COLLECTION OF THESES

of

Gergely Varga

Long run labor supply, capital supply and their macroeconomic effects

Ph.D. dissertation

Supervisor:

Klára Major, Phd.

Budapest, 2015.

Department of Macroeconomics

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CONTENTS

1. MOTIVATION AND PREVIOUS RESEARCH

The field of macroeconomics is divided by basic textbooks into long run and short run. According to the consensus by studying business cycles, it is important to take into consideration nominal price and wage rigidities (short run), hereby the output movements are in great part influenced by the shocks of aggregate demand components. If we want to analyze phenomena in a longer run, we can ignore rigidities, the flexibility of the prices and wages can be presumed (long run), an the outcomes of the economy are determined by the supply side. Economists who want to understand the long run performance of the economies, beside analyzing the institutional settings (e.g. Acemoglu, Johnson, Robinson [2005]) examine the mechanism of the technological change (e.g. Romer [1990]) and the determinants of the factor supply.

The chapters of the present dissertation also wants to analyze the properties, the determinants of the long run capital and labor supply, and their macoeconomic consequences. A common feature in the three chapters is that in explaining factor supply they build on the *heterogeneity* of the agents. However, the approach of the chapters differs. In the second chapter we simulate a new theoretical agent-based model in order to understand the capital supply, but it can be viewed as an numerical example which is not calibrated to any real economy. Contrarily, the life cycle model applied in the third

chapter and the overlapping generations model in the fourth is the application of well-known modelling tradition, they are calibrated to the Hungarian economy and investigate the effects of the Hungarian social security pension system and demography.

As we mentioned previously, in explaining the saving behavior the heterogeneity of the households plays an important role. A usually applied approach separates people into two groups: those whose behavior can be described by some version of the traditional utility maximizing rational expectations model (permanent income hypothesis) proposed in it's original form by Irving Fisher [1930], and those who seem to behave in a purely consumption-oriented manner, largely disregarding the future consequences (Hall, Mishkin [1982], Laibson [1997]). The later variant of the former approach takes into account the undiversifiable risk of income and the risk aversion ability of the consumer (Carroll [1996]). According to the buffer-stock saving model, households with prudent preferences and with considerable undiversifiable labor income risks strive to maintain a buffer-stock wealth which can be characterized by a asset-income ratio. All the three consumer types seem theoretically and empirically plausible, which raises the question: under what conditions can they coexist and what consequences their symbiosis has on the aggregate capital supply?

Agent-based models, where heterogeneity of the agents and learning plays an important role, have been established in economics for at least 20 years now (Tesfatsion [2001], [2006]). In agent-based macro models households save, generally, by following some rule (heuristics), which may be devised as a bounded rationally approximation of the traditional behaviours, mentioned in the previous paragraph, but the rules don't compete with each other. Therefore, in the **second** chapter we analyse the capital supply with the help of an

agent-based model, in which the three aforementioned consumer types (permanent income, prudent and short-sighted types) "struggle for life". With the model we investigate how the selection pressure influence the proportion of them and how it will affect the macroeconomic outcomes? Our aim is to give some advice to agent-based macro models, what kind of saving rule they should suppose and what consequences they have.

Another plausible grouping of population with regard to capital supply since Modigliani, Brumberg [1954] follows the life cycle: young and old households' saving behavior differ because they realize different incomes compared to their planned consumptions. In developed economies *social security pension systems* partially substitute the labor incomes in old ages, which also affects their saving behavior (Feldstein [1995]). Households with different age display different behavior not only concerning their capital supply, but also their labor supply (Blundell et al. [2011]), which is commonly related to the functioning of the pension system, too (Gruber, Wise eds. [2002], Wallenius [2013]).

In explaining Hungarian capital- and labor supply in the long run we also assign particular importance to the demographic process of the society and the pension system. Hungarian researchers (Augusztinovics [2005], Augusztinovics-Köllő [2007], Augusztinovics, Gyombolai, Máté [2008]) investigated mainly the other way of the labor supply-pension relationship: they explored how employment patterns affect pensions. In explaining how the pensions effect labor supply, the literature follows two approaches. The first (Gruber, Wise eds. [2002], Cseres-Gergely [2007] Cseres-Gergely [2015]) one estimates reduced form econometric models in order to reveal how incentives of the pension system influence labor market activity. The present study follows – according to our knowledge in Hungary firstly – the tradi-

tion of the other approach (Rust, Phelan [1997], French [2005]) which calibrates/structurally estimates micro-based life cycle labor supply model with dynamically optimizing agents and simulates how changes in the pension rules affect behaviour. In the **third** chapter we build a life cycle labor supply model where incentives are mainly influenced by the pension system and calibrate it to the Hungarian males' labor age-profile. With the model at hand we investigate the following questions: how different parametric reforms of the Hungarian pension system will change the aggregate labor supply of the males in the long run? How will they reallocate labor across cohorts in the long run? The partial equilibrium model is also an important piece of the next chapter's general equilibrium model.

The incentive effects of the demography and pensions system have further macroeconomic and budget consequences, which is also worthwhile to reveal. The phenomenon of demographic transition will affect the Hungarian economic growth and the finances of the social security pension system in following decades. Therefore, in the **fourth** chapter we analyze how the demographic transition will influence the sustainability pension system and how parametric pension reforms alter the picture. In addition, we also simulate the macroeconomic effects of the elderly society and the reforms.

In Hungary more economists studied the sustainability of the pension system (Orbán, Palotai [2005], Orbán, Palotai [2006], Holtzer szerk. [2010]). All the aforementioned models – in contrast to the present study – determine the path of the macroeconomic variables according to "experts' estimation", ignore the labor supply and saving reactions, so they don't take into account the possible household responses that demographic transition and pension reforms can trigger. In the *long run*, however, households' reactions and the macroeconomic feedback effects may be important. Among the traditional

macroeconomic models the most suitable to analyse the demographic transition and the pension reforms are the overlapping generations models, (Diamond [1965], Auerbach és Kotlikoff [1987]), in addition, they can take into account behaviourial responses and their macroecomic consequences. In the chapter we study the effects of the demographic transition and pension reforms with and Auerbach-Kotlikoff-type model, calibrated to the Hungarian data.

In Hungary the model of Simonovits [2009] with overlapping cohorts and demographic transition illustrates how parametric reforms influence the measures of sustainability and the cohorts' consumption along the demographic transition. The modelling technique contains more innovations: the households utility depends on the relative change of consumption, not the level, the size of the family changes along the life cycle, but – in contrast to the present study – the labor supply is constant and the general equilibrium consequences of the demographic process don't affect the real wages an the interest rate. Fehr [2000] also uses an Auerbach-Kotlikoff-type model to explore the effects of the German demographic transition, and simulates the current pension reforms afterwards. He examines how the reforms change the path of the macroeconomy, the welfare of the agents and the sustainability of the pension system. The economy is, however, – in contrast to our approach – closed, and hence doesn't track the path of the foreign debt. The openness plays an important role in the model of Fehr, Jokisch, Kotlikoff [2005], who show that incorporating China into the world economy alters drastically the sustainability of pension system in the developed countries: its abundant capital supply rises the real wages per efficient unit in the long run, and hereby alleviates the burden, the pension system entails to the government finances. We are also concerned how the financing need of the Hungarian pension sys-

tem evolves in an open economy, but instead of using a multiregion world economy, we use a small open economy. Less frequently can we find small, open economies in the literature. De la Croix, Pierrard, Sneesens [2012]) use that type of model as a contrast to their closed economy version, but with perfectly elastic capital supply, so the factor prices remain unchanged. In the present study the the capital supply is not perfectly elastic as the interest rate premium depends positively on the foreign debt rate.

2. APPLIED METHODS

Savings types: an evolutionary-adaptive approach

The production-primary income distribution side of the model follows Bewley [1980]. The model has a simple production side based on neoclassical assumptions concerning production, labour and capital service markets. Both types plan their own behavioral rule as follows. The permanent income type consumer try to figure out their total lifetime wealth, and intend to achieve perfect consumption smoothing, but according to her degree of optimism she may consume a bit less or a bit more. She uses statistical learning rules to forecast returns on capital and labour income. The prudent consumers have a desired wealth-income ratio (buffer stock) and they consume accommodate their consumption to it. Short-sighted consumers determine their reference level, which is the highest consumption among their neighbours, but they can also depart from it according to their optimism. These plans may not be feasible. In this case the potential debtors meet in the credit market the consumers who have more resources, than their planned consumption. (The debt cannot exceed a given debt constraint). After lending, the creditors use the rest of their resources to accumulate physical capital. There exists also a social adaptation-selection mechanism that favours the type of behavior that obtains more in terms of accumulated consumption. This mechanism results in mod-

ifications in the composition of the three types, thus the relative proportion of them is changing continuously. The mechanism also support spread of the optimism and buffer stock value of the successful agents.

We simulated the model and investigated how the competition among the types – the parameter which determines how important is the long run consumption in the selection process – affect the capital supply, the proportion of the types and behavior of the economy (it's ergodicity and it's stationarity).

Life cycle labor supply and social security

The third chapter describes the average profiles of the life cycle working hours of Hungarian males in the period 1999-2009 with the help of Hungarian Labor Force Survey. It also describes the components of the Hungarian old age and disability pension system, which may have had influence on the life cycle labor supply of the males, and sketches the age profile of the pensioners and the retirement behavior by (old age and disability) pension schemes in parallel with the labor force activity.

After describing the main tendencies of life cycle working hours and retirement of the Hungarian males, it uses a microfounded life cycle labor supply model to simulate the effects of different parametric pension reforms on the life cycle labor supply. The consumers, who belong to 18 five-years cohorts over age 26 and three different education level, maximize their life cycle utility, along which they take into consideration their survival chances. They make a consumption-saving and a labor supply decision, and after a common retirement age they give up work and retire. Their labor and capital income is devoted in their active worklife to consumption, asset accumulation, capital and labor income taxes, consumption taxes and social security contribution.

At the beginning of their life they don't have any wealth and they don't plan to leave any bequest at the end of the maximum lifespan. Their productivity, which determines their real wages, follows an exogenous age profile, and along their labor supply decision they take into account the influence of the earnings on the value of later pensions. At the beginning of their pension life they receive a pension which is proportional to their average life cycle net wage income, later their pension partially follows the average growth rate of the productivity. The model is calibrated according to the average values of the 1999-2009 period of the Hungarian economy. The productivity profiles of the three groups with different education level is estimated on the Hungarian Household Budget Survey data between years 1998 and 2008 with a pooled Heckman's selection model. The preference parameters of the consumers are structurally estimated with the help of the Hungarian Labor Force Survey data.

In the model simulation we investigated how parametric pension reforms (reduction of the accrual rate, increase in the retirement age, enlargement of reference period in calculating the initial pension value, change in the indexation) alter the life cycle labor supply of groups with different educational attainment and the aggregate employment.

Demographic transition, economic growth and the sustainability of social security

In the fourth chapter we simulate a general equilibrium model, which contains 18 five-years cohorts over age 26, the influence of the Hungarian demographic transition and various parametric pension reforms on the financing need of the pension system and the path of the macroeconomic variables

between 2006 and 2070. The size of the youngest cohort is determined by fertility and migration, the size of the elder cohorts is determined by survival probabilities and migration. The survival probabilities change continuously, and the size of the cohorts' follows the demographic projection of Hablicsek [2010].

The problem of the households is almost the same as in the third chapter. The most notable difference is that they accumulate three type of assets: government bonds, physical capital and foreign assets. The initial value of their pension is the constant fraction of its valorized net wage incomes in the "active years". The firms use capital and effective labor in producing output, the labor-augmenting technology evolves according to a exogenously given rate. Government collect revenues from proportional taxation and by issuing government bonds, and spend it on transfers, pensions, government consumption, interest payments and redemption. The consumptions taxes allow the government to keep government debt to GDP ratio at a given level, and the GDP-proportional deficit of the social security shows the "sustainability" of the pension system. In the open economy the interest rate depends on the world interest rate and a risk premium, which increases in the foreign debt rate of the economy.

The initial period of the simulation is calibrated according to the average values of the 1999-2009 period of the Hungarian economy, the preference parameters come from the second study, the survival probabilities and the number of the cohorts are the values from Hablicsek's [2010] demographic projections.

The model simulates the baseline path of the macroeconomic values (above all the GDP, factors of production, factor prices and foreign debt rate), the sustainability of the social security pension system and the present values of the

pensions relative to the wages, as a measure of the relative old age poverty along the demographic transition between 2006-10 and 2066-70. The second part of the study simulates the same variables when variable parametric pension reforms (reduction of the accrual rate, increase in the retirement age, increase in the social security contribution rate, change in the indexation) take place.

3. RESULTS OF THE THESIS

Savings types: an evolutionary-adaptive approach

- When the selection pressure is high, the economy is overwhelmed almost entirely by prudent households. Along intermediate selection pressure the dominance of the prudent types endures, but they are followed by a considerable proportion of short-sighted consumers, and when the pressure is low, the proportion of the three types is equal. Therefore, the viability hierarchy is the following: 1. prudent, 2. short-sighted, 3. permanent income type consumers.

- High selection pressure results in higher aggregate capital, but in somewhat lower aggregate consumption. The reason of the over-accumulation is that higher pressure selects "too many" prudent households who accumulate larger buffer-stock wealth.

- The tendency toward over-accumulation may be restricted by the reduction of the capital's effective productivity. In other words, in periods with many and large catastrophes the over-accumulation tendency may be overcame.

- Although higher selection pressure leads to over-accumulation, it also has an advantage for the society, as it moderates the aggregate fluctuations.

- Ruling out one type of households has the following consequences. Without prudent households there is no capital accumulation, the short-sighted households mitigate the over-accumulation tendencies. Permanent income type consumers may crowd out short-sighted ones, but they would have "'positive"' role only if the society would accumulate too little capital.

- Debt is mainly accumulated by short-sighted households. Relaxing borrowing constraints is conducive to even more overaccumulation, as if owners of capital were "exploited" by wage-earners.

Life cycle labor supply and social security

- All the parametric pension reforms changes the life cycle labor supply in the model through two main channels. The "wealth effect" motivates the workers to work more if the present value of their income decreases. According to the "substitution effect" labor supply increases with age if the productivity increases, or the consumer is impatient compared to the market net interest rate. In addition to the aforementioned factors another, non-traditional factor comes in effect. A further incentive of work is the influence of the earnings on the value of later pensions: the effect is stronger, if the accrual rate is higher, the reference period is shorter, the labor income taxes and the social contribution rates are lower, the marginal utility is higher (the consumption is lower) in the period of retirement. The further is the period of retirement, the weaker is the incentive, because of the impatience of the consumer and the lower conditional survival probability of the retirement.

- If the accrual rate is decreased by 10 percentage points, the present value of the life cycle incomes *ceteris paribus* decreases, which en-

hances the labor supply at all points of the life cycle. The substitution effect weakens the marginal incentives of work: an additional hour of work augment the initial pension by a smaller amount. Contrasting with the baseline path it can be seen that the substitution effect reduces stronger the labor supply in elder ages, because of the greater probability of survive until the pension age. The disincentives of the substitution effect is so strong in the 56-60 age group that the positive wealth effect is almost overwhelmed.

- Increasing the normal retirement age by 5 years (one period) reduces the expected length of the pensioner years, which *ceteris paribus* boost the labor supply throughout the whole life cycle. The effect is alleviated by the fact that the same amount of working hours is worked in one more period. For all age groups pension disbursement begins one period later. That makes the workers discount stronger the expected pension incomes, which reduces the marginal incentives. In a result the labor supply increases until age 45 and decreases afterwards, but naturally, the employment rate of the earlier inactive 61-65 age group increases considerably.

- Changing the indexation of pensions in payment from 50-50 % wage-price indexation to price indexation decreases the present value of pension incomes because of the trend growth in real wages, which makes the workers work more by the same proportion in all age groups (the substitution effect is absent).

- With enlarging the reference period in calculating the initial pensions a period of smaller productivity gets into the average wage, which increases the labor supply through the wealth effect (it decreases the

present value of pension incomes). The marginal incentives worsened with the incorporation of the first period because all period's weight decreases in the average wage. As a result the employment of the youngest age groups (until age of 35 and 45, respectively) increases, but it decreases in the older age groups.

- Aggregating the employment changes with the help of the age distributions by Hablicsek [2010], we can evaluate the magnitude the parametric reforms cause in employment (without general equilibrium feedbacks). Increasing the retirement age has the most favourable effect, extending the employment by 6.9 and 5.79 % in the groups with medium and high education level, respectively. Decreasing the accrual rate improved the employment by 1.62 and 1.58 %, changing the indexation of pensions in payment by 2.27 and 2.21 % in the same groups, and enlarging the reference period in calculating the initial pensions has ambiguous effects.

Demographic transition, economic growth and the sustainability of social security

- According to the simulation, the dependency ratio, measured by 61 years-old and older to 26-60 years old increases from 43 to 100 between 2006-10 and 2066-70. At the beginning of the lifespan (at age 26) the life expectancy is 76.99 years in the 2006-2010 period, which grows to 89.21 years by 2066-70. At age 60 the life expectancy grows from 87.58 years to 92.92 years in the same time interval.

- In the neoclassical model the GDP per efficiency capita falls by 19.98 % between 2006-2010 and 2066-2070, which means that GDP per

capita falls short by ca. 20 % of the level it could reach by the end of the period, if it would follow the 2.35% per year technological change (the GDP per capita is only the 3.26-fold of it's initial level, not the four-fold). As a consequence of the demographic transition, the number of efficient working hours per capita falls more, the capital per efficiency capita falls less.

- The efficient labor supply per capita decreases by 23.32 % along the demographic transition. A simple decomposing procedure shows that the shrinkage of the working age population (population under 60) would reduce the effective labor supply by 27.56 %, the restructuring of the working age population toward the elder cohorts by another 1.93%. The full effect is more moderate, thanks to the labor supply reactions of the cohorts (over age 35, the effective working hours grow in all cohorts), which would increase the effective labor supply by 6.17% in itself.

- The demographic transition reduces also the consumption per efficient unit directly and indirectly. From it's 15.28 % shrinkage 7.86 % can be attributed to the fact, that the consumption per capita decreases in all cohorts under age 80. The other 7.42 % from the reduction is due to the restructuring of the population toward the cohorts with smaller consumption (the proportion of the cohorts under age 65 with larger consumption reduces).

- Thanks to the lower incomes per efficient capita and despite the lower consumption per efficient capita, the accumulated wealth per efficient capita reduces, but only by 6.14 %. The decomposition shows that with unchanged behaviour of the households the wealth per efficient

capita would decrease by 25.1 % just as a consequence of demographic transition (the weight of households with small wealth increases), but due to the enhanced saving behaviour by age 40 to 85 the households accumulate more wealth, which alleviates the aggregate effect.

- Because of the enhanced savings the GDP-proportional wealth of the households increases, which reduces the GDP-proportional foreign debt. The lower debt rate reduces the risk premium and the interest rate. The accompanying smaller rent on capital makes the production capital-intensive and the wages per efficiency unit larger.

- Along the demographic transition and unchanged pension parameters the expenditures of the social security pension system grow from 11.32 % to 23.3 % of the GDP, the deficit of the social security rises from 0.67 % to 12.37% of the GDP between 2006-2010 and 2066-2070. As a result, the government have to raise the consumption tax rate from 28.35 % to 43.07 %. The changes are unequal: the variables rise steeper after the retirement of the Ratkó-grandchildren.

- With unchanged pension parameters the number of expected years house-holds spend as a pensioner rise. As a result, the present value of the pension incomes compared to the wage at age 60 is 30.9 % higher for the 2006-10 cohort than for the 1951-55 cohort.

- The reduction of the accrual rate by 10 percentage points, increasing the retirement age by 5 years, the introduction of price indexation and the 5 percentage point higher social contribution rate in itself can only slow down the rise of the pension expenditures per GDP, but in the long run cannot stop it. Introducing the first three reforms together triggers an immediate 3.64 % GDP-proportional balance-improving effect and

can ensure the balance of the pension system until 2041-45. Only if supplemented with the rising contribution rate can they keep the balance in the long run (with an immediate 6% improvement).

- The price of the shrinking burden, the social security entails to the government is the increasing old age poverty, which is measured as the expected present value of pension incomes at age 60 compared to the wages. In case of the multiple reforms, the reduction can reach a 36-42% loss compared to the baseline scenario.

- Implementing all the reforms increases the effective working hours by 5.11 %, the GDP by 8.09 %, the consumption by 5.35 %, the wealth by 9.5 %, the capital by 8.3 % by 2066-70 compared to the baseline scenario, and the foreign debt rate can be moderated by 2.08 percentage points. Without increasing the social contribution rate the macroeconomic effects can be even more favourable, but the balance of the pension system improves less.

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