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VAR models and methods
for monetary and health economics

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for monetary and health economics

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Declaration

I declare that this dissertation has not been submitted as an exercise for the degree of Doctor of Philosophy (PhD) at this or any other university. Some of the researches contained herein that are not entirely my own but are based on researches that have been carried out jointly with others are duly acknowledged in the text wherever included.

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Summary

In recent years vector autoregressive (VAR) models have become the main econometric tool to test if may exist a relationship between variables and to assess the effects of policy. This thesis studies three different identification approaches starting from reduced-form VAR models (including sample period, set of endogenous variables, deterministic terms and lag length). We use in the case of VAR models Granger Causality test to verify the ability of one variable to predict another one, in the case of cointegrating relationship we use VECM models to jointly estimate long-run and short-run coefficients from data and in the case of small dataset and problem of overfitting we use Bayesian VAR models with impulse response functions and variance decomposition to analyze the effect of shocks on the macroeconomic variables. For this, the empirical studies are carried out using specific datasets and different assumptions. The three VAR models approaches have been used: first to study decisions on monetary policy for discriminating among Post-Keynesian analyses of monetary theory and policy and more specifically the so-called "solvency rule" (Brancaccio and Fontana 2013, 2015) and nominal GDP targeting rule in the Euro Area (paper 1); second to extend the evidence of endogenous money hypothesis by evaluating the effects of banks' securitization on monetary transmission mechanism in the United States (paper 2); third to evaluate the effects of ageing on health care expenditure in Italy in terms of policy implications (paper 3).

The thesis is introduced in Chapter 1, which outlines the context, motivation and aim of this research. Furthermore the structure and a summary of the approach as well as the main findings of the remaining chapters are described.

Chapter 2 examines by using a VAR model in first differences with quarterly data of Eurozone whether decisions on monetary policy can be interpreted in terms of a "monetary policy rule" with specific reference to the so-called "nominal GDP targeting rule" (McCallum 1988; Hall and Mankiw 1994; Woodford 2012). The results indicate a causal relation proceeding from deviation between the growth rates of nominal GDP and target GDP to variation in three month market interest rate. The same analysis do not, however, appear to confirm the existence of a significant inverse causal relation from variation in the market interest rate to deviation between the nominal and target GDP growth rates. Similar results were obtained on replacing the market interest rate with ECB refinancing interest rate. This confirmation of only one of the two directions of causality does not support an interpretation of monetary policy based on the nominal GDP targeting rule and gives rise to doubt in more general terms as to the applicability of the Taylor rule and all of the conventional rules of monetary policy to the case in question. The results appear, instead to be

more in line with other possible approaches, such as those based on some Post-Keynesian and Marxist analyses of monetary theory and policy and more specifically the so-called "solvency rule" (Brancaccio and Fontana 2013, 2015). These lines of research challenge the simplistic argument that the scope of monetary policy consists in the stabilization of inflation, real GDP or nominal income around a "natural equilibrium" level. Rather, they suggest that central banks actually follow a more complex purpose, which is the political regulation of financial system with particular reference to the relations between creditors and debtors and the related solvency of economic units.

Chapter 3 analyzes loans supply by explicitly accounting for the money endogeneity arising from securitization bank's activity over the period 1999-2012. Although there is a large body of literature that investigates the endogeneity of money supply this approach has rarely been adopted to investigate money endogeneity in a short-term and long term study of the United States during the two main crises: the dot-com bubble burst (1998-1999) and the sub-prime mortgage crisis (2008-2009). Specifically, we consider the effects of financial innovation on lending channel by using the loans series adjusted for securitization to investigate whether the American banking system is incentive to seek the cheapest sources of financing as securitization, which affects its response to restrictive monetary policy (Altunbas et al., 2009). The analysis is based on the aggregate M1 and M2. In the study period the Federal Reserve uses M1, M2 money supply as its monetary target. Employing VECM models, we examine a long-run relationship among level variables and evaluate the effects of money supply by measuring how much the monetary policy stance affects short-run deviations from long-run relationship. The results show that securitization influences the impact of loans on M1 and M2. This implies money supply endogeneity in favor of structuralist approach and motivates agents to increase securitization with a preemptive motive to hedge against policy shocks.

Chapter 4 investigates the relationship between per capita health care expenditure, per capita GDP, aging index and life expectancy in Italy over the period 1990-2013 by employing Bayesian VAR models and annual data drawn from OECD and EUROSTAT database. The impulse response functions and variance decomposition analysis find evidence of a positive relationship from per capita GDP to per capita health care expenditure, from life expectancy to per capita health care expenditure and from aging index to per capita health care expenditure. The impact of ageing on health expenditure is significant and stronger than the other variables.

Overall, our findings suggest that disabilities closely associated with ageing may be the main driver of health expenditure in the short medium-run. A good health care management contributes to improve patient welfare without increasing total health expenditure. However,

policies that improve health status of the elderly might be necessary for a lower per capita demands on health and social services.

Acknowledgements

Contents

List of Figures

List of Tables

Chapter 1

Introduction

Setting the context

The VAR/VECM model has been used by researchers for decades and re-emerges as an important instrument in later years to study policy implications in monetary and health analyses especially after the Great Recession (IMF 2012). The empirical evidence suggests a large use of VAR/VECM model to test money endogeneity (Pollin 1991; Palley 1996, 1998; Vera 2001; Nell 2000-2001; Shanmungan Nair and Li 2003; Lavoie 2005; Cifter and Ozun 2007; Lopreite 2012), to analyze rules of monetary policy (Judd and Motley 1992; Clark 1994), and to examine the effects of the demography transition in terms of policy and health initiatives (Bhargava, et al. 2001; Chete and Adeyone 2002; Bloom et al., 2004; Taban 2006; Temiz and Korkmaz 2007; Aghion et al., 2010; Ogungbenle et al., 2013).

The VAR/VECM framework allows to investigate the "causal" relationship among the variables, without deciding, *a priori*, about the endogeneity or exogeneity of the included variables. The vector autoregressive model treats all variables as endogenous and determines the direction of causality between them based on econometric tests instead of assuming exogeneity based on economic theory.

In this thesis we before including the time series in regression analysis and then we test for unit roots or non-stationarity in order to avoid miss-specified or spurious regressions (Engle and Granger 1987). Given the relatively low power of unit root we use a variety of tests, including the well known Augmented Dickey Fuller (ADF) and non-parametric Phillips-Perron (PP) unit root tests, as well as the less well known (confirmatory) Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationary (no unit root) test to investigate the order of integration of the series.

Having shown that variables for each analysis (paper 1-2) are integrated of order one, I(1), we determine whether there is at least one linear combination of these variables that is I(0). In other words, is there a stable and non-spurious (cointegrated) relationship among the regressors in each of the relevant specifications? By using Johansen and Juselius (1990) cointegration method we

determine the number of cointegrating vectors for any given number of non-stationarity series (of the same order).

Therefore, we select a VAR stable specification in first difference in paper 1 and in paper 2 because there are no linear combination between the I(1) variables (i.e nominal gdp deviation, interest market rate (paper 1); industrial production index (IPI), loans (L), money supply M2 (M2), base money (BM) (paper 2)).

We estimate, instead, VECM models presented in paper 2 because we find a unique linear combination of the I(1) variables (i.e M1 money supply, loans, loans adjusted for securitization) that links them in a stable and long-run relationship. The presence of one cointegrating equation from which residuals (EC terms) can be obtained also makes it possible to investigate whether there is a short-run adjustment back to the long-term relationship after a shock.

Finally, in the paper 3 we estimate a Bayesian VAR that could be exceptionally suitable for this type of exercise because of its ability to produce more stable results for short set of time series, as compared with canonical econometric models. The model obtained is used to calculate the impulse response functions and the variance decomposition.

The rest of this chapter outlines the motivation and approach of this research within this context.

Motivation

The VAR/VECM modeling has faced severe criticism because of its no theoretic, empirically-based methodology, thought it often generates better forecasts than the complex economic theory based-models. In our case there are advantages from not predetermining the direction of causality.

First, as indicated in paper 1-2-3, there is no unique consensus in the literature about the direction of causality between the considered variables.

Second, the analysis are carried out in a period of instability that include the Great Recession of 2008-2009 and this may have some effect on the direction of causality.

In order to investigate further the "causal" relationship among the variables we employ in paper 1 unconstrained VAR models in first differences since there is no long-run relationship and variables are not cointegrated. We assess the short-run causality using the standard Granger causality test (Granger 1969). This test examines the two equations and tries to determine the

direction of "causality". Following Granger (1969) X_t Granger-Cause Y_t if and only if the information of the past and present values of X_t helps to improve the forecast of the Y_t.

In paper 2, since exists the cointegration between variables, we examine the causality using the vector error correction model (VECM). We test the short-term causality relationship using Granger Causality test and the Wald Test (Shanmugan et al., 2003, Cifter et al., 2007; Lopreite 2012). We also test the long-term causality relationship using the EC_t parameter meaningfulness (Shanmugan et al., 2003; Cifter et al., 2007; Lopreite 2012). Finally, in paper 3 to avoid problems of overfitting we use Bayesian VAR models by performing impulse response functions and variance decomposition in order to analyze the response of the variables to the shocks.

Structure of Thesis

The structure of the thesis can be broadly described as follows: in the Chapter 2 we introduce some new hypotheses to explain whether decisions on monetary policy can be interpreted in terms of a monetary policy rule with specific reference to so-called "nominal GDP targeting" using VAR model in first differences and quarterly data of the Eurozone over the period 1999Q1-2013Q3. In the Chapter 3 we test money supply endogeneity starting from securitization bank's activity and considering the three competing approaches to the determination of the passive money supply. We use VAR and VECM models and U.S monthly data over the period 1999-2012. Finally, in the Chapter 4 we analyze the effect of longevity on public health expenditure in Italy by using the VAR Bayesian approach and annual data drawn from OECD and EUROSTAT database for the period between 1990-2013. Bayesian VAR modelling substantially reduces the degrees of freedom issue by introducing relevant prior information and typically leads to a substantial improvement in model performance in the case of overfitting respect to classical VAR model.

A more detailed overview of the structure of the thesis is given below.

Paper 1

The first paper examines the monetary policy rule based on the nominal GDP targeting rule in Euro Area over the period from 1999 to 2013. In order to investigate if there is a dual causal relation- from deviations between effective and target variables to instrumental variables and conversely from instrumental variables to the same deviations- are used VAR models in first differences with reference to the three-month market interest rate and to the deviation of the log-level of the nominal GDP of the Eurozone with respect to the log-level of the target nominal GDP.

In accordance with Woodford (2012), the target nominal objective GDP series corresponds to the log-linear trend obtained from 1999Q1 to 2013Q3 by applying the ordinary-least-squares (OLS) method to the data of nominal GDP from 1999Q1 to 2008Q3, e.g. from the birth of the European single currency to the start of the Great Recession (IMF 2012).

In order to verify the robustness of the results, the analysis is then repeated for the same period with reference to the ECB three-month refinancing interest rate.

In general, results show that the decisions of monetary policy on interest rates in the Eurozone appear to be effectively influenced by the dynamics of monetary GDP with respect to the target GDP. However, there is not a confirmation of an inverse causal relation from the interest rate to the deviation of monetary GDP. This second result does not support interpretations of the behaviour of the monetary authorities in the light of the nominal GDP targeting rule.

The lack of adequate empirical evidence for even just one of the two relations would raise doubts about the very meaning usually attributed to these rules and suggest other possible approaches such as the so-called "solvency rule" (Brancaccio and Fontana 2013, 2015).

This is the precise contribute of the paper.

Paper 2

Paper 2 applies VAR and VECM models which take into account the short-run and long-run relationships and examines the money endogeneity hypothesis for United States area in the age of financial liberalization. This analysis is carried out by using M1 money supply (M1), M2 money supply (M2), loans supply (L), loans adjusted for securitization (Lsec) and industrial production index (IPI) as proxy variable for macroeconomic activity since a monthly measure of GDP is not available over the period 1999 to 2012.

Although there is a large body of literature that investigates the money endogeneity hypothesis the loans securitization has not been adopted to investigate the passive money supply.

The analysis starts from the debate among the theories that support Post-Keynesian view concerns the significance ascribed to the private initiatives of banks in accommodating increases loans demand. Accommodationalists argue that accommodation depends exclusively on the stance of the monetary authority, and its willingness to meet the reserve pressure generated by increased bank lending. In granting loans to credit-worthy borrowers, the banking system - setting a loan rate equal to a fixed markup on the overnight interest rate - acts as price setters (sets loan rate) and quantity takers (does not affect loans amount)(Moore 1988; Palley 1996). Instead, according to the Post-Keynesian "structuralist" view of endogenous money accommodation depends on both the stance of the monetary authority and the private initiatives of banks. These initiatives are independent of the monetary authority and are therefore suggestive of the structurally endogenous nature of "finance capital" (Pollin 1991, Vera 2001).

The findings of our paper provide evidence for the direct impact of the loans on policy stance through securitization. Specifically, the results show that asset securitization increases the impact of loans on M1 money supply and M2 money supply and they confirm structuralist passive money hypothesis.

Paper 3

Finally, in paper 3, since research on the societal consequences of population aging on health expenditure growth is still fragmented and not fully understood, we review the effect of longevity on health expenditure for a greater understanding of the effectiveness of government spending on health in Italy.

In fact, the existing researches are mostly focused on the analysis of GDP, life expectancy and health care expenditure (Aghion et al., 2010; Ogungbenle et al., 2013) and, therefore, this analysis may be interesting to understand what policies and programs are most effective and efficient in improving healthcare.

Also in this case there are several reasons for focusing on Italy. First, it is a country with an increased percentage between 1990-2011 of individuals aged over 65 (+5.7%); in the same period the individuals over age 85 increased of 1.6% (Altavilla et al., 2014). Second, the growth in length of life led to an higher incidence of chronic-degenerative diseases (e.g heart disease, cancer, Alzheimer's disease) and a greater demand for healthy living resources over time. More than 38.6%

per cent of population suffer at least of one chronic-degenerative diseases. In particular, they are more affected women and people aged over 75 (ISTAT, 2013).

The empirical analysis is based on OECD, EUROSTAT and ISTAT database for the period 1990-2013 and records data of per capita GDP, per capita health care expenditure, life expectancy and aging index. In this paper is developed a Bayesian VAR model for Italy with small dataset in order to estimate the effects of per capita GDP, life expectancy, aging population on per capita public healthcare expenditure.

The impulse response functions and variance decomposition analysis are undertaken to show how aging index, life expectancy and per capita GDP affect public healthcare expenditure.

Results underline the importance of shocks to aging index, life expectancy and GDP per capita for Italian health expenditure. The impulse response functions and variance decomposition indicate that life expectancy and GDP per capita have a moderate impact on health expenditure, while the effect of aging index, is considerably stronger.

The picture that emerges is very interesting and underlines the important rule of longevity on health expenditure in later years in Italy. The increase of chronic diseases (14.8%) and multiple chronic diseases (13.9%) led to a wide social and territorial discrepancy in particular for women over 75 that live in the South Italy (ISTAT, 2013).

Moreover, decreases among elderly people the demand for health service caused by economic problems and worsens the perception's index of the psychological health status (ISTAT, 2013).

This puts in evidence the need of more efficient and thus more effective health plans to improve access to and availability of healthcare (e.g. access to medicine and vaccinations, hospital beds) so as to better support elderly individuals.

Chapter 2

Monetary Policy Rules and Directions of Causality: An empirical analysis on the Euro Area[1]

Abstract

This paper uses a VAR model in first differences with quarterly data for the Eurozone to ascertain whether decisions on monetary policy can be interpreted in terms of the so-called "nominal GDP targeting rule" (McCallum 1988; Hall and Mankiw 1994; Woodford 2012). The results obtained appear to indicate a causal relation proceeding from deviation between the growth rates of nominal GDP and target GDP to variation in the three-month market interest rate. The same analyses do not, however, appear to confirm the existence of a significant inverse causal relation from variation in the market interest rate to deviation between the nominal and target GDP growth rates. Similar results were obtained on replacing the market interest rate with the ECB refinancing interest rate. This confirmation of only one of the two directions of causality does not appear to support an interpretation of monetary policy based on the nominal GDP targeting rule, and gives rise to doubt in more general terms as to the applicability of the conventional rules of monetary policy to the case in question. The results appear instead to be more in line with other possible approaches, such as those based on Post-Keynesian analyses of monetary theory and policy and more specifically the so-called "solvency rule". These lines of research challenge the simplistic argument that the main goal of monetary policy is the stabilization of inflation, real GDP or nominal income around a certain equilibrium level. Rather, they give the central bank a more complex role, which is to contribute to the maintenance of financial stability and the solvency of economic units.

Keywords: VAR approach, Granger causality test, monetary policy decisions, nominal GDP targeting rule, solvency of economic units

JEL classification: E12, E52, E58

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[1] Large part of this paper has been written while the author was in Visiting Researcher at the University of Sannio. Part of this chapter serves as the base of publication: Brancaccio, E., Fontana, G., Lopreite, M., and Realfonzo, R., 2015. Monetary Policy Rules and Directions of Causality: A test for the Euro Area, *Journal of Post Keynesian Economics*, forthcoming.

2.1 Introduction

Conventional analyses of monetary policy over the last twenty years have described the behaviour of central banks in terms of monetary policy rules. The types of rule to be found in the literature are numerous. While the best-known is perhaps the "Taylor rule", formulated by John B. Taylor in 1993, there are others, including the nominal GDP targeting rule put forward in 1977 by James Meade, which has recently found new admirers. For all their diversity, these rules of monetary policy follow the same logical framework. First, a rule of conduct is formulated for the central bank in the pursuit of particular objectives of economic policy, such as certain levels of inflation and real or nominal GDP. The rule is then taken as a point of reference to ascertain whether the monetary authority, by acting on interest rates or other instrumental variables, has effectively affected aggregate demand in such a way as to reduce deviation of the effective levels of inflation and real or nominal GDP from their respective targets. Within this logical framework, the adoption of such rules by central banks would therefore need to be confirmed by verification of the existence of a dual causal relationship: first from the gap between effective variables and target variables to the instrumental variables of monetary policy and then in the other direction from the instrumental variables to the gap. In this connection, the conventional empirical literature on the rules of monetary policy tends to focus above all on the relation that proceeds from the gap between effective variables and target variables to the instrumental variables. The inverse causal relation is instead often taken for granted or only implicitly analysed, e.g. through calculation of the variance of the gap between effective variables and target variables in the periods of application of the rule in question. Confirmation of both directions of causality is, however, required by the logic of the rules of monetary policy. The non-existence of one of them would necessarily call into question the conceptual basis of such rules.

The purpose of this study is to ascertain whether both these causal relations are supported by significant empirical evidence. The empirical criterion adopted rests on the use of a VAR model in first differences. While the VAR model is nothing new in the literature on the rules of monetary policy, this paper will take advantage of this model for the specific purpose of investigating both the directions of causality implicit in the functioning of the rules of monetary policy. The rule selected for examination is that of nominal GDP targeting, which has been the object of renewed attention on the part of researchers and policy makers in recent times. The geographical area examined is the Eurozone. In this analysis, the rule indicates a link between deviations of the growth rate of nominal GDP with respect to a given target, and a variation in the three-month market interest rate. This rule

rests on the idea that the monetary authority registers the gap between the effective growth of nominal GDP and its desired trend at set intervals and adjusts the interest rates in order to reduce it. Use is made of a VAR model in first differences with quarterly data for the Eurozone in order to ascertain the existence of a causal relation from deviation of the nominal GDP growth rate from the target GDP growth rate to variation of the three-month market interest rate and vice versa. The period considered starts from 1999Q1, when the European single currency was born, and ends in 2013Q3. In order to test the robustness of the results obtained, the analysis is then repeated for the same period of time, but using the ECB quarterly refinancing interest rate rather than the market interest rate. In accordance with Woodford (2012), it is assumed that the target levels of nominal GDP correspond to its trend from 1999Q1 to 2013Q3. This trend is calculated on the effective data of the single interval stretching from 1999Q1 to 2008Q3, i.e. to the beginning of the "Great Recession" (IMF 2012).

The chapter is organized as follows. Section 2 discusses the characteristics of the nominal GDP targeting rule, and the reasons for the renewed attention it has recently received. Section 3 describes the data and tests stationarity and cointegration. Section 4 implements an unrestricted VAR model in first differences. Section 5 presents the Granger causality test and the results obtained. Section 6 analyses the robustness of the results by replacing the market interest rate with the refinancing interest rate. Section 7 suggests a theoretical interpretation of the empirical results based on a Post-Keynesian interpretation of monetary policy and more specifically the so-called "solvency rule" proposed by Brancaccio and Fontana (2013).

2.2 The nominal GDP targeting rule

The nominal GDP targeting rule has played a non-negligible role in the debate on monetary policy over the last thirty years. The earliest advocates of the adoption of a given level or rate of variation of nominal GDP as an objective of monetary policy include Meade (1978), von Weizsacker (1978) and Tobin (1980). This proposal was then translated into a precise formal rule according to which deviation of nominal GDP with respect to a set trend should guide the decisions of the monetary authority as regards determination of a monetary aggregate or the short-term interest rate (McCallum 1988; Hall and Mankiw 1994). While the rule generally takes the past trend of nominal GDP as its point of reference, forward-looking formulations also exist in the literature (Judd and Motley 1992, Dueker 1993, Clark 1994, McCallum 1999). Attention is focused here on the most

common version, whereby monetary policy decisions regarding the current level of the short-term interest rate are to be guided by past percentage deviations of the nominal GDP from a given target. With i_t as the level of the short-term nominal interest rate at time t, Y_{t-1} as the level of nominal GDP and Y^*_{t-1} as the target level of the nominal GDP at time t-1, the rule can be expressed as $i_t = \alpha + \beta(Y_{t-1} - Y^*_{t-1})/Y^*_{t-1}$, which corresponds to:

$$i_t = \gamma + \delta[ln(Y_{t-1}) - \ln(Y^*_{t-1})] \qquad \textbf{(2.1)}$$

The same rule can obviously be represented also in terms of variations: $\Delta i_t = \beta(y_{t-1} - y^*_{t-1})$, where y and y^* indicate the growth rates of nominal GDP and target GDP.

Criticisms of this rule have been put forward in the literature and some studies have suggested that it could increase rather than decrease the variance of nominal GDP and the other macroeconomic variables around their respective targets (Taylor 1985; Ball 1997). For this reason, some maintain that it is preferable to adopt other measures, such as the Taylor rule (Taylor 1993, 1999; Taylor and Williams 2009). These observations do not appear, however, to have prevented a recent revival of interest in the nominal GDP targeting rule, and new agreement as to the possibility of its employment has emerged since the outbreak of the international economic crisis in 2008. A thesis now fashionable among its supporters is that the rule could have mitigated the effects of the Great Recession and could today help countries that adopt it to regain the rate of growth prior to the crisis more quickly. One of the reasons put forward is that the nominal GDP targeting rule would prompt the central bank to react to variations in real GDP and the rate of inflation with the same intensity, whereas other and more celebrated rules, including the Taylor rule, make the monetary authority more sensitive to changes in inflation than in real GDP. In this sense, the nominal GDP targeting rule is described as more "general" than the Taylor rule (Koenig 2012). On the basis of these and other arguments, the nominal GDP targeting rule has been revived in the academic sphere by various scholars, including Sumner (2011) and Woodford (2012), and in the political debate by the *Economist* (2011) and the *New York Times* with Christina Romer (2011). Indeed, the adoption of this rule would not be something wholly unprecedented as a number of central banks seem to have implicitly adopted it (see the case of the Bank of England in King 2011, among others; moreover, the rule has been explicitly taken into consideration by the FOMC of the Federal Reserve 2010).

It is interesting to note that the adoption of a nominal GDP targeting rule has also been suggested on the grounds of potential theoretical ecumenicity stemming from its logical

compatibility with various interpretations of how the economic system works. The readings in question regard the macroeconomic nexus between monetary and real variables and the possibility of variations in the former proving neutral or otherwise with respect to the dynamics of the latter. This is a well-known question and one upon which macroeconomists have often disagreed. There is in fact no need for the nominal GDP targeting rule to make the terms of this nexus explicit, and it has for this reason been regarded as a possible candidate to identify an area of common ground for the various scholars, at least in the sphere of monetary policy. Those who adopt models in which money is neutral also in the short period should agree that this rule would in any case ensure satisfactory stability of prices, whereas those who regard monetary variables as having at least a short-term influence on real variables could consider the rule a valid compromise between the stability of prices and the stability of real GDP and employment. In the light of this reasoning, the nominal GDP targeting rule has been described as the most "efficient" of the rules that seek to establish the optimal behaviour of the monetary authority on the basis of a single, specific macroeconomic model (Hall and Mankiw 1994; McCallum 2011).

The nominal GDP targeting rule can, however, constitute a point of compromise only between economic models based on the assumption that management of the short-term interest rate makes it possible to stabilise the movements of aggregate expenditure and nominal GDP around a given target. This assumption, which is shared by the nominal GDP targeting rule and the Taylor rule, is often taken for granted in the predominant literature or subjected only to implicit analysis. The empirical analyses most in vogue at present confine themselves in actual fact to verifying whether a decrease in the variance of the gaps between the effective variables and the target variables of monetary policy takes place in the periods when the rules examined are applied (McCallum 1997; Taylor 1999; Taylor and Williams 2009). The idea that adjustment of the short-term interest rate alone is capable of stabilising the trend of aggregate demand has, however, been called into question on various occasions. Post-Keynesians and members of the other schools of critical thought have repeatedly challenged the theoretical bases of this thesis (Garegnani 1978; Pasinetti 2000; Arestis and Sawyer 2004; Krisler and Lavoie 2007; Realfonzo 1998, among others). Difficulties have also emerged in the sphere of the predominant empirical studies with respect to the non-linearity, the asymmetry and even the existence of some of the connections that are supposed to justify it, such as those between the interest rate and investment (Blanchard 1984; Caballero 1999; Taylor 1999). The most recent debate on monetary policy does not appear, however, to concentrate on these objections. There is discussion about the choice between various rules to be adopted by the monetary authority in setting the interest rate, but not about the fact that the sole use of the interest

rate or other conventional monetary policy tools could prove inadequate for the management of aggregate expenditure and the attainment of the target variables incorporated into the same rules. These difficulties were instead well known to pioneers of nominal GDP targeting like Meade (1978) and Tobin (1980), who rightly held that responsibility for pursuing a given target of nominal GDP should be assigned to both monetary and fiscal authorities.

The problem is therefore of recognition that the nominal GDP targeting rule, just like the other conventional rules of monetary policy, is based on a dual causal relation: from deviations between effective and target variables to instrumental variables and conversely from instrumental variables to the same deviations. The lack of adequate empirical evidence for even just one of the two relations would raise doubts about the very meaning usually attributed to these rules. It may therefore prove useful to identify a criterion making it possible to ascertain the existence or otherwise of both causal relations. This is the precise purpose of the paper. A VAR model in first differences is used to assess whether the monetary policy of the Eurozone can be adequately interpreted in the light of a nominal GDP targeting rule in the sense not only of nominal GDP contributing to determination of the short-term interest rate, but also of the interest rate contributing to the stabilisation of nominal GDP around a given target trend. To this end, analysis is carried out on quarterly data for the period 1999Q1–2013Q3 with reference to the three-month market interest rate. In order to verify the robustness of the results, the analysis is then repeated for the same period with reference to the ECB three-month refinancing interest rate.

2.3 Unit roots test and Cointegration analysis

This work analyses the monetary GDP targeting rule on the basis of the equation (1) presented in the previous section. The sample examined regards the Eurozone and covers the period from 1999Q1 to 2013Q3. The back-to-top data are quarterly and drawn from the Eurostat database.[2] The analysis focuses on the following time series: the three-month market interest rate (*imr*) and the deviation of the log-level of the nominal GDP of the Eurozone with respect to the log-level of the target nominal GDP *gdp_dev*). In accordance with Woodford (2012), the target nominal objective

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[2] The series of nominal GDP expressed in millions of euros is taken from the Eurostat database at current prices and seasonally adjusted by means of the X-12 ARIMA procedure

GDP series corresponds to the log-linear trend obtained from 1999Q1 to 2013Q3 by applying the ordinary-least-squares (OLS) method to the data of nominal GDP from 1999Q1 to 2008Q3, e.g. from the birth of the European single currency to the start of the Great Recession (IMF 2012).

Both series show outliers at the end of 2008 and the beginning of 2009 in connection with the start of the Great Recession. From graphical inspection of the series in levels of the deviation of nominal GDP and the market interest rate, both appear to be I(1), i.e. non-stationary (Figure 2.1):

Please Insert Figure 2.1: Series of the levels and first differences of *gdp_dev* and *imr*

The non-stationarity of the series is confirmed by the Augmented Dickey-Fuller (ADF) test, the Phillips Perron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, as shown in Table 2.1.

Please Insert Table 2.1: Unit roots test of the series in levels

The ADF, PP and KPSS tests never reject the null hypothesis of unit root's presence at the 1% significance level. It is therefore possible to attempt to make the series stationary by transforming them into first differences (Figure 2.1). The ADF, PP and KPSS tests confirm the stationarity of the series in first differences of the *imr* at the 1% significance level and of the *gdp_dev* at the 5% significance level (Table 2.2).

Please Insert Table 2.2: Unit roots test of the series in first differences

In order to confirm the presence of a unit root and to take into account the events connected with the Great Recession (IMF 2012), which could be seen as a structural break, separate ADF tests were carried out on the pre-crisis period (1999Q1–2008Q3) and the post-crisis period (2008Q4–2013Q3) for both the series considered. The hypothesis of the presence of a unit root is never rejected at the 5% significance level. The obtained results do not support the presence of a structural break.

As the variables are I(1) in levels and they become I(0) in their first order differences, it is possible to apply the Johansen cointegration test (1991). This more general test is preferred to the Engle-Granger test (1987). In this case it is assumed that all the variables of the system are

endogenous and it is not necessary to establish a direction of causality amongst them *a priori*. The test is carried out by including the option "unrestricted constant" and two lags, which minimise the information criteria of Akaike (AIC), Schwartz Bayesian (BIC) and Hannan-Quinn (HQC). According to the trace test and eigenvalue test, the null hypothesis of the absence of a relation of cointegration between *gdp_dev* and *imr* is not rejected. In this case, the presence of a stationary linear combination between the two variables is ruled out. The results are shown in Table 2.3.

Please Insert Table 2.3: Johansen cointegration test (series in levels)

2.4 The VAR approach

As the VAR model specified on the series in levels proves non-stationary, it was decided to proceed with estimation of the model specified in first differences (for further applications of this model, see Heather et al., 1997; Lamdin et al., 2008; Coad et al., 2011, 2013). In the VAR model estimated in the reduced form, all the variables are endogenous except the dummy (dum1) inserted as an exogenous variable. In order to test for the presence of outliers, the temporal dummy variable (dum1) assumes the value of one in the quarters 2008Q4 and 2009Q1, and zero in all the other quarters. The variable is proved significant by applying the Wald test. On the basis of the information criteria of Akaike (AIC), Schwartz Bayesian (BIC) and Hannan-Quinn (HQC), it was decided to insert two lags for the series in levels, and one lag for the variables in first differences. The VAR model estimated is therefore as follows:

$$\begin{bmatrix} \Delta imr_t \\ \Delta gdp\_dev_t \end{bmatrix} = \begin{bmatrix} a_{imr\,imr} & a_{imr\,gdp\_dev} \\ a_{gdp\_dev\,imr} & a_{gdp\_dev\,gdp\_dev} \end{bmatrix} \begin{bmatrix} \Delta imr_{t-1} \\ \Delta gdp\_dev_{t-1} \end{bmatrix} + \begin{bmatrix} dum_{imr} \\ dum_{gdp\_dev} \end{bmatrix} dum1 + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \quad (2.2)$$

Table 2.4 presents the results of the estimation of the VAR model. The exogenous dummy variable (dum1) is significant. The results reported in Table 2.4 show that in the short term the variation in the three-month market rate is positively influenced by the deviation of the growth rate of nominal GDP, whereas the coefficient for variation of *imr* does not prove statistically significant in the equation of the deviation of the nominal GDP growth rate. The unidirectional relation is confirmed by application of the Granger causality test (Table 2.5). The results obtained are robust

with respect to conditional heteroscedasticity and autocorrelation. The Ljung-Box Q test shows the absence of serial autocorrelation at the 1% significance level for both the equations of the VAR model.[3] The test for the presence of ARCH effects in the residuals confirms homoscedastic residuals. The absence of serial autocorrelation and ARCH effects is also confirmed when the number of lags is varied from one to four. Moreover, the residuals plot shows that the residuals of the VAR model are stationary. The normality tests confirm normal distribution at the level both of the system and of the single equation.[4] Finally, the tests of structural stability (CUSUM test and CUSUMQ test) of the parameters of the VAR model provide no evidence of instability and the series moves within the confidence intervals.

Please Insert Table 2.4: Results of the estimation of the VAR model

2.5 Granger causality test

This section is dedicated to the Granger causality test (Granger 1969), which proposes a definition of causality centered on the lag structure of the variables of the model. Within the VAR models the null hypothesis of Granger Causality of a variable with respect to another variable is ascertained through the use of F-test of joint significance of the lags. The null hypothesis is accepted if the lags of the variable whose causality is verified are not significant. In this case, the lags of this variable do not help to predict the variable of interest. Considering the VAR estimated by the equation (2.2) it has been carried out the Granger causality test to verify if the deviation of GDP *causes* the money market interest rate and vice versa (Table 2.5).

Unidirectional Granger causality is detected from deviation of the nominal GDP growth rate to variation in the three-month market interest rate at 1% significance level. It therefore appears that deviation of the growth of nominal GDP with respect to the target precedes movement of the variation in three-month market interest rate but not the other way round. On the whole, the analysis of Granger causality shows that the deviation of the nominal GDP growth rate with respect to the target rate is a driving force capable of explaining a large proportion of variation in the three-month market interest rate. These results confirm the causality analysis of the VAR estimated. In order to confirm the robustness of the results obtained, the Granger causality test was also repeated varying

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[3] The absence of autocorrelation is also confirmed by the Pormanteau test.
[4] The normality of the residuals is confirmed by the Jarque-Bera test.

the number of lags from one to four quarters (Kholdy et al., 1990; Casillas 1993; Moosa 1997; Vera 2001).

Even in this case, the null hypothesis is rejected and the variation of the market interest rate depends on the deviation of the growth of nominal GDP delayed up to a period of four quarters. Therefore, the deviation of the nominal GDP growth can be considered influential in the prediction of the changes in the market interest rate. On the contrary, the causal relation does not apply in the other way round.

Please Insert Table 2.5: Granger causality test

2.6 Robustness check

An analysis of the robustness of the results was carried out over the same span of time (1999Q1–2013Q3) by replacing the three-month market interest rate with the ECB three-month refinancing interest rate (*refi*) and testing the relation between the three-month refinancing interest rate and the deviation between the log-level of nominal GDP and the log-level of the target GDP (*gdp_dev*). Once again, both of the I(1) series can be described as difference-stationary processes I(0) and are not cointegrated. A VAR model in first differences was therefore estimated with the same exogenous dummy as previously adopted. It emerges from estimation of the bivariate VAR model that variation in the refinancing interest rate is positively influenced (0.37) in the short term by deviation of the growth rate of nominal GDP but not vice versa. Moreover, the exogenous dummy proves statistically significant in both the equations of the VAR. The unidirectional relation from the deviation of nominal GDP to the three-month refinancing interest rate is confirmed by the Granger causality test. Here too, the analysis of Granger causality test shows that the deviation of the growth of nominal GDP with respect to the growth of the target is capable of explaining a large proportion of the variation in the refinancing interest rate but not vice versa. The result is also confirmed when the number of lags is varied from one to four quarters. The diagnostics of the model respects the requirements of the absence both of serial autocorrelation and of conditional heteroscedasticity, the normality of residuals and the structural stability of the parameters estimated. The results obtained therefore confirm the analysis of causality of the VAR model estimated for the relation *imr-gdp_dev*. The results of the estimation of the VAR model and the tests regarding the analysis of robustness are available on request.

2.7 Conclusions

This work examines the relation between the deviation of the log-nominal GDP from the log-target GDP and the three-month market interest rate in the present-day Eurozone over the period from 1999Q1 to 2013Q3. In order to test this relation, given the presence of non-cointegrated variables and the non-stationarity of the VAR model in levels, use was made of a bivariate VAR model in first differences on quarterly data. The results obtained show that the model is a good fit for the data with white noise errors and structural stability of the parameters. The estimation of the unrestricted VAR model shows that in the short term the deviation of the nominal GDP growth rate from the growth rate of the target GDP is not influenced by variation of the market interest rate. The same estimation also shows, however, that the variation in the market interest rate is positively influenced by deviations of the nominal GDP growth rate from the target. This unidirectional relation is confirmed in the period considered by the Granger causality test. The F tests carried out for Granger causality show that the deviation of the growth of monetary GDP from the growth of the target GDP is not preceded by variations in the market interest rate and that the variations in the market interest rate are Granger-caused by the deviation of the growth of the nominal GDP from the target. This result is confirmed when the number of lags is varied from one to four quarters. The robustness of the results is also confirmed by an analysis that takes the three-month refinancing interest rate rather than the market interest rate as its point of reference. It is therefore possible to draw the conclusion that the decisions of monetary policy on interest rates in the Eurozone appear to be effectively influenced by the dynamics of monetary GDP with respect to the target GDP. There appears, however, to be no confirmation of an inverse causal relation from the interest rate to the deviation of monetary GDP. This second result does not appear to support interpretations of the behaviour of the monetary authorities in the light of the nominal GDP targeting rule. In more general terms, it casts some doubt on the possibility of interpreting the case examined here in the light of the conventional rules that presuppose a two-way causal relation: not only from the divergence between effective and target variables to instrumental variables but also in the other direction.

Of course, the lack of confirmation of influence of the interest rate on nominal income should not be generalized. After all, the same Post-Keynesian literature contemplates the existence

of channels through which the interest rate can affect aggregate spending and income (see, for example, Docherty 2012). However, the empirical result obtained here seems to be in contrast with the conventional view of the conventional rules of monetary policy, according to which income should depend on the interest rate on the basis of a rigid, "mechanical" link. In the absence of an empirical confirmation of this link, the task is therefore to put forward a different interpretation of the only causal relation confirmed, which proceeds from the difference between the growth of nominal GDP and its the target level to the interest rate. This empirical result appears to be in line with those lines of research that challenge the simplistic argument that the central bank has the role of stabilizing inflation, real GDP or nominal income around a certain equilibrium level. These alternative studies give the central bank a more complex role, which is to contribute to the maintenance of financial stability and solvency of economic units. The same rules of monetary policy should therefore reflect this different function of the central bank. Although this interpretation of monetary policy is also present in the mainstream literature (Agénor & Pereira da Silva 2012; Stein 2012), it has been developed mainly in the context of Post-Keynesian studies (Minsky 1986, 1992; Argitis 2013; Girón & Chapoy 2013, among others; see also Palacio Vera 2001). In this research perspective, it appears possible to interpret the results obtained in the light of the so-called "solvency rule" put forward by Brancaccio and Fontana (2013), whereby the monetary authority decides on the levels of the interest rate in relation to the deviation of inflation, production or nominal GDP from their respective target rates. The solvency rule is, however, drawn from a model that rules out the possibility of manoeuvres of the central bank on the interest rate directly controlling fluctuations of inflation, production or nominal GDP. This rule insists rather on the fact that by acting on interest rates, the monetary authority can influence the amount of the sums that debtors must repay to creditors in every single period, and thereby affect the solvency conditions of the economic system. In phases of economic expansion, characterized by rising aggregate expenditure, nominal income, production and inflation, the solvency of debtors improves and the central bank can set comparatively higher interest rates. Conversely, in phases of depression, average solvency could be facilitated by lower interest rates (however, an easy money policy is not in itself a sufficient condition for solvency; on this point see Davidson 2008). In the light of this interpretation, it therefore appears possible to provide a coherent explanation of the causal relation that starts from deviations of nominal GDP with respect to the target and arrives at variations in the instrumental variable of the interest rate. At the same time, this explanation requires no confirmation of the inverse causal relation, as the decisions of monetary policy on interest rates are not attributed with a crucial role in the management of movements of nominal income within this

different theoretical framework. For this reason, unlike the conventional monetary policy rules, the solvency rule appears more in line with the empirical results of the present work.

Figures

Figure 2.1: Series of the levels and first differences of *gdp_dev* and *imr*
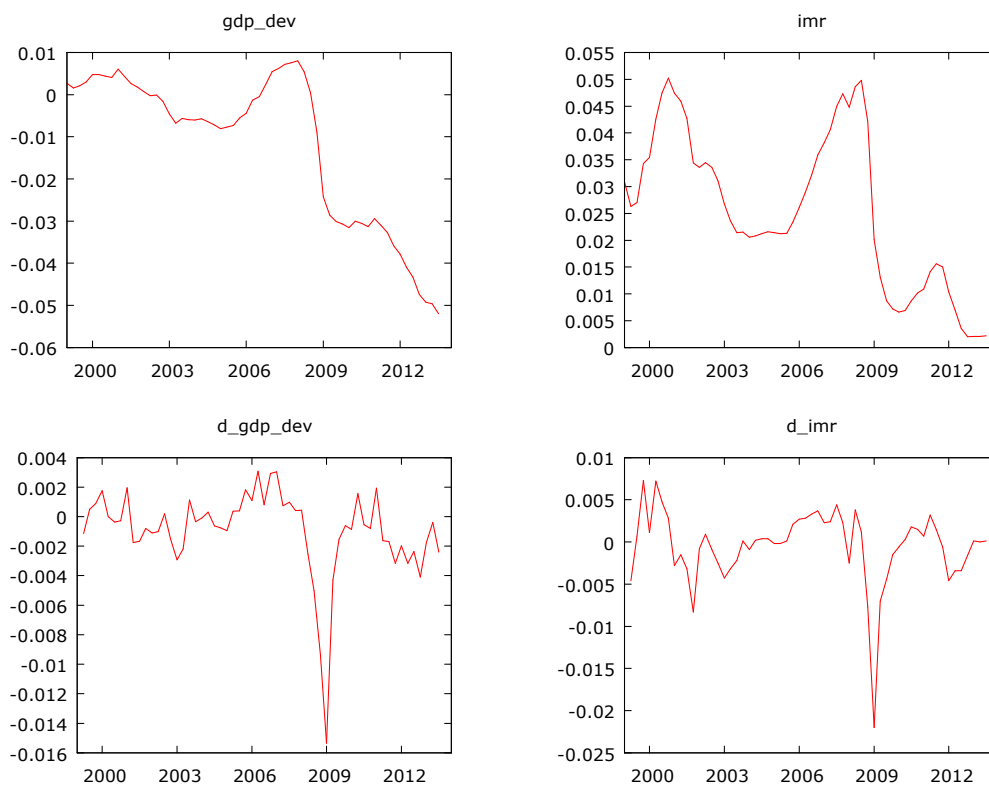
Tables

Table 2.1: Unit roots test of the series in levels

Variables	Lags	ADF Test (test statistic)[a]	KPSS Test (test statistic)[b]	PP Test (test statistic)[c]	Results
gdp_dev	2	-2.12	0.26	-1.24	I(1)
imr	2	-3.13	0.23	-2.02	I(1)

Notes: It was chosen for both series a model with trend and constant that both resulted significant on performing an OLS regression on the *imr* and *gdp_dev*.[a] The critical value for both series at the 5% level of significance is equal to -3.49 and at the 1% level of significance is equal to -4.13. [b] The critical value for both series is equal to 0.14 at the 5% level of significance and it is equal to 0.21 at the 1%level of significance.[c] The critical value for both series is equal to-3.49 at the 5% level of significance and it is equal to -4.13 at the 1% level of significance.

Table 2.2: Unit roots test of the series in first differences

Variables	Lags	ADF Test (test statistic)[a]	KPSS Test (test statistic)[b]	PP Test (test statistic)[c]	Results
d. gdp_dev	1	-3.22	0.35	-3.42	I(0)
d.imr	1	-3.87	0.12	-4.15	I(0)

Notes: [a] The critical value for both series is equal to -2.91 at the 5% level of significance and it is equal to-3.55 at the 1% level of significance.[b] The critical value for both series is equal to 0.47 at the 5% level of significance and it is equal to 0.72 at the 1% level of siginificance. [c] The critical value for both series is equal to -2.91 at the 5% level of significance and it is equal to -3.55 at the 1% level of significance.

Table 2.3: Johansen cointegration test

Variables	Lags	H_0	λ_{trace} Stat.	λ_{max} Stat.	Results
imr, gdp_dev	2	r=0	13.16 (0.108)[a]	12.75 (0.1)	NOT COINTEGRATED

Notes: [a]The p-values are shown in brackets.

Table 2.4: Results of the estimation of the VAR model

	Δ_{imr_t}	$\Delta_{gdp\_dev_t}$
$\Delta_{imr_{t-1}}$	0.29**	0.062
	(0.1217)	(0.0743)
$\Delta_{gdp\_dev_{t-1}}$	0.36*	0.35***
	(0.1956)	(0.1194)
dum1	-0.01***	-0.009***
	(0.002)	(0.0013)
R^2adjusted	0.64	0.73
AIC	-19.08	
BIC	-18.86	
HQC	-18.99	
ARCH Test	First eq.	Second eq.
Ljung-Box Q' Test	0.44	0.82
	First eq.	Second eq.
	0.32	0.40

Notes: The standard errors are shown in brackets. (*), (**), (***) respectively indicate significance at 10%, 5% and 1%. The dummy (dum1) inserted regards the trimesters 2008Q4–2009Q1.

Table 2.5: Granger causality test

Variables	Optimal Lags[a] (p.value)	2 Lags (p.value)	3 Lags (p.value)	4 Lags (p.value)
$\Delta_{gdp\_dev_t} \rightarrow \Delta_{imr_t}$	0***	0***	0.005***	0.0012***
$\Delta_{imr_t} \rightarrow \Delta_{gdp\_dev_t}$	0.36	0.10	0.204	0.32

Notes: Ho: No Granger-causality. [a] The information criteria of Akaike (AIC), Schwartz Bayesian (BIC) and Hannan-Quinn (HQC) were used to select the optimal number lag that is equal to one. (*), (**), (***) respectively indicate significance at the 10%, 5% and 1% level.

Chapter 3

Money Passive Hypothesis and Securitization: An empirical analysis on United States (1999-2012)[5]

Abstract

Endogenous money has mostly been supported on theoretical grounds by Kaldor and Trevithick (1981), Moore (1988) and Wray (1990). In this paper we try to provide empirical support for money's endogeneity by considering securitization bank's activity. We use U.S. monthly data and cointegration technique to reexamine money passive hypothesis when securitization affects monetary transmission mechanism of monetary policy via the bank lending channel. We find both short-run and long-run evidence in favor of structuralist approach. The results underline the importance of the private initiatives of banks in accommodating expansions of loans demand by using securitization.

JEL classification numbers:E12, E51, E52.

Key Words: bank supply, passive money hypothesis, securitization, monetary policy stance, VECM model, Granger Causality Test.

3.1 Introduction

The conventional money supply literature has treated money supply as exogenously given. Within orthodox monetary macroeconomics the determination of the money supply is widely regarded as unproblematic. According to Keynesians, monetary policy affects both monetary base and money supply. Changes in money supply causes interest rates fluctuations which in turn affect investments and income.

Recently, Post-Keynesian economists have sought to re-open this issue, arguing for a re-focusing of attention away from money supply toward the role of bank lending in this process. Post-Keynesian economists focus on the implications of asset substitutability for money supply linked to so-called "financialization"(that is, complex securitization, creation of some special purpose vehicles and off-balance sheet societies, trading of derivatives and structured financial products, etc) and the capacity of the banking system to underwrite economic activity. Post-Keynesian economists argue that global demand (PY) determines the amount of money transactions (MV). In this case, the direction of causality according to the quantity theory of money is reversed. Credit-money is anticipated by the banking system to finance entrepreneurs' requests. Consequently, the quantity of money is determined endogenously by market demand. According to Post-Keynesian theorists money supply is endogenous and determined by credit-money demand. The use of credit-money originated from debt and credit decisions gives a central role to the banking system (Kaldor and Trevithick 1982) and the process of money creation becomes independent from the Central Bank actions (Cottrell 1986; Laidler 1992). Money endogeneity implies a causality direction from loans to bank deposits. Money base in accordance with Post-Keynesians is a banking process to obtain reserves from Central Banks. Requests to refinance deposits may exceed the capacity of individual banks, which are forced to refund by the Central Bank: through this process additional monetary base is created (Arestis 1988). This reversed causal relationship between payments and high powered money implies that Central Banks control money supply through interest rates (Shanmugan, Nair and Li 2003). This vision contrasts the exogenous multiplier approach on the monetary base. According to this theory, Central Banks control monetary base by setting money stock equal to a given target value (Moore 1989).

The debate among the theories that support Post-Keynesian view concerns the significance ascribed to the private initiatives of banks in accommodating increases loans demand.

Accommodationalists argue that accommodation depends exclusively on the stance of the monetary authority, and its willingness to meet the reserve pressure generated by increased bank

lending. In granting loans to credit-worthy borrowers, the banking system - setting a loan rate equal to a fixed markup on the overnight interest rate - acts as price setters (sets loan rate) and quantity takers (does not affect loans amount)(Moore 1988; Palley 1996). Instead, according to the Post-Keynesian "structuralist" view of endogenous money accommodation depends on both the stance of the monetary authority and the private initiatives of banks. These initiatives are independent of the monetary authority and are therefore suggestive of the structurally endogenous nature of "finance capital" (Pollin 1991, Vera 2001).

The contribution of this paper with respect to the existing passive money hypothesis literature is twofold. Firstly, we analyze money endogeneity in a short and long term study of the United States Area during the two main crises: the dot-com bubble burst (1998-1999) and the sub-prime mortgage crisis (2008-2009), in addition to the effect of financial innovation as securitization on lending channel. Specifically, in this paper we consider the loans series adjusted for securitization to investigate whether the American banking system is motivated to seek the cheapest sources of financing as securitization, which affects its response to restrictive monetary policy and induces an increase of bank lending (Altunbas et al., 2009).

Secondly, we extend the evidence of endogenous money hypothesis on other advanced countries. In fact, there is a small amount of empirical evidence available on developed countries (Palley 1994; Howells and Hussein 1998; Moore 1998; Nell 2000; Vera 2001; Shanmugam et al., 2003) and a recent study on United States could fill this gap. The analysis is focused in particular on the money aggregate M1and M2. In the study period the Federal Reserve uses M1 money supply and M2 money supply as its monetary target.

We investigate the endogenous money supply by using monthly U.S data. Employing cointegration methods, we first examine a long-run relationship among level variables. Then, we evaluate the effect of money supply by measuring how much the monetary policy stance affects short-run deviations from long-run relationship. The results provide strong evidence for the direct impact of the loans on policy stance through securitization.

Specifically, we find that securitization increases the impact of loans (L) on M1 money supply (M1) and M2 money supply (M2). This implies money supply endogeneity and motivates agents to increase securitization with a preemptive motive to hedge against policy shocks.

The remainder of this chapter is organized as follows. In section 2, we discuss the literature on passive money hypothesis and we briefly describe the securitization market and monetary transmission mechanism in the United States. These institutional developments provide the basis for the subsequent econometric analysis. In section 3 first we define the variables that we use in our

estimation and then we test stationarity and cointegration. In section 4 by using U.S data we estimate VAR models by applying Granger causality test for non cointegrated series, VECM models based on causality test for cointegrated series and we evaluate the monetary policy effects on loans. We also provide robustness check. In section 5 we end with concluding remarks and suggestions for futures investigations.

3.2 Literature Review

The theories that support the Post-Keynesian view consider different causal relationships.

According to accommodationalists (Moore 1989) there is full settlement of reserve demand by Central Banks versus banking systems that totally accommodates loans requests. Consequently, there is a one-way causal relationship from loans to monetary base and from loans to monetary aggregates. Furthermore, debtors establish their own loans demand considering future income expectations. At the same time, deposits created with new loans are used to finance increases in aggregate demand. To sum up, the accommodationist view (Moore 1989; Pollin 1991) involves a two-way causality relationship between money revenue and money supply.

The structuralist hypothesis (Pollin 1991; Palley 1996, 1998) combines the classical characteristics of monetarism (the Central Bank controls reserves supply) with the accommodationist view. This vision implies bidirectional causality from monetary base to loans, from money supply to loans and from money multipliers to loans. Structuralists consider the use of alternative financing forms to partially exceed reserves shortage (Palley 1996). Considering the relationship between income and money supply, structuralism is consistent with accommodationalism, which implies bi-directionality between the two variables.

The exponents of the liquidity preference theory (Howells 1995) support the *core* of accommodationalist that argues a causal relationship from loans to money supply. However, the economic units involved have independent liquidity preference on how much money they wish to hold, so a supply excess may exist (Howells 1995). In this case, the liquidity preference view implies two-way causality from money supply to loans.

In Post Keynesian economics the first work on passive money is carried out by Pollin (1991) who obtains results supporting structuralism for USA during 1953-1988. Vera (2001) finds outcomes sustaining accommodationalist and structuralist theories for Spain in the period between

1987-1998 using Granger causality test applied to money multipliers and loans data. Nell (2000-2001) examines the relationships among money supply, money circulation velocity and loans using VECM models for South Africa during 1966-1997 and confirms all Post-Keynesian approaches (Structuralist, Accommodationalist and liquidity preference theorist). Shanmungan Nair and Li (2003), analyze the relationships among money base, money supply, credit and industrial production index with VECM models and Granger causality test in Malaysia in the period between 1985-2000: their results support the accommodationalist and liquidity preference theorists. Lavoie (2005) tests money endogeneity in Canada and in the United States obtaining results that sustain accommodationalist view. Ahmad and Ahmed (2006) apply VAR models for non cointegrated series (short term test) and VECM models (long term test) for cointegrated series on passivity money hypothesis for Pakistan during 1980-2003. The short term results confirm the structuralist and liquidity preference approaches while the long-run test highlights the active role of Pakistan Central Bank to set money supply. Gunduz (2001), Seyrek, Duman and Sarikaya (2004) analyze the role of Turkish lending channel during 1986-1998 applying VAR models. Their findings support an active role of monetary policy. Cifter and Ozun (2007) examine the passive money hypothesis in Turkey for the period between 1997-2006 using money base, money supply, industrial production index, interest rate, inflation rate, and exchange rate through a VECM models. Their results partially support accommodationalist theorists because there is a one-way causality relationship from credit to money base and from credit to money supply but there does not exist a causal relationship between money supply and industrial production index.

Finally, Lopreite (2014) analyzes the endogenous money supply hypothesis in the Euro Area using data from 1999 to 2010. In doing so, she makes extensive use of Vector Autoregression models (VAR) with Granger causality procedure to analyze non-cointegrated series. According to Granger causality test there is a one-way causality from loans to M3 but not from loans to industrial production index. The results are confirmed by adjusting the loans series for securitization activity in the Euro Area and partially support the accommodationist view.

Please Insert Table 3.1: The endogenous money hypothesis: a comparison of the three approaches

3.3 Securitization in United States

The view of the American bank lending channel as a monetary policy transmission mechanism focuses on the role of American banks as either amplifying or slowing down the effects of the Federal Reserve shocks over macroeconomic activity through the lending process (credit loans supply). In the presence of a restrictive monetary policy shocks, some banks would be forced to reduce their credit supply (bank lending channel). Nevertheless, other banks would have access to external sources of funding as securitization in order to protect their portfolio of credit loans. The net effect is subject to the financial system capacity, by using securitization to replace the reduction of financial resources.

There are a number of features of the U.S financial system that may have a bearing when it is analyzing the money passive hypothesis. One is that the volume of banks' securitization to firms and households has increased between 1999-2009 which indicates a potential for securitization that works through bank loans.

Securitization has become an important part of the U.S financial system. At the global level between 2000-2007 the outstanding volume of collateralized obligation (CDO) increased more than six times to US$1 trillion, while issuance of CDO-squared product increased eleven-fold to around US$300 billion. In the United States, annual issuance volumes in the subprime segment of the mortgage market increased from US$100 billion to just over US$600 billion over the 2000-06 period. This lifted the subprime share of total U.S. mortgage origination from a low of 6.9 percent to a peak of 20.1 percent in just five years. Private-label residential MBS issuance in the United States increased from US$148 billion in 1999 to US$1.2 trillion by 2006, increasing its share of total issuance from 18 percent to 56 percent (IMF 2013). So, the basic stylized facts are that securitization is an important part of the system, but it has been largely confined to the mortgage market, particularly the "prime" market, which consists of relatively low risk, single family mortgages. The concentration in a single market is important: prime mortgages are among the most transparent financial instruments in the system, particularly because of the collateral that supports them and the legal system that supports foreclosure. However, while there is no particular reason that any asset cannot be securitized, it is not an accident that high quality mortgages have been the

most successful; they suffer least from asymmetric information and small volume problems that can present important barriers to securitization. The main advantage of securitization is that it can provide an elastic and low cost source of funds, particularly for long term fixed rate funds. This is in contrast with traditional banks, which tend to rely on deposits, which are generally not elastic in supply and have variables rates.

The secondary mortgage market in the U.S is not a secondary market in the classic sense of a place where used mortgage are traded. Rather it is "secondary" in the sense that it is the second place that mortgage go, after the origination in the "primary" market. After purchase the secondary market can fund mortgage either through "securitization" which typically means packaging them into pools and selling shares in the pools or through debt funding, or some combination. The structure of the U.S mortgage market has changed dramatically in the last quarter century, largely because of the rise of the secondary market. This rise has come about largely because of standardization of pools of mortgages, brought on mainly by three secondary market "agencies": Fannie Mae, Ginnie Mae and Freddie Mac. Annual sales of mortgages to these three institution have risen from under $100 billion in 1980 to well over $1 trillion in 2002; they now own are responsible for about half of the outstanding stock of single family mortgages. The growth has been accompanied by a decline in the market share of the traditional lenders, thrift institution. The emergence of these big financial groups working on globalized financial markets, in fact allowed them to become too big to be supervised by financial market authorities. Failures of prudential supervision by regulators have been accompanied by insufficient controls within these very big financial groups, as it was possible to keep a global vision on the variety of financial activities these societies were doing that has been increasing in line with the still ongoing advances in both information and communication technologies. So, the principal activity for commercial banks (in the only for investment bank) boils down to the sale and purchase of financial assets. This is what we called their monetary function, banks have themselves created large amounts of money that they injected into these markets or indirectly through SPV whose opacity seems to be proportional to their expected returns. The ultimate positive effect of securitization in United States is an increase of banks' profits, putting off balance sheet all these risks against which they ought to have enough funds according to either Basle (I or II) or their own models of risk management (Guttmann 2007). Clearly, owing to money's endogeneity, which has traditionally been explained referring to the famous expression that *loans makes deposits*, banks can create any amount of money: lacking an appropriate book-entry structure, they can issue a number of money units having no link to income and production within the currency area in which they operate. Bank loans recorded, on the asset

side of any banks' balance sheets, can thereby correspond to the purchase of financial assets deprived of any real backing in production, against the classical theory of production.

3.4 Empirical investigations

3.4.1 Data

For this analysis we use monthly U.S observations drawn from Federal Reserve Statistical Data Wharehouse. The variables are: loans (L), M1 money supply (M1), M2 money supply (M2), and monetary base (BM).[6] We also use industrial production index as proxy variable for macroeconomic activity since a monthly measure of GDP is not available.

The sample examined is the United States area. In the estimations we use the logarithms of the data. The sample period goes from 1999:01 to 2012:05.

The total amount of observations is equal to 160. A large sample size enhances the power of this estimation. Monthly seasonal factors are estimated using the X-12-ARIMA procedure (to avoid problems related to series seasonality). Figure 3.1 depicts the monthly movements of the aforementioned variables. They exhibit the typical pattern of not stationary series with increasing trends and rapidly grew (Figure 3.1)[7].

Please Insert Figure 3.1: Series of the log-levels of *base money, monetary aggregates* and *loans* seasonally adjustment

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[6] The monetary aggregates of the United States area are defined according to the Federal Reserve definition in the following way: **M0** (**monetary base**) consists of total reserves, required clearing balances and adjustments to compensate for float at Federal Reserve Banks, the currency component of the money stock, for all quarterly reporters on the "Report of Transaction Accounts, Other Deposits and Vault Cash" and for all those weekly reporters whose vault cash exceeds their required reserves.**M1** (**M1 money supply**) consists of currency outside the U.S. Treasury, Federal Reserve Banks, and the vaults of depository institutions; traveler's checks of nonbank issuers; demand deposits at commercial banks (excluding those amounts held by depository institutions, the U.S. government, and foreign banks and official institutions) less cash items in the process of collection and Federal Reserve float and other checkable deposits (OCDs), consisting of negotiable order of withdrawal (NOW) and automatic transfer service (ATS) accounts at depository institutions, credit union share draft accounts, and demand deposits at thrift institutions. **M2** (**M2 money supply**) consists of M1, savings deposits (including money market deposit accounts), small-denomination time deposits (time deposits in amounts of less than $100,000), less individual retirement account (IRA) and Keogh balances at depository institutions and balances in retail money market mutual funds, less IRA and Keogh balances at money market mutual funds.
Finally, loans comprise credit granted by the banking system to households and enterprises (nonbank private sector) in the United States area excluding the interbank positions and the government. This series is not adjusted for securitization. All variables are in billions US dollar except money base that is in millions US dollar.
[7] The graphs of series transformed into first-order differences are available upon request.

3.4.2 Unit roots test

The non-stationarity of the series is confirmed by the Augmented Dickey-Fuller (ADF) test, the Phillips Perron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, as shown in Table 3.2. The ADF test and PP test, in fact, never reject at the 1% level of significance the null hypothesis of unit root's presence, while the KPSS test never accept the null hypothesis of unit root's absence.

Please Insert Table 3.2: Unit root test of series in log-levels

We also apply the ADF test, PP test and KPSS test to the variables in log-levels transformed into first-order differences. The results are reported in Table 3.2.

Please Insert Table 3.3: Unit roots test of series in log first-order differences

The PP, ADF and KPSS test jointly confirm stationarity of the series in first-order difference, so we can confirm that they do not contain more than one unit root and are integrated of order 1.

In order to confirm the presence of a unit root and to take into account the events connected with the U.S subprime crises (IMF 2013), which could be seen as a structural break, separate ADF tests we carry out on the pre-crisis period (1999M1–2008M9) and the post-crisis period (2008M10–2012M5) for the series considered. The hypothesis of the presence of a unit root is never rejected at the 5% significance level. The obtained results show no unit root problem in the series for both the overall sample as well as all sub-periods.

3.4.3 Cointegration Analysis

Contrarily to Shanmugam, Nair and Li (2003), where residuals based on cointegration analysis of Engle-Granger (1987) are used, we apply the Johansen (1991) procedure on bivariate

VAR models to investigate the "causal" relationship amongst the variables, without deciding, *a priori*, about the endogeneity or exogeneity of the included variables, as in Cifter and Ozun (2007).

Since the variables individually follow non stationary I(1) processes in levels and they become I(0) in their first-order differences, we employ Johansen's trace test ($J^T(1)$) and maximum eigenvalue test ($J^{MAX}(1)$). These tests accounting for simultaneity among variables are based on a vector autoregression (VAR), which include unrestricted constant.

A long-run or cointegrating relationship among the I(1) variables must exist to support the VECM model. Also deviations from the cointegrating relationship should be caused by loans if the money supply is endogenous. To examine this effect we follow a two-step approach. Firstly, we identify whether exists a long-run relationship among the I(1) variables, then we estimate the long run relationship.

We carry out the test by including the option "unrestricted costant" and we choose the optimal lags according to Akaike (AIC), Schwartz Bayesian (BIC) and Hannan-Quinn (HQC) statistics.

We add an exogenous temporal dummy to capture the effects of the policy stance and business cycle effects. In order to test for the presence of outliers, the temporal dummy variable (dum1) assumes the value of one in the months 2008M8-M9-M10, and zero in all the other months. The variable is proved significant by applying the Wald test.

Table 3.4 reports the results of trace and maximum eigenvalue cointegration tests. Both tests indicated one cointegration equation for loans-M1 relationship as shown in Table 3.4.

A nonzero cointegrating vector represents the influence from a long-term force. The cointegrating vector specifies a long term relation among the levels of loans and M1 money supply. Since a non-zero cointegrating vector has enduring effect, it represents the influence in the long run.

The results are shown in Table 3.4.

Please Insert Table 3.4: The maximal Eigenvalue Test and the Trace Test of Johansen

By using Johansen procedure results zero cointegrating vector among loans-monetary base, loans-M2 money supply, loans-industrial production index, industrial production index-M1 money

supply, industrial production index-M2 money supply and industrial production index-monetary base. So, according to Vera (2001) and Shanmugam, Nair and Li (2003) rather than levels, we consider first-order differences variables in order to estimate stationary VAR models.

3.5 Endogenous money hypothesis: VAR models approach

To check the endogeneity of the money supply we apply VAR models. We select the optimal lags order for each bivariate VAR model considering the three information criteria[8] which turn out of order 2 for the relationships loans (L)-monetary base (BM), industrial production index (IPI)-monetary base (BM), of order 1 for the relationships industrial production index (IPI)-M1 money supply (M1), industrial production index (IPI)-M2 money supply (M2), loans (L)-M2 money supply (M2), and loans (L)-industrial production index (IPI).

$$Y_t = \text{C} + \text{A(L)}\, Y_{t-1} + \text{B(L)}\, \text{X}_t + \text{\epsilon}_t \tag{3.1}$$

We divide the variables included in the model into two groups.[9] The first group of variables, X_t contains exogenous variables as a temporal exogenous dummy variable to capture the effects of the subprime crises. The temporal dummy variable (dum1) assumes the value of one in the months 2008M8-M9-M10, and zero in all the other months. The variables exogenous influence the other variables of the model Y_t but there is no feedback from the other variables to this variable. Further it is allowed for a contemporaneous impact of the exogenous variable on the endogenous variables. The endogenous variables of the benchmark model Y_t consist of loans (L), money base (BM), M2 money supply (M2) and industrial production index (IPI):

$$Y_t{}' = (\text{L, BM, M2, IPI}) \tag{3.2}$$

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[8] Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion and Schwartz Information Criterion (SIC).
[9] Each of all the VAR models contain a constant.

Finally C is a vector of constants and Ɛ is an independent and identical distributed vector of errors. More evidence in favor of money endogeneity according to the structuralist view is the rejection of the null hypothesis that loans supply are not useful to predict M2 money supply (M2), and money base (BM) and the rejection of the null hypothesis that M2 money supply (M2) and money base (BM) are not relevant to predict loans supply. The results are reported in Table 3.5 for each bivariate VAR model.

Using Granger causality tests to analyze the endogenous money hypothesis result that loans (L) helps to predict M2 money supply (M2), money base (BM) and industrial production index (IPI) in each estimations. The results also indicate that the M2 money supply (M2), money base (BM) and industrial production index (IPI) are significant in the estimations for predicting loans supply (L) when money structural endogeneity is confirmed.

Please Insert Table 3.5: Granger causality test

To sum up, in United States the VAR evidence shows that loans influence the monetary policy, suggesting that the U.S banks do not find it difficult to raise financing during periods of tight monetary policy. These results suggest that causality goes from the banking credit loans to monetary policy stance and vice versa, from the banking credit loans to macroeconomic activity and vice versa.

Since lending has effect on M2 money supply, money base and income it changes the demand for reserves and monetary policy: there is then an incentive to liability management. This also means that the money supply is affected by lending and this supports the structuralist view.

Specifically, we find that the amount of liquidity on banks' balance sheets significantly influences the degree to which they change loans after a monetary shock: the higher level of liquidity causes the stronger loans supply response. These findings confirm the endogenous money hypothesis in the United States during the period 1999-2012.

Different lag lengths, varying from optimal lag order to 12 provide qualitatively similar results. This confirms the robustness of the tests[10].

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[10] The results are also robustness to autocorrelation and heteroskedasticity. The results are available upon request.

3.6 The vector error correction models

We apply for the analysis of cointegrated series VECM models by using Wald test to analyze short-term relationships (Shanmugan, Nair and Li 2003; Cifter and Ozun 2007). We use cointegration modeling to separate the potential long term relationship between M1 money supply and loans and loans from their short term adjustment mechanisms.

We make the analysis of long-run relationship considering EC parameter (Shanmugan, Nair and Li 2003; Cifter and Ozun 2007). The error correction models imply a situation in which a long-term relationship exists among the variables (loans, M1) and in which the equilibrium error induces change in the dependent variable.

We estimate a vector error correction model of order 1 for variables in first differences with rank one for the relationship loans-M1 money supply. Since VECM order is one and the rank is one it is not necessary to impose other constraints for a correct interpretation (Luetkepohl and Reimers 1992a).

$$\begin{bmatrix} \Delta l_{L_t} \\ \Delta l_{M1_t} \end{bmatrix} = a + \begin{bmatrix} \alpha_1 \beta_1 & \alpha_2 \beta_2 \end{bmatrix} \begin{bmatrix} l_{L_{t-1}} \\ l_{M1_{t-1}} \end{bmatrix} + \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \tag{3.3}$$

Please Insert Table 3.6:Causality test for the money endogeneity hypothesis based on vector Error Correction Model

Table 3.6 reveals that M1 money supply influences loans in the long-run because the EC term is statistically significant and this relationship also exist in the short-term.

We find also that loans affect M1 money supply in the long-run and cause variations of M1 money supply in the short-run.

The earlier results of Granger causality test (Table 3.5) show a short term two-way causality from monetary base to loans, from loans to M2 money supply, and from industrial production index to loans, M2 money supply and money base.

This seems to suggest that money supply is endogenously determined and implies that the Post-Keynesian view may hold true in the case of United States supporting the structuralist view.

The model also passes the usual diagnostic tests of no autocorrelation and no arch effects in the residuals[11]. Finally, the tests of structural stability (CUSUM test and CUSUMQ test) of the parameters of the VECM model provide no evidence of instability and the series moves within the confidence intervals[12].

3.7 Securitization and Money Passive Hypothesis

In order to identify the relevance of securitization to explain money endogeneity we consider an alternative model specification. We use loans series adjusted for securitization to analyze whether banks can insulate from monetary policy negative shocks through securitization.

In this case, contrary to the Euro Area's analysis (Lopreite 2012), securitization affects the investor's decision rules, and thus the policy stance is still affected by the banking system.

We carry out the estimations by using VAR models of order 2 and 1 for stationary series and testing the endogenous money hypothesis with Granger Causality Test. The results are reported in Table 3.7.

Please Insert Table 3.7: Granger Causality test. The effect of securitization

As reported in Table 3.7 the results of the previous sections are highly confirmed. The estimates show that there is a two-way Granger Causality from loans (L) to monetary base (BM), from loans (L) to M2 money aggregate (M2), from loans (L) to industrial production index (IPI), from M2 money aggregate (M2) to industrial production index (IPI) and from monetary base (BM) to industrial production index (IPI).

These findings support the structuralist view. It is possible to interpret them as the relevance of the bank lending channel to explain the monetary transmission mechanism. This result not surprising, when the period analyzed is further confined to 1999-2012, the positive effect of banks' securitization on monetary policy becomes more evident. These results suggest that the use of securitization as financial resources is important and insulate U.S banks from negative shocks of the monetary policy's transmission mechanism.

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[11] Test of autocorrelation and ARCH effects are available upon request.
[12] The graphs of the CUSUM and CUSUMQ test are available upon request.

Finally, relevant results are obtained applying the VECM model for cointegrating relationships. The results are reported in Table 3.8.

Please Insert Table 3.8: Causality test based on Vector Error Correction Model to test endogeneity of money

In this case results a long-run and short-run relationship from loans adjusted for securitization to M1 money supply but not vice versa. This results reveal that money endogeneity increases if banks securitize loans but monetary policy doesn't affect securitized loans.

This analysis underlines the important role played by banks' securitization in the liquidity position of the banking system. The monetary policy tightening does not cause an initial liquidity shortage because of securitization. In fact, although the total stock reserves' stock remains unchanged securitization allows the banking system to fund more loans in United States.

3.8 Conclusions

A crucial condition for the existence of an active U.S banking system is that banks through securitization should be able to influence the monetary policy. This paper contributes to the discussion on the issue of passive money hypothesis by presenting empirical evidence from VAR and VECM estimations based on a dataset that comprises aggregate information on U.S loans banks and Federal Reserve monetary policy during the years 1999-2012. In this work we consider M1 and M2 money supply, monetary base, bank credit capacity and industrial production index to test the passive money hypothesis.

For no cointegrated series we carry out the regression on the basis of VAR models and we find that Granger causality runs from loans to M2 money supply, monetary base and industrial production index and vice versa. This implies that the Post-Keynesian view may be true in the case of United States Area's M2 money supply. These results show, also, that in the United States money supply is endogenous in nature and support the structuralist vision and the theory of liquidity preference.

The analysis replicated by using the VECM models and the series of loans adjusted for securitization confirms the previous results.

By estimating VECM model we find that there is a bidirectional relationship from loans to M1 money supply in the short run and long term but this relationship becomes one-way when it is considered loans series adjusted for securitization. In this case results that both in the short and long run loans affect M1 money supply. These result underline that when banks use securitization the monetary policy does not affect the lending mechanism.

In fact, by adjusting loans supply for securitization we obtain that the *securitization effect* is mainly due to the behavior of the U.S banks which hold a significant and large amount of securitized loans on which they can drawn.

This is not surprising: the strong use of securitization motivates banks in United States during 1999-2012 to increase loans supply with a preemptive motive to cushion the impact of policy shocks. This evidence suggests that in the presence of a monetary policy shock, banks that draw on secondary market liquidity through securitization will increase loans supply in order to compensate for the decrease on the financing resources.

The key assumption that must hold to interpret these results as evidence for the existence of money passive hypothesis is that these effects have to be attributable to a significant reaction of U.S banks loans supply to a restrictive monetary policy measure.

This could be comparatively a strong outcome if it takes into account securitization effect to confirm structuralist passive money hypothesis by using VAR models and VECM models unlike most of the previous literature has done so far. However, there could still remains the question whether securitization shows cyclic patterns that the models implemented in this paper are not able to capture. It may be interesting to use more sophisticated tools, such as Regime Switching variants to discriminate among the theories that support the Post-Keynesian view. This point is left for future research.

Figures

Figure 3.1:Series in log-levels of base money, monetary aggregates and loans seasonally adjusted
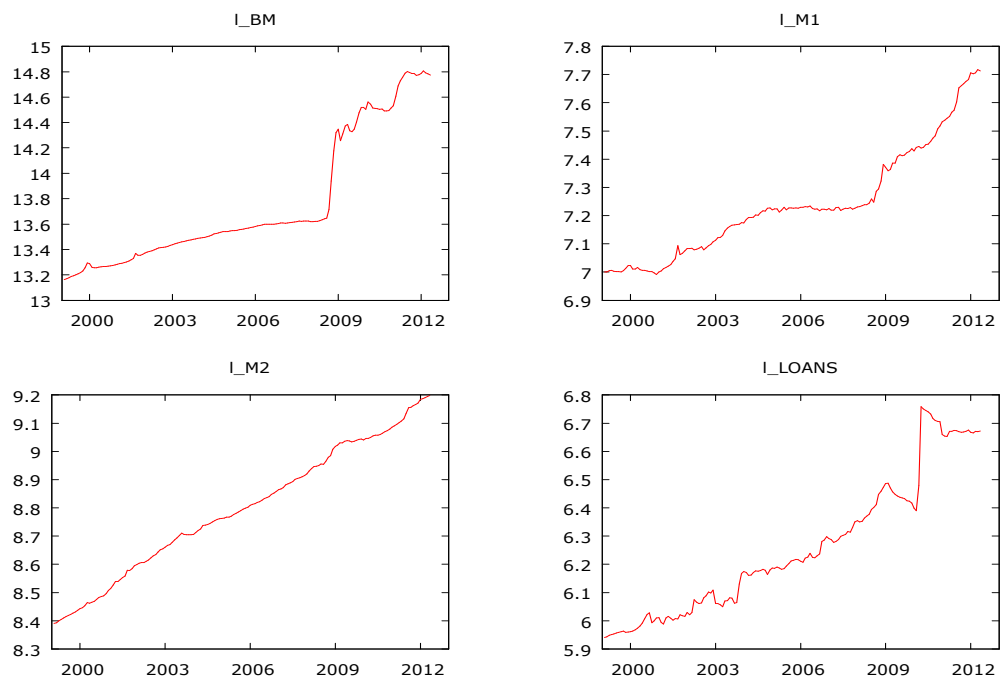
Tables

Table 3.1: The endogenous money hypothesis: a comparison of the three approaches

Accommodationalist view (Moore 1989)	Structuralist view (Palley 1996, 1998; Pollin 1991)	Liquidity preference theorists (Howells 1995)
L→M1, M2, BM	L ↔ BM, M1, M2	L↔ M1, M2
IPI↔ M1, M2	IPI↔ M1, M2	

Notes: Variables BM= monetary base (BM); M1, M2 = money supply (M1, M2); L= loans (L); IPI = industrial production index (proxy of GDP using monthly data). The symbol $\rightarrow$ implies one-way causality direction . The symbol$\leftrightarrow$ implies two-way causality direction.

Table 3.2:Unit root test of series in log-levels

Variables	Lags	ADF Test (test statistic)[a]	KPSS Test (test statistic)[b]	PP Test (test statistic)[c]	Results
l_L	9	-3.12	1.61	-2.85	I(1)
l_BM	4	-2.73	2.76	-1.78	I(1)
l_M1	13	-0.98	1.14	-0.14	I(1)
l_M2	5	-3.16	1.69	-2.15	I(1)
l_IPI	4	-2.9	1.04	-1.64	I(1)
l_LSEC	2	-0.87	2.26	-0.66	I(1)

Notes: [a] The critical value at 5% level of significance is equal to -3.43 and the critical value at 1% level of significance is equal to -4.01. [b] The critical value at 5% level of significance is equal to 0.14 and the critical value at 1% level of significance is equal to 0.21. [c] The critical value at 5% level of significance is equal to -3.43 and the critical value at 1% level of significance is equal to -4.01.

Table 3.3: Unit roots test of series in log first-order differences

Variables	Lags	ADF Test (statistic test)[a]	KPSS Test (test statistic)[b]	PP Test (test statistic)[c]	Results
Δl_L	8	-10.02	0.26	-9.59	I(0)
Δl_BM	3	-6.01	0.25	-5.94	I(0)
Δl_M1	12	-13.01	0.28	-12.53	I(0)
Δl_M2	4	-11.45	0.22	-10.01	I(0)
Δl_IPI	3	-11.22	0.9	-10.45	I(0)
Δl_LSEC	1	-12.78	0.24	-11.58	I(0)

Notes [a] The critical value at 5% level of significance is equal to -2.91, the critical value at 1% level of significance is equal to -3.55. [b] The critical value at 5% level of significance is equal to 0.46, the critical value at 1% level of significance is equal to 0.73.[c] The critical value at 5% level of significance is equal to -2.91, the critical value at 1% level of significance is equal to -3.55.

Table 3.4:The maximal Eigenvalue Test and the Trace Test of Johansen (1991)

Variables	Lags	H_0	λ_{trace} Stat.	λ_{max} Stat.
l_L and l_BM	3	r=0	8.68 [0.40]	8.53 [0.33]
l_L and l_M1	2	r=0	15.79** [0.043]	14.176** [0.04]
		r=1	1.62 [0.20]	1.62 [0.20]
l_L and l_M2	2	r=0	11.62 [0.18]	11.59 [0.13]
l_L and l_IPI	2	r=0	2.40 [0.98]	2.11 [0.98]
l_M1 and l_IPI	2	r=0	12.48 [0.13]	10.43 [0.18]
l_M2 and l_IPI	2	r=0	3.027 [0.95]	2.81 [0.9]
l_BM and l_IPI	3	r=0	10.8 [0.23]	10.47 [0.18]

Notes: The values in parentheses are the respective *p-values*. (*), (**), (***) indicate statistical significance at 10%, 5% and 1% percent level.

Table 3.5: Granger causality test[a]

Variables	Optimal Lags[b] (p.value)	6 Lags (p.value)	8 Lags (p.value)	12 Lags (p.value)
$\Delta l_{M2_t} \rightarrow \Delta l_{L\ t}$	0.023**	0.059*	0.008***	0.001***
$\Delta l_{L\ t} \rightarrow \Delta l_{M2_t}$	0.044**	0.027**	0.009***	0.005***
$\Delta l_{L_t} \rightarrow \Delta l_{BM_t}$	0.07*	0.06*	0.05**	0.026**
$\Delta l_{BM_t} \rightarrow \Delta l_{L\ t}$	0.04**	0.015**	0.05**	0.024**
$\Delta l_{L\ t} \rightarrow \Delta l_{IPI_t}$	0.03**	0.06*	0.07*	0.08*
$\Delta l_{IPI_t} \rightarrow \Delta l_{L\ t}$	0.07*	0.09*	0.09*	0.04**
$\Delta l_{IPI_t} \rightarrow \Delta l_{M1_t}$	0.06*	0.0026***	0.0067***	0.0013**
$\Delta l_{M1_t} \rightarrow \Delta l_{IPI\ t}$	0.09*	0.07*	0.08*	0.08*
$\Delta l_{IPI_t} \rightarrow \Delta l_{M2_t}$	0.022**	0.05**	0.08*	0.085*
$\Delta l_{M2_t} \rightarrow \Delta l_{IPI\ t}$	0.012**	0.067*	0.09*	0.077*
$\Delta l_{IPI_t} \rightarrow \Delta l_{BM_t}$	0.017**	0***	0***	0 ***
$\Delta l_{BM_t} \rightarrow \Delta l_{IPI\ t}$	0.005***	0.036**	0.067*	0.05**

Notes: [a] Ho: No *Granger-causality*. [b] For the optimal lag selection we use the three informative criterions. The optimal lags is equal to 1 for all relationships except Loans-BM and IPI-BM whose optimal lag is equal to 2. (*), (**), (***) indicate statistical significance at 10%, 5% and 1% percent level.

Table 3.6:Causality test for the money endogeneity hypothesis based on vector Error Correction Model

	Short Term Effect	Long Term Effect	VECM	
	Wald Test	EC_{t-1}	Short Term	Long Term
Dependent Variable: $\Delta lM1$				
	7.69*** (0.0005)	-0.026*** (0.0002)	lL→lM1	lL→lM1
Dependent Variable: ΔlL				
	3.28* (0.07)	0.028* (0.089)	lM1→lL	lM1→lL

Notes: The values in parentheses are the respective *p-values*. (*), (**), (***) indicate statistical significance at 10%, 5% and 1% percent level.

Table 3.7: Granger Causality test: The effect of securitization

Variables	Optimal Lags (p.value)	4 Lags (p.value)	8 Lags (p.value)	12 Lags (p.value)
$\Delta l_{L\,sec_t} \rightarrow \Delta l_{IPI_t}$	0.007***	0***	0***	0.0078***
$\Delta l_{IPI_t} \rightarrow \Delta l_{L\,sec_t}$	0.0058**	0.0009***	0****	0.02**
$\Delta l_{L\,sec_t} \rightarrow \Delta l_{M2_t}$	0.0075***	0.008***	0.0086***	0.0009***
$\Delta l_{M2_t} \rightarrow \Delta l_{L\,sec_t}$	0.027**	0.03**	0.012**	0.021**
$\Delta l_{L\,sec_t} \rightarrow \Delta l_{BM_t}$	0.006***	0.005***	0.008***	0***
$\Delta l_{BM_t} \rightarrow \Delta l_{L\,sec\,t}$	0.05**	0.0006***	0.003***	0.0015**

Notes: The values in parentheses are the respective *p-values*. (*), (**), (***) indicate statistical significance at 10%, 5% and 1% percent level.

Table 3.8: Causality test based on Vector Error Correction Model to test endogeneity of money

	Short Term Effect	Long term Effect	VECM	
	Wald Test	EC_{t-1}	Short Term	Long Term
Dependent Variable: ΔlM1				
	14.50*	-0.08***		
	(0.06)	(0.0012)	**lL_SEC→lM1**	**lL_SEC →lM1**
Dependent Variable: ΔlL_SEC				
	2.53	0.06		
	(0.11)	(0.9)	**lM1≠>lL_SEC**	**lM1≠>lL_SEC**

Notes: The values in parentheses are the respective *p-values*. (*), (**), (***) indicate statistical significance at 10%, 5% and 1% percent level.

Chapter 4

Population ageing and health expenditure: A Bayesian VAR analysis on Italy[13]

Abstract

Currently, in developed countries people live longer and better than ever before. However, the growing proportion of elderly people could lead to a higher incidence of chronic-degenerative diseases and a greater demand for health and social care with a consequent increase in health spending. Although the recent evidence indicates that there is a link between population aging and health care expenditure, researches on this topic are fragmented and they are not as straightforward as they appear. We use a Bayesian VAR framework to assess whether health expenditure is driven by ageing. Using annual data from OECD and EUROSTAT over the period 1990-2013, we investigate this relationship in Italy. We estimate these models by using impulse response analysis and variance decomposition. The evidence shows that health expenditure in Italy is more conditioned by the ageing index as compared to life expectancy and per capita GDP. We therefore conclude that population aging will remain in the centre of policy debate. Further research should focus on more efficient management of health expenditure to improve patient welfare and to have longevity gains.

JEL classification numbers:I1, I15, J11

Key Words: health spending; longevity gains; B-VAR models

4.1 Introduction

Better health care is a primary human need. Nutrition and health play an important role in economic growth (Fogel 2002, 2004). Developed countries spend a high proportion of their GDP on health care because they believe that their residents' health can serve as a major driver for economic activities and development. In 1990 recurrent expenditure on health in Italy was 80563 million dropped to 57418 million in 1998 and it rose again up to 112301 million in 2011 with a reduction in 2013 in per capita health spending. Moreover, the health expenditure of families started from 8707 million in 1990 and has grown up to 28827 million in 2011 (ISTAT 2013)

This scenario underlines that health care expenditure in Italy, apart from in 1998, when the capital expenditure of government decreases, has been on the increase over the years.

Long term impact of health on economic growth can be understood in the more general context of the relationship between human development and economic growth. Human capital and its impact on economic growth and welfare are closely interrelated. If a country wants to develop economically, a fair amount of money should be spent on health care and in the development process. In an aging society, as the Italian population, the mechanism by which health and health care lead to economic growth could be influenced by the growing proportion of elderly people. The aging of population is deemed to impact every area of life, including economic growth, labor market taxation, health, family composition, housing and migration.

The growth in length of life could lead to a higher incidence of chronic-degenerative diseases (e.g heart disease, cancer, Alzheimer's disease) and a greater demand for healthy living resources over time on long-term care. The expected effects should be a higher per capita health spending that points out doubts about the financial sustainability of health care system in terms of the system performance and health care supply. According to Altavilla, Mazza, Monaco (2014) in Italy the percentage of individuals aged over 65 between 1990-2011 increased from 14.9% to 20.6%; while in the same period the individuals over age 85 increased from 1.2% to 2.8%. Moreover, other indicators about aging population, such as the aging index, the elderly dependency ratio, the life expectancy increased from 1990 to 2011 with significant impact on health expenditure and economic growth. Government therefore tend to face the problem of increased demand for public health services combined with a strain on available resources to provide these services.

With this in mind, the focus of this study is to improve understanding of the consequences of population aging for health expenditure growth in Italy. Specifically, we empirically analyze the relationship among per capita health care expenditure, per capita GDP, aging index and life

expectancy. A Bayesian VAR model will be employed to analyze the data. We try to contribute to this literature by examining the initial responsiveness of health expenditure to the ageing index and whether longevity affects health expenditure.This would help to assess how relevant longevity is to health in a country and what kinds of policy and/or research recommendations would be needed at that point.

The remainder of this chapter is organized as follows. In section 2, we examine the relation with previous literature. In section 3, we compare VAR models with B-VAR models, we briefly describe the data and we estimate B-VAR models including impulse response functions and variance decompositions. Finally, in section 4 we discuss the empirical estimation results by giving suggestions for futures investigations.

4.2 Literature Review

A large and increasing body of economic literature has analyzed the relationship between life expectancy, health expenditure and economic growth trying to understand whether a linkage exists among the variables (Bhargava et al. 2001; Chete and Adeyone 2002; Bloom et al. 2004; Baldacci 2004; Taban 2006; Temiz and Korkmaz 2007; Kelley 2007; Day, Pearce and Dorling 2008; Aghion et al. 2010; Heijink, Koolman, and Westert 2013; Ogungbenle et al. 2013).

In a study conducted by Bhargava, et al. (2001) the impact of health (physical and mental health indicators) on economic growth is larger in developing countries than in developed countries. Chete and Adeyone (2002) by using VAR models and OLS analysis find that there is an unanticipated positive impact of human capital on economic growth in Nigeria.

Bloom et al. (2004) state that health has a positive and statistically significant effect on economic growth but they don't consider how health is created.

Baldacci (2004) by using a panel data for 120 developing countries during the period 1975-2000, finds that spending on health affects growth and this effect is a flow and not a stock effect.

Taban (2006) investigates the relationship between health and economic growth in Turkey by using the data of the 1980-2000 period. According to the empirical results, there is a two-way causality relationship between life expectancy at birth and economic growth, but no causal relationship between health expenditures and economic growth.

Day, Pearce and Dorling (2008) by comparing cluster of poor and rich countries by their health outcomes find that there are considerable inequalities in life expectancy and healthcare. Specifically, they show that healthcare is higher in places where life expectancy is higher.

According OECD health statistics (2015) health has improved dramatically since the 1970 with different effect on health care system in the OECD countries. The gains in health (i.e cancer rate survival, vaccination rates, in-patient care) as well as the spending levels vary across countries. Kelley (2007) shows that in general, more investments in healthcare do not translate to an equal increase in quality of healthcare.

Temiz and Korkmaz (2007) examine the relationship between health and economic growth in Turkey by using error correction model. They find a negative one-way causality relationship from infant mortality rates to economic growth and a positive two-way causality relationship between life expectancy at birth and economic growth.

Aghion et al. (2010) using cross-country panel regressions and OECD countries find a significant and positive impact of health on growth between 1940 and 1980, but this relationship tends to weaken over the contemporary period from 1960 onwards. They interpret this finding as reflecting an age-specific productivity effect of health. Indeed, in 1960, a large share of the growth in life expectancy at birth appears to be related to a reduction in mortality at old age, but they find that it is mostly the decrease in the mortality of individuals aged forty or less that matters for growth.

Heijink, Koolman, and Westert (2013), using changes in national health expenditures as an input measure analyze the relationship between avoidable mortality (health care could prevent mortality) and healthcare spending in western countries. The results, even after control for unemployment, education, and time varying determinants, underline a negative relationship between healthcare spending and avoidable mortality.

Finally, Ogungbenle et al. (2013) analyze the relationship among life expectancy, health expenditure and economic growth by using VAR models approaches. The results of the studies reveal that there is no two-way causality between life expectancy and public health spending and between life expectancy and economic growth. Moreover, the studies confirm a bidirectional causality between health expenditure and economic growth.

Although the positive impact of life expectancy and economic growth upon health expenditure is well documented, less is known about the effects of longevity on "welfare state" when population ageing becomes the main driver of the escalating health care costs in developed countries.

49

Many works focus their attention on the physiological effects of ageing on country's health expenditures (Getzen 1992; Zweifel and Ferrari 1992; O' Connell 1996; Barros 1998; Meerdin et al. 1998; Fuch 1998; Richardson and Robertson 1999; Lichtenberg 2004; Zweifel et al. 2005; Aisa et al. 2014).

Meerdin et al. (1998) find that health care demands in Netherlands are driven by disabilities associated with ageing.

Fuch (1998) in a study of U.S asserts that elderly persons aged 65 and above affect the gap between GDP and health expenditures.

Lichtenberg (2004) analyses the annual time series behavior of US longevity during the period 1960-2001. He considers public and private health expenditure separately finding that public health expenditure has a positive effect on longevity.

Zweifel and Ferrari (1992) and Zweifel et al. (2005) affirm that there is a two-way direction of causality between ageing and health expenditure-increased health expenditures leads to increased longevity which in turn leads to an increase in health care demand (Sisyphus Syndrome).

Aisa et al. (2014) for a sample of OECD countries report evidence on the contribution of health expenditure in enhancing longevity. However, its influence diminishes as the size of the public health sector on GDP expands.

According to macro-level studies on OECD country data conducted by Getzen (1992) and Barros (1998) there is no evidence of a link between ageing and health expenditures.

O'Connell (1996) find mixed evidence.

Other empirical investigations suggest that the positive relationship between health expenditure and ageing in longitudinal studies is a reflection of the high costs of dying. In this case, if proximity to death is included in the model, ageing is not statistically significant and increases the cost of health care at the end of life (Lubitz and Riley 1993; Garber et al. 1998; Lamers and van Vliet 1998; Hogan et al. 2001).

O'Neill et al. (2000) find by using U.S longitudinal data that the costs of patients in the last year of life are higher than those who survived the duration of study and age is not significant in explaining the cost difference.

Other longitudinal studies based on non-U.S data find similar results. Ageing index is not statistically significant in explaining health care expenditure growth if in the model is inserted as control variable "time to death" (Van Weel and Michels 1997; Zweifel et al. 1999; Felder et al. 2000).

Only few studies underline a negative relationship between health resource utilization near the end of life and age. In particular the costs in the last years of life of older elderly may be less than their younger counterparts (Backer et al. 1995; Felder et al. 2000; Schellhorn et al. 2000; Spillman and Lubitz 2000; Chernichovsky and Markowitz 2001).

Schellhorn et al. (2000) by using Swiss data find that the frequency of specialist visits decreases with age.

Spillman and Lubitz (2000) with U.S data discover that acute care expenditures increases less with age than long term care.

Chernichovsky and Markowitz (2001) confirm in the case of Israel a negative relationship between health expenditures and population ageing.

All in all from the existing literature based on macro level data, except for some cases, it emerges that the relationship between ageing and health expenditure is in general positive. It is obvious that the relationship between age and health expenditure depends on health. As individuals age, their health generally decreases and this in turn leads to increasing utilization of health care.

However, recent evidence indicates that the relationship between ageing and health care expenditure is not straightforward as it appears and at macro-levels often the statistical significance of ageing depends on the specification of the empirical model used (Richardson and Robertson 1999).

In addition, it is not clear exactly which demographic features have the strongest effect on health care spending: candidates include the number of people over a certain age, the number with given levels of disability or ill-health and the number in the final years of their lives. In consequences of this uncertainty, methods of projecting the impact of demographic change onto health care spending vary substantially.

Certainly, increased longevity implies more elderly persons that tends to use more health resources, thereby potentially putting a strain on health system. According to ISTAT (2013) in Italy per capita health care expenditures after age 65 is more than those before age 65.

On the other hand, a much lower labor participation rate of elderly persons implies a lower tax base for government revenue, thus population ageing could have two effects: an increasing health expenditures coupled with a reduction in tax revenue (Carey 1999).

At micro-level studies we have different results if we consider some conditioning variables (i.e time to death). The conflicting results between studies may be a consequence of authors selecting different samples from the same dataset, of different methodologies applied and of different model specification.

Moreover, while the effects of population ageing could be exaggerated, the role of medical technologies on health expenditures for older patients may be understated (Newhouse 1992; Fuchs 1998, 2001).

Starting from the idea that increased longevity, commonly taken to mean an increase in the proportion of elderly persons aged 65 and above affects health expenditure we try to evaluate using aggregate data from OECD and EUROSTAT database the impact of demographic change on national health expenditure with B-VAR models to consider the implications of this work for health care policy and future research.

4.3 Empirical investigations

4.3.1 VAR model vs B-VAR model

VAR models can be applied directly on the data to perform statistical hypothesis and they become the major tool to investigate the monetary policy transmission mechanism and health policy analysis (Sims 1982, 1998; Stock and Watson 2001).

The VAR model is a powerful tool for empirical validation of macroeconomic models, as it is essentially an easy statistical model to estimate and once identification restrictions are imposed, it can be used to evaluate the impact of economic shocks on key variables. VAR models are also used for forecasting (Litterman 1986). Nevertheless, even though the VAR approach is proven to be a reliable tool in terms of data description and forecasting the classical VAR analysis fails to take into account the inherent nonlinearities of the economy.

Another important limitation of the unrestricted VAR model comes from over-fitting that may verify when the data set is short, sample information is weak or the number of parameters is large.

 Since VAR models are not parsimonious models because they contain many parameters, it is often hard to obtain precise estimates of the coefficients and impulse responses functions.

In this case, Bayesian Inference applied to VAR models (Doan et al. 1984; Todd 1984; Litterman 1981, 1986; Spencer 1993) provides a solution and has become quite a standard in the VAR modeling (Primiceri 2005; Canova and Gambetti 2009; Banbura et al. 2010).

Moreover B-VAR models in the case of over-parametrization instead of eliminating longer lags, they impose restrictions on these coefficients by assuming that they are more likely to be near

zero than the coefficients on shorter lags. Obviously, if there are strong effects from less important variables, the data can counter this assumption. Usually, the restrictions are imposed by specifying normal prior distributions with zero means and small standard deviations for all coefficients, with a decreasing standard deviation as the lags increase. Litterman (1981) used a diffuse prior for the constant. The means of the prior are popularly called the 'Minnesota Priors'.

In this environment, an econometric approach developed specifically to overcome the problem of short time series may be highly relevant to analyze Italy. A Bayesian VAR model estimated for the Italian economy may be regarded as a novel tool for the analysis. The aim of this work is to implement such an approach.

4.3.2 Data

We use Bayesian Vector Autoregression Model (B-VAR) to estimate the impact of evolution of ageing population on health expenditure in Italy. For this analysis we use annual data drawn from OECD and EUROSTAT database for 1990-2013 period. The time sample ranges is determined by the data availability.

The variables are: life expectancy (LFE),[14] per capita expenditure on health (HEX),[15] per capita GDP (GDP)[16]. To take into account the longevity we also introduce aging index (AI)[17] to analyze the cost impact of the population senility rate usually caused by chronic illnesses and severe diseases that increase over time.

Figure 4.1 depicts the annual movements of the aforementioned variables. They exhibit the typical pattern of not stationary series (Figure 4.1).

Please Insert Figure 4.1: Series in levels of life expectancy, health expenditure per capita, GDP per capita, aging index

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[14] Life expectancy series is the life expectancy at birth, or the number of years that a newborn could be expected to live on average.
[15] Per capita expenditure on health includes government spending.
[16] Per capita GDP is used to account the variance in population.
[17] Aging index is the percentage of population aged 65 and older.

4.3.3 B-VAR estimation

In any empirical application of the B-VAR methodology, the issue of whether the variables in the VAR should be in log-levels or differenced must be addressed. For a number of reasons, we favor models which are estimated in levels rather than in first differences. Firstly, the Minnesota prior where the variable in question is posited as following a random walk with drift, is generally applicable only to economic series in levels (or log levels). Secondly, differencing discards long-run information in the data which may be of use for impulse response functions. Finally, if the data in question are cointegrated in levels, a VAR in first differences will be misspecified because it does not incorporate adjustment to the long-run cointegrating relationship within the systems dynamics.

Following Sims et al. (1990), we estimate the model in levels by using Eviews 9 package. This approach avoids inconsistency that might occur if we incorrectly impose cointegration restrictions. Further, in a Bayesian framework the non-stationarity is not an issue, since the presence of unit roots in the data does not affect the likelihood function (Sims et al., 1990).

For our baseline model we set up as endogenous variables: life expectancy (LFE), per capita expenditure on health (HEX), aging index (AI) and per capita GDP (GDP). We also add an exogenous temporal dummy to capture the effects of the Great Recession (IMF 2012). In order to test for the presence of outliers, the temporal dummy variable (dum) assumes the value of one in the years 2008-2009, and zero in all the other years. The variable is proved significant in B-VAR estimation.

 Two lags are used for estimation. We use the Litterman-Minnesota prior with diagonal VAR estimate and prior specification of the hyper-parameters.

Please Insert Table 4.1: B-VAR estimation

We start by presenting evidence about the B-VAR estimation results (Table 4.1).

The results shown in Table 4.1 seem to suggest that aging index and life expectancy have a significant impact on health expenditure underlining more health care to consumption. This is given to the fact that Italy has one of the lowest ratios of births to deaths in the world, but it also has a rapidly aging society, which limits potential economic growth and increases health care expenditure: greater health expenditure helps the old living longer.

The positive relationship between public spending and ageing and between public spending and life expectancy it may indicate that health care provided through the government may be efficient.

Moreover, we find that per capita GDP impacts with less statistical significance respect to aging index, life expectancy on per capita health care expenditure. In line with the economic theory, wealthier individuals tend to spend a larger fraction of their income on better quality nutrition and they have a better standard of living. If income levels increase then health expenditure as function of income rises. Public health expenditure improves health and labor force and consequently increases productivity with positive impact on gross domestic output and development. In this case policy makers should consider health expenses as an investment rather than a cost to sustain and improve economic and social outcomes.

4.3.4 Impulse Response Functions and Variance Decomposition

In this section we investigate the response of health expenditure to the effects of ageing, life expectancy and GDP by inspecting impulse responses functions. We calculate the impulse responses for a one-unit innovation, for the same B-VAR estimated above.

The response horizon, in years, is given on the horizontal axis.

We observe from the Table 4.2 that in response to aging index shock, life expectancy shock and per capita GDP shock, the health expenditure increases instantaneously[18].

We notice that the impulse responses of aging index, life expectancy and per capita GDP remain significant for about three years and they become weaker with lags becoming longer in ten period. We also observe from Table 4.2 that due to aging index shock health expenditure increases stronger than life expectancy shock and per capita GDP shock. A one percentage increase in aging index would raise health expenditure by roughly 1.1 percentage point after one year. The estimated impulse response for life expectancy implies that a 1 per cent increases in life expectancy raises health expenditure by 0.18 percentage points.

Finally, per capita GDP also has a substantial effect on health spending, an increase of 1 per cent in the per capita GDP increases health expenditure by close to 0.11 percentage point after one year.

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[18] We report only the impulse response function of health expenditure. The impulse response functions of aging index, life expectancy and per capita GDP are available upon request.

This findings underline a greater variability of health outlays to longevity in order to improve health status of ageing population.

These results are consistent with the B-VAR results.

Please Insert Table 4.2: Impulse Response Functions of health expenditure to per capita GDP shock, aging index shock and life expectancy shock

On the whole, as can be seen from the impulse responses the relationship between health expenditure and aging index is found to be significant.

Lastly, starting from Bayesian VAR model we present the variance decomposition for each variables of the model due to shocks in various macroeconomic variables over different horizons (Table 4.3 Table 4.4, Table 4.5, Table 4.6).

We see from the Table 4.3, Table 4.4, Table 4.5 and Table 4.6 that the aging index, life expectancy and per capita GDP shocks are the dominant source of the fluctuations of health expenditure in Italy but it is not true the vice versa.

The role of aging index and life expectancy is relatively stable over time, with aging index explaining at roughly 6.03% in of fluctuations in health expenditure in short-medium run, while life expectancy can account for up 5% of variation in health expenditure. In the case of aging index and life expectancy the results suggest no role for health expenditure shocks. Finally, GDP explains 3.45% of variations in health spending. The results are in line with the impulse response functions.

Please Insert Table 4.3: Variance decomposition for health expenditure

Please Insert Table 4.4: Variance decomposition for per capita GDP

Please Insert Table 4.5: Variance decomposition for life expectancy

Please Insert Table 4.6: Variance decomposition for aging index

4.4 Conclusions

Health is one of the most critical development issues facing the world today. In the future decades, according to ISTAT demographic forecasts, Italy will go to have a gradual ageing of the population both for the fertility rates reduction and the longevity gains. Therefore, the increasing share of older people in the population will be characterized by higher poor health (chronic-degenerative diseases, self-reported health, mental and physical illness) because will increase the period of time lived with disability or morbidity which in turn will change the demand for health services. The increasing in demand for health and social care services, such as Long Term Care (LTC), will go to have an inevitable impact on the cost of the National Health System (NHS). The growth of the health costs related to the ageing population points out doubts about the sustainable capability by National Health System to provide adequate funding for its healthcare delivery. The greater use of resources is linked to the increase both in aging index and elderly population ratio (Scarcella et al., 2007; Gabriel and Raitano 2009). The trend of the health care spending seems a J-shaped curve, with a decreasing in the years after infancy, a restarting to grow around fifty with a peak when people are aged 75-80 (Gabriel and Raitano 2009), and a following reduction over 80 (Scarcella et al., 2007). Some authors analyze this trend by considering the spending health care relative to the last year of an individual's life (mortality-related costs) that does not depend on the death's age (Zweifel et al., 1999 and 2004; Felder et al ., 2000). In this case, the correlation between health spending growth and age of population depends on the mortality rate that is higher for elderly (Rebba, 2005). A study on Brescia's ASL data (Scarcella et al., 2007) highlights the strong correlation between population's age and per capita health expenditure. The analysis shows a great increase in health care spending if age increases with a reduction for the "oldest old" people (over-age 89). However, if we consider the health expenditure for chronic diseases there is a strong incidence of the individuals less than ages 68 (considered "non-elderly").

Moreover, a much lower labor participation rate of elderly persons implies a lower tax base for government revenue, thus population ageing can result in a double whammy in public finance-increased health expenditures coupled with a reduction in tax revenue (Carey 1999).

According to this demographic scenery it becomes necessary in Italy a policy effort that investigates the long-lasting effect of aging process, chronic disease and disability among the elderly on health care expenditure and economic growth in later years.

This paper contributes to the discussion on the societal consequences of population aging by using Bayesian VAR estimations based on EUROSTAT and OECD dataset that collects aggregate information on health care expenditure, economic growth, aging index and life expectancy of Italy during the years 1990-2013. We obtain that per capita health care expenditure is influenced by per capita GDP, life expectancy and aging index.

The results are confirmed by the impulse response function and variance decomposition. The impulse response functions indicate that changes in the life expectancy, per capita GDP and aging index provide a stimulus to the Italian health expenditure.

The variance decomposition reveals that GDP per capita, life expectancy and aging index are important to health spending in Italia, with the contribution from the latter being higher.

The findings of this study underline the important rule of longevity on growth in health expenditure and economic growth.

The above results show the need for a redesign of the health system through an intensive promotion of the public health system. In any case, the relationship between longevity and health expenditure is complex, and is further influenced by other factors, namely the specific characteristic of the lifestyle of the population (obesity, chronic diseases (Habibov 2009), medication misuse (Cheaito et al. 2014)), the ways in which public resources are used (Liu et al. 2012; Wu et al. 2013) and the quality of health services.

A good health cost management contributes to improve people's health with a significant impact on efficiency, economic growth and development without increasing total health expenditure. However, the health spending efficiency may be age-biased for a greater utilization of health care among the elderly population. In this case policy actions should include improvements in public health, such as retirement plans that support elderly individuals in age-specific risks and help them not to become poor (i.e health insurance coverage, household income, informal care supply) or intervention plans oriented to young people for primary and preventive services.

Empirical evidence about health efficiency is not conclusive. For instance, ranks of health efficiency given by Evans et al. (2001) and Or et al. (2005) do not coincide, due to the use of different estimation methods and the use of different health efficiency definitions, suggesting that the countries with a better health performance are not always those with the most efficient health system. Apart from health efficiency, the financing schedule (insurance vs tax mechanisms) or even cultural differences may also be important (Clemente et al. 2004; Maziak et al. 2013).

In this context, our results may be used as a signaling device to design more effective intervention plans oriented to the accessibility of health care, pioneering medicine for chronic

diseases and encouraging healthier lifestyle for elderly. However, in the present paper we focused only on aging population while the so-called demographic transition that Italy, like other OECD countries, have been experiencing involves a higher life expectancy combined with a lower fertility rate that could affect health expenditure and economic growth. In this case, a larger share of the old (due to aging) would be associated with a lower number of young (due to lower fertility rates). Another important point that could be interesting to be taken into account for future research is the connection between demographic transition and high investment in education. The relationship of education and longevity is positive and possible going in mutual casual directions. A longer life expectancy and longevity can prompt to acquire better education and more human capital as their returns are expected to be enjoyed over a long period; but there are also good reasons to believe that life expectancy and longevity depend on the educational background of an individual: skilled people usually face a more stable social situation, have higher incomes and have a way of living which more agrees with health as compared to unskilled people. In this sense, aging society would also bring about more educated people, especially considering that better educated people are also more likely aware and this will have an effect on health expenditure and economic growth. These points are left for further research.

Figures

Figure 4.1: Series in levels of life expectancy, per capita health expenditure, per capita GDP, aging index
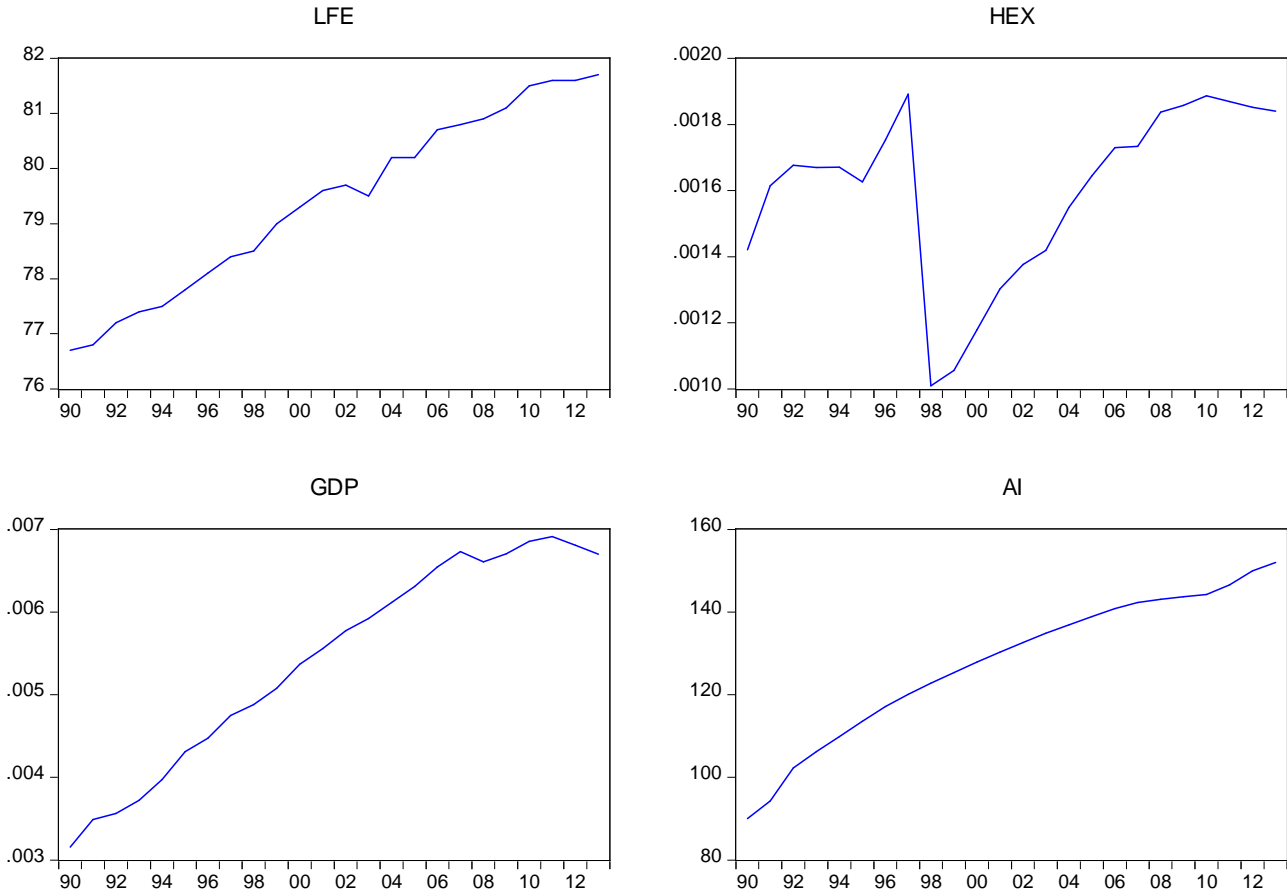
Tables

Table 4.1:B-VAR estimation

	HEX$_t$	LFE$_t$	AI$_t$	GDP$_t$
HEX$_{t-1}$	0.012*	0.08	0.046	0.0013
	(0.055)	(0.13)	(0.9)	(0.8)
HEX$_{t-2}$	0.01*	0.29	0.03	0.9
	(0.64)	(0.23)	(0.19)	(0.15)
LFE$_{t-1}$	0.1***	0.18	0.64	0.8
	(0.01)	(0.4)	(0.34)	(0.55)
LFE$_{t-2}$	0.12**	0.2	0.23	0.54
	(0.03)	(0.7)	(0.19)	(0.13)
AI$_{t-1}$	0.23***	0.03	0.47	0.32
	(0.002)	(0.002)	(0.6)	(0.3)
AI$_{t-2}$	0.28***	0.18	0.10	0.6
	(0.004)	(0.04)	(0.44)	(0.45)
GDP$_{t-1}$	0.013*	0.7	0.50	0.004*
	(0.06)	(0.6)	(0.44)	(0.07)
GDP$_{t-2}$	0.017*	0.78	0.8	0.06*
	(0.078)	(0.51)	(0.16)	(0.08)
c	0.005***	0.55*	0.03**	0.05**
	(0.008)	(0.06)	(0.049)	(0.01)
dum	0.01***	0.066**	0.06**	0.12**
	(0.004)	(0.05)	(0.019)	(0.02)

Notes: The values in parentheses are the respective *p-values*. (*), (**), (***) indicate statistical significance at 10%, 5% and 1% percent level.

Table 4.2: Impulse Response Functions of health expenditure to per capita GDP shock, aging index shock and life expectancy shock

Horizon (years)	HEX	GDP	LFE	AI
0	0	0	0	0
1	0.004	0.12	0.18	1.1
3	0.002	0.1	0.11	0.7
6	0.001	0.03	0.06	0.02
10	0	0.0001	0.00014	0.00011

Table 4.3: Variance Decomposition for Health Expenditure

Horizon (years)	HEX	GDP	LFE	AI
3	1.81	3.28	2.61	5.28
6	2.2	3.45	5.0	6.03
9	4.8	2.66	3.6	5.67
12	2.7	1.78	2.1	3.07

Table 4.4: Variance Decomposition for per capita GDP

Horizon (years)	HEX	GDP	LFE	AI
3	0.81	0.28	0.01	0.22
6	0.9	0.03	0.09	0.04
9	00.8	0.066	00.13	0.03
12	00.7	0.078	00.1	0.018

Table 4.5: Variance Decomposition for Life Expectancy

Horizon (years)	HEX	GDP	LFE	AI
3	0.51	1.28	0.22	0.56
6	1.9	2.31	2.79	1.45
9	0.8	1.66	1.8	1.66
12	0.47	1.08	0.89	0.011

Table 4.6: Variance Decomposition for aging index

Horizon (years)	HEX	GDP	LFE	AI
3	0.071	0.18	0.14	0.15
6	0.9	1.01	27.9	1.23
9	0.8	0.66	30.8	1.9
12	0.017	0.78	34.7	0.44

Chapter 5

Conclusion

Concluding remarks

The main concern of this thesis has been to analyze monetary policy rules and health economics through the use of VAR and VECM approaches.

In order to investigate the dynamic interrelations among the variables we implement econometric procedure includes unit root tests, cointegration analysis, VAR estimation (vector autoregressive model) and Granger Causality test, VECM estimation (vector autoregressive error correction model) and Bayesian VAR models with impulse response functions and variance decomposition.

The thesis offers three different advances.

The first paper investigates the relation between the deviation of the log-nominal GDP from the log-target GDP and the three-month market interest rate in the Euro Area over the period from 1999Q1 to 2013Q3. A VAR model in first differences on quarterly data is estimated to take into account the short-term relationship between the deviation of the nominal GDP growth rate from the growth rate of the target GDP and the variation of the market interest rate. The F test results of Granger causality test show that there a one-way relation from the deviations of the nominal GDP growth rate from the target to the variation in the market interest rate but not vice versa. The robustness of the results is also confirmed if we use the three-month refinancing interest rate rather than the three-month market interest rate. The main contribution of this paper compared with the existing literature is to investigate whether the behaviour of the monetary authorities in the Eurozone could be interpreted in the light of the nominal GDP targeting rule. The results obtained don't provide empirical support to the nominal GDP targeting rule.

In the second paper VAR and VECM models are used over the period 1999-2012 to study money supply endogeneity in United States. By using the loans series adjusted for securitization we test whether money supply could be affected by banking system behaviour taking into account the effects of sub-prime mortgage crisis (2008-2009). Also in this case the empirical tests are conducted

at the beginning with unit root and Johansen cointegration approach to test whether the variables are cointegrated, followed by VAR and VECM model. Results confirm the passive money hypothesis in Unites States according to the structuralist post-Keynesian approach.

Finally, in the third paper since in Italy the increased percentage of individuals aged over 65 and aged over 85 between 1990-2011 could lead to a higher incidence of chronic-degenerative diseases (e.g heart disease, cancer, Alzheimer's disease) and a greater demand for healthy living resources over time we analyze the relation among per capita health care expenditure, per capita GDP, aging index, and life expectancy over the period 1990-2013.

The estimates from Bayesian VAR models and undertaken impulse response functions and variance decomposition suggest a significant effect from per capita GDP to per capita health care expenditure, from life expectancy to per capita health care expenditure and from aging index to per capita health care expenditure. The main contribution of this paper is that it focuses on ageing, per capita health expenditure and public finance sustainability taking into account the ageing index to analyze the effects of the aging in terms of policy and health initiatives. If expensive medical treatment for patients near the end of life can be controlled for, health expenditure resulting from population ageing is unlikely to present a most serious problem.

Policy Implications

It is important to stress that VAR, B-VAR and VECM models are used to evaluate the effects of monetary policy and health policy analysis. In more general terms, we use these models to explain all the possible interrelationships among macroeconomic variables over time without impose the order of causality *ex-ante*. In terms of policy implications the thesis offer three main contributions.

In the first paper we start by analyzing whether the monetary authority, by acting on interest rates or other instrumental variables, affects aggregate demand to reduce deviation of the effective levels of inflation and real or nominal GDP from their respective targets. By using VAR model we test whether exist a dual causal relationship: from deviation of the nominal GDP growth rate from the target GDP growth rate to variation of the three-month market interest rate and vice versa. Since the estimates from VAR model confirm only one direction of causality it casts some doubt on the possibility of interpreting the case examined here in the light of the Taylor rule and all the other conventional rules that presuppose a two-way causal relation. Our results suggest that central banks

actually follow a more complex purpose than stabilization of inflation, real GDP or nominal income around a "natural equilibrium" level, which is the political regulation of the financial system, with specific reference to the relations between creditors and debtors and the related solvency of economic units.

In the second paper, we verify money supply endogeneity under a regime in which banking securitization affects monetary transmission mechanism of monetary policy. In particular by adjusting the loans series for securitization and using VAR and VECM models we find that money supply hypothesis is supported by structuralist point of view. Empirical findings show that the strong use of securitization motivates banks in United States during 1999-2012 to increase loans supply with a preemptive motive to cushion the impact of policy shocks. This evidence suggests that in the presence of a monetary policy shock and in particular during the sub-prime crises, banks that have access to securitization will increase loans supply in order to compensate for the decrease on the financing resources with significant policy implications.

Finally, the last paper examines the effect of aging on health expenditure. By using Bayesian VAR models with impulse response functions and variance decomposition we find a significant relationship from life expectancy to per capita health care expenditure and from aging index to per capita health care expenditure. In this scenery, future planning of health policies might be more effective if the focus is placed on an efficiency health cost management oriented to retirement plans that support elderly individuals and help them not to become too poor in particular in the South Italy by increasing in old people specialist visits and by improving in young people primary and preventive services.

Future Research

To the best of our knowledge, this is first rigorous time series studies to investigate the potentially causal relationship between macroeconomic variables in terms of monetary policy and health analysis. While the VAR model, B-VAR and VECM model are nothing new in the literature on the rules of monetary policy and health macroeconomic analysis, this thesis will take advantage of these models for the specific purpose of investigating the directions of causality implicit in the functioning of the rules of monetary policy and health analysis. Despite the important findings reported in this thesis, further researches and data are needed to come to more general and robust

conclusions regarding the papers. This section outlines several ways on how such research could be continued.

Since the findings of the first paper could be interpreted in the light of the so-called "solvency rule" puts forward by Brancaccio and Fontana (2013), whereby the monetary authority acting on interest rates can influence the amount of the sums that debtors must repay to creditors in every single period, and thereby affect the average solvency conditions of the economic system the first recommendation in the first paper for future research is to use Markov Switching Model to capture cyclic effects that may be important to analyze the solvency of economic units.

In the second paper given that the empirical findings show a significant impact of loans adjusted for securitization on money supply a second recommendation is to investigate whether securitization shows cyclic patterns that the models implemented in this paper are not able to capture. It is crucial importance to use more sophisticated tools, such as Regime Switching variants to discriminate among the theories that support the Post-Keynesian view.

Finally, the last recommendation in the third paper regards the Bayesian VAR results and the impact of aging on health expenditure by considering that education could be important in terms of explaining life expectancy and aging.

This relationship could be two-way: a longer life expectancy can prompt to acquire better education and more human capital; but there are also good reasons to believe that life expectancy depends on the educational background of an individual: skilled people usually face a more stable social situation, have higher incomes and have a way of living which more agrees with health as compared to unskilled people. In this sense, aging society would also bring about more educated people, especially considering that better educated people are also more likely aware and this will have an effect on health expenditure and economic growth.

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