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MONETARY POLICY AND ITS TRANSMISSION CHANNELS IN AN AGING POPULATION. A LITERATURE REVIEW*

Summary: In recent years, an interest in the macroeconomic effects of the demographic change has been rising in many countries. We claim that changes in the age structure of populations lead – in a more or less direct way – to changes in the effectiveness of the monetary policy transmission mechanism. As the hitherto literature on this issue is not very conclusive, we aim to gather the findings from different studies and build a theoretical framework for future empirical analyses.

Keywords: population aging, monetary policy, demography.

JEL Classification: E52, E71, J11.

Introduction and motivation

In the public discussion the term ‘population aging’ is becoming more and more popular. In the developed world the baby-boom generation is already approaching retirement age and, at the same time, fertility rates are decreasing, often falling below the simple replacement rate. The aspects of population aging include a significant decline in the number of children and a rise in the number of elderly people and, consequently, changes in the age structure of populations.

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As a result, the proportion of people of working age in the population is getting smaller while the relative number of those in the retirement age is increasing.

The old-age dependency ratio, defined as the number of people aged 65 and more per person in the working age, has risen significantly in most developed countries, which can be easily observed in e.g. Japan, Italy or Germany. In other developed economies, aging occurs in a subtler way (e.g. the United States of America), mostly because of the maintenance of higher birth rates than in the rest of the developed world. Regardless of its pace, over the next few decades significant aging is projected to occur in many countries. According to United Nations' prospects, in Japan, which currently has the oldest population in the world, the share of people aged 65 and more is expected to rise from 26% in 2015 to 36% in 2050. It means that in about thirty years, every third person in Japan will be in the retirement age.

It is therefore not astonishing that in recent years interest in the macroeconomic effects of the demographic change has been rising in many countries. Numerous studies have shown that aging influences different macroeconomic variables. Not only it affects a long-term economic growth by influencing the potential growth rate and the equilibrium real rate of interest. Population aging has an important effect on public finances, international capital flows and the intertemporal allocation of savings and consumption. These developments lead – in a more or less direct way – to changes in the effectiveness of the monetary policy transmission mechanism. Although some economists claim that there is no direct link between monetary policy – which operates in a shorter time period – and demography – where the changes occur rather slow – this paper aims to show on a theoretical basis the existence of this link. As the hitherto literature on this issue is not very conclusive, we aim to gather the findings from different studies and build a basis for a theoretical framework for future empirical analysis.

In the long run the impact of population aging on monetary policy is only gradual. Bean [2004] has even spoken of the 'glacial' nature of these effects that makes it difficult to link the long-term implications of population aging for the economy directly to central bank decisions. Nevertheless, although demographic change is a long-term phenomenon, the age structure of populations impacts the economy directly, even in the short run, through several channels. Wong [2014] argues that changes in the age composition of populations can alter the redistributive and aggregate effects of monetary policy for two reasons. Firstly, older households tend to smooth their consumption to a lesser extent than the younger ones, which is motivated by their shorter future time horizon. Older households immediately absorb a larger fraction of their loss from a monetary policy shock

in terms of lower consumption. Secondly, population aging can shift the aggregate response of the labour market. Older households who are less exposed to labour market risks adjust their labour supply less intensely than the younger ones.

Nevertheless, these reactions constitute only a part of possible differences in responses of older and younger households to macroeconomic shocks. Not only different age groups have different savings behaviour, but also according to age-productivity profiles, the productivity of most workers declines with age, which may have also implication on wages. These are only examples of the issues that should be taken into account as the populations age. Understanding the nature of relationship between demographics and monetary policy is a prerequisite for the setting up and conducting a monetary policy that is close to optimal.

After the Introduction, the next section analyses the definitions of the effectiveness of monetary policy and measures thereof. In the section 2 the literature on the implications of aging on monetary policy is presented. The section 4 discusses the literature on the impact of aging on particular transmission channels of monetary policy. Finally, the last section concludes.

1. Monetary policy effectiveness – definitions and measures

To evaluate the effectiveness of monetary policy, one needs to find its definition and to choose a metric by which this effectiveness can be measured. This question is a long-standing issue in the literature on monetary economics. In a detailed discussion on the effectiveness of monetary policy Rasche and Williams [2007] refer both to the terms ‘monetary policy’ and its ‘effectiveness’ as moving targets because views on them have been changing over time. As there are several approaches to measuring whether monetary policy is effective, some of them will be shortly presented in this section¹.

Since early 90s, the Taylor rules [Taylor, 1993] became the norm for the monetary policy analyses. Rasche and Williams [2007] discuss the role of inflation targeting in a central bank policy and note that implementing inflation targeting is often understood as effective monetary policy. Therefore, a straightforward way to address the question of monetary policy effectiveness is to analyse the performance of those countries that have announced an explicit numeric inflation target. Although this sample would include many countries (cur-

¹ A complex discussion of changing views of the role and effectiveness of monetary policy over time, as well as different definitions thereof, has been presented by Rasche and Williams [2007].

rently more than 40 central banks are following inflation targeting), evaluating effectiveness of inflation-targeting monetary policy by simply checking whether inflation has been on target may be too simplistic. As Svensson [2009] notes, an inflation control is imperfect and some short-term deviations from target are intentional to stabilise the real economy in the long run.

Monetary policy effectiveness may be measured in terms of the impact of interest rate changes on unemployment and inflation. In this approach, it is assessed with a standardised measure based upon the impact of a one percentage point shock to nominal policy interest rates on consumer price inflation or unemployment rate. Basing on this approach, since the publication of Sims' [1980] research, many econometric studies into vector autoregression frameworks have been published to answer the question of the effectiveness of central banks and their monetary policy to achieve a short-run stabilization [e.g. Bernanke and Blinder, 1992; Sims and Zha, 1994; Bernanke and Mihov, 1998]. In the international context, to examine the impact of monetary policy changes in many countries, it was used by e.g. Gerlach and Smets [1995], Kim and Roubini [2000] for G7 countries or Peersman and Smets [2003], Angeloni et al. [2002] for the euro area countries. To answer the question of whether the central bank can have an impact on output and inflation and whether this impact is connected with the level of credit in the economy, Saizar and Chalk [2008] applied a vector autoregression framework to monthly data and estimate the response of inflation to an unanticipated one percentage point increase in interest rates on inflation. They show that the effectiveness of changes in policy interest rates in influencing the path of inflation appears to be unrelated to the level of credit. They also suggest that the willingness to allow exchange rate flexibility is more important in this context.

To measure the effectiveness of monetary policy, one can also compare how close monetary policy is to the optimal monetary policy that offsets shocks to aggregate demand and minimises inflation and output volatility [Cecchetti, 1998; Krause, 2004; Krause and Rioja [2006]. In those countries that have announced explicit numeric inflation targets, a simple way to check the effectiveness of monetary policy would be look at the performance of those countries. However, in this context Rasche and Williams [2007] state that if effective monetary policy were to be defined in terms of stability of high-frequency rates of inflation, all of the central banks they analysed would not achieve this objective. Therefore, they run the analysis for measures based on moving averages of the observed inflation rates. The results show that monetary policy is effective in

those countries, where the moving average of the inflation rate remained within the inflation target.

The concepts discussed above are the most popular when it comes to defining monetary policy effectiveness. Another important approach is more difficult to measure empirically and bases on central banks' credibility and their ability to influence expectations. This view is supported by Blattner et al. [2008], who note that, over a longer time horizon, monetary policy predictability enhances its effectiveness. The credibility and reputation of central banks are also mentioned by Montes Caldas [2009] as vital elements of monetary policy effectiveness. Furthermore, also Woodford [2003] states that anchoring expectations may enhance the effectiveness of monetary policy.

Another approach is presented by Tenreyro and Thwaites [2015] who claim that the measures of the growth rate of activity, such as GDP growth, are the most reliable determinants of monetary policy effectiveness. This measure is also used by Georgiadis and Mehl [2015]. However, the GDP or, in fact any measure of the output of an economy, is a very complex variable, being influenced by a lot of different factors that often interact. Therefore it would be very difficult, if not impossible, to separate only the impact of monetary policy on GDP.

2. Implications of aging on monetary policy

There is a growing literature that analyses empirically possible interactions between monetary policy and demography. These studies discuss the impact of population aging on the conduct of monetary policy in various ways, i.e. by analysing how the transmission of monetary policy shocks to the economy has changed over time (along with changes in age structure of populations), by estimating changes in consumption functions for households in various age groups, or by using general equilibrium models that incorporate features of overlapping generation models.

Not only empirical research becomes interested in the linkage between demography and monetary policy. In the last years it was also mentioned repeatedly by policymakers and central bankers. Some have expressed concern that the abilities of the central banks to stimulate the economy effectively may in the future decline due to demographic reasons. Jean-Claude Trichet [2007], the former President of the European Central Bank, stated that transmission channels of monetary policy, in particular the wealth channel, may be affected by aging. Most notably, the wealth channel is expected to gain relative importance and

therefore play a more significant role than in the past. In his 2012 speech, New York Fed President William Dudley [2012] suggested that “demographic factors have played a role in restraining the recovery”. He stated that spending decisions of the elderly are less likely to be stimulated by monetary policy. Some policy-makers even hint that aging could lead the central banks to resort more often to unconventional tools [Price, 2014].

Most empirical studies on the role of demographic factors in the transmission mechanism of monetary policy suggest that population aging has a negative impact on the effectiveness of monetary policy. Fujiwara and Teranishi [2008] use a dynamic new Keynesian model that incorporates households with life-cycle behaviour to test whether structural shocks to the economy have an asymmetric effect on workers and retirees. Through this influence, they simulate the impact of the demographic structure on monetary policy. Their work shows that monetary policy effectiveness indeed depends on the demographic structure as shocks have asymmetric impacts on different households. Ambler and Kronick (2018) use a structural vector autoregression model to evaluate the impact of Canadian monetary policy effectiveness on economic variables and look at the impact of an aging population on this effectiveness. They meet ambiguous results but underline that Canada’s aging population is likely a leading cause of the systematic undershooting of inflation, which is also mostly explained by the interest rate and credit channels.

Another approach is presented by Imam [2013], who used Bayesian estimation techniques combined with dynamic panel OLS techniques to prove a general weakening of monetary policy effectiveness over time, so demonstrating that unemployment and inflation are less responsive to interest rate changes as population ages. He estimates that an increase in the old-age dependency ratio of one percentage point lowers (in absolute terms) the cumulative impact of a monetary policy shock on inflation and unemployment by 0.10 of a percentage point and 0.35 of a percentage point, respectively. Similar results obtained Kantur [2013], who introduces an OLG-DNK framework paper to study the impact of aging on effectiveness of monetary policy. Her research suggests that monetary policy should be expected to be less effective since the interest rate sensitivity of real economic activity declines as the population ages.

Using a New Keynesian dynamic stochastic general equilibrium model, Yoshino and Miyamoto [2017] also show that effectiveness of monetary policies weakens with a growing proportion of retired people in the population. They compare the dynamic responses to monetary policy shocks in a model with a small working population (aging economy) with those in a model with a large working population. They find that although, qualitatively speaking, the effects

of macroeconomic policy shocks are similar between two economies, quantitatively, the effects are mitigated as the proportion of working population decreases. Using euro area data, Bielecki, Brzoza-Brzezina and Kolasa (2018) develop a New Keynesian life-cycle model to assess the importance of population aging for monetary policy. They find that the impact of aging on the natural rate of interest may lead to a sizeable and persistent deflationary bias if the monetary authority fails to account for this slow moving process in real time.

Mixed results are reached by Kara and von Thadden [2010] who have applied a general equilibrium model that incorporates life cycle features, population aging effects and monetary policy transmission to analyse the effects of aging on the general equilibrium interest rate. They confirm that demographic change contributes to a decline in the equilibrium interest rates. However, they claim it is not important enough within the short-time horizon of monetary policy-making to impact monetary policy effectiveness. This results supports the opinion that in the long run impact of population aging on monetary policy is only gradual and linking the long-term implications of population aging for the economy directly to central bank decisions remains controversial. In line with this results, also Yoon et al. [2014] confirm that there is little empirical evidence of the different impact of monetary policy changes on different age groups and whether monetary policy effectiveness therefore changes in an aging population. However, they state that the potential demographic impact on inflation needs to be taken into account in monetary policy decisions.

The link between population aging and monetary policy transmission mechanism could be analysed from the perspective of consumption behaviour. Carvalho, Ferrero and Nechio [2016] aim to explain the declining trend in real interest rates with population aging, particularly with its effects on household saving and consumption behaviour. They argue that the overall effect of population aging on U.S. interest rates has been negative and quantitatively relevant, lowering the equilibrium interest rate by one and a half percentage points between 1990 and 2014. They argue that demographic trends therefore have important implications for monetary policy. Wong [2014] states that the tightening of monetary policy reduces young households' consumption significantly more than that of older households, as older people are less responsive to changes in interest rates. Accordingly, under an older demographic structure, a significantly lower aggregate consumption response to monetary policy shocks can be anticipated. This view is supported by Kilponen, Kinnunen and Ripatti [2005] who, using a general equilibrium model, show that aging reduces the effectiveness of monetary policy via the interest rate channel as it weakens the effects of interest rate changes on demand.

As presented in the literature review, several researchers have recently explored the subject of monetary policy effectiveness in a changing population structure; however, a consensus has yet to be reached. Reaching empirical conclusions on this topic is very challenging as demographic change occurs slowly which makes its impact on monetary policy difficult to assess. Nevertheless, even if the empirical results are quantitatively small, demographic structure of a population has implications for the conduct of monetary policy through particular channels of transmission. This issue will be discussed in the following section.

3. The implications of aging on monetary policy transmission channels

In the following section we present a discussion of the literature on the implications of aging on particular monetary policy transmission channels. Monetary policy changes have different impact on the consumption, net wealth or asset expenditures in various age groups as they have different savings and investment behaviour. In general, consumption of younger people is more responsive, so under an older demographic structure aggregate consumption is less responsive to monetary policy shocks [Wong, 2014]. We show, basing on the literature, that the relative importance of particular channels of transmission of monetary policy is different for young and elderly people. These channels and their relative importance in an aging population determine the net effect of aging on monetary policy effectiveness. Table 1 presents synthetically the result of the literature review and shows changes that are expected to occur in the effectiveness of particular monetary policy channels as population ages. The overall effect of aging on monetary policy effectiveness would depend on relative importance of each transmission channel. The effects of aging on different monetary policy channels may also, in some way, counterbalance themselves – and this is probably one of the reasons for the ambiguous results of the research discussed in the previous section.

Table 1. Effectiveness of monetary policy transmission channels in an aging population

Transmission channel	Effectiveness as population ages
Interest rate channel	declining
Credit channel	declining
Wealth effect	increasing
Risk taking channel	declining
Expectations channel	unchanged or slightly increasing
Exchange rate channel	unclear

According to the life-cycle hypothesis [Modigliani, 1970], individuals try to smooth consumption over their lifetime. They acquire assets, such as housing and financial assets, throughout their working lives and begin to sell them when they retire. Therefore, the young are usually more indebted than the elderly. For this reason, changes in interest rates are perceived differently by people in various age groups. This changes the effectiveness of the interest rate channel of monetary policy for an aging population. The young people's consumption is more sensitive to interest rate changes than the consumption of the elderly, who more often are net lenders. For the young, these changes impact mostly upon the cost of credit as well as consumption. For the elderly, the impact is concentrated more on the change in asset prices and their return to savings. Therefore, as the ratio of young and old in the population changes, the impact of changes in interest rate differs. *Ceteris paribus*, the younger the population, the more sensitive it is to the changes in interest rate. Therefore, monetary policy changes working through this channel would be more effective in younger than in older populations.

In the credit channel, the effects of monetary policy emerge via changes in the price of the credit. The credit channel assumes that the size of the external finance premium is inversely related to the borrower's net worth. As mentioned before, according to the life-cycle hypothesis, people's pattern of consumption and savings follows a predictable pattern. Tending to smooth their consumption over lifetime, individuals borrow as young adults, build up their savings during their working years and consume out of accumulated savings when retired. During the life-cycle, the stock of financial assets held by a person varies. Older households tend to hold less debt and their consumption sensitivity to changes in interest rate may therefore be reduced. In an older population, households have therefore greater net worth and the need for borrowing is smaller. The elderly would more likely rely on self-financing instead of borrowing money for consumption or investment. What is more, credit restrictions matter more to the young than the elderly. Therefore, in an aging population, credit constraints are less important than in a younger one. The availability of finance is on average better in an aged economy and its price is lower, which decreases the response to monetary policy changes [Kilponen, Kinnunen and Ripatti 2005].

Another channel through which life-cycle behaviour may influence the effectiveness of monetary policy is connected with wealth effects. There is a vast literature concerning the interactions between population aging and households' saving behaviour. Most of the research papers suggest that aging exerts negative impact on savings [e.g. Horioka, 2007; Kelley and Schmidt, 1996] unless the effect is offset by increasing uncertainty over whether pension promises will be

kept. However, some of the researches argue that, in opposition to the life-cycle hypothesis, elderly people do not necessarily dissave. Oksanen [2009] concludes that population aging increases savings rate, this relation is also confirmed by Li, Li and Chan [2012] for China. They explain it with the fact that increasing number of elderly people takes measures to ensure their welfare which means they further engage in a savings behaviour. Lindh and Malmberg [1999] explain this mechanism as follows: When fertility rates have decreased and the population starts aging domestic saving will increase faster than investment demand and current account surpluses will arise. But as the population ages further and becomes dominated by middle-aged cohorts and young retirees saving will tend to decrease faster than investment and generate current account deficits. In line with this theory, a growing share of the elderly implies that more saving will be necessary over the next decades in order to maintain growth in living standards, as Rogers, Toder and Jones [2000] suggest. Wong and Tang [2013] prove that although a longevity has a significant positive impact on savings, old-aged dependency rate has no discernible impact. They claim that the general finding within the literature where old-age dependency exerts a negative impact on savings is sensitive to the way in which the data is handled and to the selected sample.

The issue of different impact of various channels of transmission was also raised by Miles [2002], who has performed an analysis of an overlapping generation model to conclude out that changes in the effectiveness of monetary policy in aging populations are ambiguous. He underlined that due to an increased wealth effect, the effectiveness of monetary policy could even rise in an aging population, but simultaneously argues that other channels of monetary policy transmission may reduce its overall effectiveness.

Nevertheless, according to the life-cycle hypothesis, savings in the lifetime typically form a hump-shaped pattern, where a savings rate is higher during working life. For a given retirement age, population aging increases the proportion of households with a relatively lower rate of savings in the economy which tends to reduce private savings. Meredith [1995] estimates that a 10 percentage points increase in the old-age dependency ratio reduces this savings rate by around 9%.

Regardless of their actual saving rate, older households tend to be wealthier in general than the young, especially as they hold more financial assets. When a household has acquired substantial assets, the impact of interest rate changes on its wealth are larger [Iacoviello, 2005]. As wealth tends to be concentrated among the elderly, wealth effects in aging populations gain importance. Population aging increases the monetary policy effect via the wealth effect channel

because young households typically have less assets and their financial portfolio is more heavily comprised of equity investments than in the case of older households. Thus the relative effectiveness of the wealth effect channel rises in an aged economy. Price [2014] confirms that older households tend to be more exposed to the effect of interest rate changes on financial assets through changes in their wealth. Furthermore, also Bean [2004] points that the wealth channel is likely to gain on importance in the transmission of monetary policy .

The risk-taking channel of monetary policy describes the way in which monetary policy impacts economic agents' risk perception [Borio and Zhu 2008]. Imam [2013] suggests that it is likely to be less effective in an older population than in a younger one. Older people tend to become more risk-averse in their investment decisions than the younger ones as the time horizon of their investment shortens. This may be explained by the fact that the time to recoup their eventual losses is lower than for young people. Along with age, people tend to shift their assets into less risky categories. In an aging population, this leads to an increase in the number of more risk-averse households and, hence, less overall risk-taking in the population. A growing population of risk-averse investors could therefore reduce the effectiveness of the risk-taking channel of monetary policy.

In the assessment of the expectations channel, the focus should be placed on the credibility of the central bank. As it is not much influenced by demographics, this channel should not be impacted by population aging. However, Blanchflower and MacCoille [2009] suggest that inflation expectations rise with age. This would imply the existence of an increasing aversion to inflation in an aging population. Imam [2013] suggests that due to population aging, it is possible that in the future central banks will be forced to put a greater emphasis on price stability. The expectation channel may therefore gain in importance in aging populations, as the central bank would conduct monetary policy more aggressively to combat inflation.

The expected impact of aging on the exchange rate channel remains ambiguous. The net impact of aging on the external current account, and therefore on the exchange rate, depends on the relative decline in savings and investments. The life-cycle hypothesis suggests that an aging population should exert a negative impact on private savings. In addition, countries' fiscal position – and public savings – are expected to worsen with aging because of declining revenues and higher expenditures. Nevertheless, both public and private investments are expected to decline as the population ages and it remains unclear which effect would outweigh the other. Exchange rates may also be influenced through cross-

-border flows of capital between countries and economic areas that age at a different pace.

In three of the described channels there is an expected decline in their effectiveness; only one is expected to be more effective in an older population than in a younger one. This would suggest a weakening in the overall monetary policy effectiveness in an aging population. However, the question of the relative importance of each channel remains unclear. Some of described effects may counterbalance themselves. Therefore, further research is needed to empirically test the effectiveness of particular channels of transmission.

Conclusions

All developed countries are aging. In few years we will witness the baby boom generation to retire and even further increase the proportion of elderly people in population. The potential impact of aging on the economy is complex. However, population aging is gradual and forecastable; it is not a shock that implies immediate monetary policy responses. Therefore, it might be regarded not as a problem but as a policy challenge. In fact, some of its effects on the economy can be already anticipated. For this reason, this issue is of concern both for academics and policy makers.

This paper analyses the literature on relations between demographics and effectiveness and hence conduct of the monetary policy. Research so far proves that, in an aging population, the effectiveness of the monetary policy may change. According to the economic theory, the effectiveness of some of the channels of transmission decreases along population aging. Central banks work in a complex environment, analysing a massive amount of data. The current decisions on monetary policy are based mostly on the outlook for the future macroeconomic situation. For many macroeconomic variables, it is very difficult to accurately predict their value in a longer time horizon. Therefore, central banks have to deal with a lot of uncertainty. Knowing how changing demography affects the economy and how monetary policy effectiveness differs when population ages would imply that at least a part of future information is – to some extent – forecastable and, hence, open to more precise predictions which partly decreases uncertainty.

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POLITYKA PIENIĘŻNA I KANAŁY TRANSMISJI WOBEC STARZENIA SIĘ LUDNOŚCI. PRZEGLĄD LITERATURY

Streszczenie: W ostatnich latach w wielu rozwiniętych krajach rośnie zainteresowanie makroekonomicznymi konsekwencjami zachodzących zmian demograficznych. Zmiany w strukturze wiekowej ludności prowadzą – w mniej lub bardziej bezpośredni sposób – do zmian w mechanizmie transmisji polityki pieniężnej oraz w jej efektywności. W dotychczasowej literaturze tematu ścierają się różne poglądy. Ten artykuł ma na celu zebranie wniosków z wielu badań i zbudowanie ram teoretycznych dla przyszłych analiz empirycznych.

Słowa kluczowe: starzenie się ludności, polityka pieniężna, demografia.