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HAS EMU AFFECTED TO THE BUSINESS CYCLE SYNCHRONIZATION IN EUROPE?

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1. Abstract

English

The theory of Optimal Currency Areas tries to determine how big should be the appropriate extension for a set of territorial regions included under the same common currency. The debate focuses on a dilemma that sets the benefits of such unification against the associated costs, mainly losing the autonomy of monetary policy. To shed light on this debate, in 1993, Bayoumi and Eichengreen published an article using Structural VAR models to measure demand and supply shocks in an economy. Knowing these shocks and comparing them between different countries can lead to determine the degree of business cycle synchronization among them. Whenever this synchronization turns out to be high, we believe that both territories could favour the same monetary policies and, therefore benefit from sharing a common currency. Between the results of Bayoumi and Eichengreen, these authors found, for the case of Europe, a core-periphery trend between the north-central countries of Europe and those around them. In 2016, Campos and Macchiarelli, reviewed the article by Bayoumi and Eichengreen with the corresponding temporary update and more specifically for the case of Europe in order to observe how the European Monetary Union has affected the results of those authors. In this TFG thesis we try to update the studies with new data and verify the validity of these results.

Key Words: Optimal Currency Areas, Business Cycle Synchronization, Supply and Demand Disturbances.

Spanish

La teoría de las áreas monetarias óptimas trata de determinar cuál debe ser la extensión adecuada para un conjunto de regiones territoriales incluidas bajo una misma moneda común. El debate está centrado en un dilema que contrapone los beneficios que dicha unificación conlleva con los costes asociados, principalmente el perder la autonomía de la política monetaria. Para arrojar luz a este debate, en 1993, Bayoumi y Eichengreen publicaron un artículo en el que se servían de los modelos de VAR estructural con el objetivo de medir las perturbaciones de demanda y de oferta en una economía. Al conocer estas perturbaciones se puede establecer un grado de sincronización económica entre diferentes países y, en casos en que esta sea elevada, consideramos que ambos territorios podrían valerse de las mismas políticas monetarias y, por tanto, beneficiarse de compartir una moneda común. Entre los resultados de Bayoumi y

Eichengreen, estos autores hallaron, para el caso de Europa, una tendencia núcleo-periferia entre los países de centro-norte de Europa y los que se encuentran a su alrededor. En 2016, Campos y Macchiarelli, replicaron el artículo de Bayoumi y Eichengreen con la correspondiente actualización temporal y más concretamente para el caso de Europa con el objetivo de observar cómo ha afectado la Unión Monetaria Europea a los resultados de dichos autores. En esta tesis de TFG pretendemos reactualizar los estudios con nuevos datos y comprobar la validez de esos resultados.

Palabras clave: Áreas Monetarias Óptimas, Sincronización Económica, Choques de Oferta y Demanda.

<u>*Catalan*</u>

La teoria de les àrees monetàries optimes tracta de determinar quina ha de ser l'extensió convenient per a un conjunt de regions territorials incloses sota una mateixa moneda comú. El debat està centrat en un dilema que contraposa els beneficis d'aquesta unificació amb els costos que la mateixa implica, principalment la pèrdua d'autonomia a l'hora d'implementar una política monetària independent. Per tal de clarificar el debat, al 1993, Bayoumi i Eichengreen van publicar un article en el que feien ús dels models de VAR estructural amb l'objectiu de mesurar les pertorbacions de demanda i d'oferta en una economia. Tan bon punt es coneixen aquestes pertorbacions es pot establir un grau de sincronització econòmica entre diferents països i, en casos en que aquesta sigui elevada, es pot considerar que ambdós territoris poden beneficiar-se de les mateixes polítiques monetàries i, per tant, beneficiar-se també de compartir una moneda comú. Entre els resultats de Bayoumi i Eichengreen, aquests autors van trobar, per al cas d'Europa una tendència nucli-perifèria entre alguns països del centre-nord d'Europa i els països que s'hi troben al voltant. Al 2016, Campos i Macchiarelli, replicaren l'article de Bayoumi i Eichengreen amb la corresponent actualització temporal i més concretament per al cas d'Europa amb l'objectiu d'observar de quina manera ha afectat la Unió Monetària Europea als resultats obtinguts per tals autors. En aquesta tesi de TFG busquem tornar a actualitzar els estudis amb noves dades i comprovar la validesa d'aquests resultats.

Paraules Clau: Àrees Monetàries Optimes, Sincronització Econòmica, Pertorbacions d'Oferta i Demanda.

2. Presentation

Choosing a topic for the TFG thesis seems to be one of the hardest parts of it. Nonetheless, I had very clear from the beginning that among all the fields that the Economic science comprised, macroeconomics was the one that I liked the most. Specifically, macro econometrics. So, when professor Nektarios Aslanidis proposed me the subject of this TFG thesis I did not doubt that it was pretty suitable to what I wanted to do.

During all the developing process of the TFG thesis I realized that the subject itself englobed many different topics that I studied during my bachelor. First of all, the thesis is constructed on an econometric base, so I had the opportunity to deepen in some models that I worked on before, like the bivariate models. Also, I could learn new econometric tools that have waken new interests on me, like the Blanchard and Quah model. On the other hand, I discovered a new framework on the macroeconomics' branch namely the Optimum Currency Area theory. Even though I was aware about some authors that discussed towards the creation of monetary union I did not know the existence of a so developed theory about it. Third, I was able to identify the influence of the different subjects in the Economic science through the thesis; like the core-periphery pattern I studied in regional economics, the aggregate-demand-aggregate-supply model belonging to the macroeconomics field or the importance for a country to have an independent monetary policy I learned from public economics.

Another aspect I would like to highlight is the fact that developing this TFG thesis in English has provided me a lot of vocabulary and gave me a fluency that I did not have. Also, I realized that all the economic research is carried out in English and as is the path that I would like to take in the future, I need to get used to it.

I tried to do my best as far as writing expression is concerned for making an easy reading to any kind of lector. So, I hope this TFG thesis is liked by the reader and that it can find it interesting.

Finally, I would not like to end this presentation without thanking to all the people that helped me either professionally or emotionally while I was writing this thesis. In the first place, I would like to acknowledge my professor Nektarios Aslanidis for all the guidance that he has provided me even during the quarantine times. I am pleased I had him as a tutor. In the second place, I have to thank Joana for giving me support and for correcting and helping me improve my English. Finally, I would like to appreciate all the support that my parents gave me during the time I was writing the thesis and for cheering me up whenever I felt discouraged.

3. Introduction

Through time and space there have been multiple currencies in the world. Some of them have been created, others have appeared as a result of a unification of countries, some others have disappeared and so far, and so on. Observing this scenario some questions rise. For example, which are the implications of having a particular currency in a territory? Of course, at the time we live in we are aware that having one currency or another it allows the government to carry out an independent monetary policy, or it affects the change rate between territories, for example. But the question that seems a bit more complicated to answer is, how many different countries should comprise a single currency? Or, in economics' theory words, how big needs to be an optimal currency area?

The optimal currency area (OCA, from now on) framework was first developed by Mundell (1961) with the aim of answering that question. Mundell proposed a dilemma as an answer to that question that consisted in confronting the pros and cons of sharing a currency with other territories. In particular, the pros consisted on the benefits derived from reducing the transaction costs and exchange rate uncertainty and from an increasing price transparency, trade and competition. On the other hand, the cons were basically the costs associated to the loss of monetary policy autonomy.

Taking Mundell's proposal as a starting point, many authors have contributed to shed light on this dilemma. Two of these authors are Bayoumi and Eichengreen, who published in 1993 one of the papers in which this TFG thesis is based on. In this paper, Bayoumi and Eichengreen aimed to determine if it was possible to achieve a monetary union in different regions of the world. They focused their study in the following way: as the main problem for determining whether a grouping of countries would benefit from a monetary union or not is the loss of monetary policy autonomy (as is the principal cost of abandoning their own currency), they studied the business cycle synchronization between countries in different regions in the world so if this synchronization is high between a number of countries, these countries would favour the same monetary policy and minimize the costs of abandoning their independent currency. As a result, a monetary union between such countries would have positive effects.

Bayoumi and Eichengreen (1993), among all the regions they include in their study, applied the aforementioned procedure for the European region, incorporating some of the northern countries and some of the southern ones. Regarding these countries they observed in the business cycle synchronization results a core-periphery pattern, where the northern countries, namely Germany, France, Denmark and the Benelux countries, showed a high degree of synchronization; and the southern countries as Spain, Portugal, Italy and Greece, as well as Ireland and the United Kingdom, diverge from that synchronization showing no common patterns (except between Spain and Portugal).

A priori, these results seem to indicate that a European monetary union (EMU, hereafter) would present positive effects in the northern countries but not in the "peripheric" ones. Nonetheless, almost thirty years later, we know that the EMU has been achieved and that no only the northern countries but also the southern ones share a common currency. Now, the obvious question is, has been this beneficial?

At this point, the main purpose of this TFG thesis is to review the work done by Campos and Macchiarelli (2016), since these two authors updated the study of Bayoumi and Eichengreen focusing on the European region and for a new time period that includes already the existence of a common currency in Europe. As those authors, we have interest in determining whether the EMU has strengthened or weakened the core-periphery pattern found by Bayoumi and Eichengreen (1993).

The methodology used with the objective of answering our question has been the Blanchard and Quah procedure for decomposing a Structural VAR and obtaining the supply and demand shocks of the model. This approach developed by Blanchard and Quah (1988) is based on a Structural VAR model in which are imposed long run restrictions. These restrictions stem from a traditional Keynesian view of fluctuations, so there are two type of disturbances in the model: the ones that have no permanent effect on the production level, known as demand disturbances; and those that have a permanent effect on the production, known as supply disturbances.

Once we obtain the demand and supply shocks for the different countries in our sample data, we study the existent correlation between them and compare it with the one obtained by Bayoumi and Eichengreen.

The data sample used for this TFG thesis is composed by the 27 countries that compose the EU and the United Kingdom, for the time period from 1996 to 2019. The Standard VAR modelling has been carried out with a bivariate model composed by two variables: the real GDP per capita and the variation of the harmonised index of consumer prices.

The main results obtained in this TFG thesis are the following. In the first place, we observe how the core-periphery pattern has been weaken since the creation of the EMU.

As Campos and Macchiarelli (2016) found, in this TFG thesis, the results show how the synchronization between the European countries has increased. On the other hand, we can guess that the monetary integration between countries favours their business cycle synchronization. This conclusion is reached because the countries that are included in the Euro have improved their synchronization between one another and those which conserved their own currencies stay with low degrees of synchronization (with the clear exception of Denmark).

Finally, this TFG is structured as follows: section 4 presents a literature review of the theory highlights in the OCA framework; section 5 explains exhaustively the methodology used to obtain all the econometric results; section 6 shows and comments the empirical results; in section 7 the lector can appreciate a summary of the conclusions; and in section 8 are showed all the information sources that have been consulted.

4. Literature Review

The Optimum Currency Area (OCA from now on) is a branch of economic research focused on identifying which is the best territorial domain that a currency union should have. The aim to determine the boundaries of a currency union, and therefore the regions to be included, leads us to a classical trade-off in this field of macroeconomics. To deepen our understanding towards this trade-off, let's go to the beginning and recall the famous example proposed by Mundell (1961).

Robert Mundell in *A Theory of Optimum Currency Areas* begins his dissertation defining a currency area as "a domain within which exchange rates are fixed", what can be the case of a region which comprises many currencies that cannot fluctuate freely or an area comprising many regions that share a single currency. According to this definition, it follows the key question: how big needs to be the domain of this currency area?

In the first step, Mundell shows us how the optimum currency area is not the entire world, because neither a currency area comprising different national currencies nor one that comprises different regions under a common currency, cannot avoid both unemployment in deficit regions and inflation in surplus regions after an imbalance of the balance-of-payments. That is, imagine a currency area that includes two regions; starting from balance, a shift of demand from the first region to the second region would trigger an imbalance on the balance-of-payments, creating unemployment in the first region and inflationary pressure in the second. The central monetary authorities have two alternatives: either they try to reduce unemployment in the deficit region by increasing the money supply or they restrain inflation in the surplus region, permitting thus unemployment in the deficit one. Inferring from this that there is no possible solution that leads to prevent both unemployment and inflation within a currency area.

Then, the author criticizes the Ricardian model of international trade for its assumption that production factors are internationally immobile. Mundell states that in a world like the one described by Ricardo, the OCA would be the nation based on a system of flexible exchange rates, since depreciation or appreciation would correct the external imbalance, preventing from unemployment or inflation. However, in the world that we live in, there are regions that cut across national boundaries and countries comprising multiple regions. At this point, he proposes the region as the OCA, defining it as an area within which production factors are mobile and with fixed internal exchange rates (or a single currency) and variable external exchange rates. Nonetheless, we need to take into account that factor mobility is considered more a relative concept than an absolute one and that it tends to change over time. So, if we are to pursue stability objectives, this argument leads us to the conclusion that the grater is the number of separated currency areas, the more successfully will be these objectives achieved. As everyone can reason, this conclusion is little more than ridiculous and this is because we have pushed it to a limit that has not any sense. But why we have reached this limit?

As we can appreciate, thus far, we have only discussed the motivations to create the greater number of currency areas. Indeed, the last point's conclusion seems to be the creation of an arbitrary large number of OCA, which is reasonably ridiculous. But, obviously, there are some associate costs to the creation of many currency areas. Of course, the costs of valuation and money-changing are the greater ones and, moreover, these costs tend to increase with the number of currencies. In a similar way, money is less useful in its role of medium of exchange the larger the number of currencies. Besides, the larger is the number of currencies the thinner are the currency markets, so that are much easier to be affected by a single speculator. Contrary to the former, those arguments lead to restrict the optimum number of currencies.

We now see clear the trade-off: the main cost when adopting a common currency is the loss of monetary policy autonomy, while the benefits are the reduction on transaction costs and exchange rate uncertainty as well as increasing price transparency (Campos and Macchiarelli, 2016).

Keeping this trade-off in mind we can state without risk that between any two regions that practice the same monetary policy, a monetary union would be, doubtless, profitable, since the costs arising from loss of monetary policy autonomy would tend to zero. Indeed, if two regions present the same nature of disturbances, they will presumably favour the same policy responses. Also, the ease of response in those countries affect that decision, as if the market mechanisms adjust smoothly and restore equilibrium rapidly, the costs of denying an independent monetary policy need not to be significant. (Bayoumi and Eichengreen, 1993)

So, the question that follows is: how we measure this kind of business cycle synchronization? To respond this question, a variety of approaches have been conducted by different authors. For example, Eichengreen (1992) compares the real exchange rate variability among all EC members with the one among the principal regions of the United States (since the latter is actually a currency union). A drawback of this approach is that the movement of relative prices combines the effects of disturbances and responses making impossible to identify the structural parameters of interest. Other authors, like Cohen and Wyplosz (1989), consider the behaviour of output itself attempting to distinguish common from idiosyncratic national shocks. Again, the problem of this approach is also the converging on disturbances and responses, as output movements are not the same thing as shocks. The method that we use in this thesis, nonetheless, is the one used in Bayoumi and Eichengreen (1993), which consists on identifying the aggregate demand and aggregate supply disturbances for many countries and analysing whether they are correlated or not between the regions of interest.

The current TFG thesis adapts insights from the OCA theoretical context to replicate and update the empirical work by Campos and Macchiarelli (2016) and by Bayoumi and Eichengreen (1993). We update the aforementioned studies by using a more recent sample period up until 2019.

The article of Bayoumi and Eichengreen aims to study the viability of monetary unions in different regions of the world. It does it through a specific macro econometric model, described in the following section known as the Blanchard and Quah decomposition. The main results obtained provided solid evidence to the possibility of tree regional economic groupings, namely: northern European countries; some countries of northeast Asia; and some other in the southeast of Asia. They also found a core-periphery pattern in Europe, where some northern countries (Germany, France, Denmark and the Benelux countries) seem to be remarkably synchronized, while southern countries (Portugal, Spain, Italy, Greece) as well as the United Kingdom and Ireland show some divergence in that aspect.

Twenty-three years later, Campos and Macchiarelli (2016) published a revisit of Bayoumi and Eichengreen ‘s work with the objective of rechecking the core-periphery pattern found in Europe. The main idea is to compare the results on business synchronization obtained by Bayoumi and Eichengreen with the new ones, as during this time-lapse the European Monetary Union (EMU) has been established, to determine whether the EMU has strengthened or weakened this pattern.

5. Methodology

a. Structural Vector Autorregressions

This section incorporates an exhaustive review of the methodology and the econometric tools used for the empirical analysis. The model handled in this thesis is a Blanchard-Quah decomposition which is, basically, a specific way to impose long-run restrictions for the obtainment of the disturbances in a Structural VAR.

To reach a complete understanding of the aforementioned model, this section carries out a step-by-step construction of all the parts that integrate it. That is the reason why we are beginning with the study of a Structural VAR.

In his seminal paper, Sims (1980) argued against the style with which researches used to make identification in their models and had the intention of explaining why those researchers were sceptics about using models with large number of variables as well as contribute with some ideas for improvement in that direction. Specifically he criticised: the use of restrictions in large macro models as they were build up from partial-equilibrium models that, when aggregated, they developed undesirable properties; the role of dynamics in such macroeconomic models, since the exogeneity of many variables is not carefully considered, leading many times to a wrong identification of the models; and the way expectations were treated, as a sound treatment of expectations complicate identification considerably.

Then, Sims states that it should be possible to estimate macroeconomic large models "as unrestricted reduced forms, treating all variables as endogenous". And he clarifies that by 'unrestricted' he means "without restrictions based on supposed a priori knowledge", since some restrictions, at least on lag length, are essential. Since this moment, Structural VAR modelling has been the main econometric tool used by economists to recover economic shocks from observables by imposing a minimum of assumptions compatible with a large class of models.

This type of VAR representation is called 'structural' since they are assumed to be derived from some underlying economic theory and they consist on a multivariate, linear representation of a vector of variables regressed on their own lags and, sometimes, exogenous variables.

So, understanding dynamic economic models as restrictions on stochastic processes, economic theory takes the role of mapping between a vector of 'k' economic shocks, 'ω_t', and a vector of 'n' observables 'y_t'. Expressed by the form: $y_t = D(\omega^t)$; where 'ω^t' represents the whole history of shocks up to 't'. For the case of interest here, we are focusing our attention to linear mappings with the form: $y_t = D(L)\omega_t$; being L the lag operator.

Consider, then, a stationary bivariate model:

$$y_{1t} = \gamma_{10} - b_{12}y_{2t} + \gamma_{11}y_{1t-1} + \gamma_{12}y_{2t-1} + \varepsilon_{1t} \qquad \textbf{(1)}$$

$$y_{2t} = \gamma_{20} - b_{21}y_{1t} + \gamma_{21}y_{1t-1} + \gamma_{22}y_{2t-1} + \varepsilon_{2t}$$

Where ε_{it} are independent and identically distributed random variables with mean zero and variance-covariance matrix: $\begin{pmatrix} {\sigma_1}^2 & 0 \\ 0 & {\sigma_2}^2 \end{pmatrix}$.

Model (1) is a Structural VAR since it is assumed to be derived by some underlying economic theory; and ε_{it} are exogenous error terms interpreted as structural innovations. In matrix form, model (1) becomes:

$$\begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix}\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \gamma_{10} \\ \gamma_{20} \end{pmatrix} + \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{pmatrix}\begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$$

or $\quad By_t = \gamma_0 + \Gamma_1 y_{t-1} + \varepsilon_t \qquad$ **(3)**

Having constructed this model from the economic theory, nonetheless, researchers often do not have access to it. Instead, they have access to the reduced form of the SVAR. This one is found by multiplying (3) by $\mathbf{B}^{-1}$, if it exists:

$$y_t = a_0 + A_1 y_{t-1} + u_t$$

or $\quad A(L)y_t = a_0 + u_t \qquad$ **(4)**, where:

$$a_0 = \begin{pmatrix} a_{10} \\ a_{20} \end{pmatrix} = \frac{1}{1 - b_{12}b_{21}}\begin{pmatrix} \gamma_{10} - b_{12}\gamma_{20} \\ \gamma_{20} - b_{21}\gamma_{10} \end{pmatrix}$$

$$A_1 = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} = \frac{1}{1 - b_{12}b_{21}}\begin{pmatrix} \gamma_{11} - b_{12}\gamma_{21} & \gamma_{12} - b_{12}\gamma_{22} \\ \gamma_{21} - b_{21}\gamma_{11} & \gamma_{22} - b_{21}\gamma_{12} \end{pmatrix}$$

$u_t = \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} = \frac{1}{1-b_{12}b_{21}}\begin{pmatrix} \varepsilon_{1t} - b_{12}\varepsilon_{2t} \\ \varepsilon_{2t} - b_{21}\varepsilon_{1t} \end{pmatrix}$ and the covariance matrix:

$E[u_t \cdot u_t'] = \mathbf{B}^{-1} \cdot E[\varepsilon_t \cdot \varepsilon_t'] \cdot \mathbf{B}^{-1\prime} = \mathbf{\Omega}$. The reduced form SVAR (4) is covariance stationary as long as the eigenvalues of A_1 have modulus less than 1.

Now an identification problem arises, as there are ten structural parameters (eight coefficients and two covariance elements) and only nine reduced form parameters (six coefficients and three covariance elements), at least one restriction needs to be imposed in order to identify all of the structural parameters (Zivot, 2000).

Aiming to solve this identification issues, there are typical two restrictions imposed:

- Zero restrictions on the elements of **B**; e.g., $b_{12} = 0$.
- Linear restrictions on the elements of **B**; e.g., $b_{12} + b_{21} = 1$.

We can now derive the 'moving average' (MA, from now on) or Wold representation of the reduced form VAR (4) by multiplying both sides of the equation by the inverse of the matrix $\mathbf{A}^{-1}(L) = (\mathbf{I_2} - \mathbf{A_1}L)^{-1}$:

$\boldsymbol{y}_t = \boldsymbol{\mu} + \boldsymbol{\psi}(L)\boldsymbol{u_t}$ **(5)**.

In the Wold representation the error terms are contemporaneously correlated and have a covariance matrix **Ω**.

This 'structural moving average' (SMA) representation is based on an infinite moving average of the original shocks from the Standard VAR representation. Indeed, substituting $\mathbf{u_t} = \mathbf{B}^{-1} \cdot \varepsilon_t$, we obtain:

$\boldsymbol{y_t} = \boldsymbol{\mu} + \boldsymbol{\theta}(L)\varepsilon_t$ **(6)**, where:

$\boldsymbol{\theta}(L) = \boldsymbol{\psi}(L)\boldsymbol{B}^{-1} = \sum_{k=0}^{\infty} \boldsymbol{\psi_k}(L)B^{-1}$.

This type of representation is interesting because the elements of the $\mathbf{\Theta_k}$ matrices give the dynamic multipliers or impulse responses of 'y_{1t}' and 'y_{2t}' to changes in 'ε_{1t}' and 'ε_{2t}'.Then, the impulse response functions (IRFs, from now on) are the plots of those elements, which represent how unit impulses of the structural shocks at time 't' impact the level of '**y**' at time 't + s' for different values of 's'. (Zivot, 2000).

The statistical theory on SVARs and its different applications, as it's obvious, includes much more information and goes much deeper than we are reviewing here; specifically, in all kind of restrictions and its multiple interpretations. Nonetheless, as this is all we need to know from basics SVARs for our purpose, we are going to enter now the Blanchard and Quah approach, which is based on a specific long run restriction.

b. Blanchard and Quah approach

The Blanchard and Quah decomposition (hereafter BQ) is a type of SVAR representation where we impose long-run restrictions on the impact that the shocks have on the variables. Since this model was developed in the paper *The Dynamic Effects of*

Aggregate Demand and Supply Disturbances published in 1988 by Olivier Blanchard and Danny Quah, the following information is based on its contents.

Blanchard and Quah (1988) make the following assumptions. The model includes two types of disturbances that affect the two variables included in the model, namely: unemployment and output. One of those disturbances has no long run effect on either output or unemployment. The other one may have a long run effect on output but does not on unemployment. Finally, these two shocks are uncorrelated at all leads and lags.

Motivated by a traditional Keynesian view of fluctuation, Blanchard and Quah (1988), interpret these disturbances as follows: shocks with permanent effects on output as supply disturbances, and shocks with transitory effects as demand disturbances.

An easy way to understand the reason underlying this decision is the classic and well-known aggregate-demand and aggregate-supply model (AD-SD). The 'Chart 1', extracted from: *One money or many? On analysing the prospects for monetary unification in various parts of the world*, written by Bayoumi and Eichengreen (1993); shows the AD-SD model and its responses to a demand and a supply shock. As it can be appreciated, there are three curves in the graphic: one corresponding to the aggregate demand (AD) and the other two corresponding to the aggregate supply in the long-run (LRAS) and in the short-run (SRAS). The LRAS curve is vertical giving sense to our assumption; this is, it prevents demand shocks from permanently affect the level of production. Indeed, departing from the equilibrium, the effect of a positive demand shock is a shifting from AD to AD' by the aggregate demand curve what, in the short-run, it means that both prices and the level of production increase to the new levels P' and Y', the intersection with the SRAS. However, as the aggregate supply curve becomes increasingly vertical over time, this intersection shifts from D' to D'', increasing again the level of prices but decreasing to the initial value the level of production. On the contrary, a supply shock provokes a shifting of the SRAS curve and the LRAS curve from SRAS to SRAS' and from LRAS to LRAS', respectively. In the short run, the economy equilibrium shifts from E to S', increasing production and decreasing the level of prices. As the time passes and the aggregate supply curve becomes to turn into the LRAS curve, the production keeps on increasing and the prices keep on decreasing.

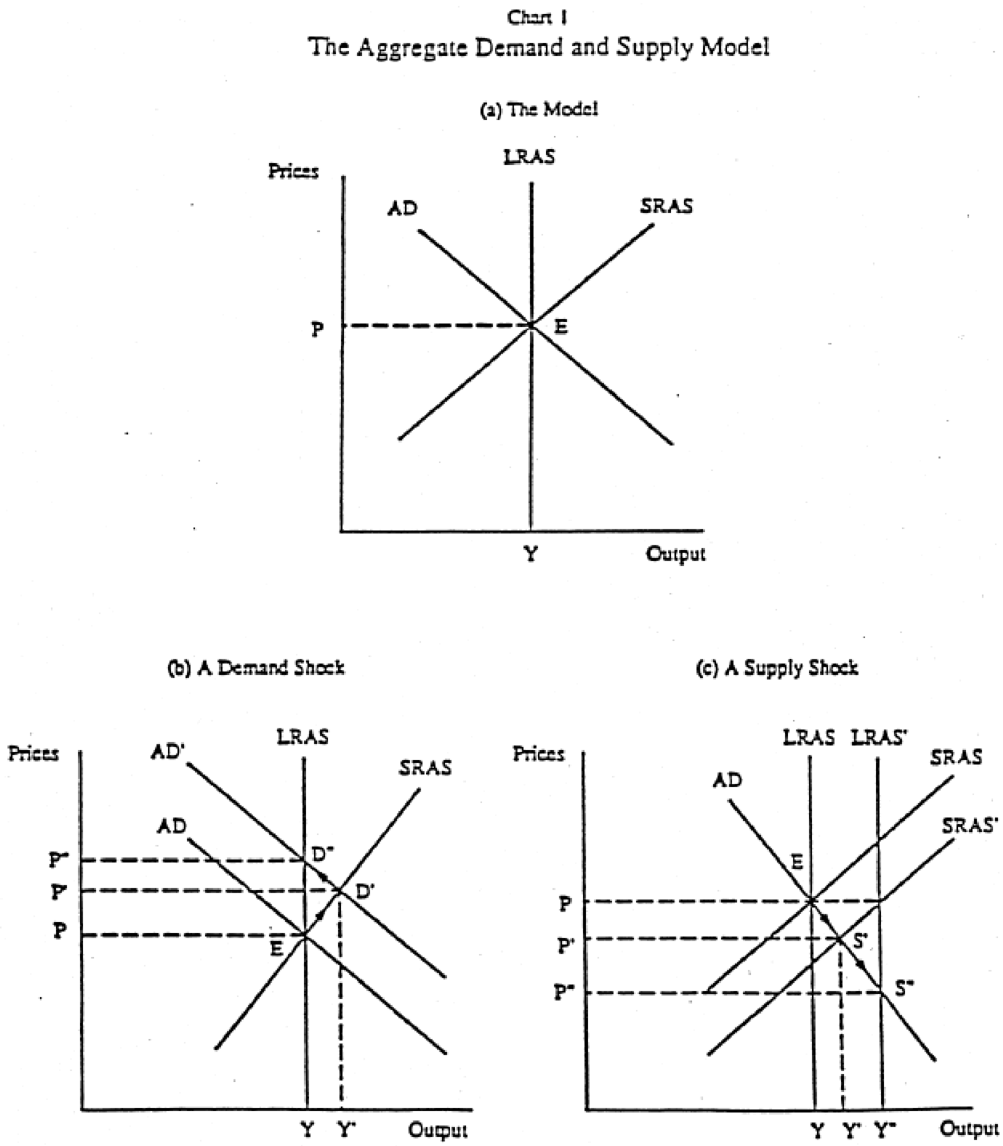

Figure 1. Aggregate-demand aggregate-supply model.

Now, let 'Y' and 'U' denote the logarithm of GNP and the level of the unemployment rate, respectively, and let 'e_d' and 'e_s' be demand disturbances and supply disturbances, respectively. Let 'X' be the vector (ΔY, U)' (with ΔY the first difference of logarithm of GNP) and 'e' the vector of disturbances (e_d, e_s)'. So, from the assumptions imposed, the joint process followed by 'X' is a stationary process given by:

$X(t) = A(0)e(t) + A(1)e(t-1) + \cdots = \sum_{j=0}^{\infty} A(j)e(t-j)$, **(7)** with Var(e) = I

where the sequence of matrices A is such that its upper left-hand entry, $a_{11}(j)$, j = 1,2..., sums to zero. This restriction is fundamental for the model since it implies that e_d has no long-run effect on the level of Y. The assumption that the covariance matrix is the identity is simply a convenient normalization as it needs to be diagonal, since the two disturbances are assumed to be uncorrelated. (Blanchard and Quah, 1988)

Now, the Wold representation can be obtained by first estimating and then inverting the vector autoregressive representation of 'X' in the usual way, and it is like follows:

$X(t) = \nu(t) + C(1)\nu(t-1) + \cdots = \sum_{j=0}^{\infty} C(j)\nu(t-j)$, **(8)** with Var ($\nu$) = $\mathbf{\Omega}$.

We can see, comparing **(7)** and **(8)** that ν, the vector of innovations, and e, the vector of original disturbances, are related by $\nu = A(0)e$, and that $A(j) = C(j)A(0)$, for all j.

How can we obtain A (0), though? Again, if we compare equations **(7)** and **(8)**, it follows that A(0) satisfies: $A(0)A(0)' = \mathbf{\Omega}$, and that the upper left hand entry in $\sum_{j=0}^{\infty} A(j) = \left(\sum_{j=0}^{\infty} C(j)\right)A(0) = 0$. Given $\mathbf{\Omega}$, the first relation imposes three restrictions on the four elements of A (0) and given $\sum_{j=0}^{\infty} C(j)$, the other implication imposes a fourth restriction. (Blanchard and Quah, 1988)

So, as the authors stated: "In summary, our procedure is as follows. We first estimate a vector autoregressive representation for 'X' and invert it to obtain (1.2) [**(8)** in this thesis]. We then construct the matrix A (0); and use this to obtain A(j) = C(j)A (0), j=0,1,2..., and $e_t = A(0)^{-1}$ ν_t. This gives output and unemployment as functions of current and past demand and supply disturbances."

Let us consider the following bivariate VAR

$\begin{pmatrix} \Delta Y_t \\ U_t \end{pmatrix} = \begin{pmatrix} F_{11}(L) & F_{12}(L) \\ F_{21}(L) & F_{22}(L) \end{pmatrix} \begin{pmatrix} e_{dt} \\ e_{st} \end{pmatrix}$, where the identification restriction is given by $F_{11}(1) = 0$.

The restriction can be implemented in the following way. Let us consider the reduced form VAR:

$\begin{pmatrix} \Delta Y_t \\ U_t \end{pmatrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{pmatrix} \begin{pmatrix} \nu_{dt} \\ \nu_{st} \end{pmatrix}$, where E (ν_{dt}, ν_{st}) = $\mathbf{\Omega}$.

Let S = Chol (A (1)$\mathbf{\Omega}$A (1)') (being Chol(.) the Cholesky factorization) and K = A $(1)^{-1}$·S. The identified shocks are $e_t = K^{-1}$ ν_t and the resulting impulse response to structural shocks are F (1) = A(L)·K.

c. The model used in this thesis

Finally, we now have all the necessary tools to establish our model:

$\begin{pmatrix} \Delta y_t \\ \Delta p_t \end{pmatrix} = \sum_{i=0}^{\infty} L^i \begin{pmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{pmatrix} \begin{pmatrix} \varepsilon_{st} \\ \varepsilon_{dt} \end{pmatrix}$ **(9)**, where Δy_t and Δp_t represent the first difference of the logarithm of real GDP per capita and the index of consumer prices, respectively.

As we have made clear, the theoretical framework in which we are working (Blanchard and Quah style) leads us to identify the model through the long-run restriction by which the demand shocks have no effect on the output in the long term. This implies that: $\sum_{i=0}^{\infty} a_{12i} = 0$ **(10)**.

Equation **(9)** represents the process followed by the variables as an infinite moving average of demand and supply disturbances. However, what we need to identify are the structural shocks, derived from the Structural form of the VAR representation. Since we know the relation between residuals on both models ($\begin{pmatrix} e_{st} \\ e_{dt} \end{pmatrix} = \boldsymbol{C} \begin{pmatrix} \varepsilon_{st} \\ \varepsilon_{dt} \end{pmatrix}$), all we need to do is to impose four restrictions that exactly identify matrix **C**. The first one is derived from equation **(10)**. Two of these restrictions are convenient normalizations, which define the variance of the shocks ε_{st} and ε_{dt}. The fourth restriction is obtained by assuming that demand and supply shocks are orthogonal to each other.

Once the estimation has been done and the demand and supply shocks have been obtained, the main goal is to calculate the correlation of these shocks between the different countries that have been selected for the database (listed in the next subsection). The criteria to compare those disturbances correlations has been to select Germany as the 'economic centre' of the EU and express the shock correlations between it and the different countries.

Finally, I would like to make a couple of clarifications regarding the estimation process. The program I used to carry out the simulations has been *Gretl*, especially its add-on specifically prepared for handling the BQ decomposition. The lag length I imposed in all the countries' VAR representation has been 1; because according to the corresponding test, it was the one that favoured most of the countries and then I decided to treat all them equally for homogeneity convenience.

d. Data

To end this section, and before discussing the empirical results, we are going, now, to take a look to the data we used to run the estimations.

As the lector could observe in the previous subsection, the variables used to carry out the empirical practice are the level of real GDP per capita and the index of consumer prices. Both data samples were found in the *Eurostat Database* webpage. Actually, I downloaded the nominal GDP per capita and the HIPC data and with the second one I deflated the GDP with the aim to turn it on to real GDP per capita. The time-window used goes from 1996 to 2019. The sampling is formed by 28 countries, which are, all the EU countries and the Great Britain.

In 'Table X' and 'Table X' presented in the appendix we can appreciate the sampling data on real GDP per capita and HIPC, respectively. In the next page we can see the main statistical indicators, namely: the mean and the standard deviation of growth and inflation in 'Table 1' and 'Table 1', respectively.

	GDP Growth		**Inflation**	
Country	***Mean***	***Standard Deviation***	***Mean***	***Standard Deviation***
Belgium	0,97%	0,0164	1,87%	0,0099
Bulgaria	4,59%	0,0452	4,36%	0,0479
Czechia	3,64%	0,0578	2,70%	0,0245
Denmark	1,26%	0,0204	1,58%	0,0093
Germany	0,91%	0,0179	1,46%	0,0068
Estonia	5,56%	0,0656	3,95%	0,0281
Ireland	5,07%	0,0866	1,71%	0,0184
Greece	-0,04%	0,0465	2,28%	0,0196
Spain	1,18%	0,0312	2,09%	0,0139
France	0,86%	0,0159	1,48%	0,0080
Croatia	2,10%	0,0493	2,11%	0,0159
Italy	0,37%	0,0231	1,80%	0,0100
Cyprus	1,50%	0,0396	1,82%	0,0170
Latvia	6,14%	0,0924	3,79%	0,0372
Lithuania	7,55%	0,0823	2,87%	0,0306
Luxembourg	1,93%	0,0371	2,11%	0,0124
Hungary	0,98%	0,0614	5,61%	0,0445
Malta	3,15%	0,0342	2,23%	0,0105
Netherlands	1,29%	0,0237	1,89%	0,0113
Austria	1,10%	0,0151	1,75%	0,0079
Poland	2,97%	0,0764	3,69%	0,0393
Portugal	1,48%	0,0294	1,93%	0,0134
Romania	3,85%	0,1064	19,62%	0,3392
Slovenia	0,77%	0,0347	3,71%	0,0299

Slovakia	3,79%	0,0659	3,98%	0,0344
Finland	1,77%	0,0310	1,61%	0,0103
Sweden	1,23%	0,0596	1,49%	0,0075
United Kingdom	1,35%	0,0853	1,98%	0,0100
AVERAGE	2,40%	0,0482	3,12%	0,0310

Table 1. Basic Economic Indicators: GDP Growth and Inflation.

Looking at 'Table 1' we can appreciate a considerable divergence between the different countries, as reflected by the average of the standard deviation of both GDP growth and inflation. Nonetheless, we can easily differentiate between two groupings in the sample.

The first one is composed by those countries that are supposed to be wealthier and that have been longer in the EU: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Luxembourg, Malta, the Netherlands, Austria, Portugal, Slovenia, Finland, Sweden and the UK. These countries are all alike in the sense that they present much more stability both on growth and on inflation as shown by the deviation of their data, with the clear exception on the growth deviation in Ireland, Sweden and the UK. They are also similar in the low rates of growth and inflation that they present. It draws attention the fact that Croatia and Cyprus must been included in this group, since they are not supposed to be rich countries neither they are old members of the EU.

The second one incorporates the Eastern Europe countries and the offspring of the former Soviet Union, namely: Bulgaria, Czechia, Estonia, Latvia, Lithuania, Hungary, Poland, Romania and Slovakia. This second group stands out for the high standard deviations it presents both on growth and inflation. This fact reflects that have been countries with an unstable development.

However, as stated back in the *Literature Review* section, this is not an indicator that can confirm the viability of a monetary union. It could happen that, though they have different models of growth, two countries of different regions favour the same monetary policy. This is an aspect to be discussed in the next section.

6. Empirical Results

In this section we will evaluate and comment the empirical results that we have obtained. We are going to proceed as it follows: first, we are going to check that the estimation results are consistent; second, we will have a look at the IRFs obtained from the BQ decomposition and analyse them; and finally, we will discuss the results observed in the correlation diagrams and determine whether the European Monetary Union has contributed to reinforce or not the core-periphery pattern detected by Bayoumi and Eichengreen (1993).

As the reader will consider reasonable, the results and IRFs of all the countries will not be presented here but in the appendix, showing in this section only the ones for Germany, as all of them are similar.

Without further delay, shown below in 'Figure 1' can be appreciated the estimation results for Germany. We can see on it the specifications, like the endogenous and exogenous variables and the restrictions imposed; as well as the estimation results that, in this case, turn out to be a C-matrix with all of its components statistically significant.

```
Model type: C

Endogenous variables:

DY, DP

Exogenous variables:
const, time

Restriction patterns:

(No short-run restrictions)
Long-run restrictions:
  0  0  1  0  0

Sigma =
  0.000190  0.000024
  0.000024  0.000041
Optimization method = Scoring algorithm
Unconstrained Sigma:
     0.00019     0.00002
     0.00002     0.00004

             coeficiente   Desv. típica     z       valor p
  -----------------------------------------------------------
  C[ 1; 1]    0.00883215   0.00250722     3.523   0.0004    ***
  C[ 2; 1]   -0.00361902   0.00119780    -3.021   0.0025    ***
  C[ 1; 2]    0.0105766    0.00152660     6.928   4.26e-012 ***
  C[ 2; 2]    0.00528062   0.000762192    6.928   4.26e-012 ***

Estimated long-run matrix (restricted)
longrun (2 x 2)

    0.011660       0.0000
  -0.0025355    0.0070726

  Log-likelihood = 150.327
```

Figure 2. Estimation specifications and results for Germany.

Let's, now, take a look at the IRFs derived from the BQ procedure.

'Figure 2' and 'Figure 3' show the dynamic effects of demand and supply disturbances on the inflation level. As it can be seen in this figure neither the demand nor the supply disturbances have a permanent effect on this variable, since it's about the change on the level of prices and not about the level of prices itself. In other words, if on the contrary we accumulate inflationary responses to demand and supply shocks, we would get the effect on the price level and this one would do show a permanent effect derived from a demand shock as well as a supply one. The fact that a supply shock shows a positive variation in the inflation level is due to the *Gretl* code that has been used, as explained in the methodology section. The code used come out from the main webpage of the program. As that code included a change of sign in this IRF print order, I decided not to change it, for precaution

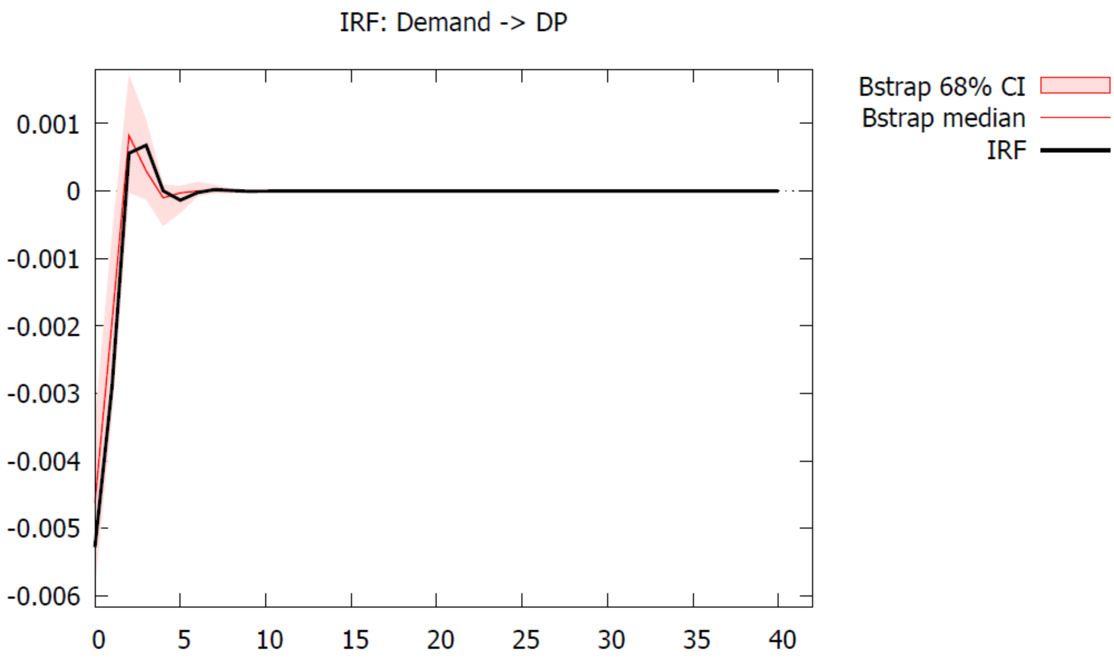

Figure 3. IRF of demand on inflation for Germany.

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'Figure 5' and 'Figure 6' show the demand and supply disturbances on the level of output. As the reader will appreciate, the disturbances on real GDP per capita are the cumulative ones, since the restriction of interest in the BQ procedure stems from the long-run effect of demand on output.

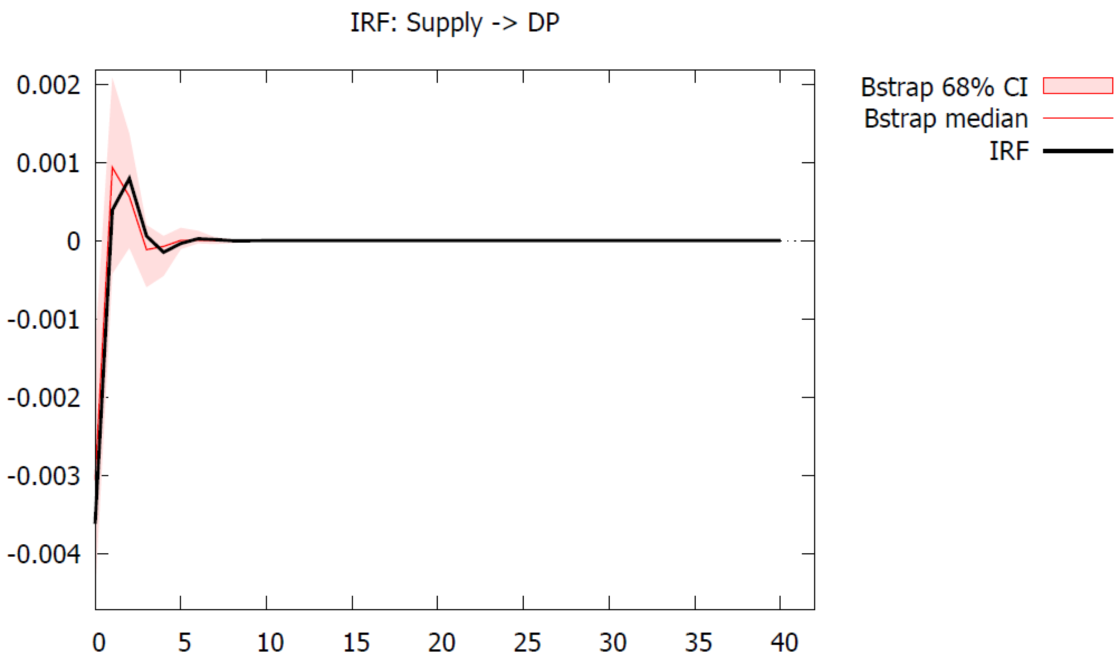

Figure 4. IRF of supply on inflation for Germany.

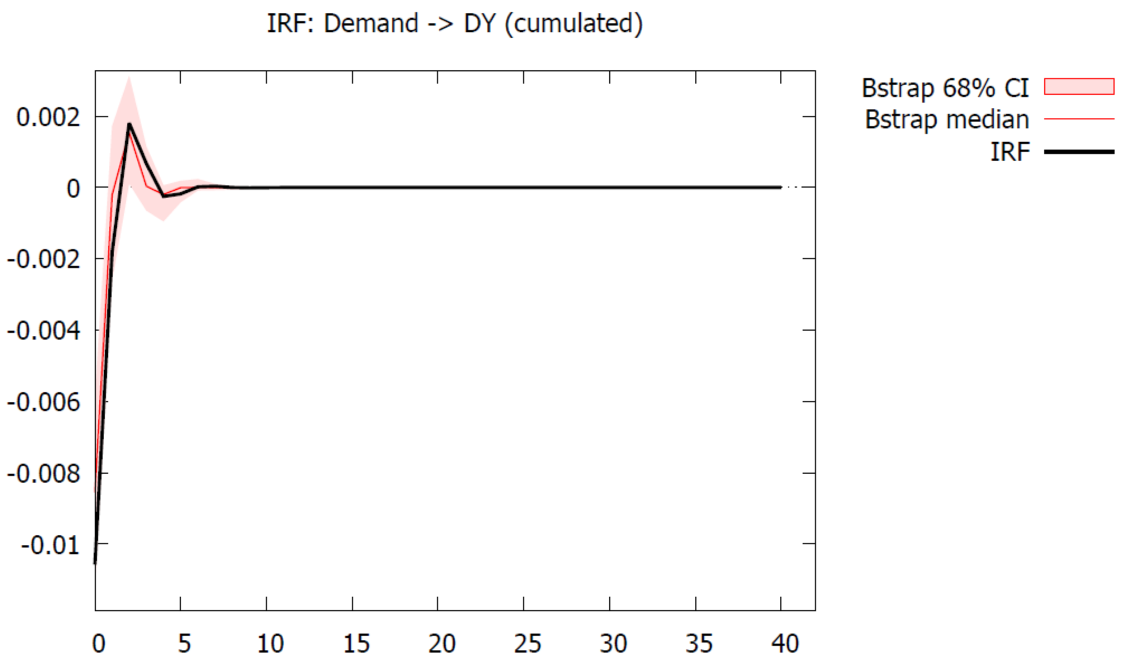

Figure 5. IRF of demand on the level of output for Germany.

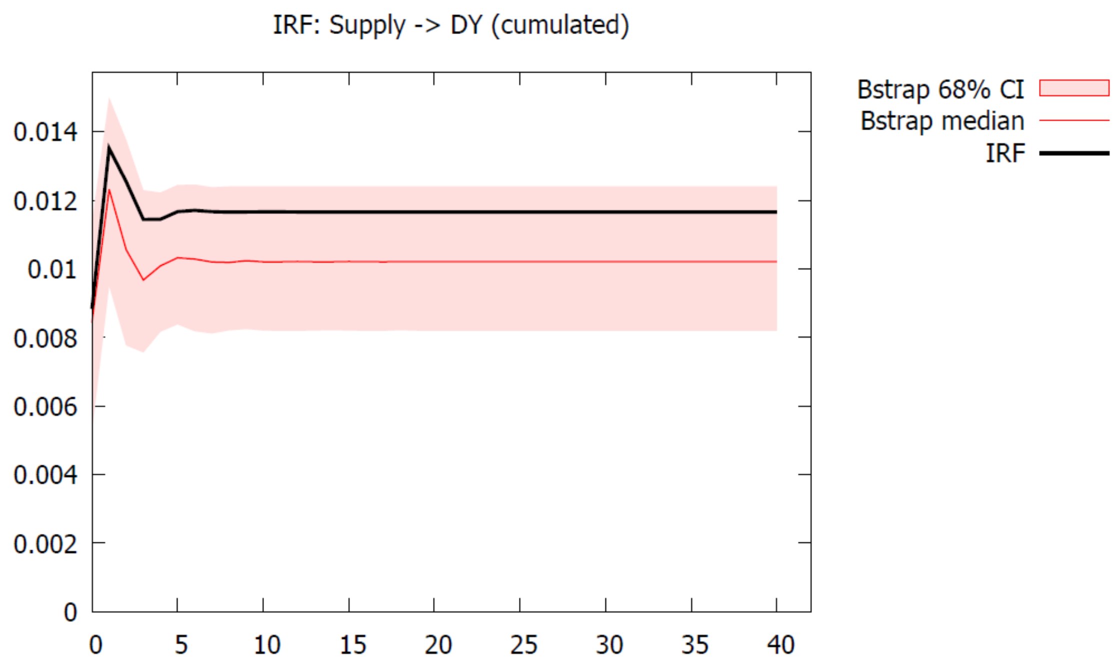

Figure 6. IRF of supply on the level of output for Germany.

As it can be appreciated in ‘Figure 5’, demand shocks have a hump shaped effect that peaks after a year and it vanishes from the fourth year leaving no long-run impact on the level of GDP. This result has no mystery for us, since it is one of the restrictions we have imposed from the beginning. As shown in ‘Figure 6’, the behaviour of supply shocks is similar. The output response peaks after a year and then decreases to stabilize after four to five years. As opposed as demand shcoks, supply disturbances do have a permanent effect on the output level. This is not a surprise either, since we explained the economic fundamentals for these results back in the methodology section.

Finally, we are getting to the end of the analysis and we are about to discuss the correlation values of the supply and demand disturbances between Germany and the rest of the European countries. As the aim of this thesis is to determine whether the European monetary union (EMU hereafter) have strengthen or weakened the core-periphery pattern found by Bayoumi and Eichengreen (1993), following there is a brief summary of main results for Europe that these authors obtained. The core-periphery pattern they described was based on the highly correlated supply disturbances existing between Germany, France, the Netherlands, Belgium, Denmark and Austria. The supply shocks correlation between all the other countries were insignificant or did not suggest any consistent regional patter, with the exception worth to mention of the positive correlation between Spain and Portugal. Nonetheless, the correlation of demand disturbances is less interesting. Though they obtained a considerable number of significant correlations, these seem not to describe any geographical pattern.

So, in the next two figures (‘Figure 7’ and ‘Figure 8’) we can see the correlation disturbances between Germany and the rest of the European countries as explained. As it can be seen, to achieve the main goal they have been separated into two charts, those countries included in the EMU plus Denmark (for its strong correlation with Germany) and those countries that do not handle the Euro.

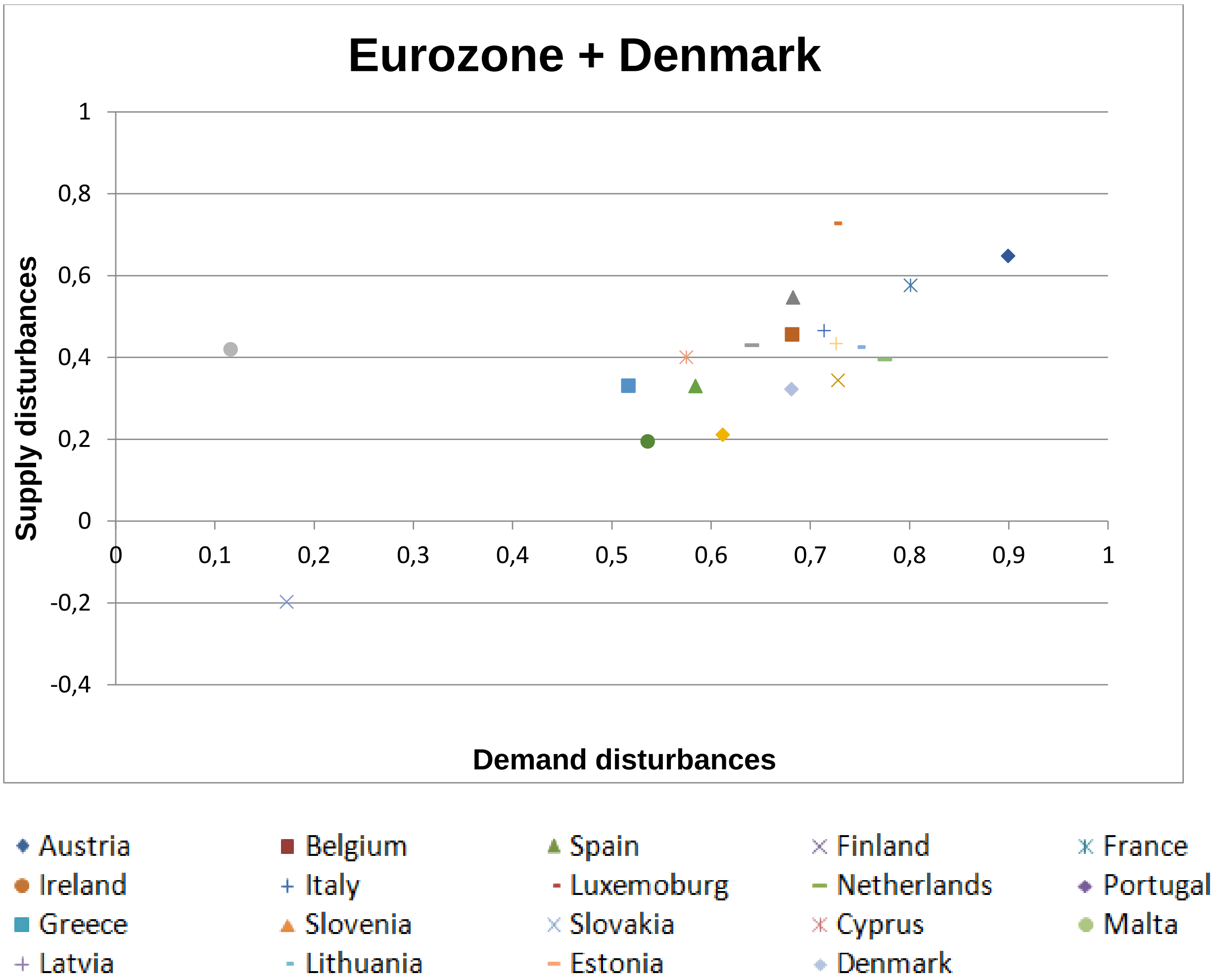

Figure 7. Disturbances correlations between Germany and the rest of the Euro zone + Denmark.

‘Figure 7’ presents the correlation disturbances within the Euro zone. This graphic is more than surprising as it shows levels of correlation highly significant. There are many features that stand out.

The first one, in comparison with the results presented by Bayoumi and Eichengreen (1993), is the addition to the ‘core countries’ group of many other that were not twenty-five years ago. As the correlation between Germany and France, Austria, and the

Benelux countries stays high; the supply shock correlation between Germany and Spain, Italy, Lithuania, Latvia, Estonia, Cyprus and Malta draw attention for being equally relevant.

In the other hand, is worth to mention that Denmark and Germany have lost an important degree of correlation and that their supply correlation has been overcome by countries that did not seem to have a significant correlation with Germany in the past.

In the demand shocks' side there is also an interesting result. While Bayoumi and Eichengreen (1993) obtained for Germany a series of demand disturbances correlations with other European countries that did not present any significant value, we can observe in 'Figure 7' how the demand shocks correlations between Germany and the rest of the EMU countries (plus Denmark) do not drop below 0.4, with the clear exceptions of Malta and Slovakia.

If we recall the basic indicators (mean and standard deviation) that we presented back in the *Methodology* section for the real GDP per capita as well as for the inflation value, there were two groupings of country according to the level of stability that divided the sample between the Western Europe countries and the Eastern Europe countries and former Soviet Union members. However, according to the business cycle synchronization criteria those different regions do not exist. Indeed, as we see in the graphic, Germany presents highly significant correlations with Eastern countries like Estonia, Latvia or Lithuania.

Here below, we observe in 'Figure 8', a graphic showing the level of disturbances correlation between Germany and the countries of the EU that do not share the Euro and the United Kingdom.

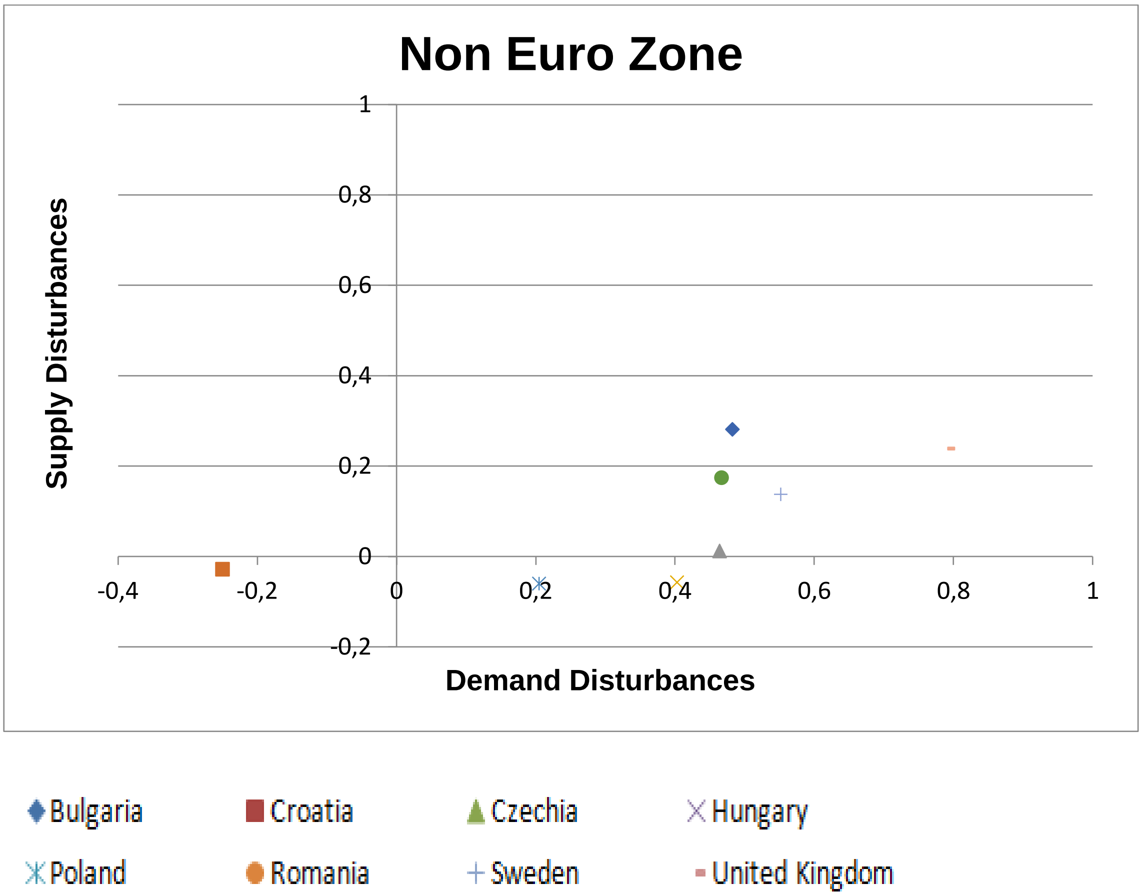

Figure 8. Disturbances correlations between Germany and the European non-Euro zone countries.

Observing the chart in 'Figure 8' words are unnecessary. We can easily deduct that in a supposed core-periphery model if Germany was the core, all these countries would be the periphery. As far as supply disturbances are concerned, the higher value for this group of countries is the one for Bulgaria without even reaching 0.3, which in the Euro zone group of countries was considered a considerably low value. In the other hand, for the demand shocks' correlations, except for the United Kingdom, there are not high values either. Moreover, if we try to put our mind in the map; we can appreciate that the nearest countries from Germany in this group, namely Czechia and Poland, have a supply disturbances' correlation with it almost null, discarding any geographical pattern that could be imagined.

So, having reviewed these results the questions that we made have been answered almost automatically. It is evident that the degree of synchronization between countries seems to be much stronger when they share the same currency, as the countries in the Euro zone show much higher values that those which have not adopted the Euro.

Furthermore, in comparison with the results obtained by Bayoumi and Eichengreen (1993), we can see how the adoption of the same currency for the EMU countries has contributed to weaken the core-periphery pattern that those authors described in his work.

7. Conclusions

The main purpose of the current TFG thesis was to review the work done by Bayoumi and Eichengreen (1993) as Campos and Macchiarelli (2016) did. The general idea is based on the willingness to determine whether the EMU has contributed to reinforce or to weaken the core-periphery pattern found by Bayoumi and Eichengreen in the late 20th century. These authors found a synchronization convergence in the business cycle between some of the northern European countries (Germany, France, Denmark and the Benelux countries), as well as a divergence in the same feature between these countries and the "peripheric" ones (Spain, Italy, Ireland, Portugal and Great Britain). Taking these results as the starting point, Campos and Macchiarelli wanted to determine whether the creation of an OCA in Europe had contributed to increase the synchronization between the core countries and the periphery ones. Then, the objective of this TFG theses was to replicate Campos and Macchiarelli 's updating the time-window until 2019.

The way how we conducted our study was based on an econometrical method developed by Blanchard and Quah (1988), who used the Standard VAR modelling with the aim of obtaining two series of disturbances, which they identified as supply and demand disturbances. Once we get such disturbances, we need to look at the existing correlation between the demand and supply shocks of the different countries, to determine both if this correlation is significant and if has increased or not since the results obtained by Bayoumi and Eichengreen.

For accomplishing our objectives in this TFG thesis we have used a sample data composed by 28 countries (all the EU members and the United Kingdom) and two variables, namely the real GDP per capita and the harmonised index of consumer's prices, for the period 1996-2019.

The main results obtained from the econometric estimation of the Blanchard-Quah approach of the Standard VAR have been the following.

As far as GDP and HIPC responses to demand and supply are concerned, we got similar results as Blanchard and Quah (1988) did. The GDP response to a positive supply shock is composed by an initial increase on production that peaks after two to four years and then it decreases slowly until it reaches a plateau after five to six years. On the other hand, the response of the production to a positive demand shock has no long run effects, this is: it increases initially and then it decreases steadily until it vanishes after four to six years. The price response to supply shocks as well as to demand shocks have no long run effects neither. As the classic aggregate-supply aggregate-demand model shows us, a positive shock on demand creates inflation, so initially it provokes a positive shock on HIPC and then it tends to zero within the next three to five years. Also, as the model states, a positive shock on supply, decreases the HIPC in the first years to, then, tend to zero within in the next three to five years. At this point, we need to highlight the fact that this TFG thesis has carried out the estimations with the variation of the HIPC, so that's why the increase or the decrease on our price's variable is not permanent. Otherwise, if we had worked with the prices' level, instead, we would have obtained long-run effects.

Regarding the results of the correlation between countries' shocks, we obtained the same conclusions as Campos and Macchiarelli (2016) did. We can appreciate how, in comparison with the results of Bayoumi and Eichengreen (1993), the synchronization between almost all the countries that had joined the EMU has increased a lot since the creation of the Euro. This means that the core-periphery pattern that these authors identified in the European region has weakened as a result of a monetary union. Those countries that were identified as the peripheric ones, show in our results a much higher correlation with the core countries than they did at the end of the 20th century. Moreover, we see in our estimations, that while the countries that have adopted the Euro have experienced a convergence to a higher synchronization, those which have chosen to keep their own currency have not experienced significant changes in that aspect. From that, we can conclude that the economic integration represents a forward step to a higher business cycle synchronization.

Finally, I would like to propose some contributions that could be added in these TFG thesis but that they have been omitted for time reasons.

The first one is to deepen in the business cycle synchronization aspect, in the sense that, while developing this work, some questions have arisen towards the fact that a higher synchronization seems to eliminate the need of an independent monetary policy. Specifically, I would like to determine whether an increasing business cycle synchronization also tends to synchronize other features of the countries, like the stability or the rates of growth.

Another improvement for this TFG thesis that I consider interesting is strictly econometrical. I would like to carry out the same estimations but including three variables instead of two, adding the unemployment to the equations. In fact, this variation is proposed by Blanchard and Quah as well at the end of their seminal paper.

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9. Appendix

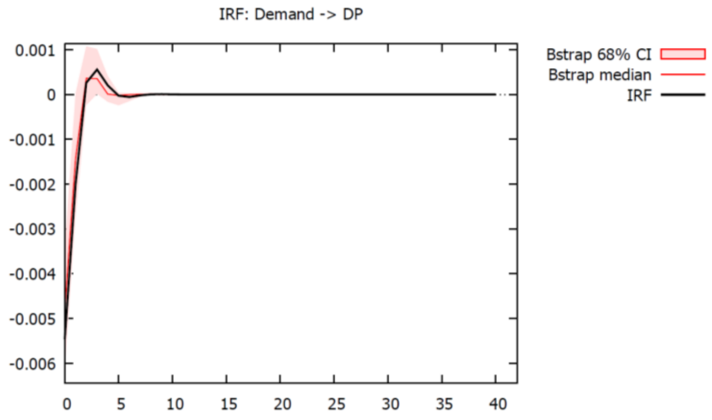


Figure 9. IRF of demand on inflation for Austria.

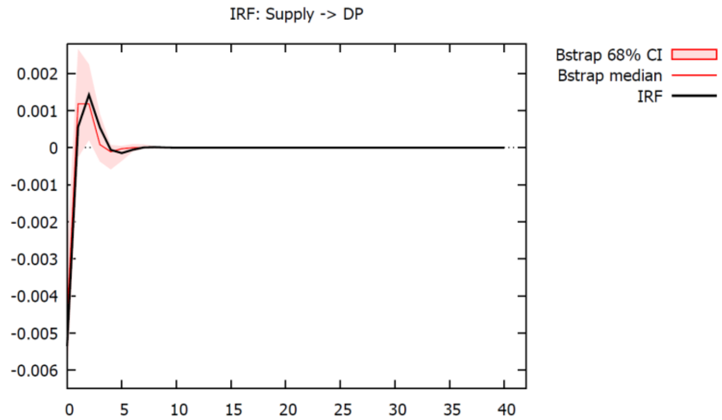


Figure 10. IRF of supply on inflation for Austria.

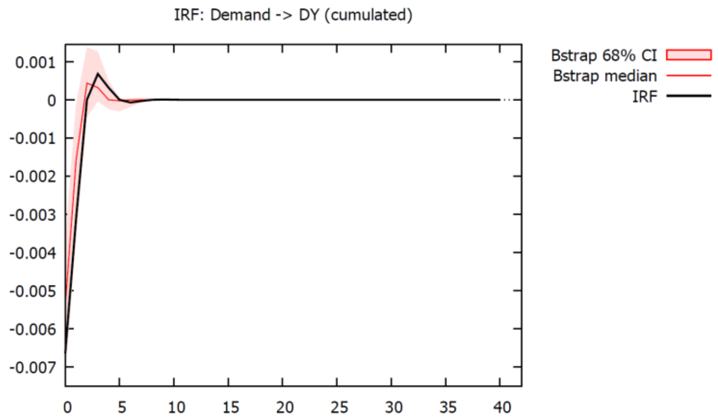


Figure 11. IRF of demand on the level of output for Austria.

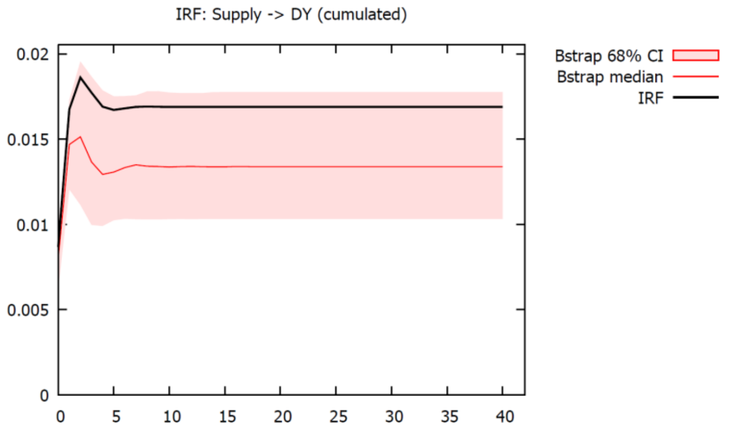


Figure 12. IRF of supply on the level of output for Austria.

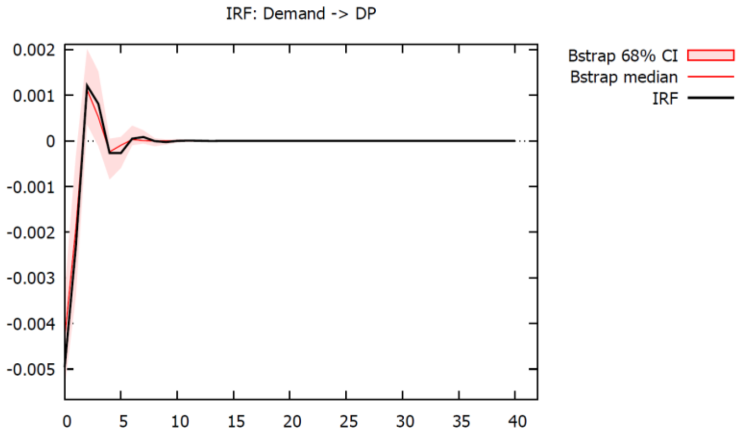


Figure 13. IRF of demand on inflation for Belgium.

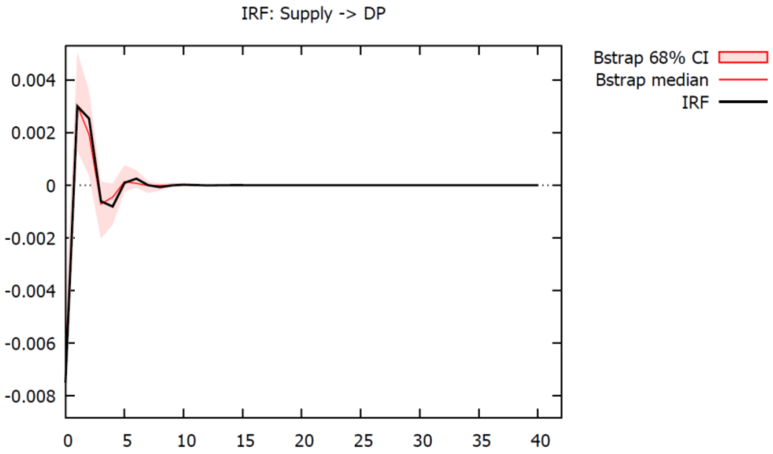


Figure 14. IRF of supply on inflation for Belgium.

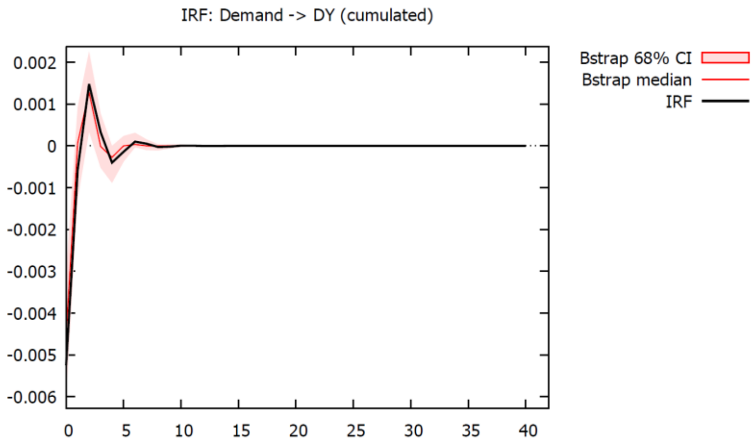


Figure 15. IRF of demand on the level of output for Belgium.

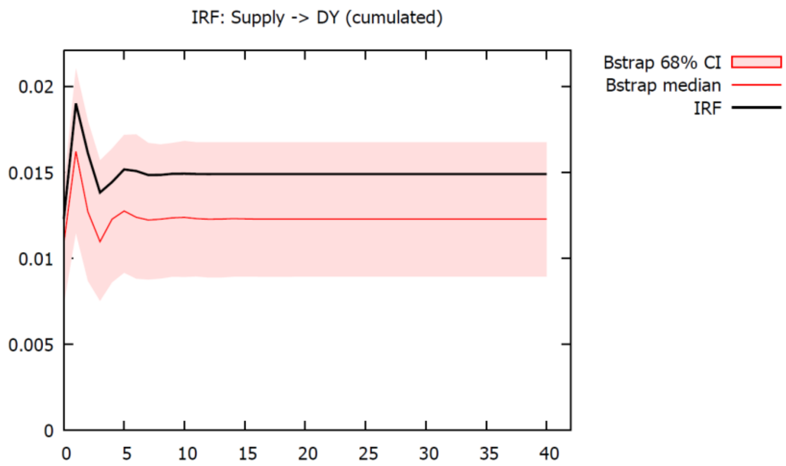


Figure 16. IRF of supply on the level of output for Belgium.

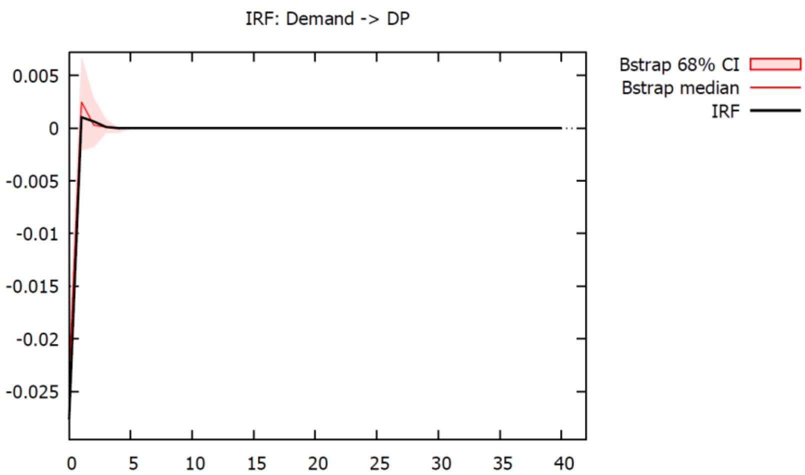


Figure 17. IRF of demand on inflation for Bulgaria.

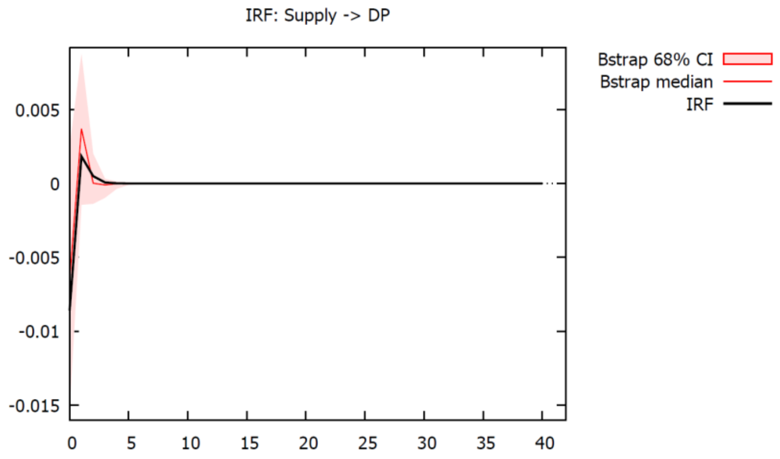


Figure 18. IRF of supply on inflation for Bulgaria.

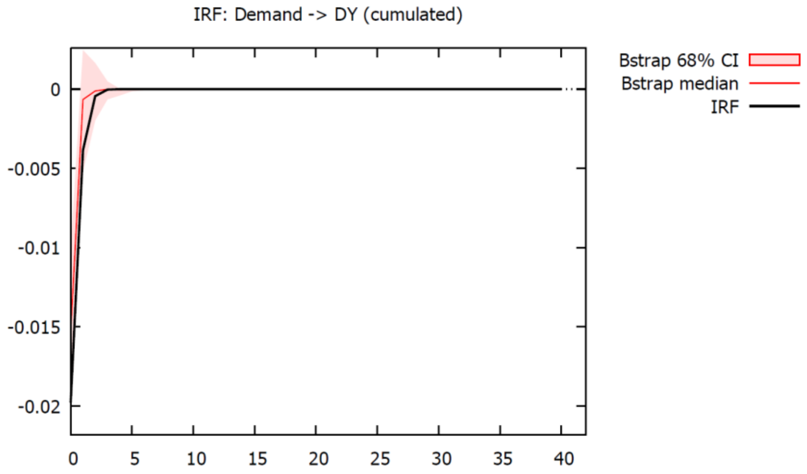


Figure 19. IRF of demand on the level of output for Bulgaria.

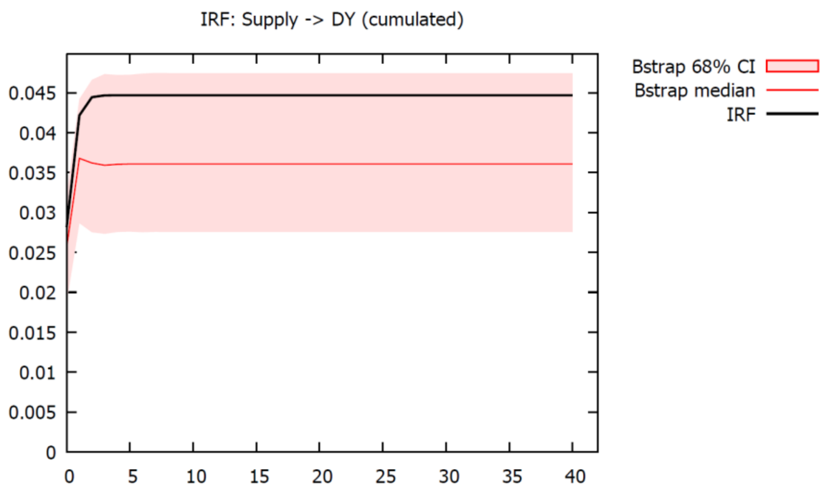


Figure 20. IRF of supply on the level of output for Bulgaria.

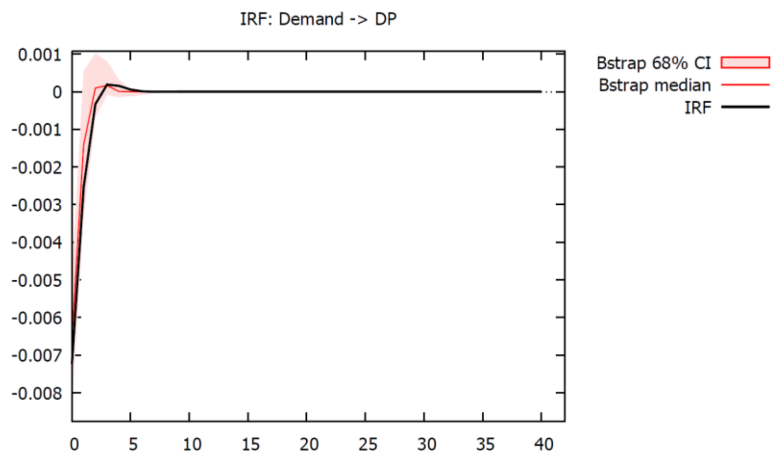


Figure 21. IRF of demand on inflation for Croatia.

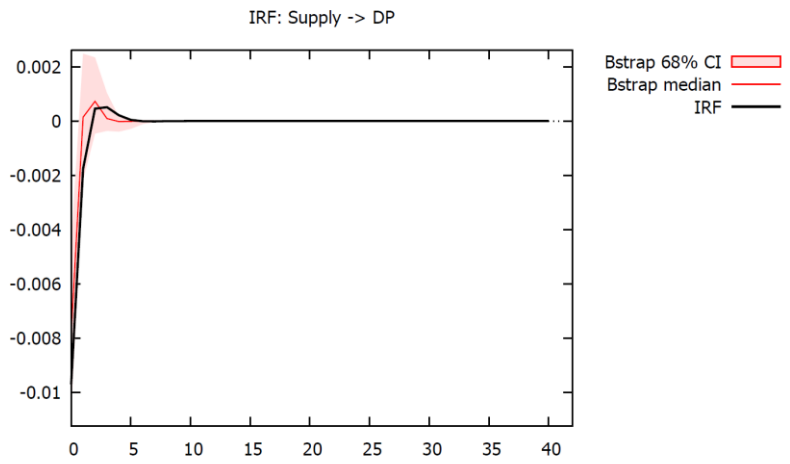


Figure 22. IRF of supply on inflation for Croatia.

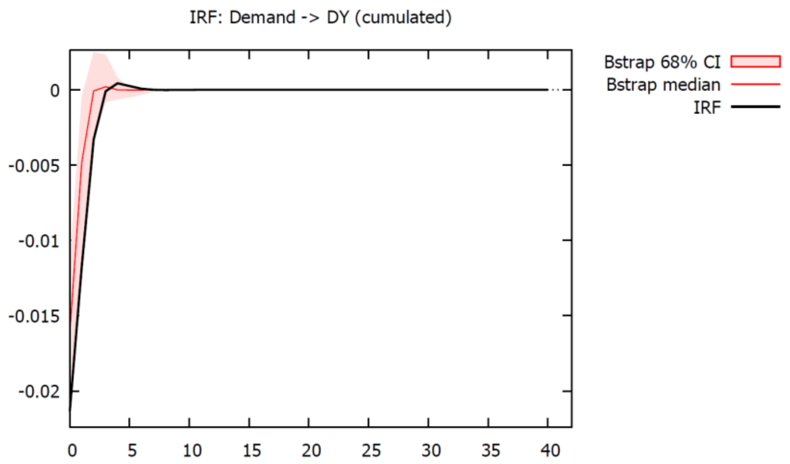


Figure 23. IRF of demand on the level of output for Croatia.

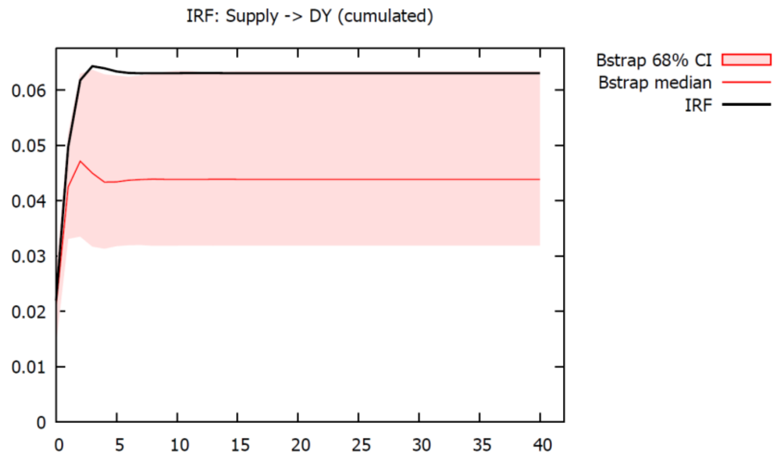


Figure 24. IRF of supply on the level of output for Croatia.

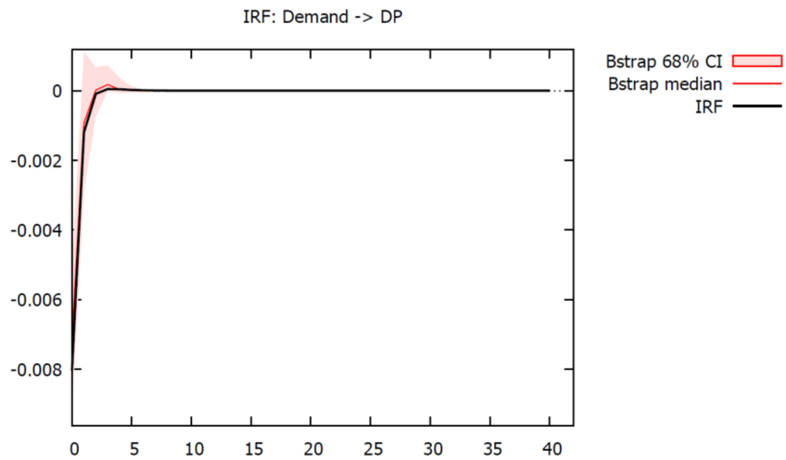


Figure 25. IRF of demand on inflation for Cyprus.

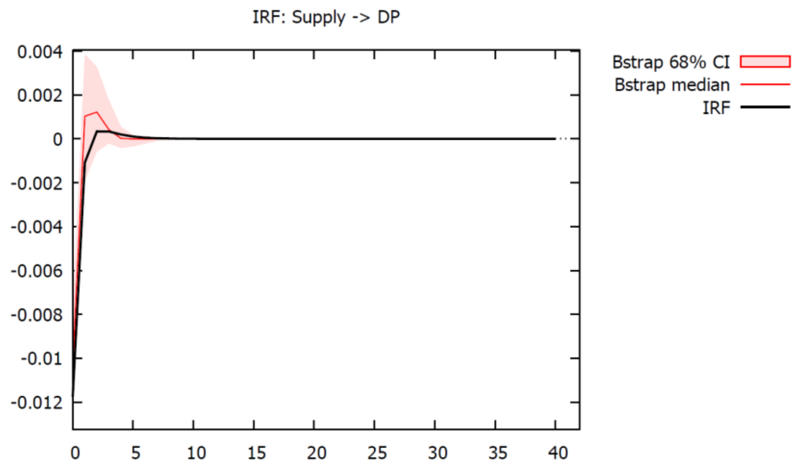


Figure 26. IRF of supply on inflation for Cyprus.

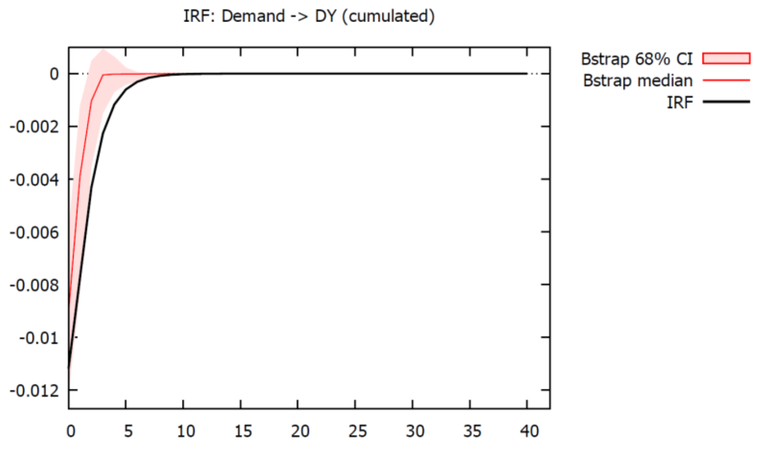


Figure 27. IRF of demand on the level of output for Cyprus.

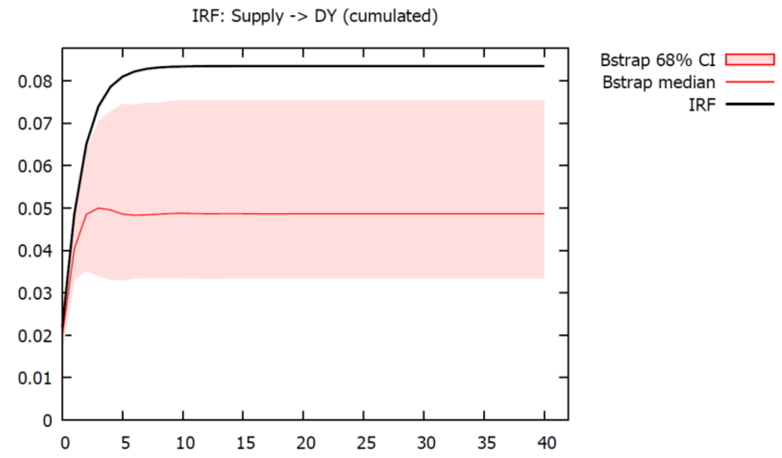


Figure 28. IRF of supply on the level of output for Cyprus.

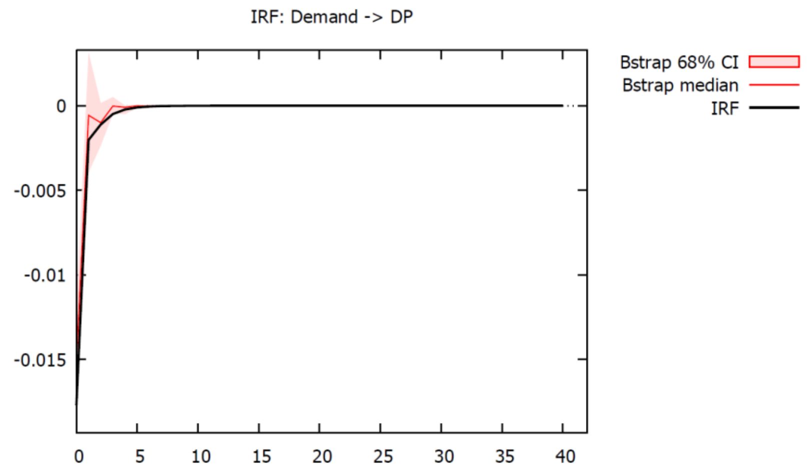


Figure 29. IRF of demand on inflation for Czechia.

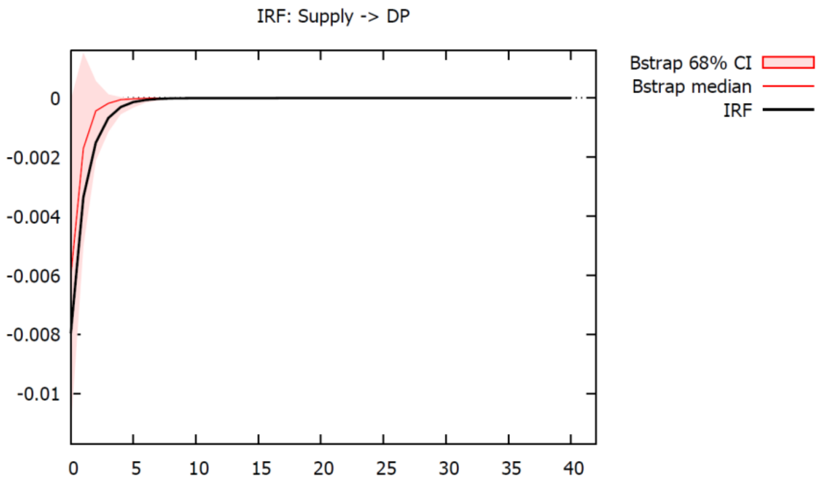


Figure 30. IRF of supply on inflation for Czechia.

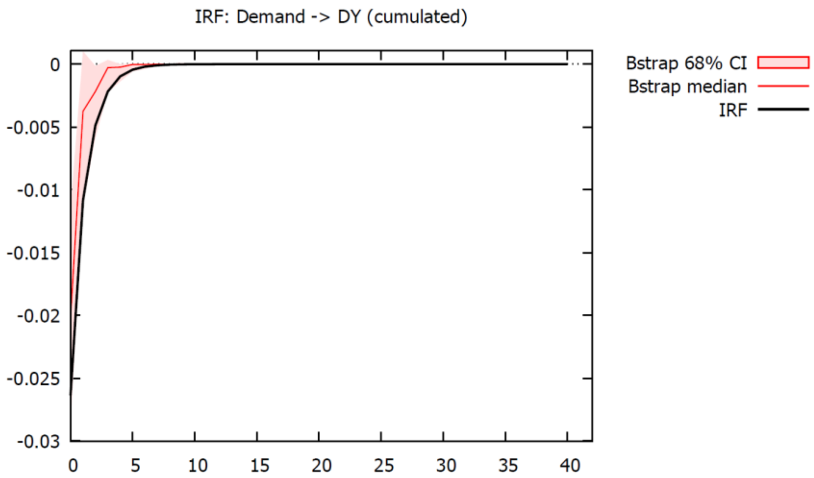


Figure 31. IRF of demand on the level of output for Czechia.

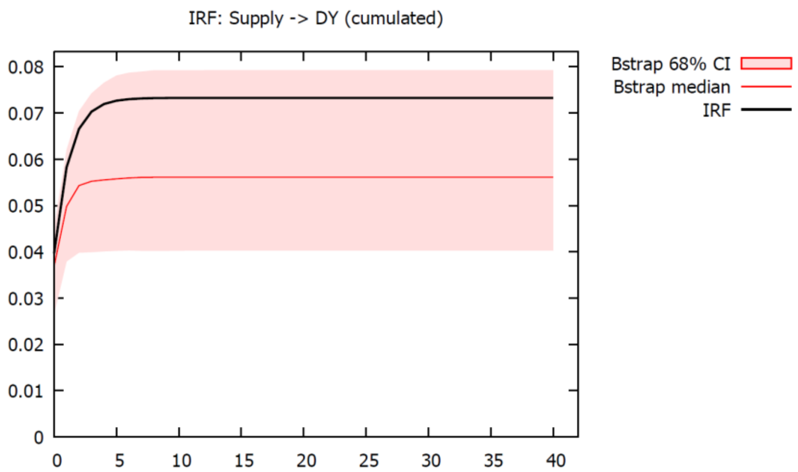


Figure 32. IRF of supply on the level of output for Czechia.

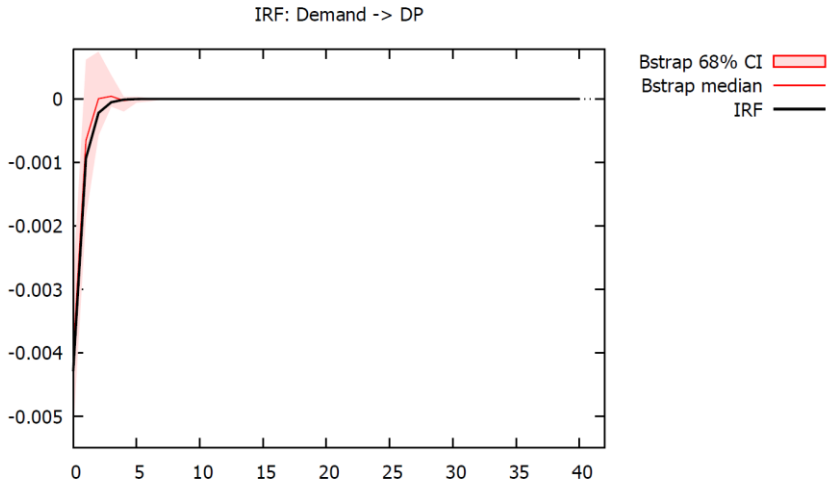
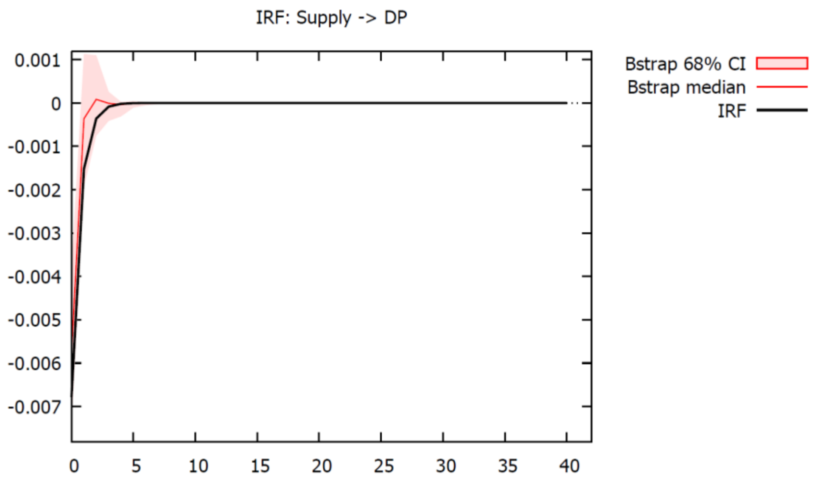


Figure 33. IRF of demand on inflation for Denmark.



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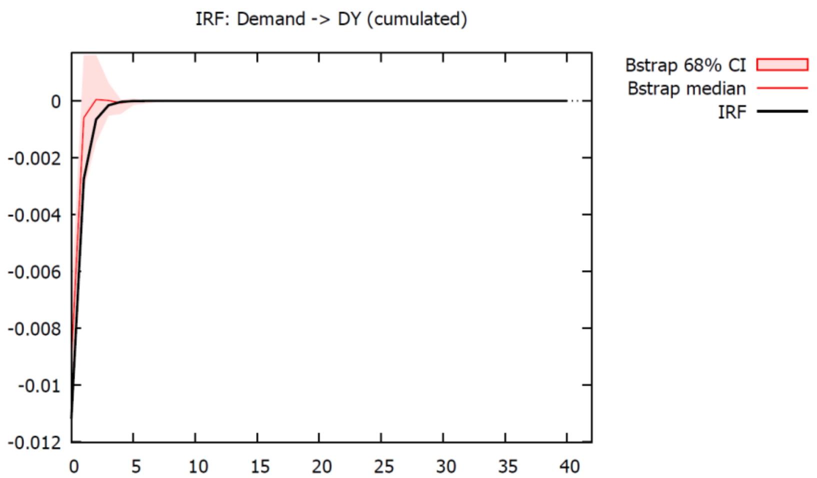

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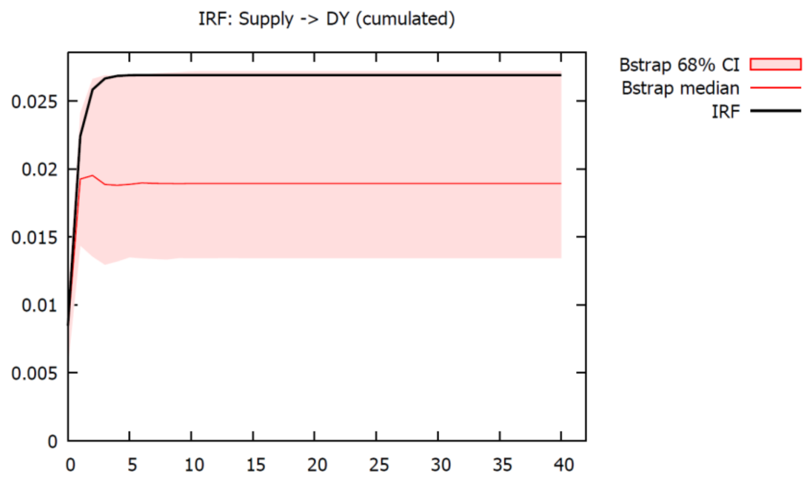


Figure 36. IRF of supply on the level of output for Denmark.

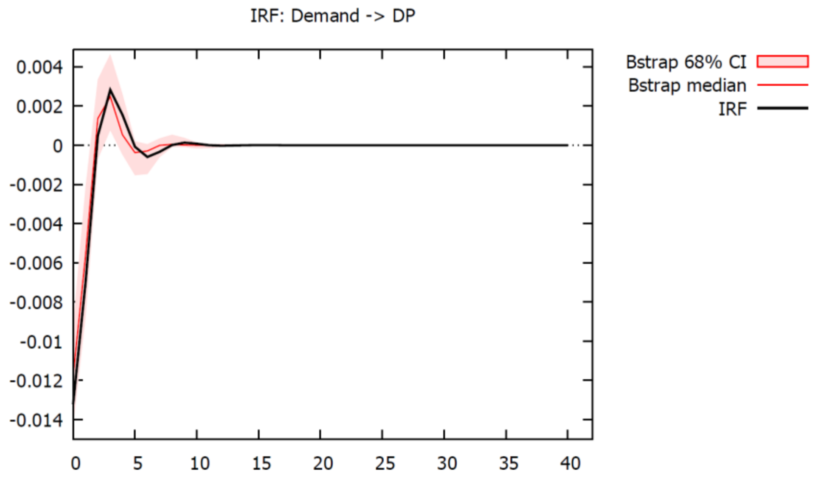


Figure 37. IRF of demand on inflation for Estonia.

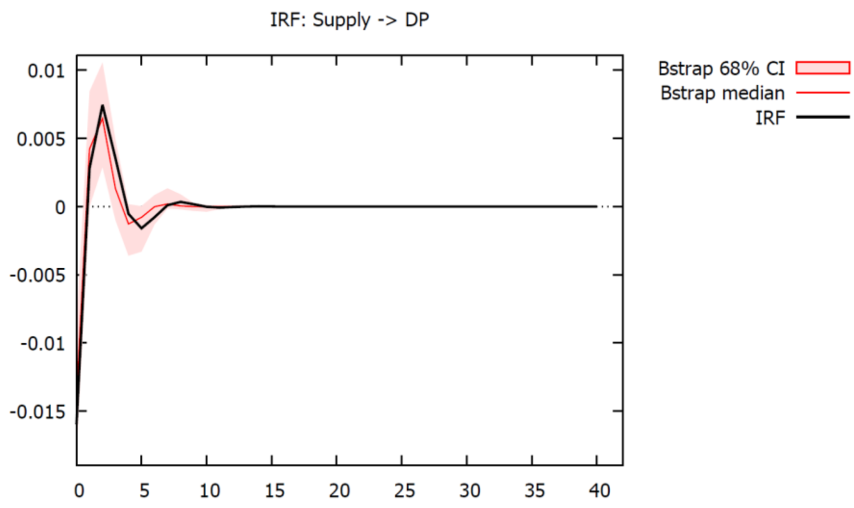


Figure 38. IRF of supply on inflation for Estonia.

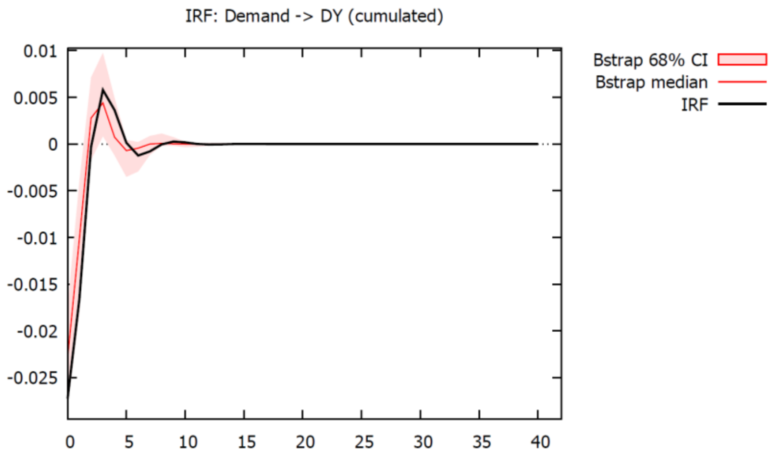


Figure 39. IRF of demand on the level of output for Estonia.

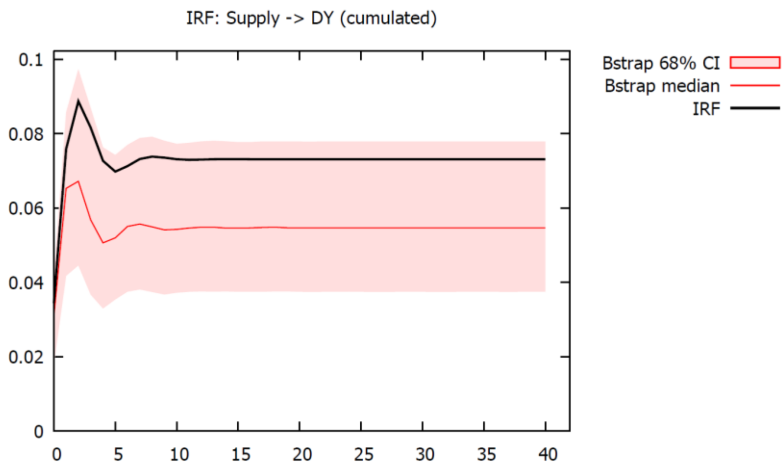


Figure 40. IRF of supply on the level of output for Estonia.

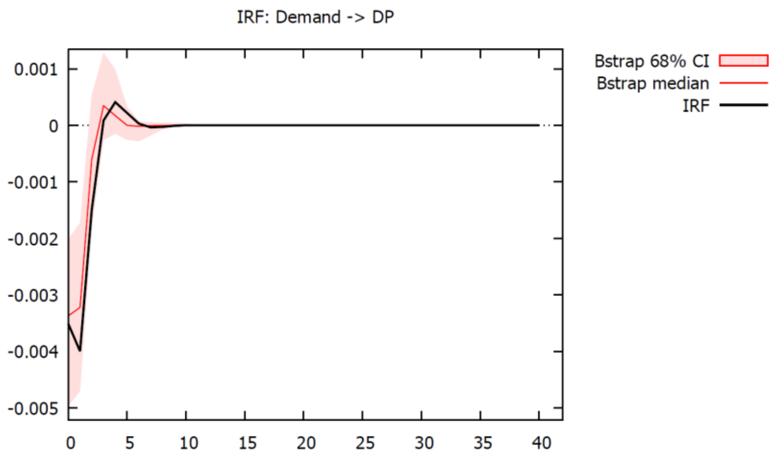


Figure 41. IRF of demand on inflation for Finland.

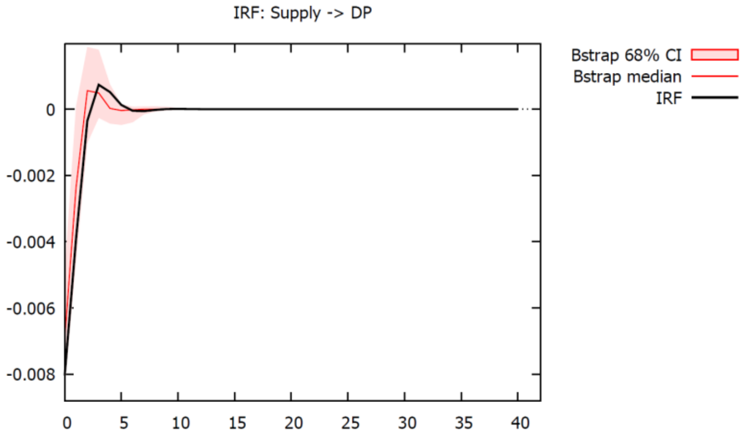


Figure 42. IRF of supply on inflation for Finland.

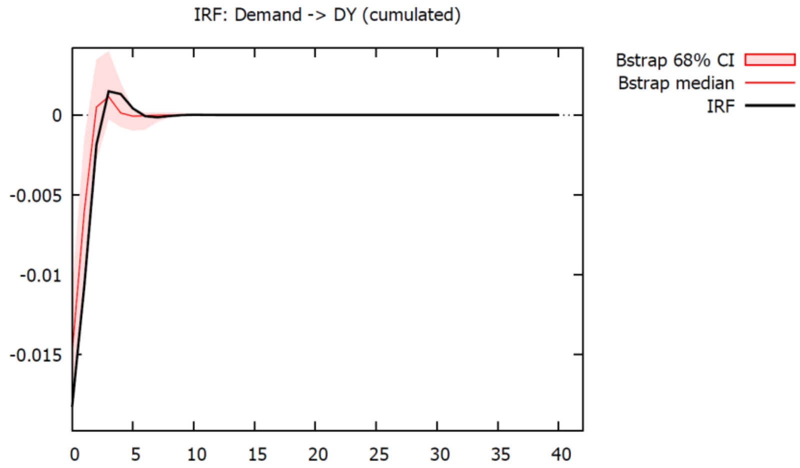


Figure 43. IRF of demand on the level of output for Finland.

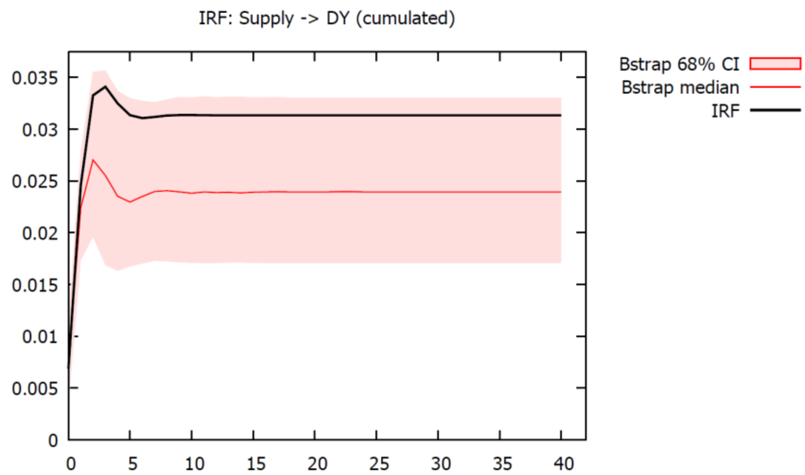


Figure 44. IRF of supply on the level of output for Finland.

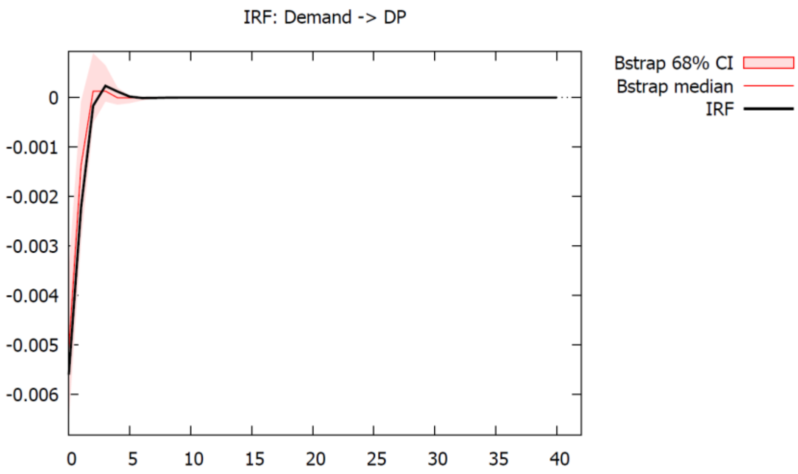


Figure 45. IRF of demand on inflation for France.

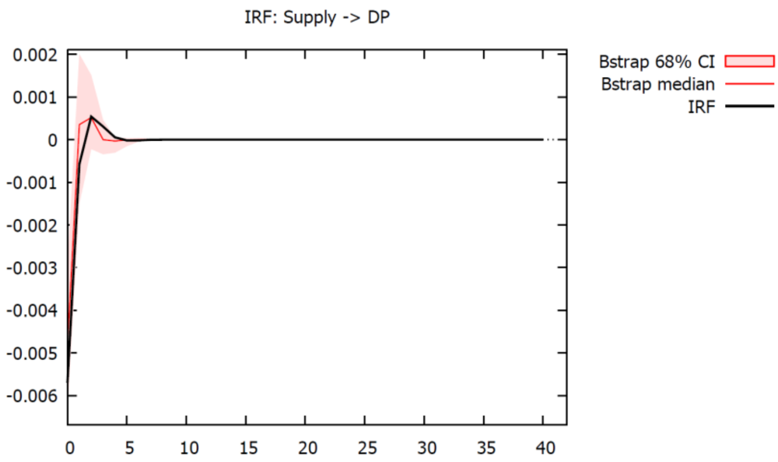


Figure 46. IRF of supply on inflation for France.

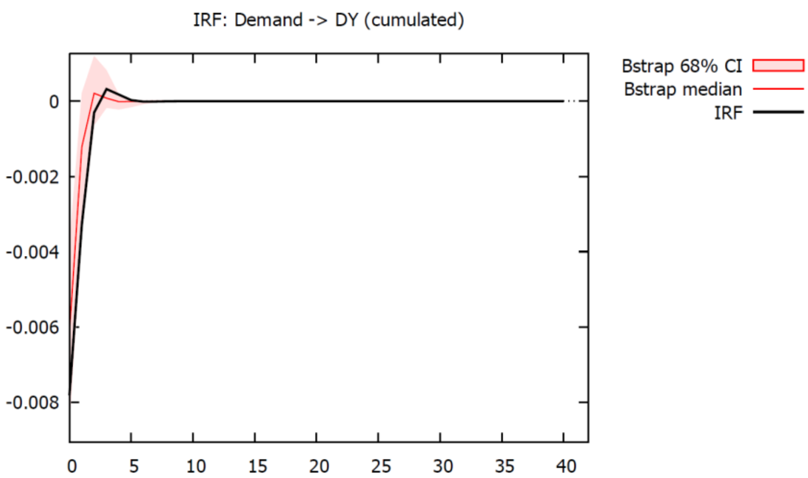


Figure 47. IRF of demand on the level of output for France.

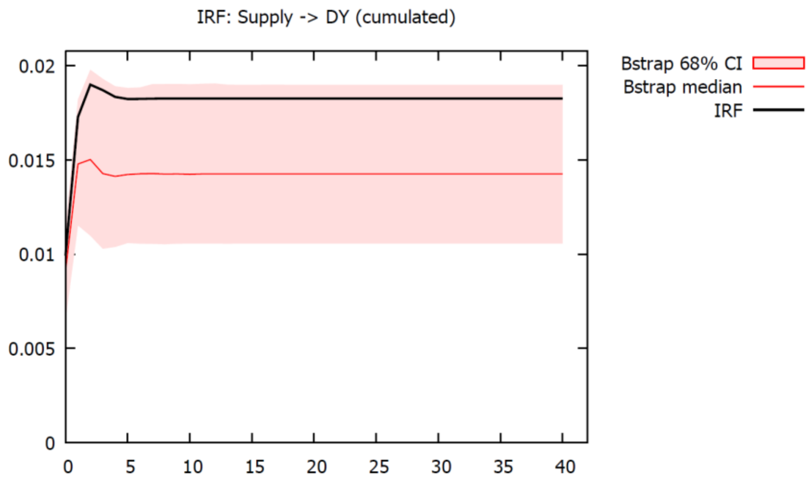


Figure 48. IRF of supply on the level of output for France.

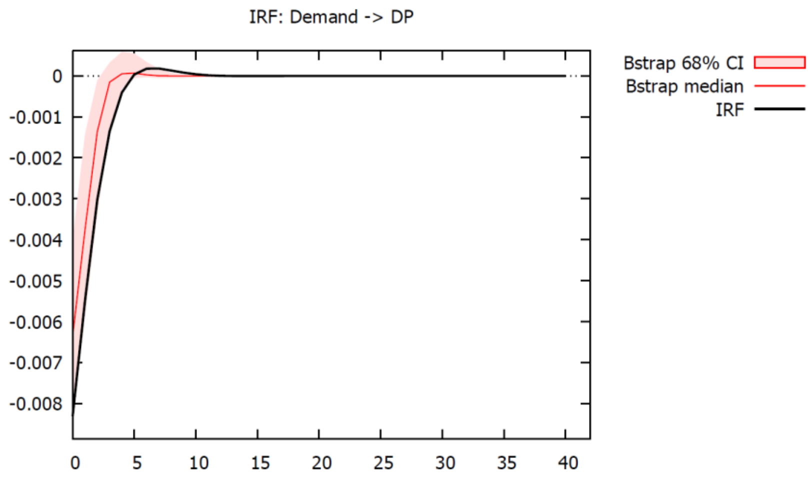
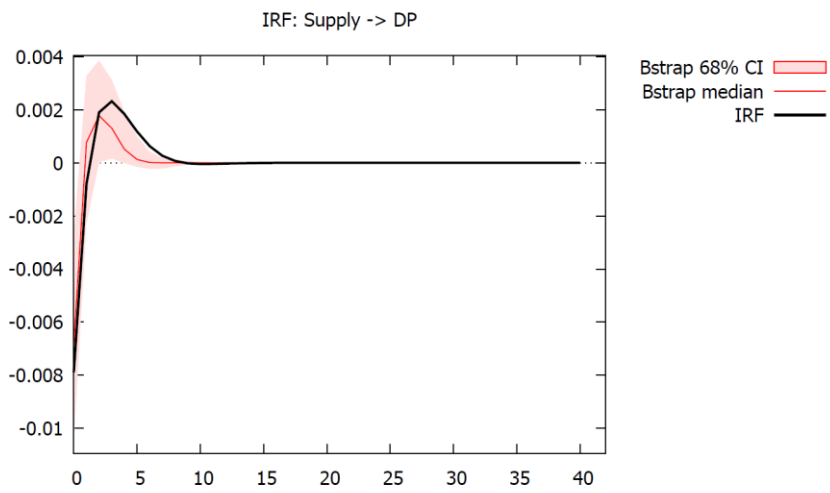


Figure 49. IRF of demand on inflation for Greece.



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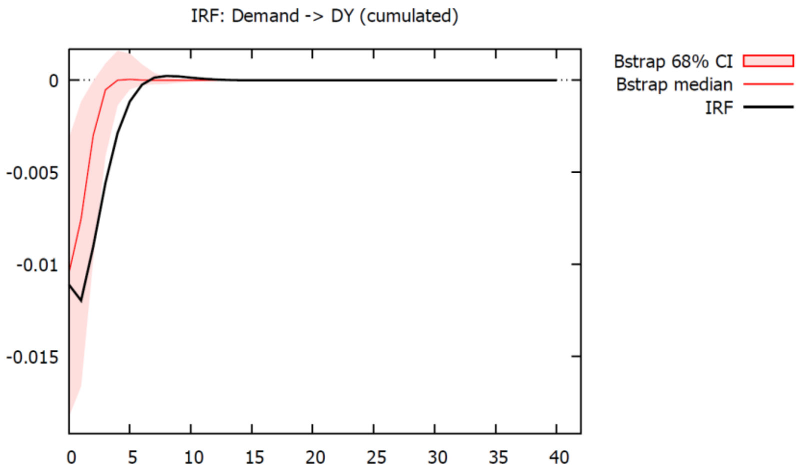


Figure 51. IRF of demand on the level of output for Greece.

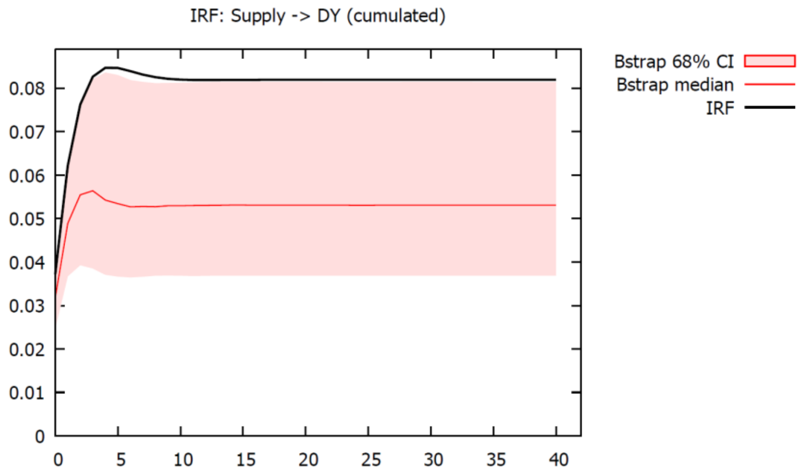


Figure 52. IRF of supply on the level of output for Greece.

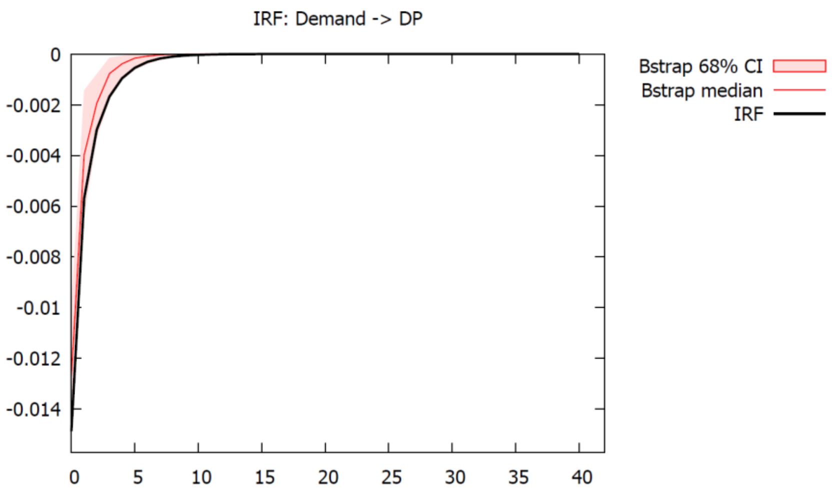


Figure 53. IRF of demand on inflation for Hungary.

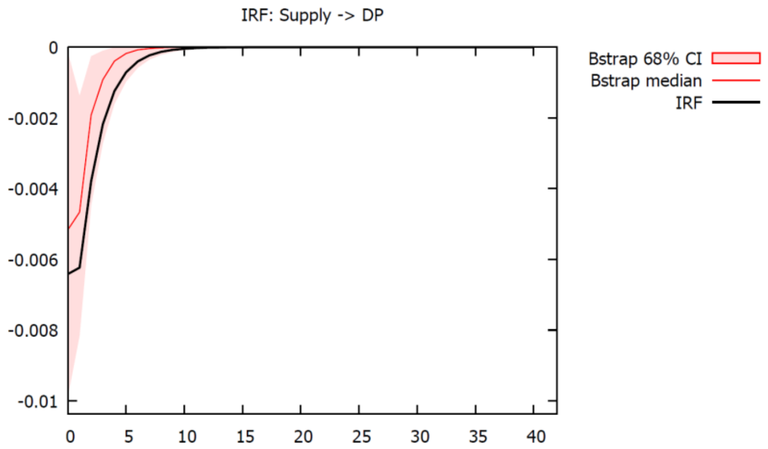


Figure 54. IRF of supply on inflation for Hungary.

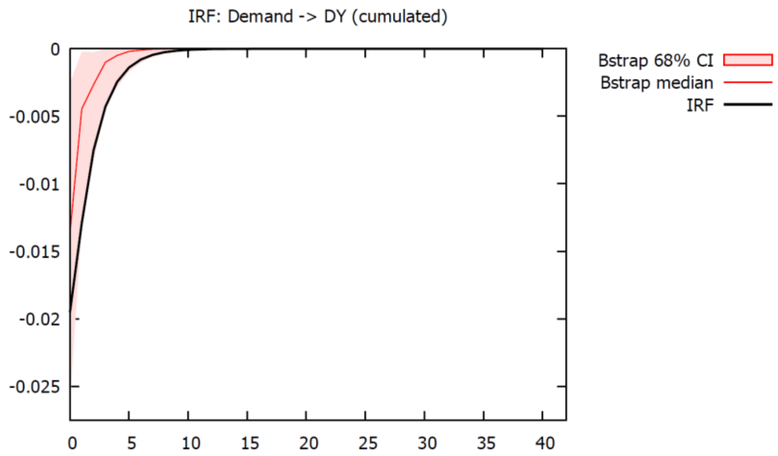


Figure 55. IRF of demand on the level of output for Hungary.

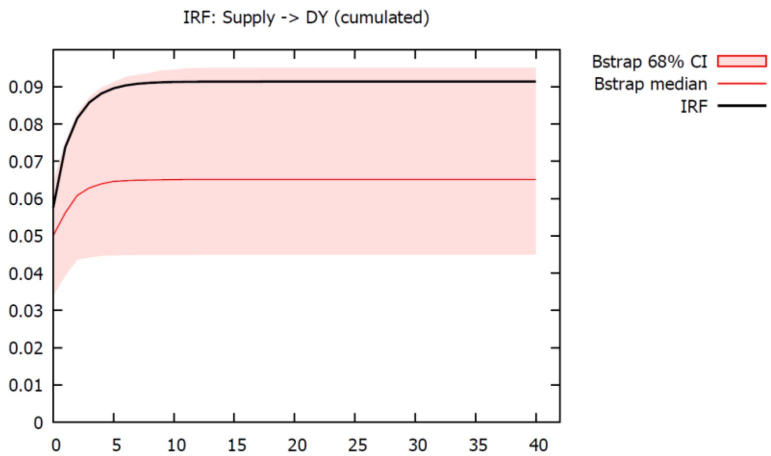


Figure 56. IRF of supply on the level of output for Hungary.

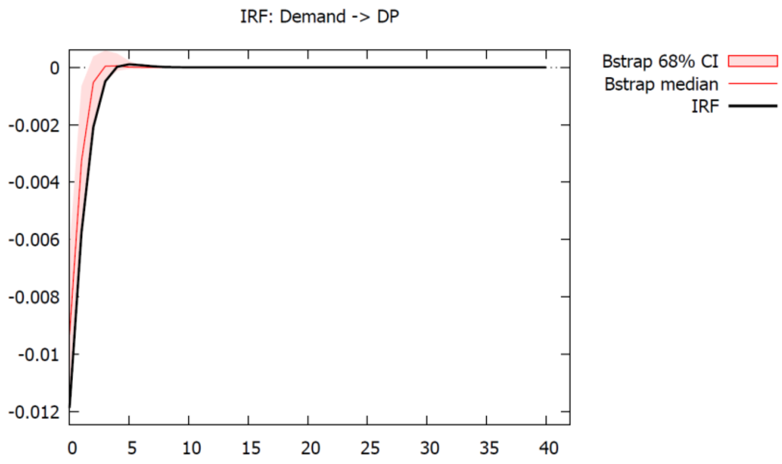
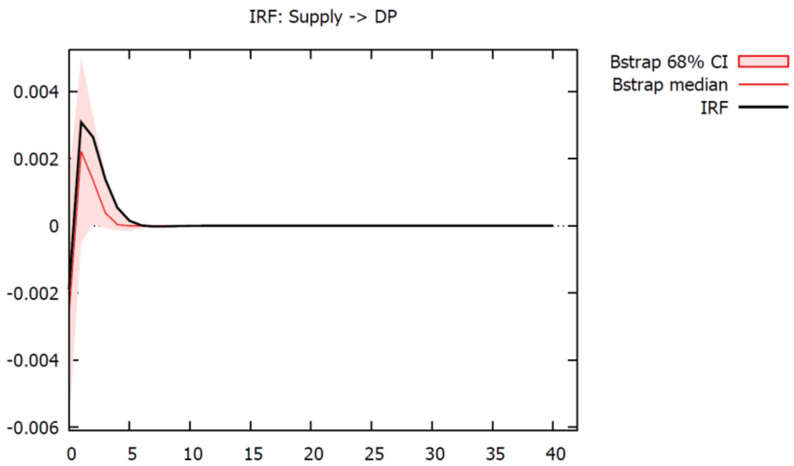


Figure 57. IRF of demand on inflation for Ireland.



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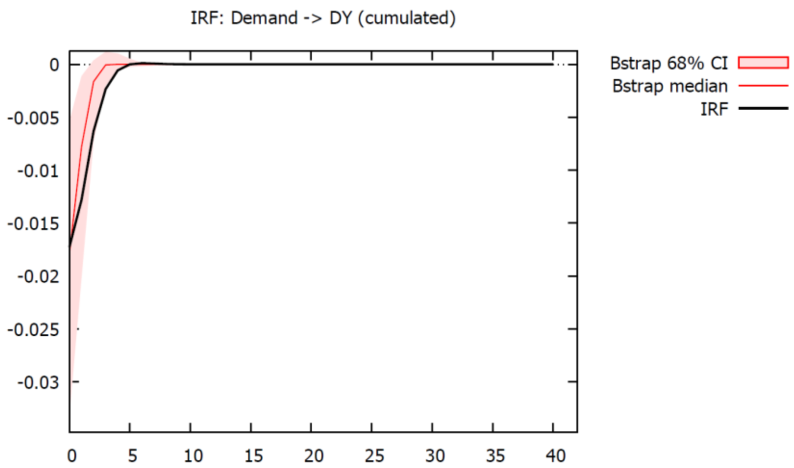

Figure 59. IRF of demand on the level of output for Ireland.

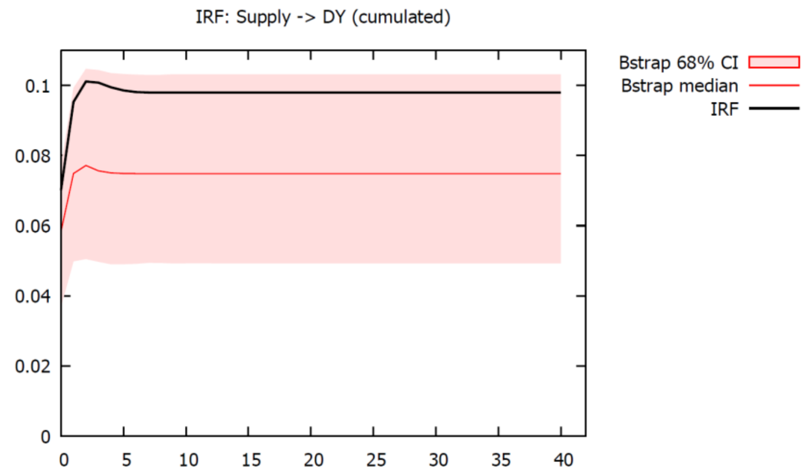

Figure 60. IRF of supply on the level of output for Ireland.

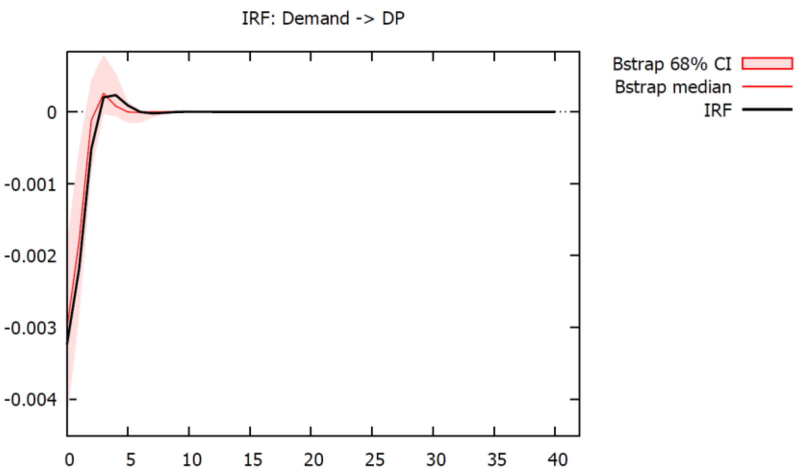

Figure 61. IRF of demand on inflation for Italy.

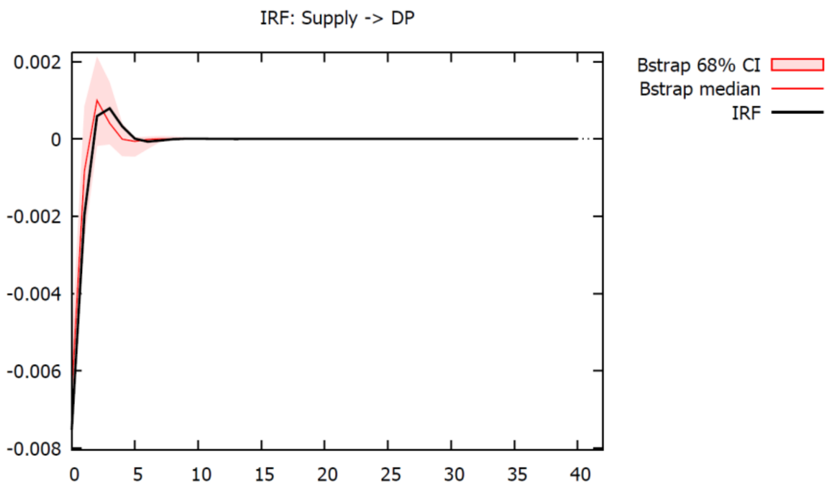

Figure 62. IRF of supply on inflation for Italy.

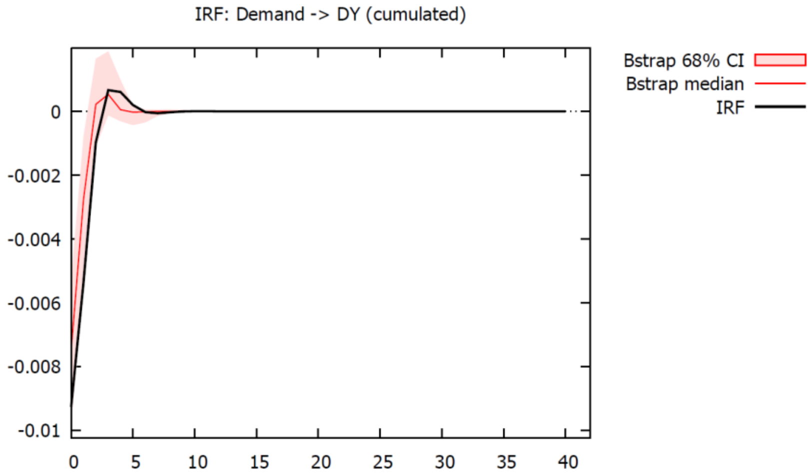

Figure 63. IRF of demand on the level of output for Italy.

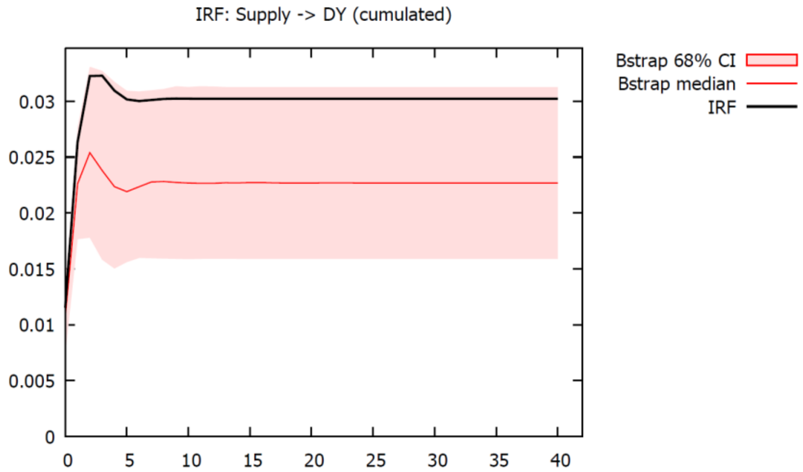

Figure 64. IRF of supply on the level of output for Italy.

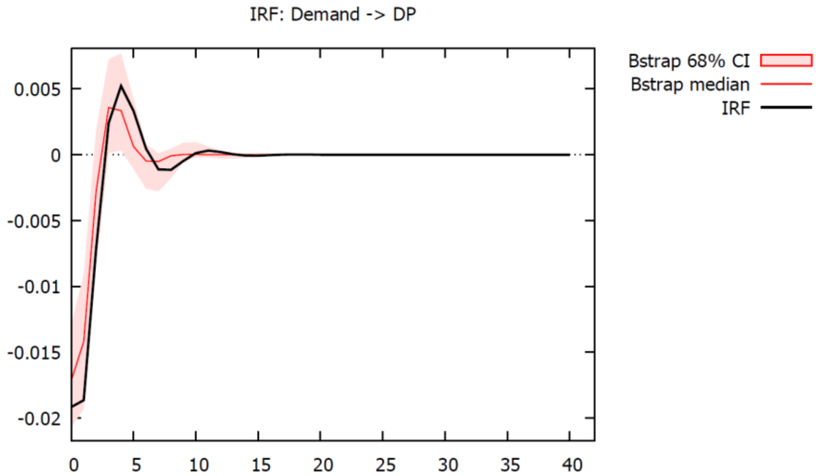

Figure 65. IRF of demand on inflation for Latvia.

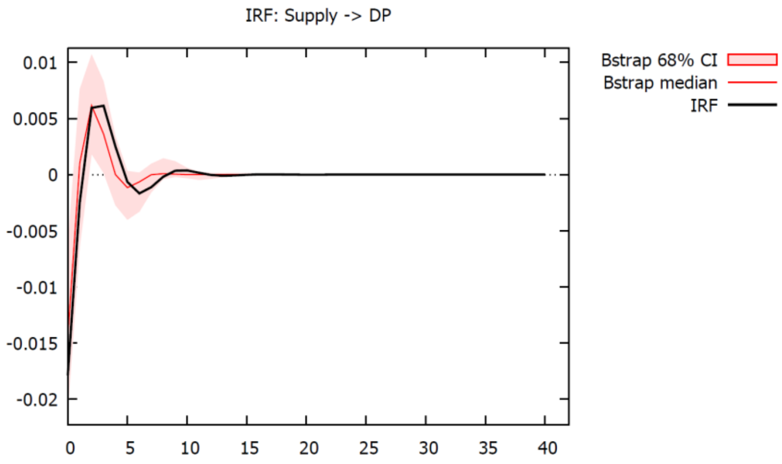

Figure 66. IRF of supply on inflation for Latvia.

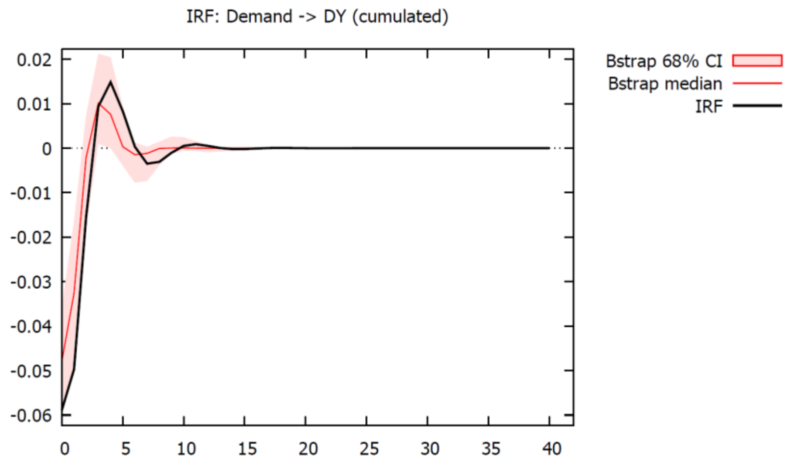

Figure 67. IRF of demand on the level of output for Latvia.

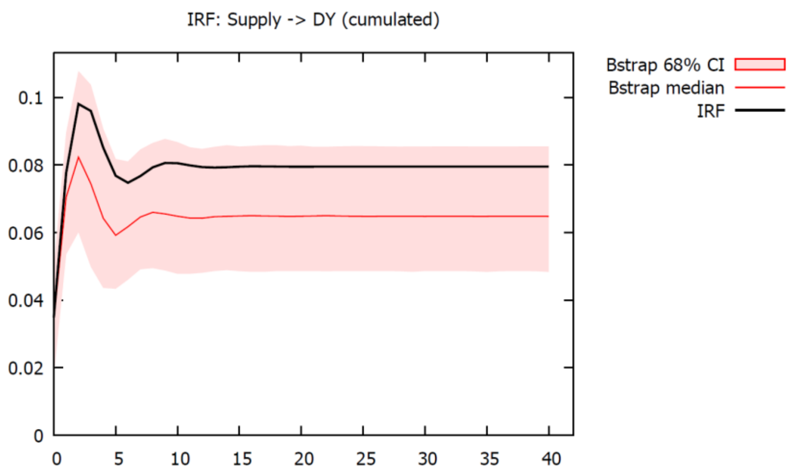

Figure 68. IRF of supply on the level of output for Latvia.

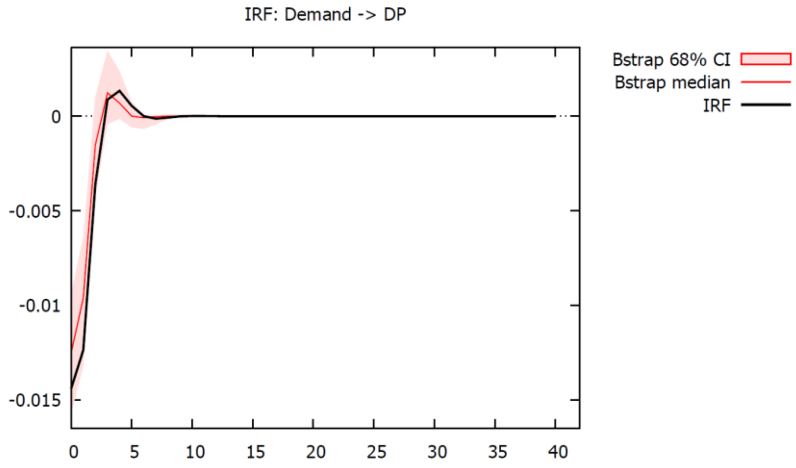

Figure 69. IRF of demand on inflation for Lithuania.

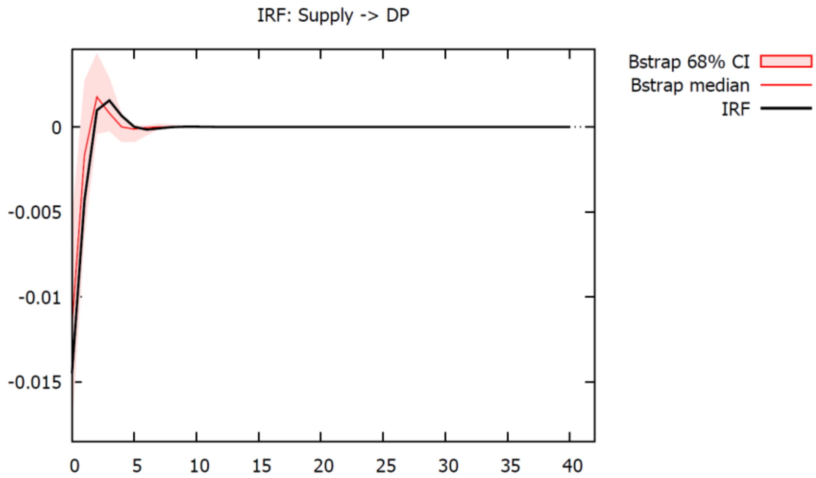

Figure 70. IRF of supply on inflation for Lithuania.

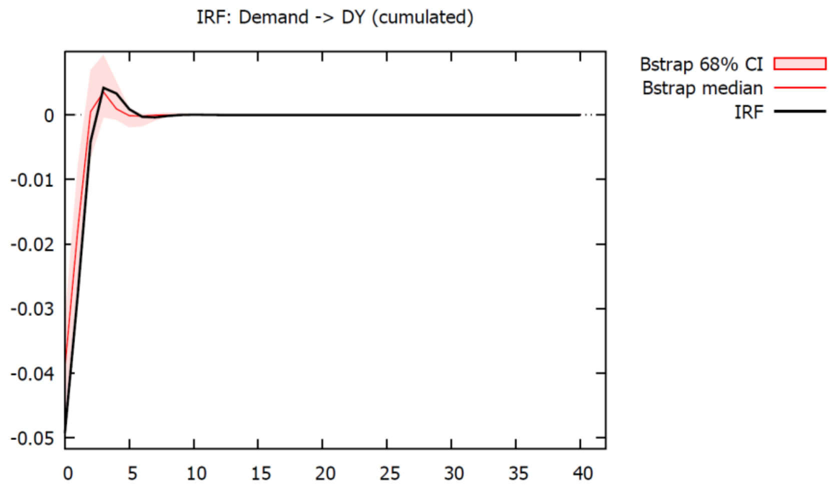

Figure 71. IRF of demand on the level of output for Lithuania.

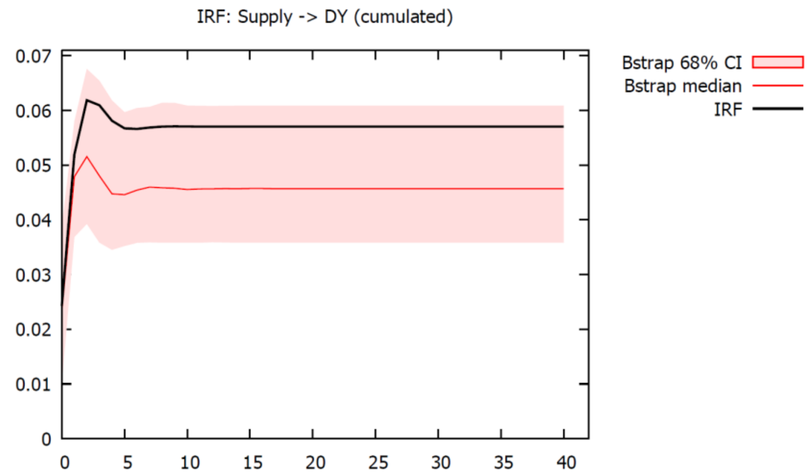

Figure 72. IRF of supply on the level of output for Lithuania.

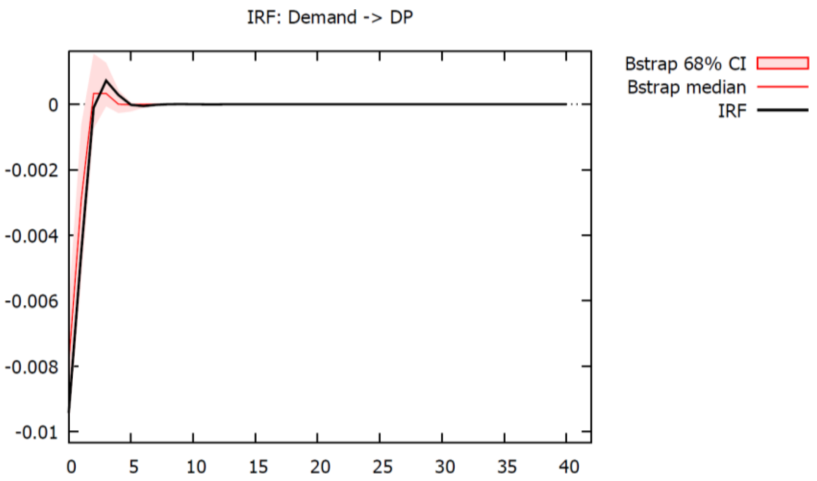

Figure 73. IRF of demand on inflation for Luxembourg.

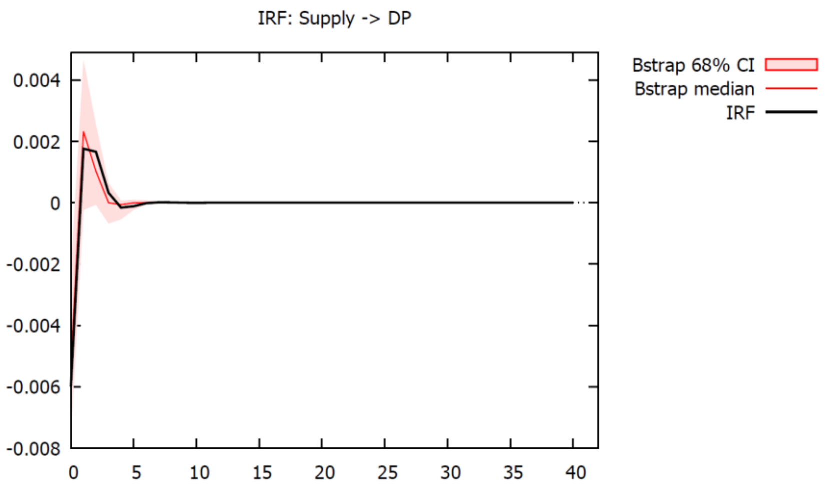

Figure 74. IRF of supply on inflation for Luxembourg.

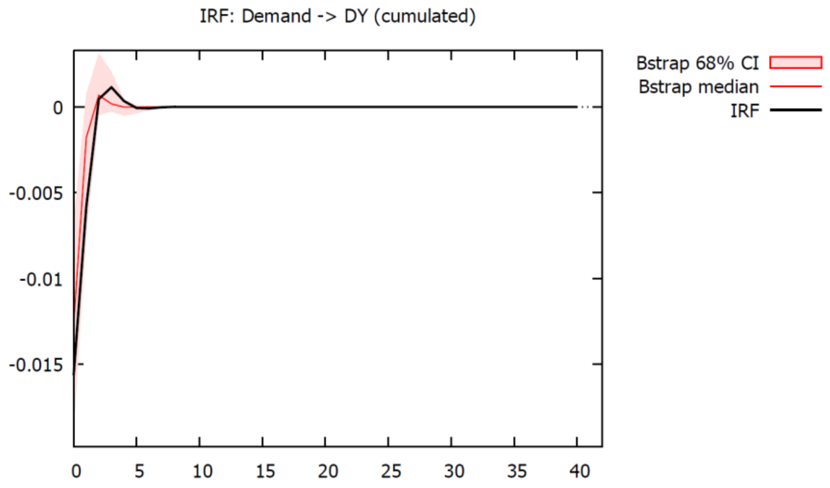

Figure 75. IRF of demand on the level of output for Luxembourg.

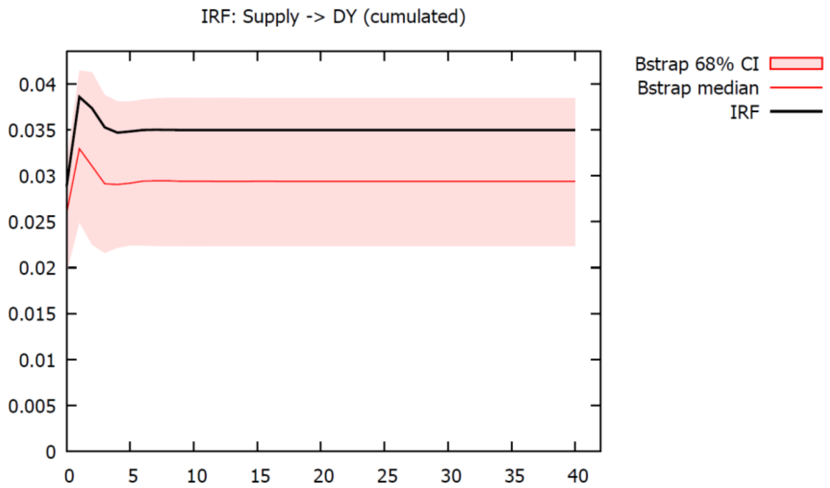

Figure 76. IRF of supply on the level of output for Luxembourg.

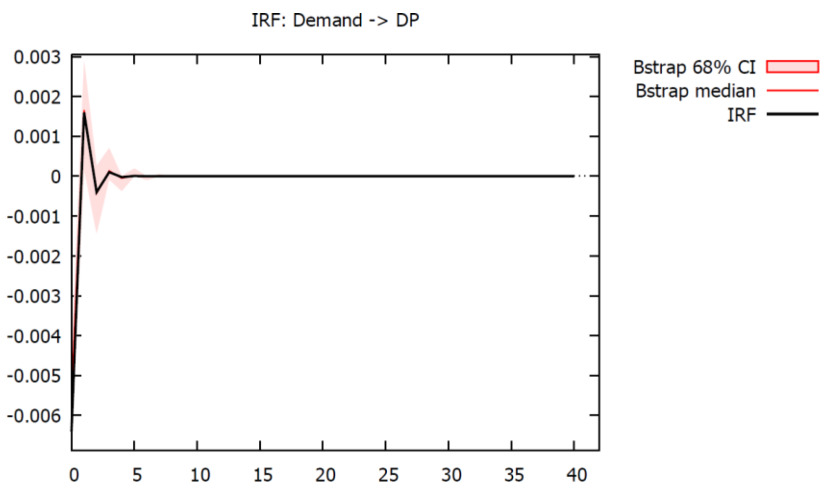

Figure 77. IRF of demand on inflation for Malta.

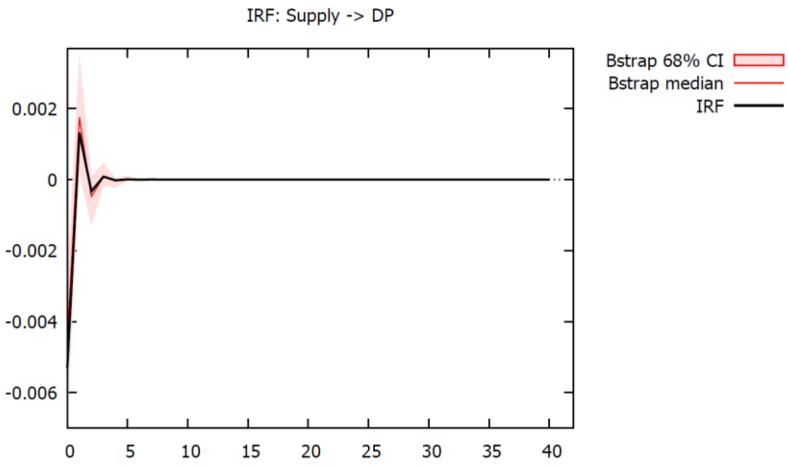

Figure 78. IRF of supply on inflation for Malta.

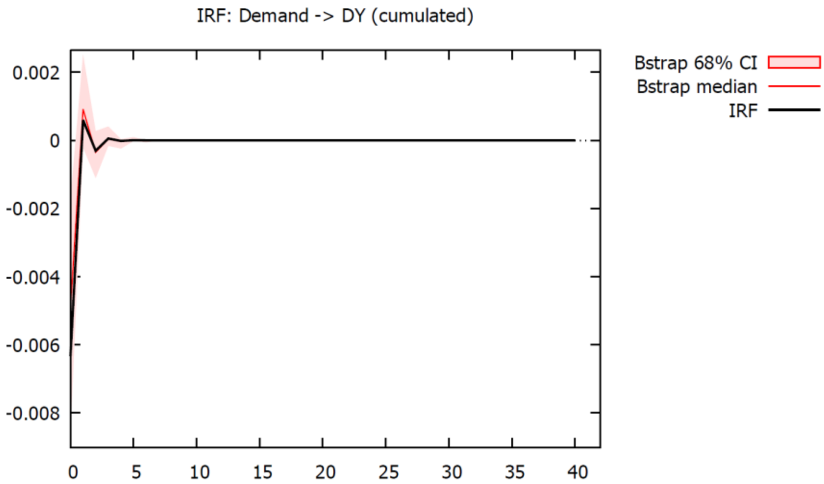

Figure 79. IRF of demand on the level of output for Malta.

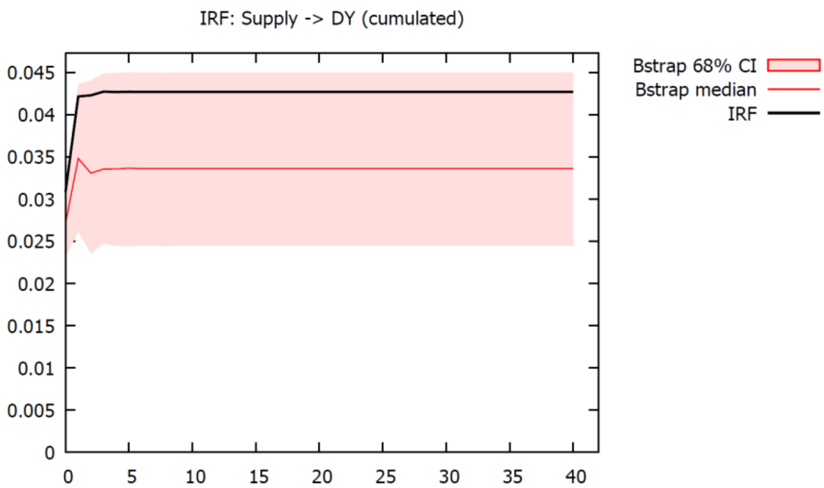

Figure 80. IRF of supply on the level of output for Malta.

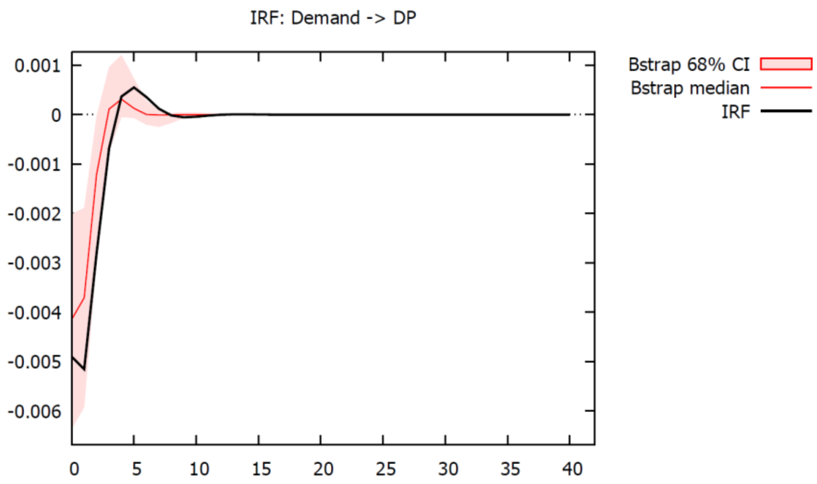

Figure 81. IRF of demand on inflation for the Netherlands.

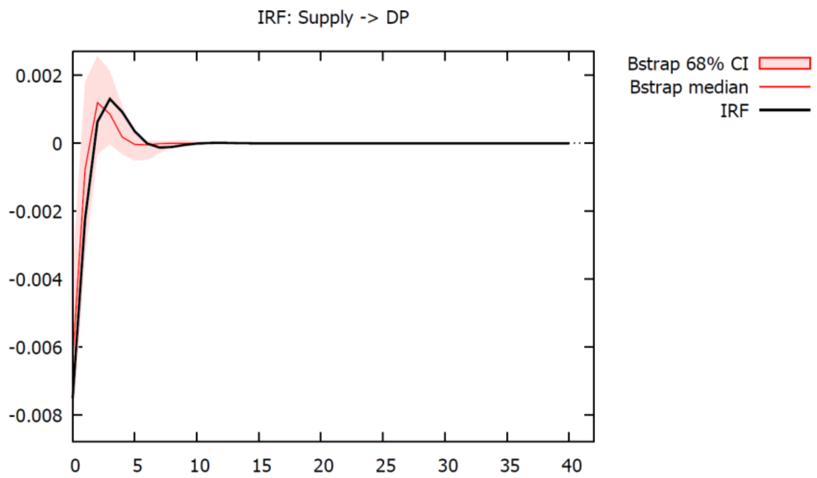

Figure 82. IRF of supply on inflation for the Netherlands.

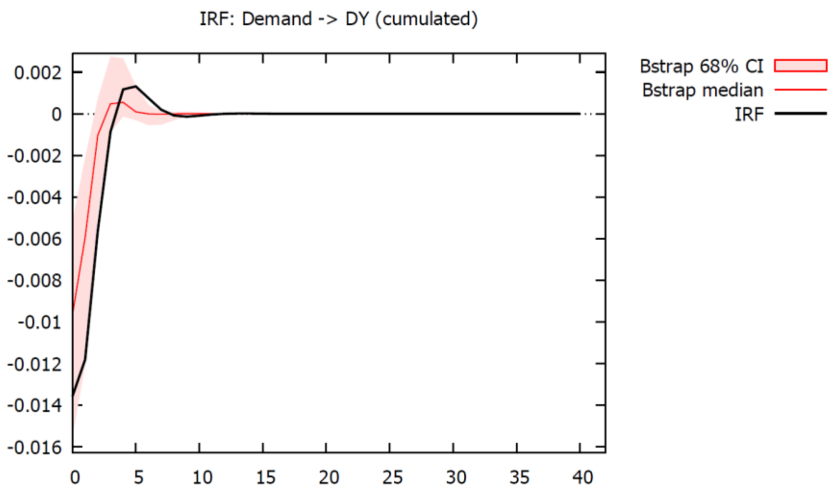

Figure 83. IRF of demand on the level of output for the Netherlands.

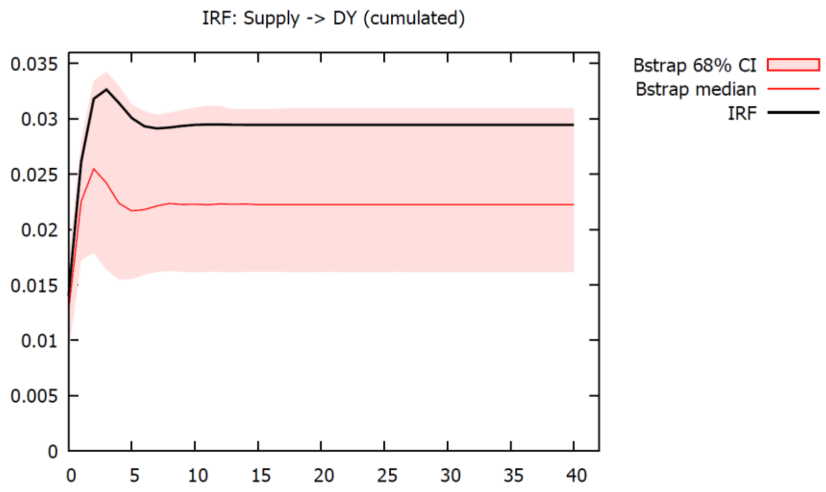

Figure 84. IRF of supply on the level of output for the Netherlands.

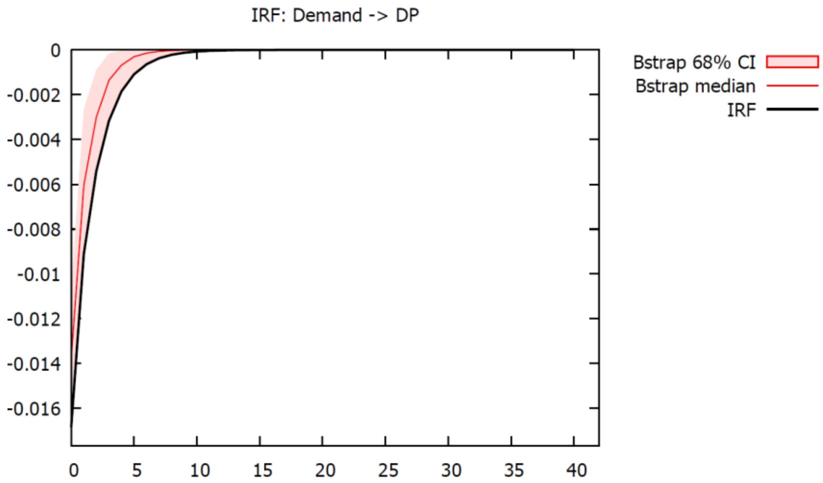

Figure 85. IRF of demand on inflation for Poland.

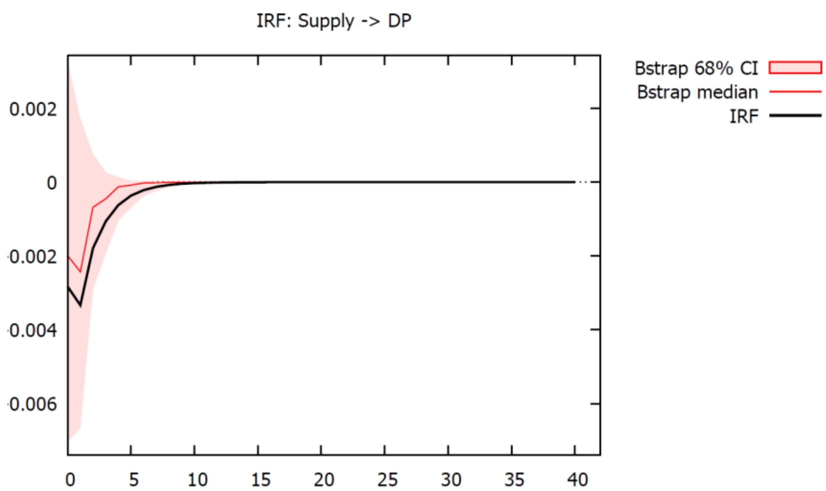

Figure 86. IRF of supply on inflation for Poland.

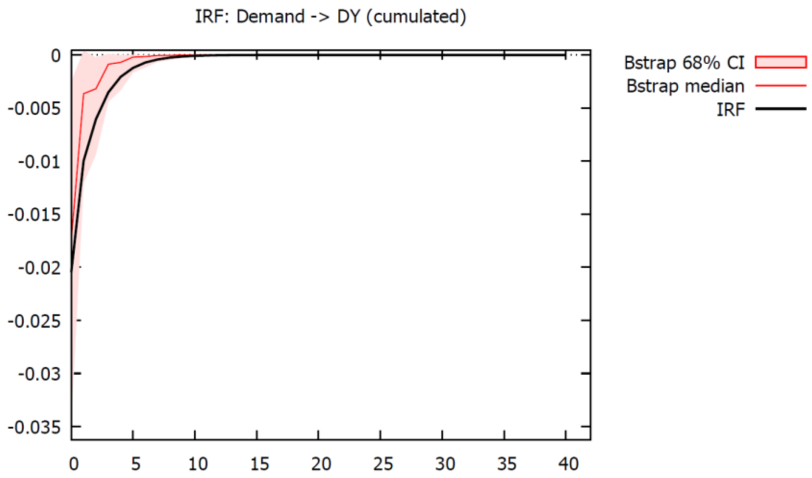

Figure 87. IRF of demand on the level of output for Poland

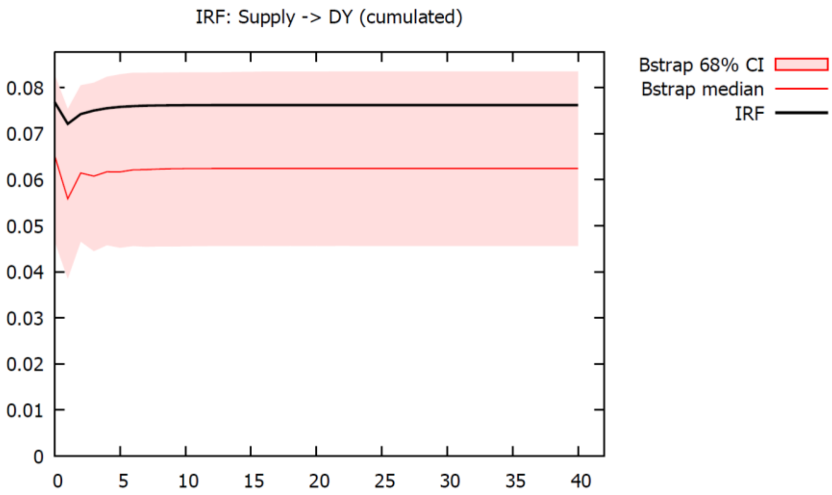

Figure 88. IRF of supply on the level of output for Poland.

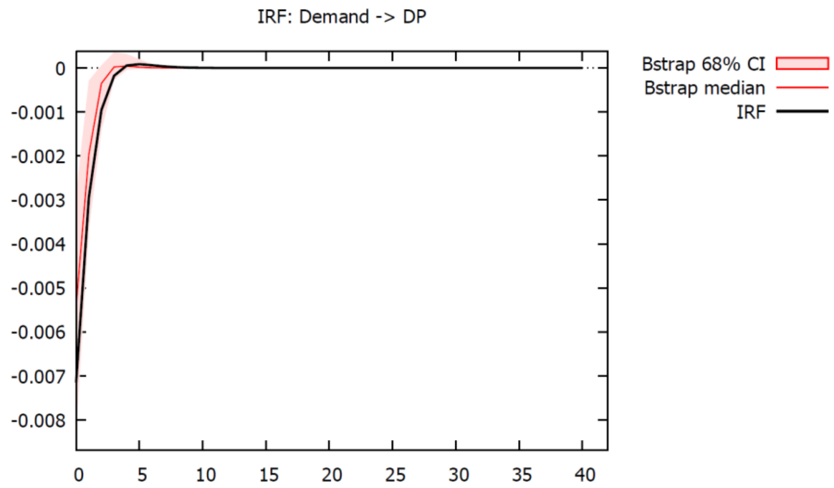

Figure 89. IRF of demand on inflation for Portugal.

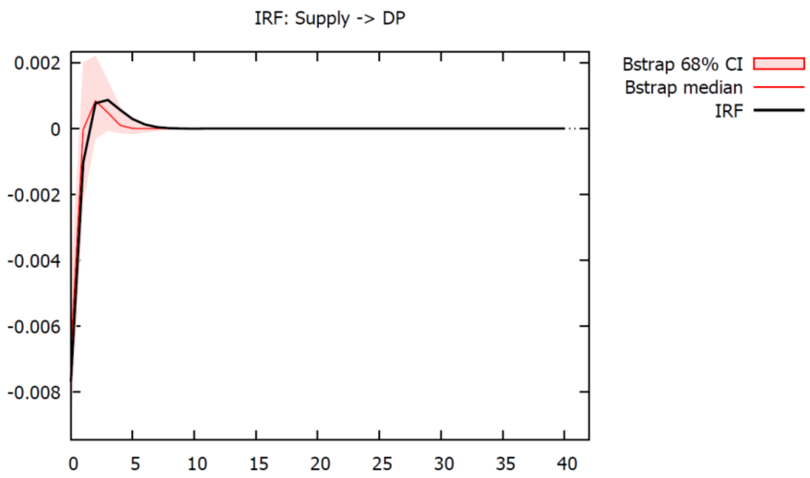

Figure 90. IRF of supply on inflation for Portugal.

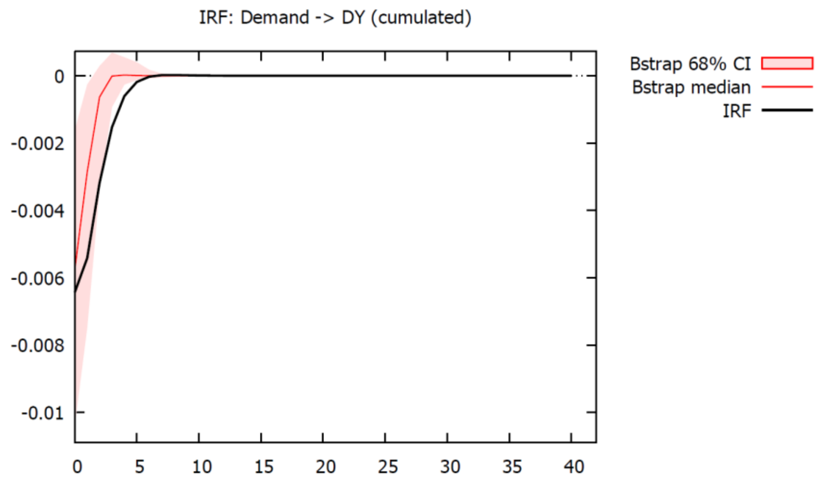

Figure 91. IRF of demand on the level of output for Portugal.

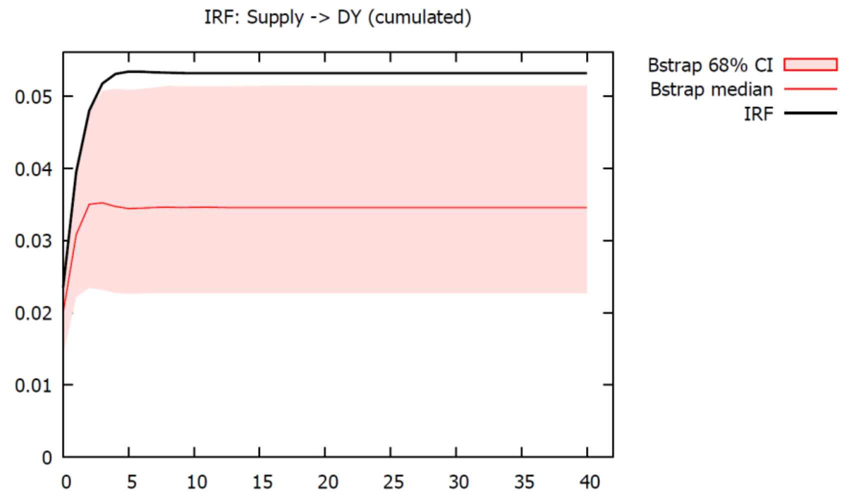

Figure 92. IRF of supply on the level of output for Portugal.

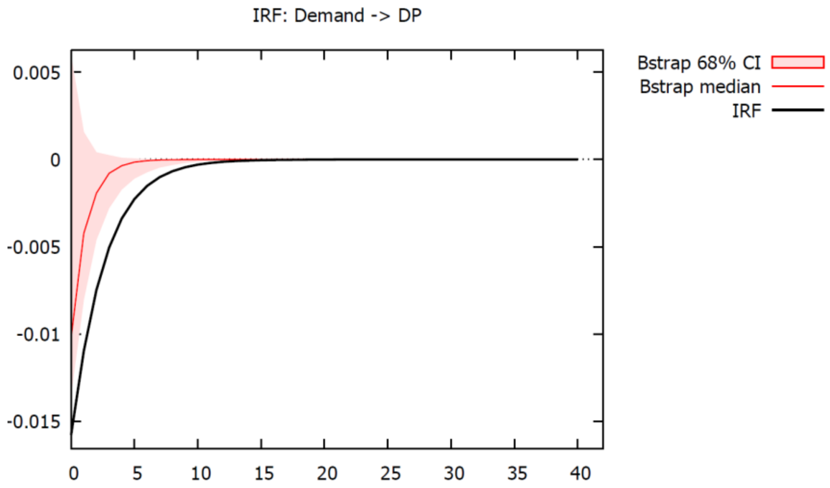

Figure 93. IRF of demand on inflation for Romania.

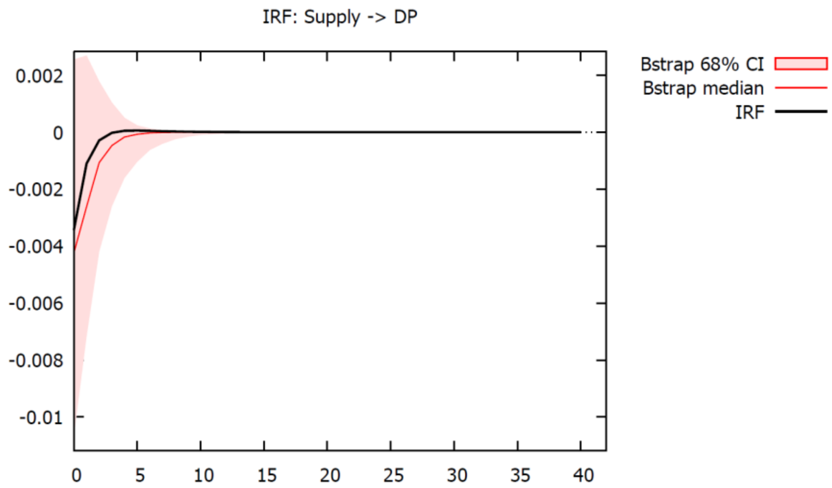

Figure 94. IRF of supply on inflation for Romania.

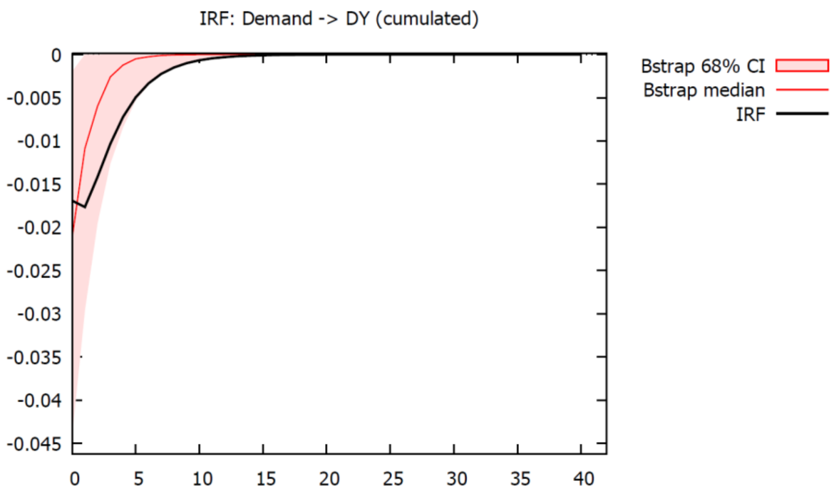

Figure 95. IRF of demand on the level of output for Romania.

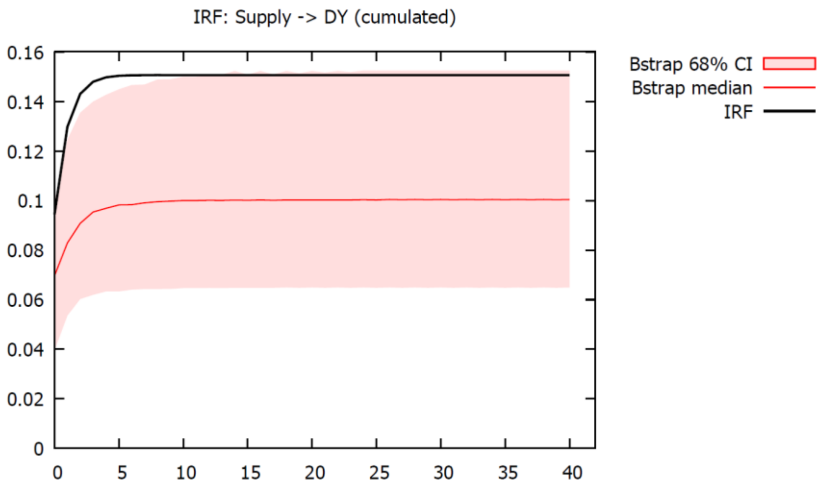

Figure 96. IRF of supply on the level of output for Romania.

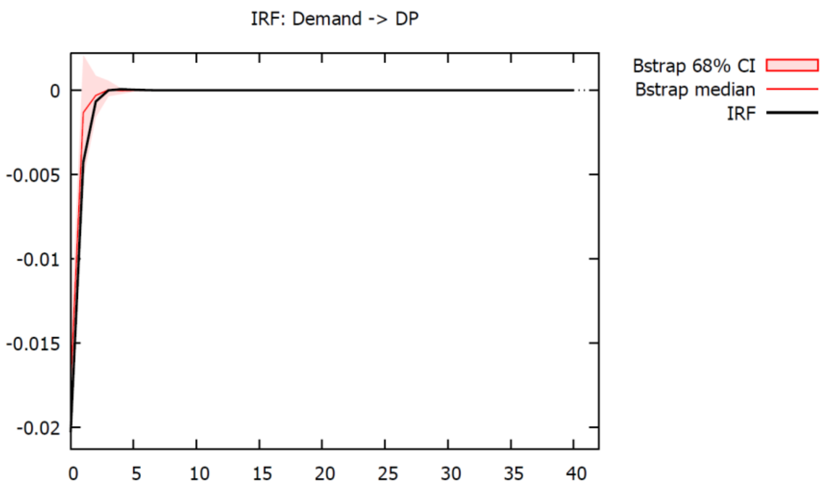

Figure 99. IRF of demand on inflation for Slovakia.

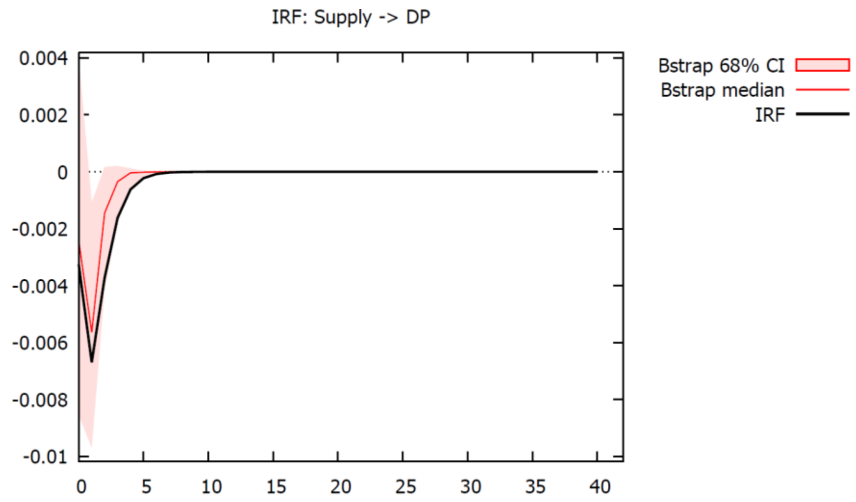

Figure 100. IRF of supply on inflation for Slovakia.

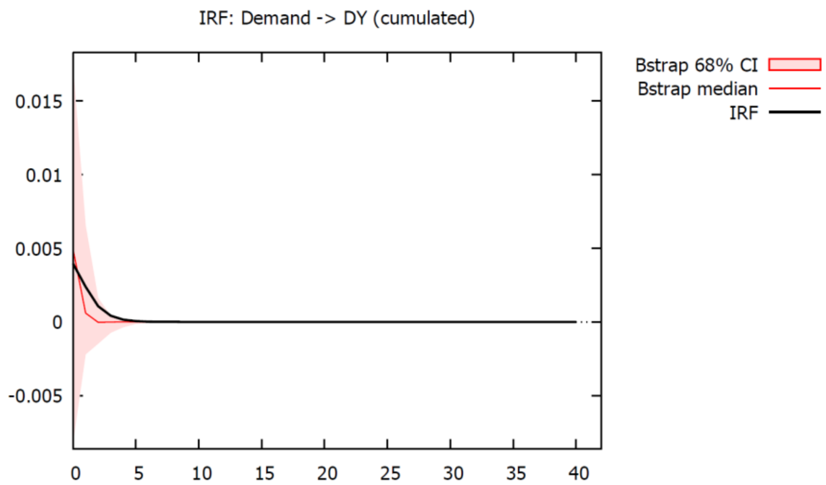

Figure 101. IRF of demand on the level of output for Slovakia.

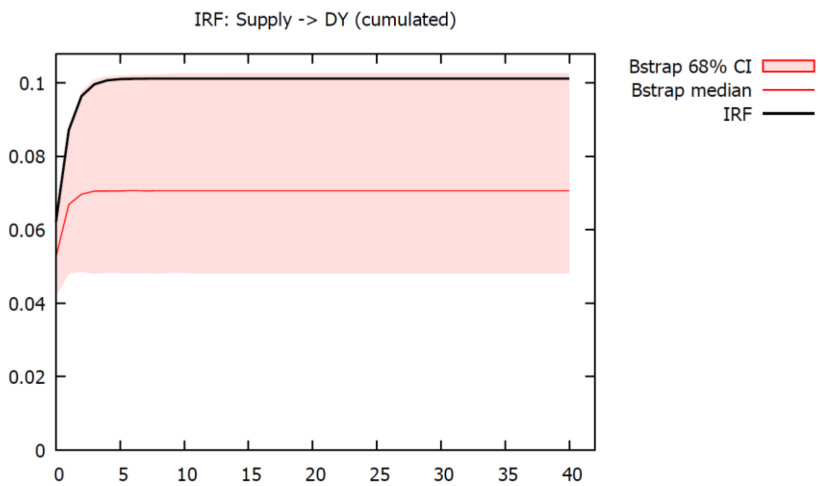

Figure 102. IRF of supply on the level of output for Slovakia.

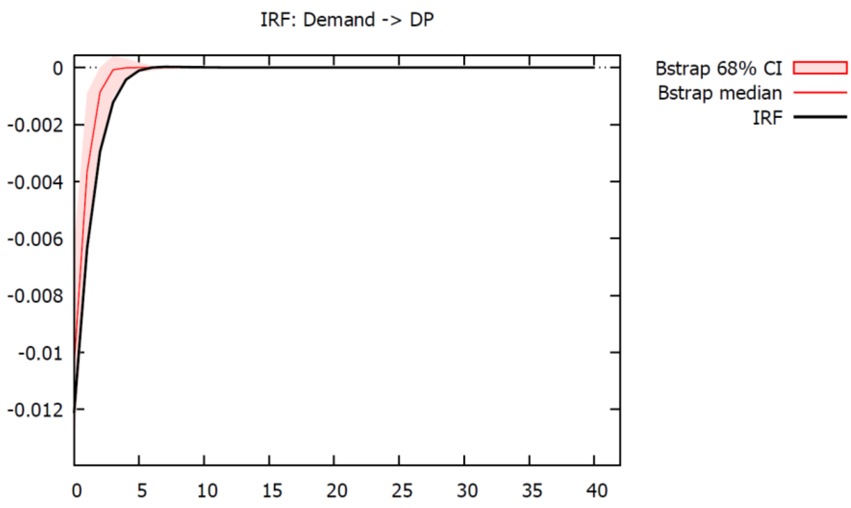

Figure 103. IRF of demand on inflation for Slovenia.

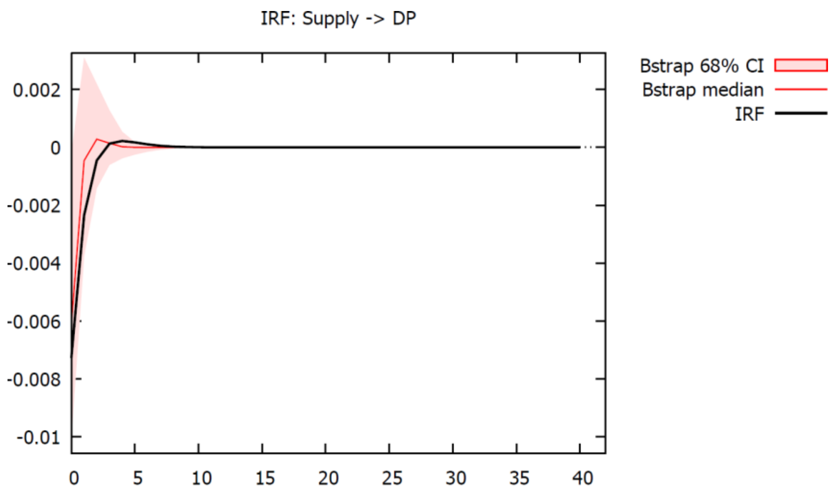

Figure 104. IRF of supply on inflation for Slovenia.

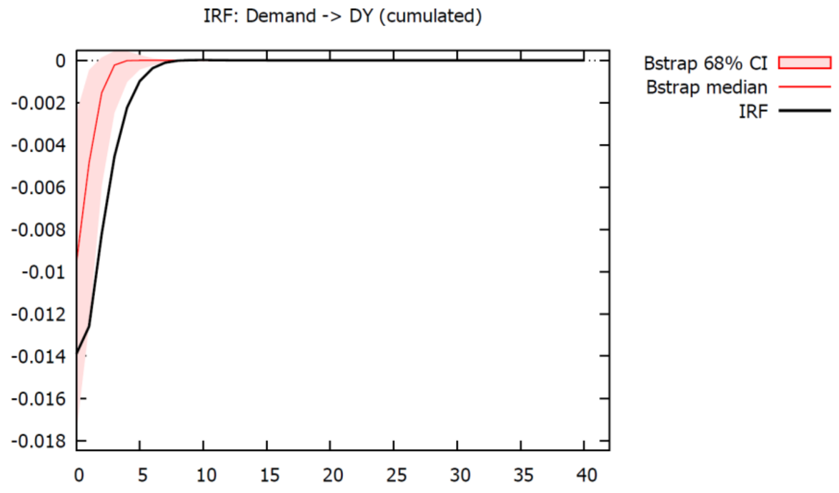

Figure 105. IRF of demand on the level of output for Slovenia.

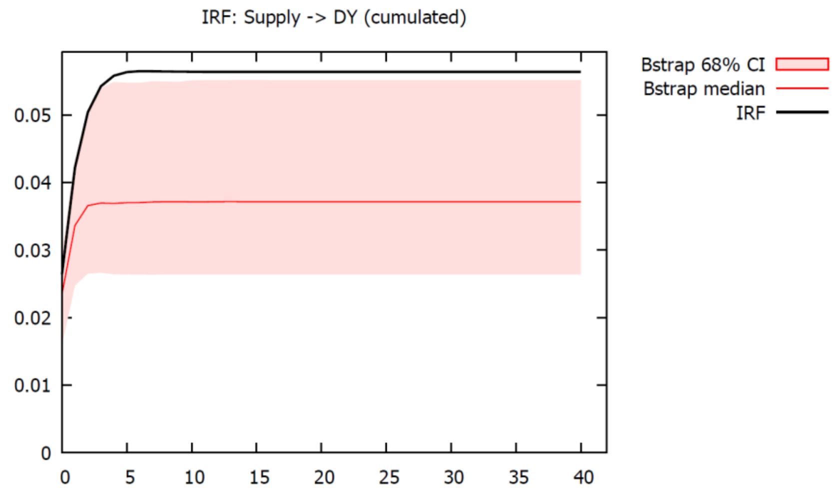

Figure 106. IRF of supply on the level of output for Slovenia.

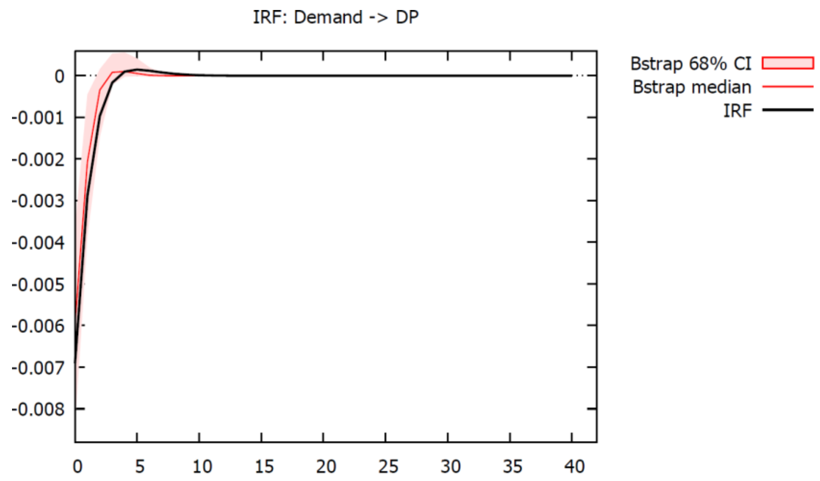

Figure 107. IRF of demand on inflation for Spain.

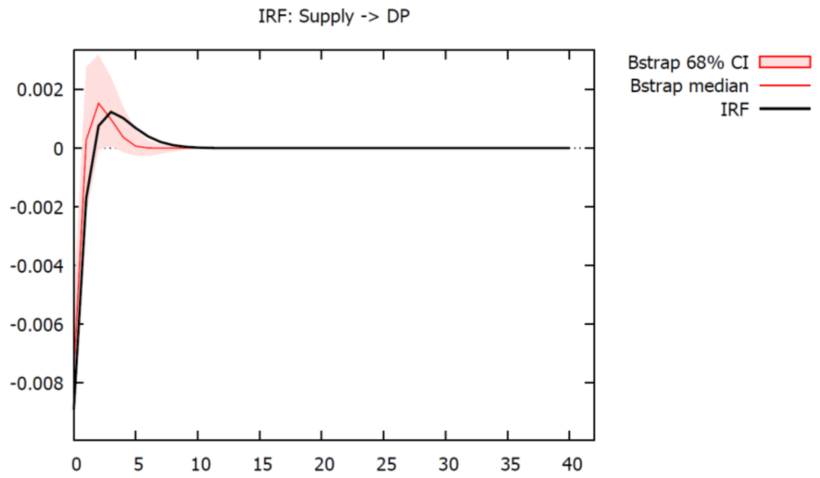

Figure 106. IRF of supply on inflation for Spain.

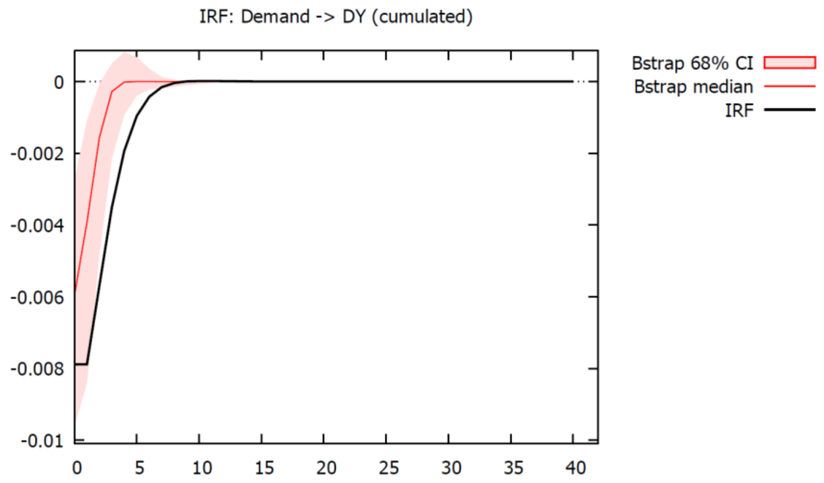

Figure 107. IRF of demand on the level of output for Spain.

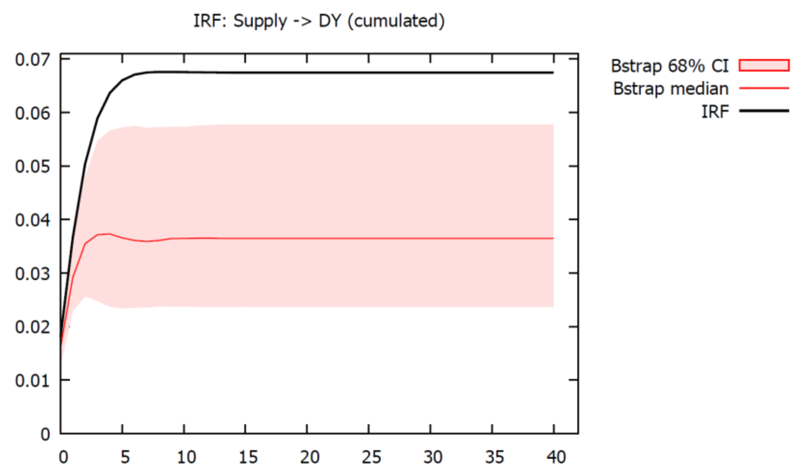

Figure 108. IRF of supply on the level of output for Spain.

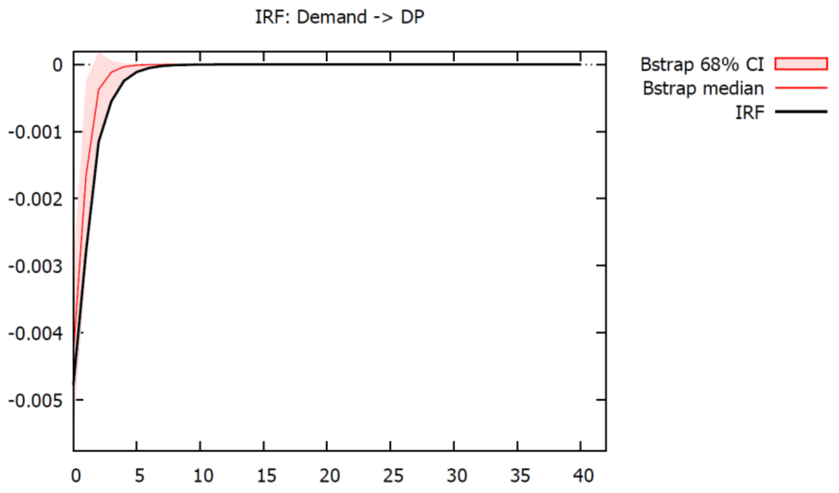

Figure 109. IRF of demand on inflation for Sweden.

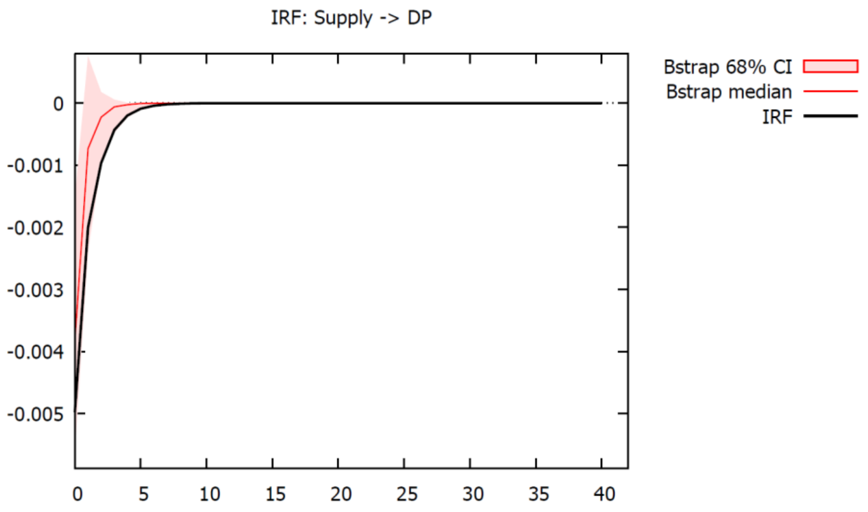

Figure 110. IRF of supply on inflation for Sweden.

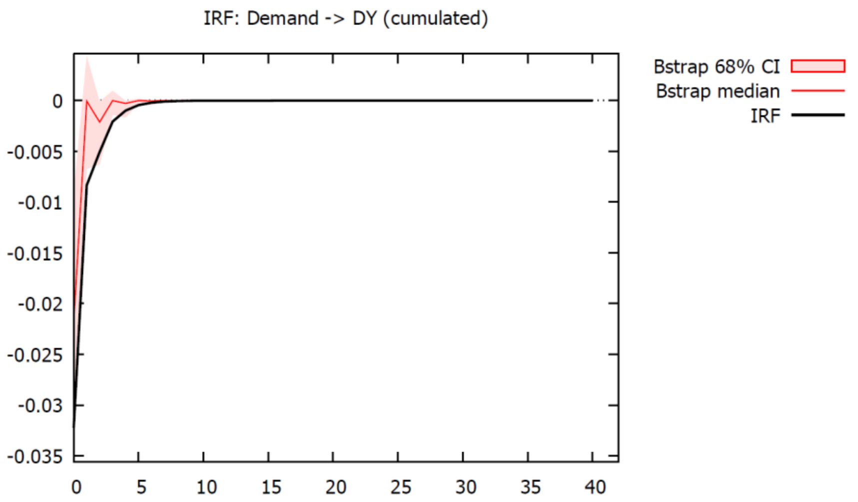

Figure 111. IRF of demand on the level of output for Sweden.

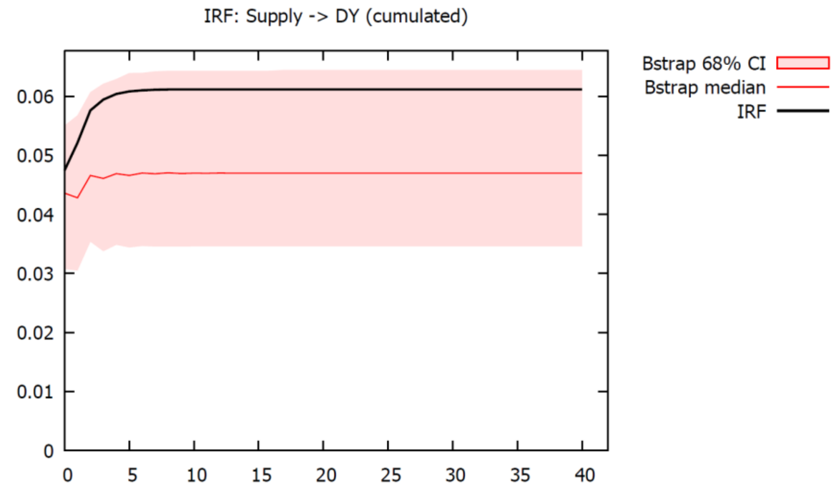

Figure 112. IRF of supply on the level of output for Sweden.

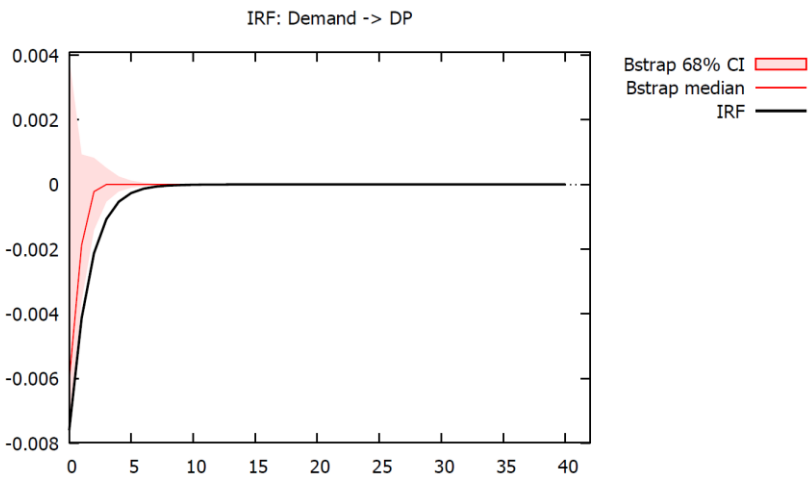

Figure 113. IRF of demand on inflation for the United Kingdom.

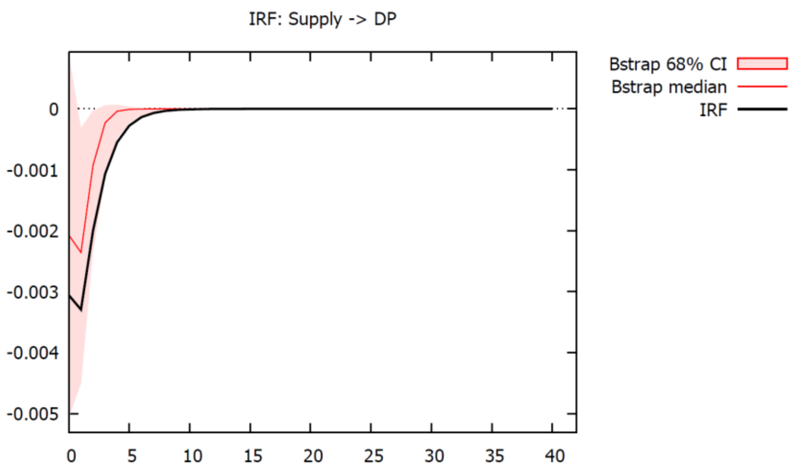

Figure 114. IRF of supply on inflation for the United Kingdom.

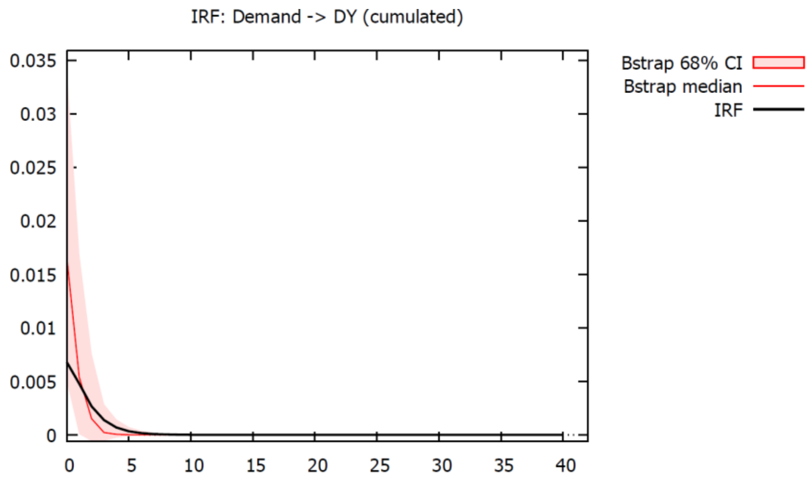

Figure 115. IRF of demand on the level of output for the United Kingdom.

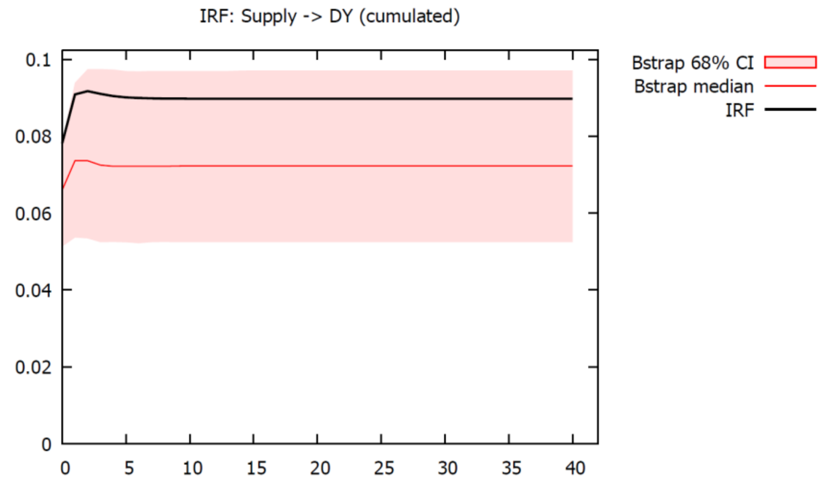

Figure 116. IRF of supply on the level of output for the United Kingdom.