NEWS SHOCKS:
The impact on the Term Structure

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Abstract

The aim of this work project is to get better sense of what moves the Term Structure and, consequently, the slope of the Yield Curve. To do so, we first present the most common economic theories that attempt at explaining what drives investors' expectations and the shape of the Yield Curve. Following the research of Kurmann and Otrok (2013), we then analyse the impact of a news shock on both macroeconomic and monetary policy variables using a Vector Autoregression (VAR) identification model and the impulse response functions (IRFs) of the aforementioned variables in the VAR. After having carried out this analysis, the final lesson is: news shock about future growth of Total Factor Productivity (TFP) determines a constant drop in Inflation as well as Federal Fund Rates while, at the same time, increasing the slope of the Term Structure, and these results could be used to forecast a possible future scenario for the Euro Area.

Keywords

- Term Structure
- Expectation Hypothesis
- Vector Autoregression
- Total Factor Productivity news shock

Introduction

The Term Structure of interest rate and its slope has always kept the attention of many different literatures. As reported by the economist Frederick Mishkin, in his book "*The economics of money, banking and financial markets" (2015)*, the Term Structure displays how interest varies with different maturities, maintaining risk, liquidity and tax regime unchanged . The Yield Curve is the plot of the yields of different bonds as a function of their maturities on a 2-dimensional Cartesian plane, with maturities on the horizontal axis and yields on the vertical one. The latter has a key role in an economy, given that it is possible to look at its slope in order to forecast future economic activity, as proven by Estrella Arturo, and Gikas A. Hardouvelis in their paper *"The Term Structure as a Predictor of Real Economic Activity" (1991)*. Indeed, it reveals the expectations of market participants about future interest rates level, as well as monetary policy conditions. In addition to this, the economists Clarida Richard, Jordi Gali, and Mark Gertler have shown in the late 1999 - with their paper *"The Science of Monetary Policy: A New Keynesian Perspective"* - that the slope of the Term Structure is essential for the transmission of monetary policy. A contradistinctive feature of the Yield Curve is its slope. Most of the time, the curve is upward-sloping, meaning that the difference between long-term and short-term of interest rate at a date t (namely, the spread) is positive and future rates are expected to increase. In other words, the economy is expected to grow in the future. Nevertheless, the Yield Curve can take various forms: it could be flat, or even downward-sloping. If long-term and short-term bonds are expected to offer the same returns from date t to $t + 1$, then the Yield Curve would be horizontal. On the other hand, when the spread is negative, meaning that long-term interest rates are lower than short-term ones, the Yield Curve is downward-sloping. The latter is also called Inverted Yield Curve and it signals that the economy may be in a recession, or very close to one, if critical real-time decisions are not taken. A prime example of the latter is central banks' Quantitative Easing (QE), an unconventional monetary policy that has commonly been used in order to restore economic growth.

The purpose of this study is therefore to better grasp the Term Structure of interest rate and the impact of news and monetary policy on the Yield Curve. In other words, in this paper it will be investigated to what extent expectations and news about future changes in

fundamentals - such as consumption, inflation and investments - are essential drivers of economic fluctuations and business cycles. The present report is meant to reviews and contributes to the recent literature that analyse the determinants of business cycle fluctuations. The most important finding from these recent studies is that the slope of the Yield Curve is strongly connected with macroeconomic dynamics. For this reasons, this paper will investigate which are the major determinants of movements in the slope, before finally concluding that news shocks about future total factor productivity (TFP) and the endogenous response to monetary policy play a central role in driving the steepness of the Yield Curve.

The paper will be organised as follows: Section 1 define which are the fundamental economic theories on the Yield Curve, hence The Expectation Hypothesis, The Liquidity Preference and The Segmented Market Hypothesis will be presented; Section 2 will review the most important literature concerning the connection between the slope of the Term Structure and both news as well as monetary policy shocks; starting from Pigou (1927) before moving to Beaudry and Portier (2006) and then Kurmann and Otrok (2013) which is the reference point of this research. Last but not least, Section 3 will introduce the methodology, in other words the economic model suggested by Kurmann and Otrok (2013) is presented, highlighting the data used and the reasons for the choice of the latter. Section 4 examines the empirical results of the study proving an economic interpretation of the news shock, as well as defining its impact on the Term Structure of interest rates. Finally, Section 5 will report model's result to current Euro Area context and Section 6 will present the conclusions.

1. Theories on the Yield Curve

As mentioned earlier, the Yield Curve changes over time and it can take three different shapes: upward-sloping, downward-sloping or flat. Normally, short-term interest rates are lower than long-term ones, so the curve is upward-sloping. In this specific case, it signals that investors expect future economic expansion, so they require a higher yield to take the risk of lending their money in the long-term. On the contrary, if short-term rates are greater than the long-term ones, the Yield Curve slopes downward and it indicates that the market is contracting, therefore, it is expected to go through a recession phase. Finally, when short-term

rates are on the same level as long-term ones, the Yield Curve is flat. In such a case, future economic growth is uncertain and the economy may be soon in recession.

So, what drives investors' expectations and consequently the shape of the Yield Curve? There are three main economic theories that need to be studied in depth in order to answer this question:

- *The Expectation Hypothesis*
- *The Liquidity Preference Hypothesis*
- *The Segmented Market Hypothesis*

1.1 The Expectation Hypothesis

The Expectation Hypothesis attempts to explain why bonds with different maturities have different yields and it is considered one of the most important theory to analyse long-term yields.

According to this economic theory, the current yields on bonds reflect investors' expectations about future interest rates. Hence, it is possible to predict future short-term interest rates from current long-term rates. The intuition behind the Expectation Hypothesis is relatively simple: the interest rates on holding a long-term bond until maturity (T) is equal to the expected interest that derives from investing in a series of consecutive short-term bonds for a period of time T that is the same as the long-term bond's maturity. In other words, the Expectation Theory suggests that bonds of different maturities are perfect substitutes, holding risk, liquidity and tax treatment constant; so, investors would be indifferent between holding short-term bonds whose average interest rate is equal to that of a long-term one (David Angelo, 2017). Consequently, as it is argued by David Angelo in his research paper, short-term and long-term rates move together. As a matter of fact, an increase (or decrease) in long-term yields needs to be followed by a decrease (or increase) in short-term yields, until the average expected yields of the two are equal. If this is not the case, investors would have not been indifferent and they will always buy bonds with the greater expected yield.

For these reasons, the Expectation Hypothesis plays an important role in forecasting financial market expectations about the course of future interest rates. As proved in a research paper conducted for Bank of Canada (Lange, R. (1999)), the Expectations Hypothesis has

substantial economic and statistical content for explaining why the Yield Curve commonly slope upward for some countries, including Canada and Australia[1], even though it might be rejected statistically for others, such as the U.S.

Nevertheless, it is important to always keep in mind, not only the strengths, but also the weaknesses of the theory. As a matter of fact, a common issue of the Expected Hypothesis is that it might overestimate future short-term yields. As it can be easily understood, the aforementioned problem could have serious consequences on investors' investment strategy due to a wrong prediction of the Yield Curve. In addition to this, it does not take into account fundamental macroeconomic factors that have an impact on interest rates, such as inflation and economic growth, so the results might be biased and not reliable in every point time, especially when short-terms rate are "excessively" volatile, meaning that they vary more than it is warranted by the theory (Lange, 1999).

1.2 The Liquidity Preference Hypothesis

The Liquidity Preference Theory was first introduced in the late 1936 by Keynes in his revolutionary book *The General Theory of Employment, Interest and Money*, where he examined the link between money demand and interest rates. The Liquidity Preference Hypothesis states that investors prefer short-term debt rather than long-term ones, since the former have higher liquidity and investors are usually risk-averse. Hence, they must be compensated with a liquidity premium for holding long-term bonds because of bearing higher interest rate risk. The term premium increases monotonically over time to maturity, which means that expected returns increase, as well as bonds' maturity increases. In other words, the Liquidity Preference Hypothesis claims that the Yield Curve is generally upward-sloping and any deviance from a positive Yield Curve will only prove to be a temporary phenomenon (Ornelas, J. & Almeida Silva, A., 2014).

In addition to this, according to the Liquidity Preference Theory, interest rates are determined by the demand for and supply of money, rather than investment and savings. In its turn, the money demand could be measured through liquidity and it depends on three different

[1] Warren J. Tease (1986). "*The Expectations Theory of the Term Structure and short-term interest rates in Australia"*. Reserve Bank of Australia, Research Discussion Paper 8607.

motives: the transactions motive, the speculative motive, and the precautionary motive. The former states that investors have a high demand for liquidity in order to have sufficient available cash to cover day-to-day needs. According to the speculative motive, investors used to hold liquidity in their portfolio to be sure they will not miss any good investment opportunity that may arise late in the future. Finally, the precautionary motive suggests that individuals have a preference for liquidity for the purpose of having enough cash to cover unanticipated costs or unforeseen problems. Later on, Keynes also added a fourth motive, the finance motive, in response to the critique moved by Dennis Robertson and Bertil Ohlin, two loanable funds theorists. They argued that if the propensity to invest increases, the level of income increase as well and desired level of investment should not be equal to desired savings, as supported by Keynes.

1.3 The Segmented Market Hypothesis

The Segmented Market Theory was developed by the economist John Mathew Culbertson in his work *The Term Structure of Interest Rates* released (1957). This theory attempts at explaining how fixed securities are priced by the market and demonstrates that the shape of the Yield Curve depends on bonds' supply and demand at each maturity length.

According to the Segmented Market Hypothesis, the market is segmented into as many segments as there are bonds' maturities. Each maturity is traded in an independent market, with its particular supply and demand forces, that is completely unrelated to all the others. For this to happen, there should exists different type of investors with a strong preference for maturities which is, of course, not realistic. Nevertheless, the Segmentation Theory, as the Liquidity Preference Hypothesis, supports the idea that Yield Curve usually slope upward. Indeed, since investors are risk-averse, so they do not want to hold interest rate risk on long-term bonds, they mainly invest in short-term securities. As a consequence, the latter will have higher prices as well as lower yields resulting in an upward-sloping Yield Curve. In the event that short-term interest rates are high, the Yield Curve will be inverted. In particular, it is important to highlight the fact that the Yield Curve depends on supply and demand forces within each market segments and could be seen as a reflection of prevailing investment policies. Moreover, short-term and long-term yields are absolutely not related to

each other, so it is impossible to estimate expected short-term interest rates from long-term ones.

Related to the Segmented Market Hypothesis, is the so-called Preferred Habitat Theory. The latter is considered a variant of the abovementioned theory: it implies that investors not only care about maturity, but they also care about bonds' yields. For this reason, they need to be compensated with a risk premium for shifting their maturity preferences, holding a long-term bond, as well as bearing a higher interest rate risk. That is why short-term yields are usually lower than long-term ones.

2. Related Literature

This section of the paper provides a review of the literature that has attempted to analyze the link between market shocks, both total factor productivity (TFP), as well as monetary policy shocks, and Term Structure of interest rate.

The macroeconomic literature on the Term Structure and the slope of the Yield Curve is relatively recent. The idea that economic fluctuations are driven by news shock was originally introduced by the English economist Arthur C. Pigou (1927) in his paper. This idea was then picked up again in 2005-2006 by Beaudry and Portier with their paper "*Stock Prices, News, and Economic Fluctuations",* followed by the research entitled "*When Can Changes in Expectations Cause Business Cycle Fluctuations in Neo-Classical Settings?"* only one year later. They studied time-series data and proved that the joint action of stock prices and Total Factor Productivity (TFP) might be a significant driver of business cycles. They suggest that this shock represent news about future technological opportunities and it does not have an impact on the short-term, like a standard technology shock, but it affects the productivity only in the long run. As a consequence, the shock provokes a huge increase in consumption, investment, as well as hours worked that outpaces the expansion in productivity and justify almost 50% of business cycle variations (Beaudry and Portier, 2006).

Nevertheless, for the purpose of this research, the economic model that has been followed in order to study the relationship between news shock and the Term Structure of interest rate, is the one suggested by André Kurmann and Christopher Otrok in their paper *"News Shocks and the Slope of the Term Structure of Interest Rates"* (2013). The latter aims

at answering some of the fundamental economic questions: What causes movements in the slope of the Yield Curve? Do these causes look like macroeconomic shocks? In order to do so, the authors suggest a novel statistical identification approach which demonstrates that 50% of all uncertain movements in the slope over a forecast horizon of 10 years depend on TFP news shocks (Kurmann and Otrok, 2013). This alternative approach proposed by Kurmann and Otrok provide a very similar response, regarding the relation between the Yield Curve's slope and news shocks concerning future innovations in TFP, as the one suggested by Beaudry and Portier (2006).

The DSGE Model has been investigated by the same authors in 2012 following Smets and Wouters' study of 2007. They study if a medium-scale New Keynesian DSGE Model can explain well Term Structure movements as a consequence of TFP news shocks drawing the conclusion that TFP shocks only have a transitional effect, while news about future TFP have an immediate impact due to the shock (Kurmann and Otrok, 2012). Furthermore, the two economists also presented five main "Lessons" regarding a New Keynesian DSGE Model's ability to predict macroeconomic trends depending on TFP shocks. In particular, the model has both positive features as well as limits. On the one hand, it is able to define how Federal Funds rate reacts to TFP shocks; changing preferences and wage bill expenditures is possible to improve the model fit and reduce pressure on labor costs and, as a consequence, marginal costs due to the impact of the shocks. Moreover, restricting the risk to depend only on expected inflation and expected consumption growth, following Ang and Piazzesi (2003), movements in term premia are fully explained by the solution of the model, thus they depend exclusively on two variables. On the other hand, the model estimates investment adjusted costs close to zero implying a constant firms' value and, therefore, no stock prices fluctuations, which is essential in order to identify the response to monetary policy shocks. Generally speaking, the unrestricted estimation model explains well the responses of the macroeconomic variables. It produces an increase in both consumption and economic growth; while output, investment as well as inflation, initially decrease and then gradually increase again. Nevertheless, the drop in inflation occurs only if there is a lot of wage rigidity but when a reasonable constraint to the wage rigidity is introduced, the model is not able to match

anymore the response of the Term Structure variables to a news shock (Kurmann and Otrok, 2012).

In addition to the previously mentioned models, it is possible to use different ones to investigate the relationship between news shocks and the Term Structure, such as, for example, a no-arbitrage Term Structure model proposed by Anna Cieslak and Pavol Povala (2013). In their paper, they focused on the economic information included in interest rates volatility reaching the conclusion that volatility can be decomposed into a short-rate expectation component and a term premium component. Specifically, they demonstrate that both short-rate expectations (short-end volatility) and risk premia (long-end volatility) comove over time. In particular, the correlation between them is time-varying: it increase during expansion and decrease during recession, impacting on interest rate volatility, as well as the slope of the Yield Curve, accordingly. Generally speaking, at short maturities, most of the variations depend on short-rate expectations; while for long maturities, the term premium component prevails (Cieslak and Povala, 2013).

Finally, Nir Jaimovich and Sergio Rebelo (2009) proposed an additional model: a unified model that explains both aggregate, as well as sectoral comovements, in response to aggregate and sectoral shocks. The fundamentals which have been considered by the authors are just two, TFP shocks and investment-specific technical change; while the underlying idea is that news shocks can modify agents' expectations affecting the level of investment, consumption and work decision. As a matter of fact, positive expectations about future earnings growth lead to an increase in investments and, consequently, economic growth (Jaimovich and Rebelo, 2009). They conclude that aggregate and sectoral comovements are both an essential features in driving business cycles.

For what concerns the monetary policy shocks, an important paper that needs to be mentioned is the study of Angar Belke, Daniel Gros and Thomas Osowski (2017). After the huge financial crisis of 2008-2009, which caused a deep recession in the financial markets, central banks all around the globe opted for an unconventional monetary policy in order to boost the economic growth. Thus, Belke, Gros and Osowski study the effects of non-standard monetary policies, namely the Quantitative Easing (QE), on international yield relationships. The purpose of the QE is to put pressure on long-term interest rates to stimulate demand;

nevertheless, it is difficult to define which is the exact channel through which it should do so (Belke, Gros and Osowski, 2017). While most of the studies focus only on the QE's effect on long-term yields, such as Gagnon et al. (2011) or Thornton (2014), they investigate the correlation of interest rate differentials between the US and other major markets, in particular the Euro Area.

In addition to the analysis suggested by Berkle at al. (2017), another valid economic model which studies the impact of the Central Banks' Quantitative Easing to the Term Structure of interest rate and, consequently, the slope of the Yield Curve, is the one introduced by David Angelo (2017). The author has been used data from the second quarter of 2007 to 2015, in order to compare the Term Structure before as well as after the recession, and then it has been computed the spread between 1-year and 10-year bonds. Doing so, it was possible to find out if there was any interaction between short-term and long-term maturity and, as a consequence, demonstrate that there is a chance to use one to predict the other. This model suggested by Angelo implement a heuristic approach resembling the one of Michal Kalecki (1965) in his research *"Theory of Economic Dynamics"*. It uses a practical methods that is not guaranteed to fully work, but it is the most suitable one for immediate goals (Angelo, 2017). After performing a stationary test and a test statistic and check for serial correlation between the variables, two versions of the same equation[2] were developed to examine the relationship between 1-year and 10-year treasury yield. To be more precise, the first version of the equation assumes no Quantitative Easing; while the second does. In both cases all the coefficients show statistical significance, but when a proxy variable for QE is included, the change in the employment growth rate increase. This result reflects the positive impact of the QE in boosting the economy and it is a proof of the effectiveness of this unconventional monetary policy.

As it can be understood, there are several different economic models which attempt at interpreting the impact of news shocks on one hand, and monetary policy shocks on the other

[2]Angelo's equation is the following: i=(**α**o+a-e+Bo)/(1+a/imax)+(B1/(1+(a/imax))*r1+[**α**1/(1+a/imax)]*ΔEG), where "i" is the yield on 10-year bonds and "imax" is maximum observable 10-year yield; "r1" is the 1-years yield; "e" is an inconvenience factor due to holding 1-year bond; "a" denotes the long-term risk coefficient; "**α**" refers to the level of the labor market and "EG" refers to the employment growth.

hand. Looking at them as a reference point, this paper will try to propose a joint view about what it is affecting the Term Structure of interest rates and the slope of the Yield Curve.

3. Methodology

Considering that this research has meant to pursue a strictly theoretical approach, for the purpose of the analysis, we refer to the estimations of Kurmann and Otrok (2013).

The starting point of the analysis is a Vector Autoregression (VAR) which incorporates both Term Structure variables and macroeconomic aggregates, as developed by Jon Faust in the late 1998, and subsequently enhanced by Harald Uhlig in 2003. In contrast with the existing macro-finance paper, there will be presented a VAR identification and the impulse response functions (IRFs) of the variables in the VAR. The first approach will be necessary to discover the most important shock that has an impact on the Term Structure; while the second one will be fundamental in order to give an economic interpretation to this shock. To do so, it has been applied the methodology proposed by Uhlig (2003). Hence, it was possible to derive the exogenous slope shock that describes to the greatest extent possible the Forecast Error Variance (FEV). As a matter of fact, the FEV, also called Variance Decomposition, is a common econometric tool used to favor the interpretation of a VAR. The FEV signals the amount of information each shock contributes at explaining the target variable in the VAR that is, in this specific case, the slope of the Yield Curve. Regarding the IRFs, this type of functions are commonly used in order to analyse the response of a system's variables over a specific timeframe subject to an external shock. In this specific case, it will be study the IRFs of the VAR's variables subject to a 1% innovation in the slope shock, as suggested by Barsky and Sims (2011).

For what concerns the data, there have been used two different data time series for the Term Structure, and a dataset for the macroeconomic data. With regards to the Term Structure data, the first time series is the Federal Funds rate for a 5-years bond; while the second is the spread between the latter and the Fama-Bliss unsmoothed zero-coupon yields for a 60-months maturity (i.e. 5-years). To clarify the reasons of this choice, the Federal Fund Rate has been used as the short-rate, in the place of the widely used U.S. Treasury interest rate, in order to capture the part of monetary policy in changing the slope of the Term Structure. As a matter

of fact, it is the interest rate that banks charge each other for lending their reserve balances overnight. Moreover, the Fed Fund Rate is a notorious tool to monitor the U.S. economic growth, as well as a reference point for customer loans. In addition to this, there have been chosen the unsmoothed yields derived from the Fama and Bliss (1987) bootstrap method since they are able to accurately forecast the Term Structure. In particular the choice fell on the 60-months yield mainly because the data are available from the second quarter of 1959. Hence, such a long history of data helps improve the forecasts.

Regarding the macroeconomic variables, it has been used a small dataset in order to understand how many variables account for the greatest part of changes in the slope of the Yield Curve. As a matter of facts, it takes into account only three variables: Total Factor Productivity (TFP), consumption and inflation. Specifically, following Kurmann and Otrok (2013), TFP has been derived from Fernald's (2012) quarterly measure adjusted for factor utilization; consumption is computed as the log of real chain-weighted total personal consumption expenditure; while inflation is equal to the growth rate of the GDP deflator. Furthermore, all of the macroeconomic series refer to a sample period that goes from the second quarter (Q2) of 1959, to Q2 of 2005, the data are in quarterly frequency and the rotation condition is imposed after 5 quarters.[3]

Finally, it is important to emphasize the fact that it is also possible to use a larger dataset that include more than two variables as an alternative. An example of large dataset is suggested by Kurmann and Otrok (2013). Hence, it consists of a five variables in total and it adds three more variables to the small dataset: namely, real chain-weighted Gross Domestic Product (GDP), real chain-weighted gross private domestic investment and the S&P 500 index deflated by the consumer price index (Kurmann and Otrok, 2013). Nevertheless, for the purpose of the analysis, it has been used only and exclusively the small dataset with three variables.

[3] The shock extraction method used in the paper imposes that the shock is orthogonal to movements in TFP at 5 quarters; later the model has been modify to impose the response at 40 quarters.

4. Empirical Results

The main objective of this section is to conduct an in depth study of the connection that exists between market shocks and the Term Structure of interest rates with the aim of comprehending what moves the slope of the Yield Curve.

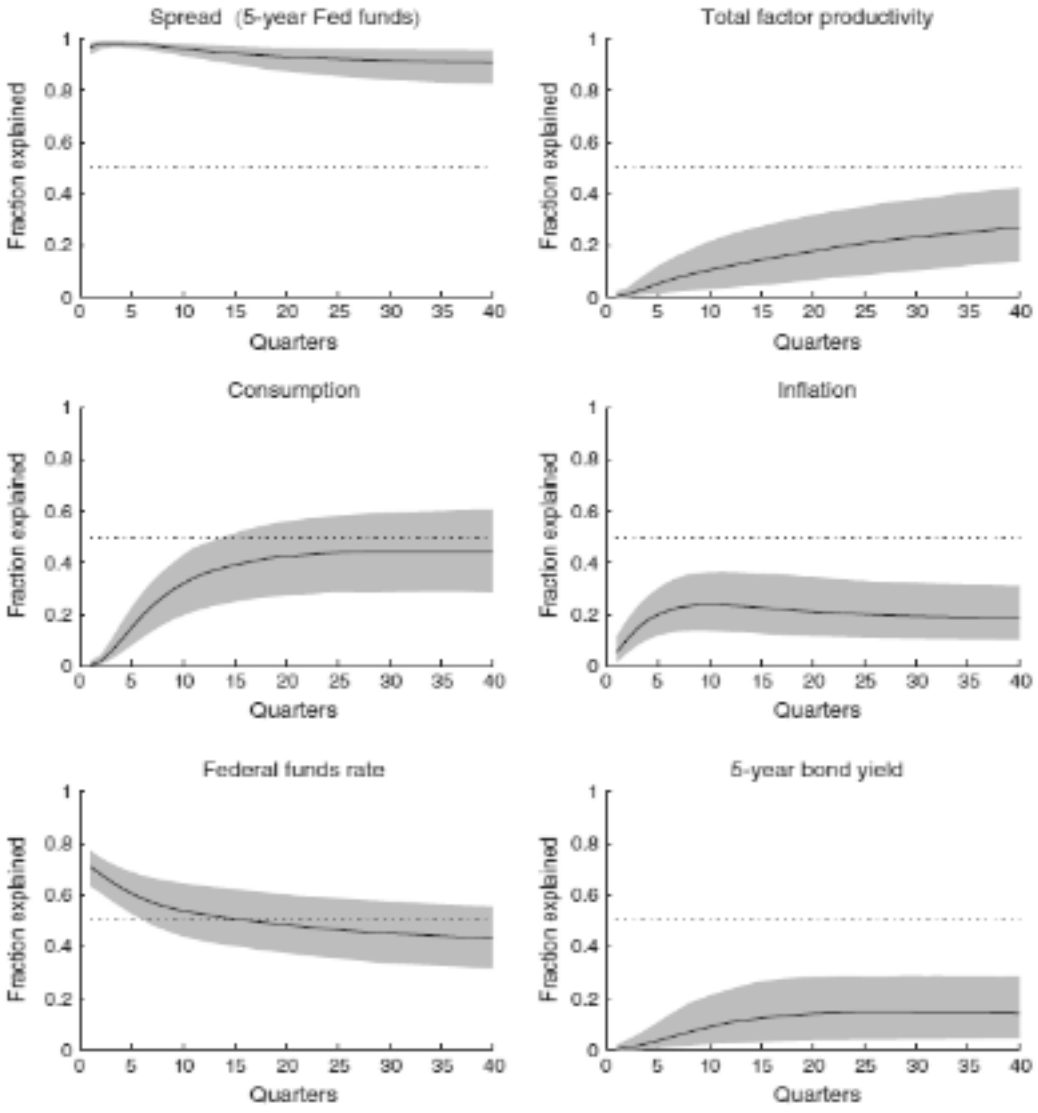
As already introduced in the previous section, it has been followed the analysis conducted by Kurmann and Otrok in their paper *"News Shocks and the Slope of the Term Structure of Interest Rates"* (2013). Moreover, this Section is divided in two parts. The starting point of this analysis is the identification of the main shock which explains most of the movements in the slope of the Yield Curve that is, as mentioned before, the target variable of our VAR. To do so, it has been used the small dataset composed of three different macroeconomic variables. Both short and medium-term movements in the slope are captured by the model and, at the same time, it is possible to provide accurate estimations for the long-term horizon. Subsequently, it will follow the second part of the analysis whose aim is to provide a possible economic interpretation of the slope shock. It is important to highlight the fact that it has been considered only a slope shock. Behind this choice is that it has been proven that two is the number of shocks in total which explain almost all of the movements in the slope of the Term Structure. Nevertheless, Kurmann and Otrok (2013) has demonstrated that one shock accounts for about 75% of all slope movements, while a second shock is responsible for the remaining part of just 25%. That is why the focus of the analysis will be on one slope shock only.

The results of this first step of the analysis are displayed in *Figure 1* that follows. The black line in the graphs represents the posterior median estimates, which is the median of a posterior distribution[4] computed following the common statistical definition[5]. On the other hand, the gray area corresponds to the so-called coverage interval, defined as the interval which contains the group of quantity values of a measurement that are considered to be true according to the information available.

[4] As defined by Byes, a posterior distribution is the condition probability of the distribution after taking into consideration relevant information about the parameter of that distribution.

[5] The median is statistically defined as the measure of the central tendency. It is the middle value of a distribution that separate the higher half from the lower half of the dataset.

Figure 1: Portion of Forecast Error Variance explained by one Slope Shock



Source: Kurmann and Otrok, 2013.

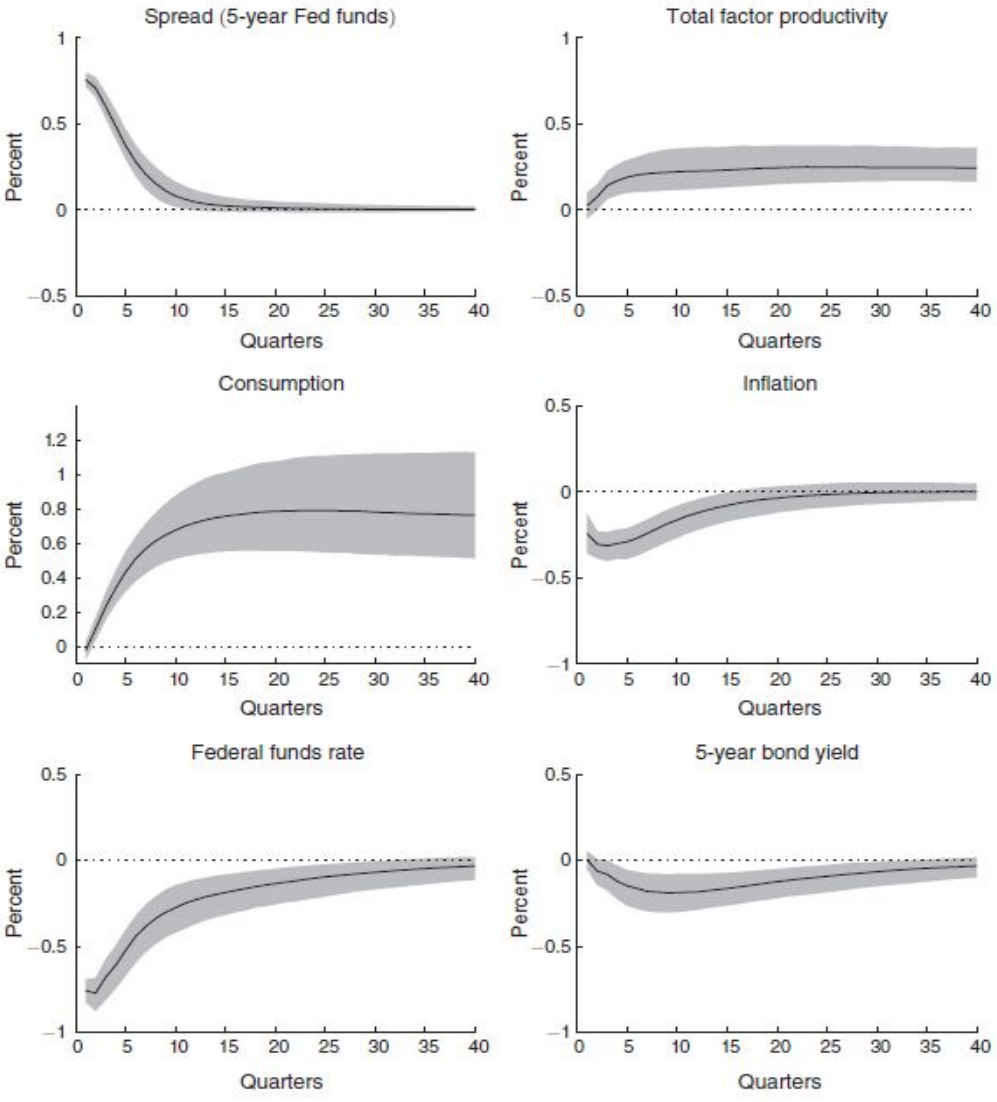
As it can be seen from *Figure 1* above, the portion of FEV explained by the slope shock depends on the type of variable taken into account and it changes as the time-horizon changes. Starting from the macroeconomic variables, namely the Total Factor Productivity (TFP), Consumption as well as Inflation, the fraction explained increases as the time-horizon increases. In particular, the slope shock accounts for a larger portion of movements after 5 quarters for both Consumption and Inflation. Regarding the former, the shock explains about 40% of all variations in Consumption after 20 quarter and then this value remains constant in the long-term. On the other hand, it reaches almost 30% of changes in Inflation between

quarters 5 and 10 and it decreases thereafter until explaining about 20% of variation. With regards to the TFP, the fraction of movements explained by the slope shock gradually increases over time: from 20% after 20 quarters, to 30% at quarter 40.

These results show that there is a strong relationship between macroeconomic variables and slope shocks. As a matter of fact, as TFP increases, both consumption and investments increase in their turn and economic growth is expected to be greater in the future. Additionally, higher inflation expectations imply lower rates and stimulate as well investment and consumption: they decrease the cost of funding making savings less appealing for investors. Thus, the Yield Curve will be upward-sloping and expected to be steeper in the future. For what concerns the Term Structure variables, the first thing which stands out is the relationship between the slope shock and the 5-years Spread. Notice that, the shock explains approximately 90% of the Spread over the entire time horizon. Furthermore, the fraction of Federal Funds rate explained by the shock increases in the short-term up to 70% and then it decreases to 50% after 5 quarters; while it accounts for only the 20% of all movements of the 5-years Bond Yield. These variables reflect the impact of Central Bank's monetary policy on the Term Structure. In particular, the results highlight the fact that monetary policy interventions affect the Term Structure, especially in the short-term, and they drive the Yield Curve's slope movements.

The second part of the analysis focuses on defining the slope shock previously identified. As already mentioned in Section 3, this study has been performed analysing the IRFs of all the variables in the VAR. *Figure 2* below shows the results.

Figure 2: Responses of VAR Variables to a 1% Innovation in the Slope Shock



Source: Kurmann and Otrok, 2013.

As it can be seen from *Figure 2*, taking the zero-level as a reference, all the macroeconomic variables have a no significant reaction on impact and then they gradually stabilize over time. In particular, both Consumption and TFP start to increase after about 2 quarters and they reach a permanently higher level, compared to the initial one, after 5 quarters remaining constant all over time. By contrast, the Inflation is subject to an initial drop of almost 0,5% and it recovers its initial level only after about 2 years (25 quarters). On the other hand, the Spread has a strong reaction on impact - it decreases by 0,70% - and it then remains roughly constant in the long-term; while the 5-years Bond Yield stays pretty much

stable over the time horizon. As a matter of fact, the latter slightly decreases between 5 and 10 quarters before returning to its initial level. Moreover, it is important to notice some crucial implications of this analysis. To be more precise, the Spread and the Federal Fund rate are clearly interlinked: the Spread's response to 1% innovation in the slope shock is caused by considerable and persistent drop in the Federal Funds rate. Since the latter decreases, future short-term rates are expected to be lower, causing the Spread to be very high and the Yield Curve to be really steep on impact. Furthermore, the fall in Federal Funds rate is greater compared to the one in Inflation. It means that the short-terms rates after the shock are lower than the rates before the shock for the same level of inflation; therefore, the Term Structure respond negatively to the shock. In addition to this, the response of both TFP as well as Inflation on impact, suggests that the slope shock partially explains the diffusion of a new technology anticipated by the market. As a matter of fact, the adoption process of technological innovations is very slow and it takes on average between 5 and 15 years, although these innovations are already known by market players.[6]

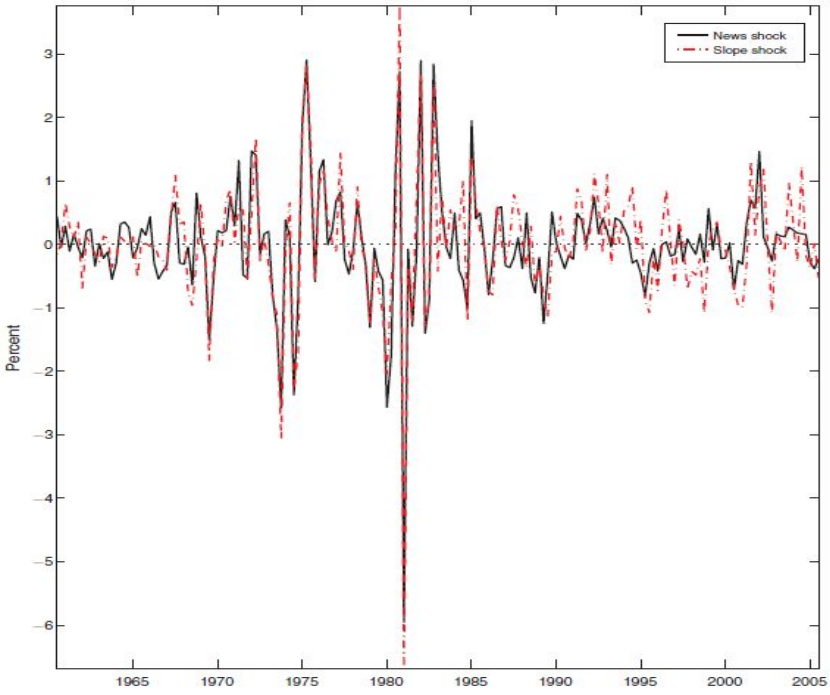
On account of all the observations that have been made following the VAR analysis, as well as the variables' response to a new technological innovation in the slope shock, it is possible to come to the conclusion that the market shock which primarily affects the Term Structure and consequently the slope of the Yield Curve, is a news shock about future TFP.

This conclusion has been drawn due to the variables response when subject to a 1% innovation in the slope shock. Recalling the analysis above, both Federal Funds rate and Inflation experienced a large drop on impact, before returning to their initial value in the long-term. On the other hand, the TFP as well as the Consumption reach a higher permanent level, even if their growth is delayed over time. Moreover, if the decrease of Federal Funds rate had been caused by a monetary policy shock, the Inflation would have increased. A monetary policy shock does not explain the impact on macroeconomic variables in the long-term: the latter should have been temporary rather than permanent. Hence, Central Banks' monetary policy intervention indirectly affects the slope of the Yield Curve reducing interest rates and investment costs, while the main driver of Yield Curve movements is a

[6] Comin and Gertler (2006) have empirically demonstrated that the adoption of new technological innovations implies and average time to adoption of about ten years.

shock concerning news about future innovation to productivity, giving credit to the Expectations Hypothesis. In support of this claim, it is useful to consider the study of Barsky and Sims in their paper "*News Shocks and Business Cycle"* (2011), where they show that technology news shocks are responsible for economic fluctuations, and their influence depends on agents' expectations about the future. Finally, the relationship between slope shock and TFP shock is illustrated by *Figure 3* which follows. As it can be seen, news and slope shock are highly correlated. They follow the same path over time, even if the slope shock is a bit more volatile than the news shock. Therefore, TFP shocks appear to be a major determinant of movements in the slope of the Term Structure in the long-term, as well as at the short-term, due to its influence on monetary policy.

Figure 3: Relationship between Total Factor Productivity Shock and Slope Shock.



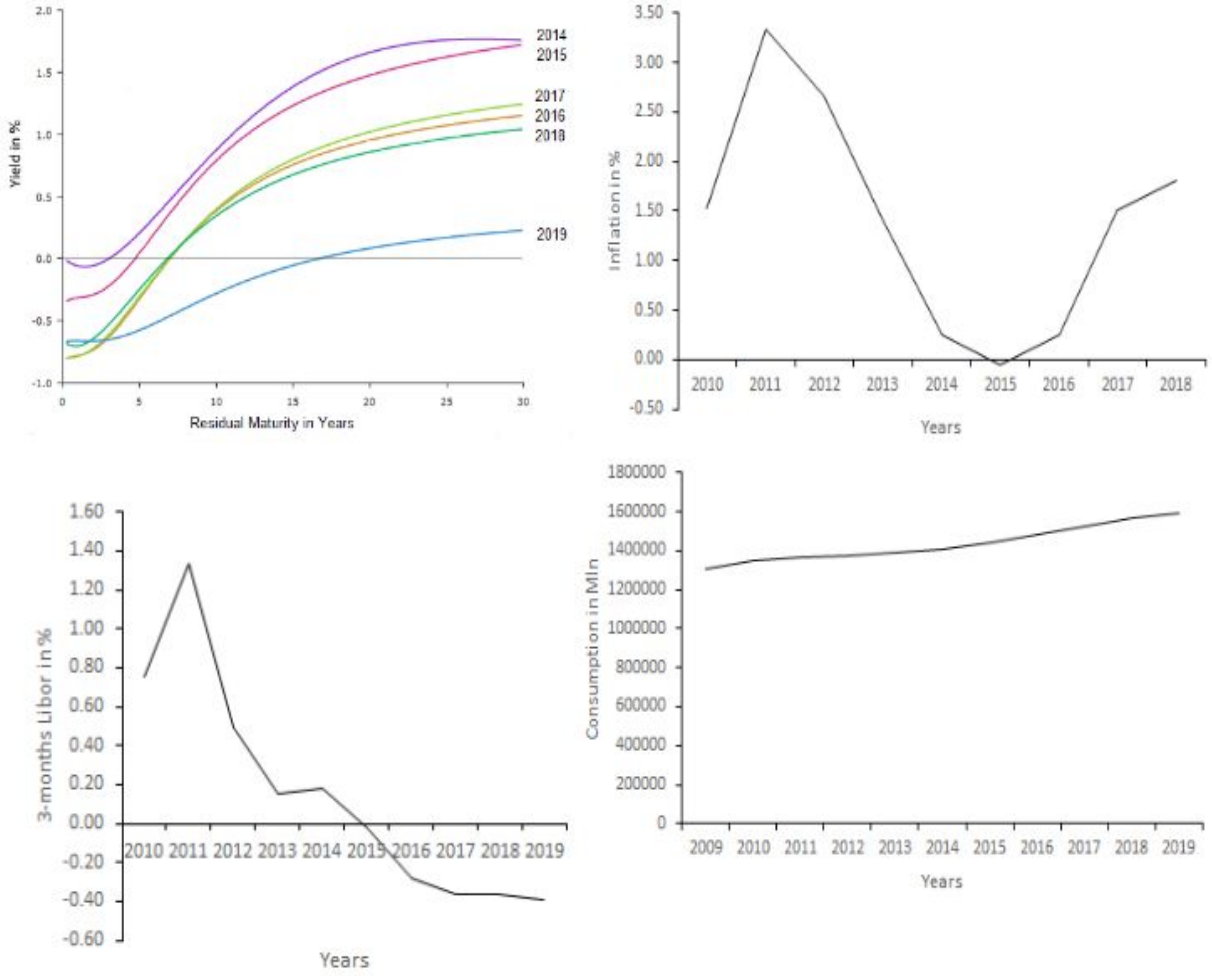
Source: Kurmann and Otrok, 2013.

5. Euro Area Implications

As recently stated by Mrs. Lagarde - President-in-Office of the European Central Bank (ECB) - the "economic growth is fragile and over-reliant on Central Banks' actions". So, what will be the future of the Euro Area? Of course, there is a lot of uncertainty, especially when it

comes to future economic growth. Nevertheless, it was possible to partly answer to the above question comparing the behavior of the VAR variables for the Euro Area - presented in *Figure 4* below - with the one predicted by Kurmann and Otrok' model. Even if the authors had made some changes in their model in order to be consistent with different data, they impose the news shock to have an impact on TFP at a long forecast horizon (at least 40 quarters). In light of this fact, the Eurozone historical data are still too recent[7] to be used to implement the VAR model.

Figure 4: Euro Area Yield Curve & Macro Variables



Source: Fred St. Louis Fed Database & ECB Statistical Data Warehouse, 2019.

[7] The Eurozone was formally born in 2001.

Euro Area data shown in above - namely Consumption, Inflation and Libor[8] - have been downloaded from Fred St. Louis Fed Database for the last decade, after the TFP news shock hit following the great financial crisis of 2009. Data on current Yield Curve, the 3-months spot rates and 30-years rates have been retrieved from ECB Statistical Data Warehouse for the same period of time.

Looking at *Figure 4*, it immediately stands out that the current Yield Curve is much flatter and the European economic growth has slowed down compared to the previous years. As a matter of fact the 3-months spot rates decreased from -0.016% in 2014, to -0.826% in 2017, before reaching -0.662% in 2019; and the 30-years interest rates went from 1.716%, through 1.206%, to 0.266% during the same years. On the other hand, the data about macroeconomic variables taken into consideration by Kurmann and Otrok VAR identification model, confirm their theory. The level of Inflation for the Euro Area is subject to a first drop before recovering to approximately its initial level in the last 5 years: it decreased from 1.400% in 2013, until reaching -0.046% and subsequently increasing to 1.812% in 2015 and 2018 respectively. In addition to this, also the Libor decreased during the same horizon, going through 0.179% in 2014, to -0.389% in 2019; while the level of the European Consumption increases over time. It reached 1,440,396 Million at the end of 2015, 1,523,806 Million in 2017, until 1,587,929 Million on Q2 of 2019, and it is expected to keep increasing in the future.

Additionally, looking at the reaction of the expected Inflation due to a TFP news shock, it is possible to extract information about Central Banks' - in this specific case the ECB - monetary policy interventions. Indeed, it is well-known that the Inflation is one of the most important channel of monetary policy transmission. The relationship between the latter and the macroeconomic variable is explained by Central Banks' objective of maintaining the level of Inflation constant over time. To do so, they need to anchor the expectations about future Inflation in order to stabilize the economy. Therefore, it can be stated that the Inflation is highly responsive to rises in TFP, as already argued by Barsky et al. (2005) and Christiano et al. (2010). As a consequence, if future TFP increases due to a news shock, as in Kurmann

[8] It is one of the most important benchmark rate that could be considered as the European counterpart of Federal Funds Rate.

and Otrok' model, then Inflation is expected to increase in the future as well. This result suggests that the ECB needs to adopt an efficient, as well as accommodative, monetary policy in order to control market expectations: the adoption of QE is a good example. In this way, the ECB can use its influence on the market to change interest rate yields, so as to cope with the increase in Inflation over the long-term due to TFP future growth expectations.

Finally, it is essential to state that it has been chosen to take Kurmann and Otrok (2013) study as reference paper because their results are proved to be consistent independently from the dataset used, and their model is a valid empirical approach that is able to explain the source of movements in the Term Structure of interest rate, taking into account the impact of both TFP news shock and monetary policy interventions. Another possible economic model that is commonly used in order to study the aforementioned relationship is the Dynamic Stochastic General Equilibrium (DSGE) Model. The latter has been investigated by the same authors in their paper *"News Shocks and the Term Structure of Interest Rates: Lessons for DSGE Models"* (2012). Nevertheless, the most famous research about this topic is *"Stock Prices, News and Economic Fluctuations"* by Paul Beaudry and Franck Portier. The latter shows that business cycles are affected by TFP news about future technological opportunities anticipated by stock prices changes. DSGE Model are commonly used in macroeconomic in order to describe the behavior of an economy as a whole. As it is stated in its name, a DSGE Model is *dynamic*, namely it study how an economy evolves over time, and *stochastic* since it takes into account random shocks. One of the most relevant difference between VAR and DSGE models is that the latter are not subject to Lucas critique who argues that is "naive" to use historical data to predict the impact of future changes in the economy. Despite that, Beaudry and Portier' model has both positive features as well as limits. First of all, they touched an interesting point analysing the combined behavior of TFP and stock prices movements: future growth in productivity is anticipated by the market with an increase in stock prices, hence supporting the Expectation Hypothesis. On the other hand, among macro models that could explain the direct link between TFP and stock prices, Beaudry and Portier' observations can be easily reproduced only in a sticky price context. Therefore, the main weakness is that it implies a sub-optimal monetary policy in order to require price stickiness. Hence, relying on a sub-optimal monetary policy over time is not feasible and it is

still not clear how to interpret their data. For these reasons, it has been chosen to interpret the results of Kurmann and Otrok' research in the context of Euro Area, rather than Beaudry and Portier' work.

To conclude, even if the shape of the recent Yield Curve signals a possible slow-down of the Euro Area's growth and a not bright future, according to the available data on the VAR variables, this negative sentiment is proved wrong. In addition to this, market agents expect that Mrs. Lagarde will follow the footsteps of Mario Draghi, implementing an expansive monetary policy, which is essential in order to anchor Inflation expectations, and encouraging Government spending. For both these reasons, considering the behavior of the variables and the results of Kurmann and Otrok (2013) empirical model, along with the increase in future interest rates yields, from negative to slightly positive - as preannounced by Mrs. Lagarde - it is possible to expect an increase in TFP simultaneously with a future expansionary phase, although the economic growth will surely be slow and not so dynamic. Hence, the current slope of the Yield Curve could be due to a structural trend that has begun before the financial crisis and involved both the Euro Area and the U.S.

6. Conclusion

This paper examines what moves the Term Structure; defining the type of shock which has the strongest impact on the latter, and how it affects the macroeconomic variables. The results demonstrate to be consistent for both the U.S. and the Euro Area and that the main driver of Yield Curve movements is a shock concerning news about future innovation to productivity. As a matter of fact, it determines a constant drop in Inflation as well as interest rates while, at the same time, increasing the slope of the Term Structure. This outcome, not only shows that there is a strong bond between macroeconomic variables and slope shocks, but also that TFP news shocks and the Expectations Hypothesis account for a large part of the movements of the Yield Curve. Even though monetary policy shocks still play a key role in determining the Term Structure, they only have a temporary influence in the short-term. Thus, Central Banks' intervention affects the slope of the Yield Curve only indirectly.

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