ECB Information Shocks*

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Abstract

This paper examines whether the immediate reaction of the Stoxx50 index to an unexpected change in the interest rate is predictive for the reaction of the Spanish economy. We find evidence that a tighter monetary policy, if accompanied by an immediate increase in the Stoxx50 index, is expansionary for the Spanish economy. We argue that this provides evidence that the ECB conveys information to Spanish agents about economic fundamentals of the Spanish economy.

Keywords: Information Effects, Monetary Policy Shocks, Open Economy New Keynesian Model
JEL Codes: E30, E40, E50

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I Introduction

The widespread use of monetary policy by central banks worldwide contrasts with the lack of empirical evidence on the impact that these tools have on the economy. It is difficult to estimate the causal impact of these interventions because they are usually endogenous responses to other economic conditions. Isolating the effect of monetary policy, thus, is far from trivial.

In addition, monetary policy is frequently accompanied by a transfer of information to the public (Romer & Romer (2000)). The magnitude of this information shock can be substantive: in contrast to the theoretical prediction of the contractionary effects of a tightening of monetary policy, Jarociński & Karadi (2020) show that an unexpected increase in the interest rate can have expansionary effects.

The identification problem is pervasive throughout the recent empirical literature on monetary policy. An approach that has been proposed by Jimenez et al. (2014) exploits heterogeneity in a monetary union to argue for the exogeneity of monetary policy in some peripherical members of the union. In particular, they set forth the claim that interest rates in the Euro area are set without considerations to economic conditions in Spain.

My paper critically assesses the empirical validity of this strategy. In particular, I study whether regional disparities in the Euro area are sufficient to claim that monetary policy is exogenous for peripherical markets such as Spain. I provide evidence that the reaction of the Spanish economy depends on the information content of monetary policy shocks, measured using the methodology proposed by Jarociński & Karadi (2020) that uses a high-frequency identification strategy with stock market data. Consistent with standard economic theory, I estimate impulse response functions to find that an unexpected increase in the interest rate accompanied by a decrease in the Stoxx50 index depresses economic activity. If, instead, the shock is accompanied by an increase in the stock index, monetary policy is associated with

an expansion of Spanish output.

I interpret these results as evidence against the identification strategy in Jimenez et al. (2014). An expansionary effect may be reconciled with the exogeneity of monetary policy if the increase in output is due solely to spillovers from the central economies in the Euro area. To disentangle the effects of spillovers and information effects, I propose a simple model to rationalize the differential response that I observe in the data. My model has the advantage of provididing a testable implication to disentangle information effects from spillover effects. In particular, I show that a shock to foreign output increases domestic output and prices but improves the trade balance. Instead, an information shock has similar effects on output and inflation but it worsens the trade balance. Therefore, I am able to classify shocks and empirically evaluate the validity of the strategy in Jimenez et al. (2014). The intuition of the model is simple. If a country's trading partners improve their economic outlook they import more, causing the net exports of the home country to increase. If, instead, the domestic economy expands due to more optimistic expectations, the domestic economy imports more, causing net exports to decrease.

The paper suffers from the limitation that it does not propose a way to model a currency union between two countries. It also models the foreign country as exogenous and, thus, is silent on issues related to feedback from the domestic economy to the foreign economy. In addition, information effects are included ad hoc by assuming that a change in the interest rate can influence the natural interest rate.

There is a vast literature on the subject of monetary policy which this paper contributes to. Christiano et al. (2005), Romer & Romer (2004), Cochrane & Piazzesi (2002) and Kuttner (2001) are concerned with identifying monetary policy shocks. Gertler & Karadi (2015) look at credit costs applying a high-frequency approach. Regarding information effects, Melosi

(2017) and (Nakamura & Steinsson, 2018) consider information effects for a closed economy. Spillovers between open economies are considered by Jang & Okano (2015), though, they consider the spillover effects of shocks to technology. Considering spillovers in a two-country framework is also done by R. H. Clarida (2009).

The rest of the paper is organized as follows. Section II describes the data used, section III explains the econometric approach, section IV is dedicated to the main results, section V develops an open economy New Keynesian model with information effects, section VI discusses plausible explanations for the results obtained in the empirical part of the paper, and finally section VII concludes.

II Econometric Approach

This paper will follow the same approach as Jarociński & Karadi (2020). For the reader's convenience, the econometric strategy will briefly be summarized below. For a more extensive treatment, the reader is referred to the aforementioned paper.

The authors measure the change in the 3-month Eonia swaps and the Stoxx50 index[1] in a 30-minute window around the press statements or press conferences made by the ECB. To identify MP shocks and CBI shocks from this data set, (Jarociński & Karadi, 2020) define a monetary policy shock as the change in the 3-month Eonia swaps in the months where the correlation between the change in this rate and the Stoxx50 index was negative. Otherwise, the monetary policy shocks will be zero. In months with more than two monetary policy shocks, we will simply add the sum of the change in the 3-month Eonia swaps. Information shocks will, on the other hand, be defined as the change in the 3-month Eonia swaps when there was a change of the *same* sign in the Stoxx50 index. In months with no information shock, we will set the shock to 0. They call this the poorman's sign restrictions. As pointed

[1]The European Stock index.

out by Jarociński & Karadi (2020) this is paramount to assuming that each announcement can be considered either a pure monetary policy shock or a pure central bank information shock.

Trivially, each announcement will in practice be a combination of a monetary policy shock and an information shock. Making this sharp distinction for each announcement gives an attenuation bias to the chosen empirical approach. We may therefore expect the confidence interval of the estimated coefficients to provide a lower bound of the true values.

A VAR model will be estimated by using a Choleski decomposition. The shocks, monetary policy shock or CBI shocks, are placed first. That is to say that these shocks are orthogonal to the macroeconomic variables. The VAR is the following

$$\begin{pmatrix} m_t \\ y_t \end{pmatrix} = \sum_{p=1}^{P} \begin{pmatrix} 0 & 0 \\ B_{YM}^{p} & B_{YY}^{p} \end{pmatrix} \begin{pmatrix} m_{t-p} \\ y_{t-p} \end{pmatrix} + \begin{pmatrix} 0 \\ c_Y \end{pmatrix} + \begin{pmatrix} u_t^m \\ u_t^y \end{pmatrix}$$

m_t denotes the shocks that are either a monetary policy shock or a CBI shock. y_t denotes the macro variables industry production, inflation, and the trade balance in goods between Spain and the Euro area in the baseline estimation.

We emphasize that we use the shocks identified for the Euro area. We would like to examine if the response of the Spanish economy to an increase in the 3-month Eonia swaps is dependent on the immediate reaction of the Stoxx50 index.

III Data

This section describes the data that we will employ to estimate impulse response functions for the Spanish economy in response to a change in the 3-month Eonia[2] swaps. In appendix A we provide links to all of the data sources to ease the replication of the results obtained for Spain.

The response of the Eonia Swaps is interesting as it provides us with a measure for the unexpected change in the interest rate that has been brought about by an ECB press conference. The change is measured as the change in the 3-month Eonia swaps in a 30-minute window around the press statements or press conferences. The window starts 10 minutes before either a press statement or a press conference, and it ends 20 minutes after. This data has been provided by Jarociński & Karadi (2020). We stress that the data used for MP shocks and CBI shocks are for the Euro area. In this thesis, we just seek to examine if the response to the Spanish economy to these shocks resembles the response of the Euro area to these same shocks.

The data that we have collected for the Spanish economy is described in table 1. In appendix A, we provide links to the data sources to ease access to the data and to facilitate the replication of the results.

[2]The Euro Over-Night Index Average.

Variable	**Abbreviated Name**	**Data source**
Consumer Price Index	CPI	FRED
Production of Total Industry in Spain	PROD	FRED
Importaciones De la zona del euro	ImportEA	Banco de España
Exportaciones a la zona del euro	ExportEA	Banco de España
pmposm_eureon3mstoxx50	CBI shock	Jarociński & Karadi (2020)
pmnegm_eureon3mstoxx50	MP shock	Jarociński & Karadi (2020)
Net trade between Spain and the world	TB_{world}	FRED
Trade Balance with Euro Area	TB_{EA}	Banco de España
Net trade between Spain and the world	TB_{world}	FRED
Spanish Consumer Confidence	ConsumerConfidence	FRED

Table 1: Data

The data covers the period March 1999 to December 2016, which is the sample period that we will use to estimate the response of the Spanish economy. All variables for the Spanish economy are measured at monthly frequencies.

BoP states the balance of payments between Spain and the rest of the world. TB_{EA}, instead, states the trade balance between Spain and the Euro area. It has been calculated as the difference between $Exports_{EA}$ and $Imports_{EA}$.

Figure 1 provides a graphical illustration of the data.

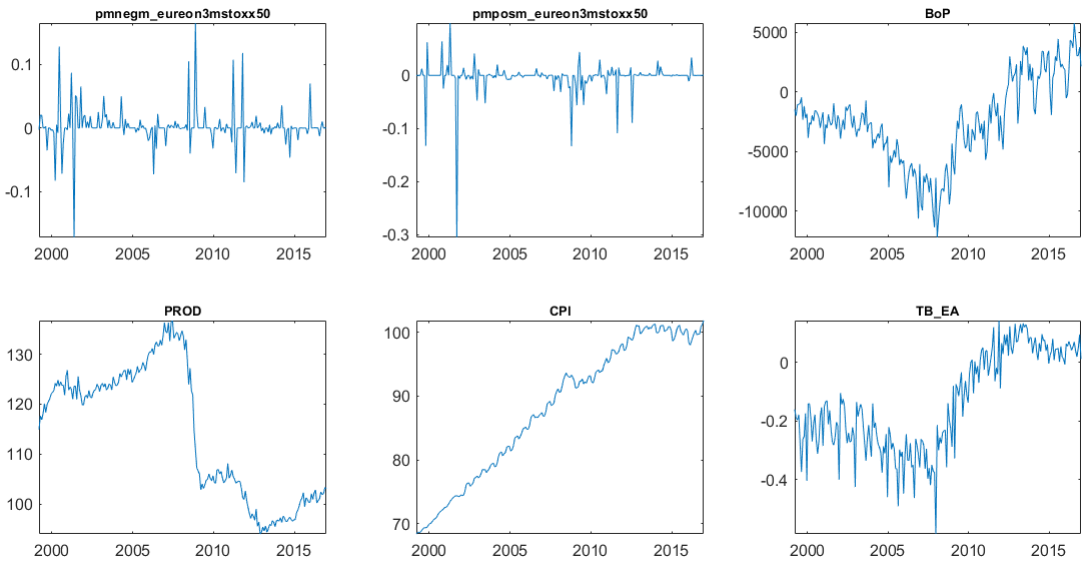

Figure 1: Graphical illustration of the data

Note the sharp drop in industry production in 2008 during the financial crisis. To test if our results are robust to the exclusion of this year, we will also estimate impulse response functions on two samples that both exclude the year of 2008. They will be from March 1999 to December 2007 and January 2009 to December 2016, respectively.

We notice that the Spanish economy seems to have become more competitive over time as we see an improvement both in the balance of payments with the rest of the world, and in the trade balance with the Euro area. In addition, we have data for Spanish consumer confidence. A direct link to these data is also provided in appendix A.

IV Results

This section presents the empirical results of the paper. It reports the impulse response functions of the Spanish economy for the shocks that (Jarociński & Karadi, 2020) have identified for the Euro area.

A standard monetary policy shock (MP shock, henceforth) is defined as an unexpected increase in the interest rate accompanied by a simultaneous decrease in the Stoxx 50 index. A Central Bank information shock (CBI shock, henceforth) is defined as an unexpected increase in interest rate accompanied by an immediate increase in the Stoxx50 index.

The main results are presented in figures 2 and 3. They both show the impulse response functions of the Spanish economy in reaction to a MP shock (left column) and a CBI shock (right column), respectively. In figure 2 we display the response of the Stoxx50 index, Spanish industry production, Spanish consumer prices and the trade balance in goods between Spain and the Euro area.

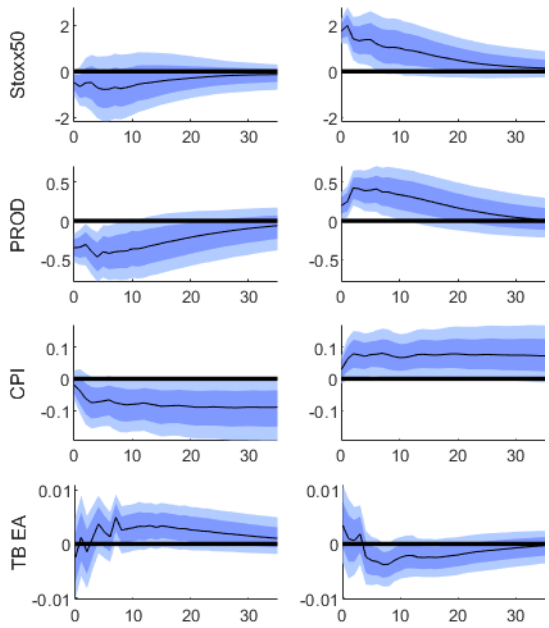

Figure 2: percentiles 16-84 (darker band), percentiles 5-95 (lighter band). MP shock to the left. CBI shock to the right.

It follows from the figure that a MP shock is associated with a decrease in industry production and prices. The effect on industry production appears to be temporary while prices show a more persistent reduction. The results for the trade balance between Spain and the

Euro area are less clear but it does appear that Spanish trade balance improves. Hence, we find evidence suggesting that exports increase more than imports.

Regarding a CBI shock we find that there is an increase in industry production as well as consumer prices. These results are the same as in (Jarociński & Karadi, 2020) who study the Euro area. The results are less clear for net exports in goods to the Euro area but it appears that the Spanish trade balance worsens after an information shock.

The impulse response functions after an unexpected increase in the interest rate, characterized as a MP shock, are consistent with the predictions of standard economic theory. The positive effects on the Spanish economy after an increase in the interest rate, characterized as an information shock, cannot be explained by a standard New Keynesian model. Taken together, we replicate for Spain what Jarociński & Karadi (2020) have found for the Euro area. In addition, we find some evidence indicating an improvement of the Spanish trade balance with the Euro area after a standard monetary policy shock, and a worsening after an information shock.

In figure 3 we report the results for net trade between Spain and the rest of the world. TB world denotes the net trade between Spain and the rest of the world in billions of dollars.

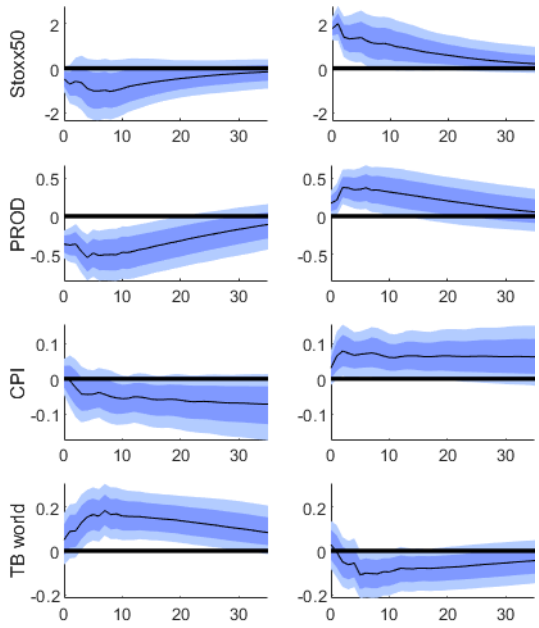

Figure 3: percentiles 16-84 (darker band), percentiles 5-95 (lighter band). MP shock to the left. CBI shock to the right.

The results are similar to those where we use the trade balance between Spain and the Euro area. We do, however, find that net trade increases significantly in response to an increase in the interest rate when the shock is characterized as a monetary policy shock. We find some evidence that it worsens after a CBI shock.

Notice that these two different types of shocks to the interest rate are associated with very different impulse response functions. A standard monetary policy shock is contractionary while a CBI shock is expansionary.

We find a worsening of the trade balance for Spain with the world. We speculate that this is due to the fact that the information effects are present for Spain causing, *ceteris paribus*, Spanish imports to increase while the information effects are absent for non-Euro area countries thus not having an effect on these countries' imports.

In summary, we find evidence that the immediate reaction of the Stoxx50 index is infor-

mative of the effect that a change in the interest will have on the Spanish economy. This is the same conclusion reached by Jarociński & Karadi (2020) for the Euro area.

The observation that CBI shocks are expansionary has commonly been interpreted as evidence that Central Banks provide information about economic fundamentals to economic agents. The intuition is that the Central Bank responds to economic fundamentals and has an informational advantage as argued by (Romer & Romer, 2000).

Interpreting the results for Spain as evidence that the ECB responds to the economic fundamentals of the Spanish economy would thus imply that it is not possible to separate monetary policy from economic conditions, as in (Jimenez et al., 2014). We do, however, face a challenge when making the claim that the approach followed in that paper is flawed. It may be that the reaction of the Spanish economy is due to spillover effects from the Euro area to Spain. That is, a CBI shock is associated with expansionary effects for the Euro area, and this may have expansionary effects for Spain due to spillover effects. The next section will therefore develop an open economy New Keynesian Model which will allow us to think clearly about these issues.

As a robustness check, we will now consider different subsamples. We will consider the period March 1999 to December 2007, and the period January 2009 to December 2016. We exclude the year of 2008 as there was a very sharp drop in industry production due to the financial crisis. The results are presented in figures 4 and 5, respectively.

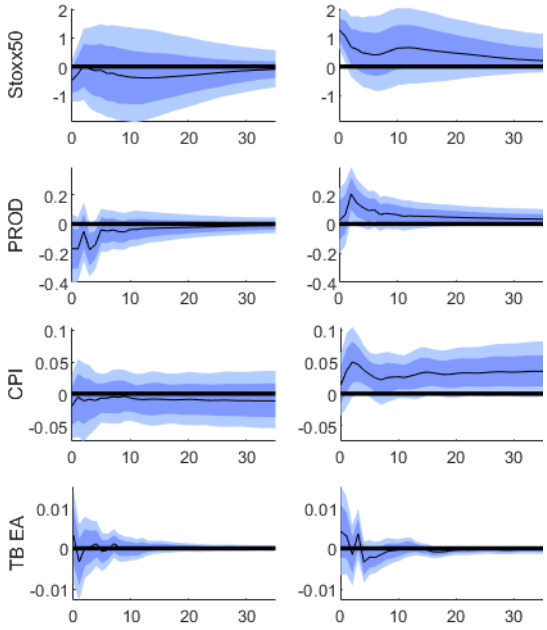

Figure 4: percentiles 16-84 (darker band), percentiles 5-95 (lighter band). MP shock to the left. CBI shock to the right.

From figure 4 we see that the Spanish economy is less responsive to a change in the interest rate in the period leading up to the financial crisis. We do, however, find that the response of the Spanish economy seems to depend on the immediate reaction of the Stoxx50 to an unexpected change in the interest rate even though the trade balance between Spain and the Euro area seems to be more or less unaffected.

In figure 5 we show the results where the sample period is after the 2008 crisis.

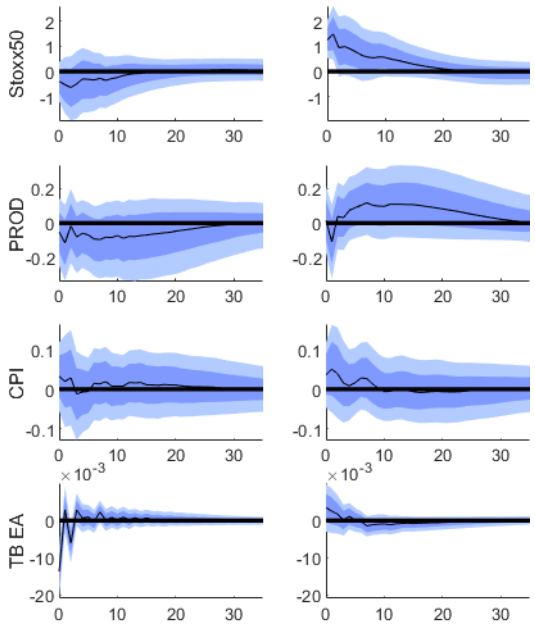

Figure 5: percentiles 16-84 (darker band), percentiles 5-95 (lighter band). MP shock to the left. CBI shock to the right.

For the period after the financial crisis, we see that the impulse response functions have the same signs as for the entire sample. However, we have a large degree of uncertainty in these estimates, and so the evidence from this period is far from conclusive. Still, we see that, once again, the two shocks appear qualitatively different.

Nakamura & Steinsson (2018) consider the effect that these shocks have on expected future output growth. Inspired by this approach, we will consider the possibility that an increase in the interest rate affects consumer confidence differently depending on whether we consider it a MP shock or a CBI shock.

To do this we estimate the following regression

$$\Delta ConsumerConfidence_{t+1,t} = \beta_0 + \beta_1 MP_t + \beta_2 CBI_t + \epsilon_t$$

where we define $\Delta ConsumerConfidence_{t+1,t} = ConsumerConfidence_{t+1} - ConsumerConfidence_t$

where consumer confidence is in logs. The results are reported in table 2 below.

	$\Delta ConsumerConfidence_{t+1,t}$
CBI shock	0.00515
	(1.26)
MP shock	-0.00275
	(-0.66)
Constant	-0.0000135
	(-0.11)
Observations	213

t statistics in parentheses

Table 2: Regression results

Nakamura & Steinsson (2018) find that information shocks significantly increase expected output growth. If CBI shocks are informative about future economic growth, we would expect an increase in consumer confidence, instead tighter monetary policy is negative for the economy so confidence is expected to decrease. We find that the coefficients have the expected signs, but the results are not significant.

V Model of ECB information effects

In this section we will consider a simple open economy New Keynesian model. We will show the impulse response functions in response to a foreign output shock, and to an increase in the interest rate in the presence of information effects. The model that we will follow will be a simple two-country version of the Galí & Monacelli (2005) model. This approach has also been taken by Jang & Okano (2015) to consider spillovers in the presence of technological shocks. Below we will briefly describe the model. The idea is to have a model that will allow us to think about foreign output shocks and information effects. We will closely follow Nakamura & Steinsson (2018) when modelling information effects.

The Economic environment

The home economy is composed of households and final output producers. Households derive utility from consumption and leisure. They supply labor to intermediate goods producers for which they are remunerated by a wage. The problem of the representative household is the following

$$\max_{\{C_t, N_t, D_{t+1}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [B_t \frac{C_t^{1-\sigma}}{1-\sigma} - B_t \frac{N_t^{1+\phi}}{1+\phi}]$$

subject to

$$P_t C_t + \mathbb{E}_t[Q_{t,t+1} D_{t+1}] = W_t N_t + D_t + \Gamma_t$$

$Q_{t,t+1}$ is the price of a risk free bond with a gross return of 1, D_t denotes the quantity of the risk free bond, W_t is the wage, N_t is hours worked, and finally Γ_t is lump sum profits received from ownership of final goods producers.

B_t is a preference shock. It was introduced by Nakamura & Steinsson (2018) as a way of modelling information effects. They assumed a more general specification as they stated the household utility as

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [u(C_t, \Psi_t) - v(L_t, \Psi_t)]$$

The specific formulation we have chosen implies that there are periods of time where consumption and leisure, respectively, are more valued. We suppose that B_t is a random variable independent of consumption and leisure. Households thus have to form expectations about the path of B_t.

P_t is the price of the composite consumption index C_t. Galí & Monacelli (2005) define the composite consumption index as follows

$$C_t = [(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} (C_{F,t})^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}$$

where $C_{H,t}$ denotes consumption of the consumption good produced in the home country at time t, and $C_{F,t}$ denotes consumption of the foreign output good at time t. The parameter α is a measure of the openness of the economy. The higher α, the more open the economy. η is a measure of the degree of substitutability between foreign and home goods.

Further, we suppose that the consumption goods $C_{H,t}$ can be aggregated as follows

$$C_{H,t} = \left(\int_0^1 C_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$
$$C_{F,t} = \left(\int_0^1 C_{F,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

where $C_{H,t}(j)$ is produced by firm j in the home country, and $C_{F,t}(j)$ is produced by firm j in the foreign country.

We see that goods produced domestically are imperfect substitutes providing each final output producer with some market power. The price index in the economy is a composite index of prices in the domestic economy and in the foreign economy

$$P_t = ((1-\alpha)(P_{H,t})^{1-\eta} + \alpha(P_{F,t})^{1-\eta})^{\frac{1}{1-\eta}}$$

(Galí & Monacelli, 2005) shows that this description gives rise to the following optimality conditions.

$$C_{H,t} = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\eta} C_t$$
$$C_{F,t} = \alpha(\frac{P_{F,t}}{P_t})^{-\eta} C_t$$

and we notice that the foreign demand for the goods produced by the home country will be

$$C^*_{F,t} = (1-\alpha)(\frac{P_{F,t}}{P^*_t})C^*_t$$

where a star denotes the foreign economy such that $C^*_{F,t}$ is the foreign demand for the good produced in the home country.

We see that demand for goods produced in the home country is decreasing in the price of home goods while it is increasing in the consumption level. The higher C^*, the higher the demand for home goods causing, *ceteris paribus*, the home country to export more.

Utility maximization of the household problem gives rise to the familiar Euler equation

$$Q_{t,t+1} = \beta \mathbb{E}_t[(\frac{C_{t+1}}{C_t})^{-\sigma} \frac{P_t}{P_{t+1}} \frac{B_{t+1}}{B_t}] \tag{1}$$

and the intra temporal optimality condition

$$\frac{W_t}{P_t} = N_t^{\phi} C_t^{\sigma} \tag{2}$$

We see that the higher the level of consumption, the lower the labor supply holding the other parameters constant. This is the so-called wealth effect. It implies that a lump sum transfer to households will discourage labor effort and depress output. We notice that the preference shock does not influence labor supply. This is due to the strong assumption that the marginal utility of consumption and the marginal utility of leisure are influenced equally such that the trade off between working and consuming in the present is unaffected, as is seen from equation (2). For derivations of equations (1) and (2), we refer the reader to appendix B.

Producers of the consumption good produce according to the following production tech-

nology

$$Y_t(j) = AN_t(j)$$

Unlike Jang & Okano (2015) we will assume that technology is not time dependent.

We assume that prices are not perfectly flexible. In particular, we will follow Calvo (1983) and assume that each firm faces an independent probability $(1-\theta)$ each period of being able to change its price.

Hence, the problem faced by the intermediate goods producers is

$$\max_{P^0_{H,t}(j)} \mathbb{E}_t \left[\sum_{k=0}^{\infty} \theta^k Q_{t,t+k} Y_{H,t+k}(j) \left[P^0_{H,t}(j) - P_{H,t+k} MC_{t+k} \right] \right]$$

where an equilibrium condition is

$$Y_t(h) = C_t(h) + C^*_t(h)$$

and $C_t(h)$ is domestic demand for good h, and $C^*_t(h)$ is foreign demand for good H. Jang & Okano (2015) show that this gives rise to the following optimal price

$$P^0_{H,t}(j) = \frac{\epsilon}{\epsilon - 1} \frac{\mathbb{E}_t[\sum_{k=0}^{\infty} \theta^k Q_{t,t+k} Y_{H,t+k}(j)[P_{H,t+k} MC_{t+k}]]}{\mathbb{E}_t[\sum_{k=0}^{\infty} \theta^k Q_{t,t+k} Y_{H,t+k}(j)]}$$

Hence, firms will set the price as a markup over weighted expected future marginal costs.

Due to the assumption of Calvo price setting, prices in the home country can be written as follows

$$P_{H,t} = [\theta P_{H,t-1} + (1-\theta) P^0_{H,t}]^{\frac{1}{1-\epsilon}} \tag{3}$$

which combined with the optimal price can be derived to give the New Keynesian Phillips curve. See Galí & Monacelli (2005) for a derivation.

$$\pi_t = \mathbb{E}_t[\pi_{t+1}] + \lambda x_t \tag{4}$$

Where $\lambda = \frac{(1-\beta\theta)(1-\theta)}{\theta}(\frac{\sigma}{(1-\alpha)+\alpha\omega} + \phi)$ and x_t denotes the output gap in the economy. This is the New Keynesian Phillips curve of the model. It relates the output gap to inflation. The higher the output gap, the higher the level of inflation.

We will now consider the demand side of this economy as summarized by the IS-curve. We notice that in equilibrium we have

$$Y_t(h) = C_t(h) + C_t^*(h)$$
$$Y_t^*(f) = C_t(f) + C_t^*(f)$$

where a variable denoted with a star denotes the foreign country such that $C_t^*(h)$ is the foreign demand for the consumption good produced by firm h in the home country.

(Jang & Okano, 2015) show that this can be log-linearized to yield

$$y_t = c_t + \frac{\alpha[2(1-\alpha)(\sigma\eta - 1) + 1}{\sigma} s_t$$

Insert this together with

$$\pi_t = \pi_{H,t} + \alpha(s_t - s_{t-1})$$

in the log-linearized Euler equation to obtain

$$y_t = \mathbb{E}_t[y_{t+1}] - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{H,t+1}]) - \frac{2\alpha(1-\alpha)(\sigma\eta - 1)}{\sigma}\Delta s_{t+1} - \frac{1}{\sigma}\Delta B_{t+1} \tag{5}$$

The derivations are shown in appendix C. s_t denotes the terms of trade and are defined by $s_t \equiv \frac{P_{F,t}}{P_{H,t}}$ and Jang & Okano (2015) show that they can be written as

$$s_t = \frac{\sigma}{4\alpha(1-\alpha)(\sigma\eta - 1) + 1}(y_t - y_t^*)$$

From this we can arrive at the IS curve expressed in terms of output gap

$$x_t = \mathbb{E}_t[x_{t+1}] - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{H,t+1}] - r_t^n)$$

where we have defined

$$x_t = y_t - \bar{y}$$

and we have exploited that the natural level of output is constant as we consider a model with o variation in technology. The natural interest rate is defined as[3]

$$r_t^n = 2\alpha(1-\alpha)(1-\sigma\eta)(\Delta s_{t+1}) - \Delta b_{t+1}$$

The natural interest rate denotes the real interest rate that is consistent with a zero-inflation steady state with no output gap.

An interesting variable is net exports (nx). We have that

$$nx_t = \frac{1}{Y}(Y_t - \frac{P_t}{P_{H,t}})C_t$$

Jang & Okano (2015) show that this can be written as

$$nx_t = \alpha(\frac{\omega}{\sigma} - 1)s_t \quad \omega \equiv 2(1-\alpha)(\sigma\eta - 1) + 1$$

[3]See appendix C for a derivation

To close the model, we need to specify a rule for the interest rate. In the baseline case, we will assume that the Central Bank follows a Taylor rule where they track the natural interest rate.

$$r_{H,t} - \mathbb{E}_t[\pi_{H,t+1}] = \rho r^n_{H,t} + \phi_\pi \pi_{H,t}$$

We will model the foreign country as exogenous. Thus, we implicitly make the assumption that the home country is small enough not to have an impact on the foreign country, but we allow for the foreign country to impact the home country. Hence, we will simply describe the foreign country by its level of output. This follows the approach taken by R. Clarida et al. (2002).

Information Effects

Above we laid out the building blocks of the open economy New Keynesian model that we will use in this section to think about information effects. The idea of information effects in a New Keynesian model was pioneered by Nakamura & Steinsson (2018). They argued that announcements from the FED did not only affect future beliefs about monetary policy but also affect the beliefs of economic agents about other economic fundamentals. Nakamura & Steinsson (2018) further argue that their empirical results are consistent with the idea that expectations about the natural interest rate are influenced by announcements from the FED. They argue that a natural way to model information effects is by having Central Bank announcements influence beliefs about the natural interest rate.

They assume that expectations about the natural interest rate shifts with some fraction as expressed in the following equation[4]

$$\mathbb{E}_t \hat{r}^n_{t+j} = \Theta \mathbb{E}_t \bar{r}_{t+j}$$

[4]They use ψ instead of Θ

where they define

$$\bar{r}_t = (\rho_1 + \rho_2)\bar{r}_{t-1} - \rho_1\rho_2\bar{r}_{t-2} + \epsilon_t$$

with ϵ_t denoting the shock to the process. They assume that the Central bank follows the following Taylor rule

$$i_t - \mathbb{E}_t[\pi_{t+1}] = \bar{r}_t + \phi_\pi \pi$$

In a model without information effects Θ would be zero as the Central Bank only informs agents about the stance of monetary policy but not about other economic fundamentals. Hence a shock to $\bar{r}$ would not change the expected path of the natural interest rate.

In our setup, we have that the natural interest rate is given by

$$r_t^n = 2\alpha(1-\alpha)(1-\sigma\eta)(\Delta s_{t+1}) - \Delta b_{t+1}$$

Inspired by the approach pioneered by Nakamura & Steinsson (2018) we will suppose that economic agents perceive a change in the interest rate as also reflecting news about economic fundamentals. We will assume that

$$\mathbb{E}_t[-\Delta b_{t+1}] = \Theta\epsilon_t$$

where Θ denotes the strength of the information effect, and ϵ_t is the shock to the interest rate. The intuition is that agents will perceive that there will be a preference shock in the future when the Central Bank increases the interest rate. This is a way of modelling the idea that the Central Bank conveys information to economic agents about economic fundamentals and not just monetary policy.

Impulse response functions of the model

In this section we will present the reaction of the economy to a foreign output shock in the absence of information effects. We will thereafter consider an increase in the interest rate in the presence of information effects.

Regarding the deep parameters, we will consider the values stated in table 2.

ϕ_{pi}	σ	ϕ	η	β	ϕ_π	α	θ	ρ	ρ_y
0.1	1	1	0.5	0.99	0.05	0.5	0.75	0.8	0.8

Table 3: Parameter values

We shock foreign output by ν_t, and assume that foreign output (y^*) follows the following AR(1) process

$$y_t^* = \rho_y y_{t-1}^* + \nu_t$$

The impulse response functions are reported in figure 6.

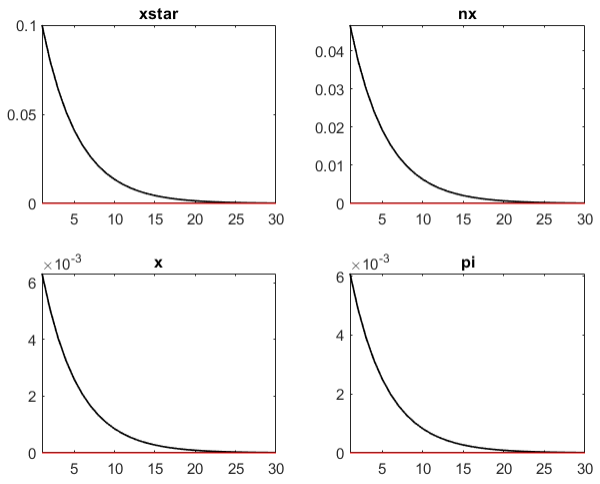

Figure 6: IRFs to a shock to foreign output

We see that an increase in foreign output is associated with an increase in output, inflation and net exports for the home country. This result appears intuitive. There is an expansion in the foreign country causing them to consume more. Therefore, they import more of the foreign good causing net exports to increase for the home country.

We notice that a shock to foreign output cannot easily explain the results in the empirical section of this paper. With the chosen parameter values, we find an increase in output and inflation in the home country but only an improvement of the trade balance. Empirically it seems that the Spanish trade balance worsens both with the world and the Euro area when there is an information shock. Thus, we find it hard to reconcile this finding with the idea that Spain is purely affected by spillover effects.

We previously assumed that the Central Bank followed the following Taylor rule

$$r_t - \mathbb{E}_t[\pi_{t+1}] = \rho r_t^n + \phi_\pi \pi_t + \epsilon_t$$

We will give a shock ϵ_t to the interest rate where we assume that ϵ_t follows an AR(1) process. We suppose that information effects are present. The figure below reports the impulse response function for an increase in the interest rate where we consider $\Theta = 5.5$. The higher Θ, the stronger the information effect. The standard case with no information effects are tantamount to the assumption that $\Theta = 0$.

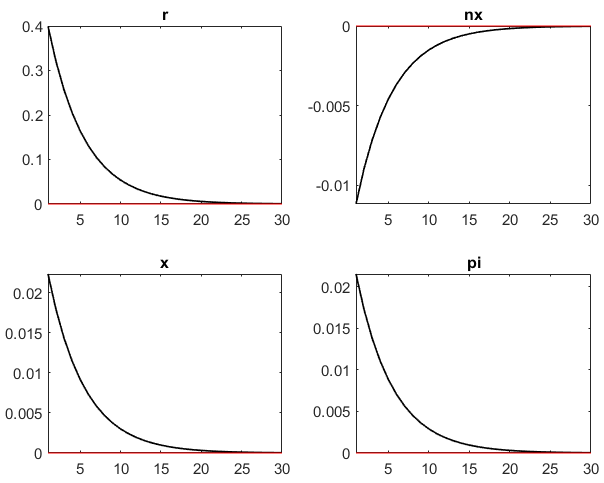

Figure 7: IRFs to a CBI shock

We see that this kind of shock is associated with an expansion of the economy as economic agents will perceive the interest rate to be below the natural interest rate. The impulse responses show an increase in output and prices but a worsening of net exports.

With this model's framework in mind, we thus consider it plausible that information effects can partly explain why the Spanish economy expands after an increase in the 3-month Eonia swaps.

We acknowledge that Jarociński & Karadi (2020) find that these shocks also have an expansive effect on the Euro area. However, due to the fact that Spanish imports increase more than exports after this kind of shock, we find it unlikely that the impulse response of industrial production and CPI is driven solely by spillover effects from the Euro area.

VI Discussion

In the empirical section of the paper, we were able to replicate the empirical results that Jarociński & Karadi (2020) have found for the Euro area for Spain. They argue that the

expansive effects of an increase in the interest rate can be rationalized by the presence of information effects.

The results for Spain are analogous to those found by Jarociński & Karadi (2020). This can be interpreted as evidence that the ECB conveys information to Spanish agents about economic fundamentals. It would, thus, be difficult to argue that monetary policy is unrelated to Spanish economic conditions.

Naturally, it may be that these results are also rationalizable by spillovers from the Euro area. However, the combination of an increase in production and prices and a *decrease* in net exports is hard to reconcile with an effect fully explained by spillovers.

A careful treatment of the effects of a currency union would increase the credibility of the model. In addition, it is necessary to carefully calibrate the parameter values used to compute the theoretical impulse response functions since the results are sensitive to the initial parameter choices.

Taken together, we find suggestive evidence that the ECB conveys information to economic agents in Spain about the outlook of the Spanish economy. Therefore, empirical approaches that think about monetary policy in Spain as exogenous are likely to confound the proper effects of monetary policy from those derived from an information shock induced by the policy change.

VII Conclusion

The causal impact of monetary policy on economic activity is an elusive topic since monetary policy is usually an endogenous response to underlying economic conditions. We evaluate the empirical validity of using heterogeneity in a currency union to argue for the exogeneity of monetary policy in peripherical economies, using the case of Spain. We find that an unexpected increase in the interest rate is sometimes expansionary. In these cases, the Spanish trade balance worsens. We argue that this is suggestive of an improvement in the economic outlook of agents due to an information shock. We use an open economy New Keynesian model to rationalize the responses we observe in the data.

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VIII Appendix

Appendix A: Data

We provide links to directly access the data used in the thesis for ease of replication.

To get access to the data used for Spanish industry production the following link can be used

https://fred.stlouisfed.org/series/ESPPROINDMISMEI

To get access to the data on Spanish consumer prices, the following link can be used

https://fred.stlouisfed.org/series/ESPCPIALLMINMEI

To get access to the data for Spanish imports and exports to the Euro Area, the following link can be used

https://www.bde.es/webbde/en/estadis/infoest/bolest18.html

To get access to the data on Spanish share pries the following link can be used

https://fred.stlouisfed.org/series/ESPLOCOSPORIXOBM

To access the data used for consumer confidence, please access the following link

https://fred.stlouisfed.org/series/CSCICP03ESM665S

To access the data used for net trade with the rest of the world the following link can be accessed:

https://fred.stlouisfed.org/series/ESPXTNTVA01CXMLM

VIII.I Appendix B: The household's Problem

The household problem is the following

$$\max_{\{C_t,N_t\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [\frac{B_t C_t^{1-\sigma}}{1-\sigma} - \frac{B_t N_t^{1+\phi}}{1+\phi}]$$

subject to

$$P_t C_t + \mathbb{E}_t[Q_{t,t+1} D_{t+1}] = W_t N_t + D_t + \Gamma_t$$

Consider the Lagrangian function

$$\mathcal{L}(C_t, N_t, D_t, \lambda_t) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi}] + \lambda_t [W_t N_t + D_t + \Gamma_t - P_t C_t - \mathbb{E}_t[Q_{t,t+1} D_{t+1}]]$$

The first order conditions are

$$\frac{\partial \mathcal{L}}{\partial C_t} = 0 : \beta^t B_t C_t^{-\sigma} = \lambda_t P_t \tag{6}$$

$$\frac{\partial \mathcal{L}}{\partial N_t} = 0 : B_t \beta^t N_t^{\phi} = \lambda_t W_t \tag{7}$$

$$\frac{\partial \mathcal{L}}{\partial D_{t+1}} = 0 : \lambda_t Q_{t,t+1} = \lambda_{t+1} \tag{8}$$

Combining (8) and (10) yields

$$Q_{t,t+1} \frac{1}{P_t} \beta^t C_t^{-\sigma} B_t = \beta^{t+1} E_t[C_{t+1}^{-\sigma}] \frac{1}{P_{t+1}} B_{t+1}$$

Solving for $Q_{t,t+1}$ yields

$$Q_{t,t+1} = \beta \mathbb{E}_t[(\frac{B_{t+1}C_{t+1}}{B_t C_t})^{-\sigma}] \frac{P_t}{P_{t+1}} \frac{B_{t+1}}{B_t}$$

This is equation (1) in the paper.

Combining (7) and (8) yields

$$\beta^t N_t^{\phi} B_t = \beta^t C_t^{-\sigma} \frac{1}{P_t} W_t B_t$$

Solving for the real wage we obtain

$$\frac{W_t}{P_t} = N_t^{\phi} C_t^{\sigma}$$

This is equation (2) in the paper.

Appendix C: IS-curve

(Jang & Okano, 2015) reports the following equations.

$$y_t = c_t + \frac{\alpha[2(1-\alpha)(\sigma\eta - 1) + 1]}{\sigma} s_t \tag{9}$$

$$\pi_t = \pi_{H,t} + \alpha(s_t - s_{t-1}) \tag{10}$$

and log-linearizing the Euler equation yields

$$c_t = \mathbb{E}_t[c_{t+1}] - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{t+1}]) - \frac{1}{\sigma}\Delta b_{t+1} \tag{11}$$

We will show how to combine them to obtain equation (5) in this paper. Insert (10) to (11) to obtain

$$c_t = \mathbb{E}_t[c_{t+1}] - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{H,t+1}]) - \frac{\alpha}{\sigma}\Delta s_{t+1} - \frac{1}{\sigma}\mathbb{E}_t[\Delta b_{t+1}] \tag{12}$$

where we have defines $\Delta s_{t+1} = s_{t+1} - s_t$ From equation (12) we know that

$$c_t = y_t - \frac{\alpha[2(1-\alpha)(\sigma\eta - 1) + 1]}{\sigma} s_t$$

Inserting this to equation (12) and solving for y_t yields

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{H,t+1}]) - \frac{\alpha[2(1-\alpha)(\sigma\eta - 1) + 1]}{\sigma}\mathbb{E}_t[\Delta s_{t+1}] - \frac{\alpha}{\sigma}\Delta s_{t+1} - \frac{1}{\sigma}\mathbb{E}_t[\Delta b_{t+1}]$$

Collecting terms yields

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{H,t+1}]) - \frac{\alpha[2(1-\alpha)(\sigma\eta - 1)]}{\sigma}\mathbb{E}_t[\Delta s_{t+1}] - \frac{1}{\sigma}\mathbb{E}_t[\Delta b_{t+1}]$$

This is equation (8) in the paper. Notice, we can write

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}(r_t - \mathbb{E}_t[\pi_{H,t+1}] - r_t^n)$$

with

$$r_t^n = 2\alpha(1-\alpha)(1-\sigma\eta)(\Delta s_{t+1}) - \Delta b_{t+1}$$

IX Summary for LUISS

To comply with the rules of LUISS, I've made the summary below where I've inserted my introduction and my conclusion.

The widespread use of monetary policy by central banks worldwide contrasts with the lack of

empirical evidence on the impact that these tools have on the economy. It is difficult to estimate the causal impact of these interventions because they are usually endogenous responses to other economic conditions. Isolating the effect of monetary policy, thus, is far from trivial.

In addition, monetary policy is frequently accompanied by a transfer of information to the public (Romer & Romer (2000)). The magnitude of this information shock can be substantive: in contrast to the theoretical prediction of the contractionary effects of a tightening of monetary policy, Jarociński & Karadi (2020) show that an unexpected increase in the interest rate can have expansionary effects.

The identification problem is pervasive throughout the recent empirical literature on monetary policy. An approach that has been proposed by Jimenez et al. (2014) exploits heterogeneity in a monetary union to argue for the exogeneity of monetary policy in some peripherical members of the union. In particular, they set forth the claim that interest rates in the Euro area are set without considerations to economic conditions in Spain.

My paper critically assesses the empirical validity of this strategy. In particular, I study whether regional disparities in the Euro area are sufficient to claim that monetary policy is exogenous for peripherical markets such as Spain. I provide evidence that the reaction of the Spanish economy depends on the information content of monetary policy shocks, measured using the methodology proposed by Jarociński & Karadi (2020) that uses a high-frequency identification strategy with stock market data. Consistent with standard economic theory, I estimate impulse response functions to find that an unexpected increase in the interest rate accompanied by a decrease in the Stoxx50 index depresses economic activity. If, instead, the shock is accompanied by an increase in the stock index, monetary policy is associated with an expansion of Spanish output.

I interpret these results as evidence against the identification strategy in Jimenez et al. (2014). An expansionary effect may be reconciled with the exogeneity of monetary policy if the increase in output is due solely to spillovers from the central economies in the Euro area. To disentangle the effects of spillovers and information effects, I propose a simple model to rationalize the differential response that I observe in the data. My model has the advantage of provididing a testable implication to disentangle information effects from spillover effects. In particular, I show that a shock to foreign output increases domestic output and prices but improves the trade balance. Instead, an information shock has similar effects on output and inflation but it worsens the trade balance. Therefore, I am able to classify shocks and empirically evaluate the validity of the strategy in Jimenez et al. (2014). The intuition of the model is simple. If a country's trading partners improve their economic outlook they import more, causing the net exports of the home country to increase. If, instead, the domestic economy expands due to more optimistic expectations, the domestic economy imports more, causing net exports to decrease.

The paper suffers from the limitation that it does not propose a way to model a currency union between two countries. It also models the foreign country as exogenous and, thus, is silent on issues related to feedback from the domestic economy to the foreign economy. In addition, information effects are included ad hoc by assuming that a change in the interest rate can influence the natural interest rate.

There is a vast literature on the subject of monetary policy which this paper contributes to. Christiano et al. (2005), Romer & Romer (2004), Cochrane & Piazzesi (2002) and Kuttner (2001) are concerned with identifying monetary policy shocks. Gertler & Karadi (2015) look at credit costs applying a high-frequency approach. Regarding information effects, Melosi (2017) and (Nakamura & Steinsson, 2018) consider information effects for a closed economy. Spillovers between open economies are considered by Jang & Okano (2015), though, they

consider the spillover effects of shocks to technology. Considering spillovers in a two-country framework is also done by R. H. Clarida (2009).

The rest of the paper is organized as follows. Section II describes the data used, section III explains the econometric approach, section IV is dedicated to the main results, section V develops an open economy New Keynesian model with information effects, section VI discusses plausible explanations for the results obtained in the empirical part of the paper, and finally section VII concludes.

The causal impact of monetary policy on economic activity is an elusive topic since monetary policy is usually an endogenous response to underlying economic conditions. We evaluate the empirical validity of using heterogeneity in a currency union to argue for the exogeneity of monetary policy in peripherical economies, using the case of Spain. We find that an unexpected increase in the interest rate is sometimes expansionary. In these cases, the Spanish trade balance worsens. We argue that this is suggestive of an improvement in the economic outlook of agents due to an information shock. We use an open economy New Keynesian model to rationalize the responses we observe in the data.