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Annuities, public policy and demographic change in overlapping generations models

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Chapter 1

Introduction

In contrast to its Keynesian counterpart, neoclassical macroeconomics prides itself that it is rigorously derived from solid microeconomic foundations. Indeed, the canonical neoclassical macroeconomic model is typically based on the aggregate behaviour of infinitely-lived rational agents maximizing their life-time utility. But, really, how micro-founded are these models? Is it proper to suppose that the aggregate economy acts as though it were one agent? Is it proper to assume that individuals live forever? The commonplace reaction to these questions is, of course, to ignore them under the Friedman norm that if the model is able to replicate reality then it must be fine.

The neoclassical model, however, is not able to replicate reality. This simple observation induced a long line of research trying to incorporate features into large macroeconomic models that would bring them closer to reality. To no avail it seems, for Sims (1980) went so far as to argue that macroeconomics is so out of touch with reality that a straightforward “measurement without theory” approach seemed to outperform the most sophisticated models. Measurement without theory, however, also implies outcomes without policy implications. For the mechanisms at play remain hidden from view.

In a seminal contribution Blanchard (1985) introduced the most basic of human features into an otherwise standard macroeconomic model and came to a surprising conclusion. If non-altruistic individuals are finitely lived, then one of the key theorems of neoclassical thought – the Ricardian equivalence theorem – no longer holds. Innovative as it was, the Blanchard model still suffers from serious shortcomings. For instance, it assumes that individuals have a mortality rate that is independent of their age, that is, a 10-year old child and a 969-year old Methuselah have the same probability of dying (indeed in Blanchard’s model there is not even an upper limit for the age of individuals). Furthermore, it assumes that perfect life-insurance markets exist so that, from the point of view of the individual, mortality hardly matters much at all.

In reaction to Blanchard’s analysis, a vast body of literature evolved introducing additional features aimed at improving the description of the life-cycle behaviour of the individual who stands at the core of the model. As computing power became more readily available, the so-called computable general equilibrium (CGE) approach was close to follow.

The outward shift in the computational technology frontier made ever more com-

plex models feasible but Sims' (1980) critique seemed to have had a short echo for within foreseeable time these models had again become so complex that the mechanisms translating microeconomic behaviour into macroeconomic outcomes were lost in aggregation and details of the solution algorithm.

The challenge thus remains to construct macroeconomic models that, on the one hand, are solidly founded in the microeconomic environment of the individual agent and, on the other hand, are able to show to the analyst which main mechanisms are at play.* In this thesis we contribute our part to this challenge. That is, we construct a series of tractable macroeconomic models that can replicate basic facts of the individual life-cycle and, at the same time, clearly show which mechanisms drive the two-way interaction between microeconomic behaviour and macroeconomic outcomes.

The advantage of this approach over the basic Blanchard (1985) framework is that it can replicate the most important life-cycle choices that an individual makes. The advantage of the approach over the CGE framework is that it retains the flexibility necessary to analyze which factors are driving the relationship between individuals and their macroeconomic environment. Although CGE models can account for numerous institutional traits that are beyond our model, such models fare worse at identifying which mechanisms are at play.

This thesis consists of three substantially independent parts. In the first part we take the assumption of perfect life-insurance markets by the horns and develop a model in which we study the consequences of imperfect annuity markets and use the model to study the effects of different types of taxation and to study how the pension system moderates the impact of a demographic shock. In the second part we return to the theme of annuity markets but ask whether annuities are desirable in the first place. In the final part we focus once more on the impact of demographic changes by studying the different impact of changes in the population growth rate driven by either a change in the birth rate, a change in the mortality rate or a combination of the two.

In a seminal contribution, Yaari (1965) showed that, faced with longevity risk, individuals derive substantial benefits from life-annuities. In fact, in the absence of a bequest motive individuals should invest all their assets in such annuities. Annuities

* For an eloquent yet vociferous eulogy of the use of small models in macroeconomics see Turnovsky (2011).

are life-insured financial assets that pay out conditional on the survival of the individual. If the individual survives he receives a premium over and above the market interest. In return, if he dies his savings flow to the annuity firm. Although welfare enhancing from an individual perspective annuity markets are notoriously thin. That is, the availability of annuities is generally limited and, if they exist, annuities are over-priced.

The objective of the chapters 2-4 is to develop an overlapping generations model of a closed economy that incorporates possible imperfections on the annuity market. We introduce these imperfections by allowing for a load factor on the price of annuities that assures that annuities become overpriced. In the second chapter we use the basic framework to study the impact of overpriced annuities on labour-supply and savings decisions at the individual level and growth at the aggregate level. By departing from the classical Blanchard (1985) model and adding sequentially more realistic features we are able to highlight the mechanisms along which the individual life-cycle impedes on the macroeconomic environment. This procedure allows us to stress the importance of both a realistic demographic structure and a realistic labour productivity schedule over the life-cycle. We find that annuity market imperfections have a mild impact on both the aggregate economy and individual decisions.

In the third chapter we apply the basic framework to study the impact of consumption and labour-income taxation. As before, we focus on savings and labour-supply decisions at the individual level and economic growth at the aggregate level. We provide special attention to the way in which the tax income of the government is distributed over the agents. That is, we compare and contrast regimes in which government income is distributed equally over all agents, distributed with a skew toward the elderly or distributed with a skew toward the young. We find that, in principle, the consumption tax redistributes funds from the elderly, who are strong consumers and thus pay the lion's share of tax, to the young, who barely consume but save a lot. The labour income tax, on the other hand, redistributes funds between the working and the idle. Idleness being an attribute of the retired, the tax induces redistribution from saving workers to consuming retirees. Hence, both in welfare and growth terms a consumption tax dominates a labour income tax.

In the fifth chapter we use the model to study the moderating role of the pension

system during an ageing shock. We introduce a pay-as-you-go pension system that can be financed on either a defined benefit or a defined contribution basis. In addition, the retirement age may be used as policy parameter. In the wake of an ageing shock we find that the growth rate increases. The rise in the growth rate occurs because individuals have to save for a longer retirement period and, hence, accumulate more capital. This effect is mitigated, though not nullified, if a defined benefit system is in place because the contribution rate has to adjust to accommodate the change in the dependency ratio. Surprisingly, we find that increasing the retirement age dampens economic growth. Intuitively, a higher retirement age decreases the period spent in retirement and therefore the funds necessary to finance it.

Whilst in chapters 2-4 we put emphasis on the consequences of imperfect annuity markets, we do not answer the question of whether these markets are beneficial in the first place. From a microeconomic perspective, we know that annuities are welfare maximizing because they allow for risk sharing between lucky (long-lived) and unlucky (short-lived) individuals. From a macroeconomic perspective, matters are less clear because the microeconomic analysis ignores two key mechanisms. First, the change in savings induced by the opening of an annuities market influences the capital stock and, thereby, wages and the interest rate. Second, in the absence of an annuity market individuals leave accidental bequests that are in one way or the other distributed over the surviving agents.

Thus, the objective of the fifth chapter is to study the general equilibrium effects of opening up an annuity market. Our point of departure is the two period Diamond (1965)-Samuelson (1958) model of overlapping generations. This model contrasts the model in chapters 2-4 in that it does not allow for a very detailed description of the individual life-cycle. However, being more stylized, the model allows us to obtain a full analytical description of the impact, transition and long-run effects of the introduction of annuities. The model features individual agents that can live for a maximum of two periods but transition between the periods is probabilistic. In the absence of annuity markets accidental bequests flow to the government, which can then decide between distributing the funds to the currently young, the currently old or to outright waste them.

Starting from any of these three redistribution possibilities we study the opening up of an annuity market. In line with the microeconomic literature we find that opening up an annuity market is beneficial from an individual perspective. From a macroeconomic perspective, however, matters differ dramatically. We find that there exists a tragedy of annuitization; although full annuitization of assets is privately optimal it may not be socially optimal due to adverse general equilibrium repercussions.

We show that there are two instances of this tragedy. The strong version describes the situation in which accidental bequests were initially wasted by the government. In that case opening up an annuity market induces individuals to save less (because they are now receiving a higher rate on their savings). Because it is welfare enhancing to annuitize all individuals will save less so that the aggregate capital stock and, thereby, wages decline over time. The decline in wages makes individuals worse off, so much that the level of welfare after the introduction of annuities is far less than it was without the annuities.

In the weaker version of the tragedy the government was initially distributing the funds to the young. In that case the introduction of an annuity market sets the economy on a lower welfare path because young agents lose the accidental bequests that they were initially receiving. Part of these were used for savings, hence, their abolishment decreases aggregate capital accumulation because all agents now have less assets to save. Naturally, if the bequests were initially given to the elderly the introduction of an annuity market is welfare enhancing because they eliminate transfers received late in life. These transfers initially acted as a disincentive to save, so that their abolishment increases private, and aggregate, savings.

In the final chapter we return to the analysis of demographic change. However, rather than studying the moderating role of the pension system we use this chapter to study how different types of demographic change affect the aggregate economy. How does a change in the birth rate affect the capital stock? How does a change in the mortality rate affect the capital stock? And what is the impact of a combined mortality and birth rate shock? To analyse these issues, we construct a continuous-time overlapping generations model similar to the one used in the first part of this thesis. However, in contrast to the earlier chapters, in this chapter we focus on an exogenous

growth model featuring perfect annuity markets. This set-up allows us to study how demographic changes affect the aggregate capital stock and gives us a basic idea of the dynamics governing the model.

In the theoretical part of the chapter we highlight the mechanisms whereby the demographic life-cycle of the individual agents impedes on the macroeconomic equilibrium. This happens through the “generational turnover term”, which refers to the reduction in aggregate consumption due to the addition of newborn agents having no accumulated assets, together with the departure of agents with accumulated lifetime assets. By explicitly setting out the underlying dynamic system, we are able to establish that there are in fact two steady-state equilibria instead of just one as implied in the literature.

The two equilibria contrast sharply in how they are influenced by the demographic structure. In the first equilibrium (the one previously identified in the literature) demographic factors play an important role. They impede on equilibrium per capita consumption directly, through the impact of the mortality function on the discounting of future consumption. In contrast, in the second equilibrium we identify, demographic factors play no direct role, except insofar as they influence the overall population growth rate. The key feature of this equilibrium is that the equilibrium growth rate of consumption just equals the growth rate of population. However, through deeper analysis of this equilibrium we are able to establish that it implies a bubble on the goods market and can only be sustained in the presence of intergenerational or international transfers. Hence, in the remainder of the chapter we focus on the equilibrium previously established in the literature.

To obtain a better understanding of the dynamics governing the model and to prepare for the numerical analysis, we add more demographic structure by focusing on a parameterized mortality function. Using this function we provide an explicit representation of the aggregate macroeconomic dynamic system. This turns out to be a highly nonlinear fifth order system involving not only capital and consumption, as in the standard representative agent economy, but also the dynamics of the various elements of the intergenerational turnover term. This extensive model embeds the classical Blanchard (1985) model, the dynamics of which simplifies dramatically due to the constant mortality assumption.

In our numerical simulations we study the long-run behavior of the model in response to both structural and demographic changes, illustrating their effects on aggregate quantities, as well as on the distributions of consumption and wealth across cohorts. Our numerical results show how the effects of a given increase in the population growth rate contrast sharply – both qualitatively and quantitatively – depending upon whether it occurs through an increase in the birth rate or a decrease in mortality. Whereas in the former case an increase in the population growth rate is associated with a mild decline in the capital stock, in the latter case it leads to a substantial increase in the per capita stock of capital. In addition, a combination between the two can exist such that the impact on the capital stock is exactly off-set. Hence, an increase in the population growth rate can increase, decrease or not affect the capital stock.

As it stands, the final chapter studies mainly theoretical and quantitative issues pertaining to fertility and mortality in the neoclassical framework. However, just as the model in the second chapter served as a stepping stone to the analysis of taxation and pensions in follow-up chapters, this chapter will serve as a stepping stone for the analysis of public policy issues in future research.