Claimants	5,766	6,001	6,344	6,970	8,169	7,195	7,266	7,404	7,794
	Average monthly benefits in $ of 2005. ***Adjusted by the ARF and the DRC***								
Age	**1994**	**1996**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
62	1,203.60	1,179.96	1,233.06	1,302.46	1,315.69	1,352.61	1,402.60	1,414.35	1,356.50
63	1,161.82	1,178.75	1,199.40	1,205.90	1,275.80	1,264.56	1,310.93	1,355.05	1,317.45
64	1,209.15	1,227.03	1,209.64	1,223.97	1,240.47	1,322.56	1,344.97	1,359.56	1,354.08
65	1,260.02	1,264.51	1,243.25	1,234.88	1,258.35	1,298.34	1,348.48	1,384.61	1,349.91
66	1,333.34	1,275.72	1,279.76	1,286.73	1,331.57	944.09	856.84	1,157.49	1,300.07
67	1,205.93	1,261.28	1,155.12	1,274.97	1,398.17	848.03	869.19	925.18	1,078.54
68	1,062.62	1,191.53	1,238.22	1,183.47	1,367.90	918.91	922.04	679.81	678.86
69	1,311.41	1,218.69	1,140.63	1,211.33	1,333.55	1,069.62	852.70	712.98	836.69

Data Source: OASDI Public-Use Microdata File 2004. Social Security Administration.

Table 5: Labor Supply Facts (CPS, 1996-2006)

full-time	1996	1998	2000	2002	2004	2006
60	56.27	50.63	54.56	52.79	54.87	56.64
61	51.17	50.80	57.67	48.02	52.05	54.46
62	39.95	41.10	39.93	39.09	41.94	44.45
63	30.09	31.39	31.32	32.88	37.45	39.76
64	23.81	26.08	30.78	30.32	30.31	32.87
65	21.48	18.06	23.20	23.47	23.14	26.05
66	15.65	15.42	22.98	19.20	20.41	20.47
67	12.66	12.52	15.76	16.94	17.70	15.61
part-time	1996	1998	2000	2002	2004	2006
60	10.73	12.91	10.34	11.19	11.79	11.27
61	12.38	12.76	11.03	12.16	10.96	11.14
62	11.28	13.35	12.14	13.61	10.86	12.59
63	15.28	14.66	12.76	13.32	12.98	13.87
64	13.12	10.69	13.95	14.91	12.30	12.70
65	14.68	14.30	13.65	13.95	13.74	13.95
66	16.66	12.34	13.32	13.74	12.35	14.74
67	14.61	12.04	15.04	14.06	11.53	12.45
no work	1996	1998	2000	2002	2004	2006
60	33.00	36.47	35.10	36.02	33.33	32.09
61	36.44	36.44	31.30	39.82	36.99	34.41
62	48.77	45.54	47.93	47.30	47.20	42.96
63	54.63	53.94	55.92	53.80	49.57	46.36
64	63.07	63.22	55.28	54.76	57.38	54.42
65	63.84	67.63	63.15	62.58	63.12	60.00
66	67.70	72.24	63.70	67.06	67.24	64.79
67	72.73	75.45	69.20	69.01	70.77	71.94

Table 6: US 10,000 Simulations of the Individual Model

Ages	Survivors	Work[a]	Claimers[b]	Benefits ($)	Consum. ($)	Wealth ($)
			Benchmark Model			
Age 60	8,331	5,625 (67.5%)	—	—	1,957	107,576
Age 61	8,205	5,560 (67.77%)	—	—	1,984	102,953
Age 62	8,055	4,081 (50.67%)	3,726(47.33%)	999	1,999	97,571
Age 63	7,883	2,559 (32.46%)	1,437(18.25%)	1,115	2,005	93,695
Age 64	7,726	2,924 (37.85%)	1,042(13.24%)	1,273	1,986	85,589
Age 65	7,555	3,659 (48.43%)	1,463(18.6%)	1,397	1,927	78,244
Age 66	7,357	4,753 (64.61%)	203(2.58%)	1,477	1,946	76,135

Notes: [a]In numbers, and as percentage of survivors. [b]Number of First Claimers at that age, and as percentage of the total who ever claimed.