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Abstract

A growing empirical literature has shown, based on structural vector autoregressions (SVARs) identified through sign restrictions, that unconventional monetary policies implemented after the outbreak of the Great Financial Crisis (GFC) had expansionary macroeconomic effects. In a recent paper, Elbourne and Ji (2019) conclude that these studies fail to identify true unconventional monetary policy shocks in the euro area. In this note, we show that their findings are actually fully consistent with a successful identification of unconventional monetary policy shocks by the earlier studies and that their approach does not serve the purpose of evaluating identification strategies of SVARs.

Keywords: unconventional monetary policy, SVARs.

JEL classification: C32, E30, E44, E51, E52.

Resumen

Diversos estudios empíricos han demostrado, basándose en autorregresiones vectoriales estructurales (SVAR) identificadas mediante restricciones de signo, que las políticas monetarias no convencionales implementadas después del estallido de la crisis financiera global tuvieron efectos macroeconómicos expansivos. En un artículo reciente, Elbourne y Ji (2019) concluyen, por el contrario, que estos estudios no logran identificar verdaderos *shocks* de política monetaria no convencional en la zona del euro. En este documento mostramos que sus hallazgos son en realidad totalmente coherentes con una identificación exitosa de los *shocks* de política monetaria no convencional de los estudios anteriores, y que su enfoque no sirve para evaluar estrategias de identificación de modelos SVAR.

Palabras clave: política monetaria no convencional, modelos SVAR.

Códigos JEL: C32, E30, E44, E51, E52.

1. Introduction

Assessing the macroeconomic effects of unconventional monetary policies implemented by the major central banks in the wake of the Great Financial Crisis (GFC) represents a formidable challenge for empirical research. Unlike conventional monetary policy implemented by adjusting a short-term interest rate, unconventional monetary policies were implemented through changes in the size and composition of the central bank's balance sheet and targeted risk premia in money and capital markets. Identifying the effects of these policies on output and inflation required novel identification schemes to be devised.

Several studies have estimated the effects of unconventional monetary policies using structural vector autoregressive (SVAR) models that are identified with sign restrictions, often in combination with zero restrictions (e.g. Gambacorta *et al.* (2014); Weale and Wieladek (2016); Haldane *et al.* (2016); Panizza and Wyplosz (2016); Boeckx *et al.* (2017); Burriel and Galesi (2018); Hesse *et al.* (2018); Feldkircher *et al.* (2019); Lewis and Roth (2019)). In general, these studies find that policy measures which expand the balance sheet of the central bank had a significant positive impact on economic activity and consumer prices. However, in a recent study by the Netherlands Bureau for Economic Policy Analysis that has received considerable media attention, Elbourne and Ji (2019) challenge these findings for the euro area.[1] They conclude, based on empirical analysis that revisits the findings for the euro area of Boeckx *et al.* (2017) and Burriel and Galesi (2018), that *"these findings result from an identification strategy that does not successfully uncover unconventional monetary policy shocks"*.

The conclusion of Elbourne and Ji (2019) is based on three observations:

1. When switching the sign of the response of the balance sheet in the identification scheme such that an expansionary unconventional monetary policy shock reduces the size of the balance sheet, the resulting impulse responses are very similar to those obtained under the original restriction such that the size of the balance sheet expands.
2. When the size of the ECB's balance sheet in the SVAR model is replaced by random numbers, the resulting impulse responses and time series of unconventional monetary policy shocks are indistinguishable. In conjunction with the first observation, this seems to suggest that the results are independent of the information about the evolution of the ECB's balance sheet.
3. The identified unconventional monetary policy shocks in the original studies are uncorrelated with alternative monetary policy shocks identified from futures rate surprises by Jarocinski and Karadi (2018) and Corsetti *et al.* (2018).

Based on these findings, Elbourne and Ji (2019) conclude: *"Not only is it highly implausible that the identification scheme of Gambacorta et al. (2014), Boeckx et al. (2017) and Burriel and Galesi (2018) recovers the true unconventional monetary policy shocks without the information contained in the size of the ECB's balance sheet, the resultant shocks bear no resemblance to*

[1] See e.g. "Important time series evidence about the efficacy of the ECB's balance sheet policies is flawed" (*VoXEU column*, https://voxeu.org/article/revisiting-efficacy-ecb-s-balance-sheet-policies), "ECB QE Boosted Inflation, Not Output" (*Wall Street Journal*, https://www.wsj.com/articles/ecb-qe-boosted-inflation-not-output-1517926383), "'No evidence' ECB bond-buying helped euro economy" (*EUobserver*, https://euobserver.com/economic/144215) or "CPB: 'Geen aantoonbaar effect ECB-beleid'" (*De Telegraaf*, https://www.telegraaf.nl/financieel/3176603/cpb-geen-aantoonbaar-effect-ecb-beleid).

other credibly identified monetary policy shocks in this period. As such, the logical conclusion is that the SVAR models are not identifying unconventional monetary policy shocks."

This conclusion has potentially important implications as it casts doubt on benchmark empirical findings which suggested that unconventional monetary policy was effective in stimulating the economy. In this paper, we revisit the analysis of Elbourne and Ji (2019) in order to better understand what drives their findings and whether they really imply that previous empirical analysis on the subject is seriously flawed.[2]

In Section 2 we reproduce their results using the model of Boeckx *et al.* (2017), which is the benchmark study for the euro area that uses SVARs identified with a combination of zero and sign restrictions to estimate the effects of unconventional monetary policies, in particular credit support policies that were introduced by the ECB to stimulate bank lending in the period after the GFC.[3] In doing so, we revisit key aspects of the analysis in Elbourne and Ji (2019), specifically the choice of the sample period and model specification, which differ from the targeted benchmark studies, and the lack of statistical tests used to derive conclusions. In addition, several impulse responses of variables included in the VAR are not reported in their study.

Our analysis yields the following main findings (in chronological order of the three observations as listed before):

1. Switching the sign of the restriction on the central bank balance sheet does not yield results that are statistically indistinguishable from those of the benchmark studies. There is indeed also a rise in output and prices when the opposite sign restriction is imposed on the balance sheet, but this is not in itself surprising since this alternative shock can be considered as a linear combination of expansionary financial market shocks; that is, the shock is still assumed to lower financial stress and the spread between the EONIA and the ECB's main refinancing operations rate on impact (two other restrictions of the identification algorithm). Importantly, the patterns, magnitudes and even direction of several impulse response functions of the variables included in the SVAR are different for the shock with the opposite sign restriction on the balance sheet. Moreover, formal tests confirm that the differences between the impulse responses to both shocks are statistically significant. Accordingly, the (sign) restriction on the balance sheet encompasses crucial information for the identification of unconventional policy shocks and subsequent macroeconomic dynamics.
2. Obtaining similar results when replacing the size of the ECB's balance by random numbers is fully consistent with a successful identification of the shocks in the original studies. Specifically, estimating the SVAR model in which the size of the ECB's balance sheet has been replaced by random numbers amounts to estimating the SVAR without the balance sheet. This is because the random numbers carry no informational content and, in practice, the balance sheet becomes an unobserved variable in the estimation. We show that, by

[2] We only focus on the observations that are used to criticize the identification strategy. Elbourne and Ji (2019) also find that the policy shocks identified from futures rates surprises do not have a significant effect on economic activity. In this note, we do not discuss this finding, which is left to the authors of the original studies. In fact, Jarocinski and Karadi (2018) and Corsetti *et al.* (2018) both document a fall (rise) in economic activity and inflation following a restrictive (expansionary) monetary policy shock.

[3] These policies should not be confused with pre-announced asset purchased such as the Expanded Asset Purchases Program (EAPP) of the ECB.

construction, the estimation results represent a *weighted average* of the unconventional monetary policy shocks that are identified with the restriction that the balance sheet increases and the above shocks obtained with the opposite balance sheet restriction. Since the balance sheet is unobservable, the estimation algorithm cannot disentangle these two shocks. Thus, the finding that this exercise generates impulse responses and shocks that are very similar to the original identification scheme simply (and mechanically) implies that the weight (relevance) of the original shocks in the data is much larger than the shocks with the opposite restriction. We document that this is indeed the case, which is not surprising given the unrealistic combination of restrictions that are used to identify the alternative shock. In sum, it is pointless to include random numbers in an estimation and it is impossible to draw conclusions about the plausibility of the identification strategy based on this exercise.

3. The unconventional monetary policy shocks identified through SVARs need not be highly correlated with shocks that are identified from interest rate futures because both shocks capture different aspects of monetary policy. Specifically, the shocks in futures interest rates identified by Jarocinski and Karadi (2018) and Corsetti *et al.* (2018) reflect ECB announcements about *conventional interest rate policies*, including actual changes to the ECB's policy rates or adjustments to forward guidance, while the shocks identified by Gambacorta *et al.* (2014), Boeckx *et al.* (2017) and Burriel and Galesi (2018) are *unconventional monetary policies that are linked to changes in the central bank's balance sheet and orthogonal(!) to changes in the policy rate*. Put differently, both shocks are fundamentally different and the absence of a correlation is again consistent with a successful identification of the unconventional monetary policy shocks. In fact, the opposite finding (i.e. a high correlation) would have been problematic for the identification strategy. Furthermore, we discuss that other studies have shown that even a low correlation between the *same type of shocks* across models does not tell whether an identification is flawed or not (e.g. Sims (1998)).

Overall, the approach and findings of Elbourne and Ji (2019) are not informative about the successfulness of identification strategies and do not support the notion that studies evaluating the macroeconomic effects of central bank unconventional monetary policy based on VARs identified through zero and sign restrictions are flawed. As an alternative, in Section 3, we evaluate whether the shocks identified through the model of Boeckx *et al.* (2017) are consistent with the narrative of the unconventional monetary policy measures launched by the ECB since 2007. The time series of shocks suggests that the expansionary measures are indeed reflected in expansionary unconventional monetary policy shocks identified through the SVAR, while periods of more restrictive balance sheet policies were associated with contractionary shocks. Even though we are well aware that any identification strategy has its drawbacks and needs to be interpreted carefully, the fact that the shocks capture the most important non-standard monetary policy measures during the sample period indicates that the identification strategy is plausible.

2. Revisiting the effects of unconventional monetary policy in the euro area

In order to assess whether SVAR models are able to plausibly recover unconventional monetary policy shocks in the euro area, Elbourne and Ji (2019) reproduce some of the existing studies for the euro area; that is, Gambacorta *et al.* (2014), Boeckx *et al.* (2017) and Burriel and Galesi (2018). Nonetheless, there appear to be some important differences, which we discuss in the first subsection. In the following, we reproduce the model of Boeckx *et al.* (2017), which is the benchmark study for the euro area. Using this model, we replicate the analysis of Elbourne and Ji (2019) and discuss their approach.

2.1. *The VAR model of Boeckx et al. (2017)*

Boeckx *et al.* (2017) was the first paper that used the identification strategy based on zero and sign restrictions to estimate the effects of the ECB's balance sheet policies on the euro area economy in the aftermath of the financial crisis. The approach in Boeckx *et al.* (2017) elaborates on Gambacorta *et al.* (2014), who have estimated a panel VAR for eight industrialized countries.[4] Burriel and Galesi (2018), in turn, extend the analysis of Boeckx *et al.* (2017) to individual euro area countries by estimating a global VAR that takes into account cross-country interdependencies among euro area members. We therefore base the analysis in this note on Boeckx *et al.* (2017). Notice, however, that the results reported in the following also apply to these other studies.

Boeckx *et al.* (2017) estimate a monthly SVAR model for the euro area containing output (real GDP interpolated using industrial production), consumer prices (HICP), the ECB's main refinancing operations (MRO) rate, the size of the balance sheet of the ECB (total assets), an indicator of financial stress (CISS-indicator of Holló *et al.* (2012)), and the spread between the overnight (EONIA) and the MRO rate. These variables are shown in Table 1, which also includes the restrictions that have been imposed on the SVAR in order to disentangle exogenous balance sheet shocks (for a given policy rate) that are caused by unconventional monetary policy measures of the ECB (*UMP shock*) from other economic shocks. For a discussion of these policies, we refer to Boeckx *et al.* (2017).

Table 1 – Restrictions for the identification of unconventional monetary policy shocks

	UMP shock	*Shock B*	*Shock C*
Output	0	0	0
Prices	0	0	0
ECB Total Assets	≥ 0	≤ 0	
CISS-indicator of financial stress	≤ 0	≤ 0	≤ 0
EONIA-MRO spread	≤ 0	≤ 0	≤ 0
Policy rate (MRO rate)	0	0	0

The restrictions to identify *UMP shocks* are based on the following assumptions.

[4] The identification strategy of Boeckx *et al.* (2017) is better tailored for the euro area than the parsimonious panel VAR of Gambacorta *et al.* (2014). For example, Gambacorta *et al.* (2014) do not distinguish between policy-induced and demand-driven innovations to the balance sheet of the central bank. While this is an appropriate approach for most industrialized countries, Boeckx *et al.* (2017) argue that this could be misleading for the euro area given the fixed rate tender with full allotment strategy of the ECB. Notice that Gambacorta *et al.* (2014) also exploit the cross-section dimension of their panel to achieve identification, which is not possible for an estimation solely for the euro area.

First, there is no immediate impact of the shock on output and consumer prices. This assumption, which is plausible for monthly estimations, allows to disentangle the *UMP shocks* from real economy disturbances such as aggregate supply and demand shocks.

Second, *UMP shocks* that increase the balance sheet of the ECB do not increase financial stress (CISS-indicator). This restriction disentangles such innovations from the endogenous response of the balance sheet to financial stress. It follows as a complementary restriction from the assumption that central bank assets typically increase in response to a rise in the CISS-indicator. The latter reflects the idea that (i) the ECB may react to increased financial stress by expanding its balance sheet, and (ii) due to the fixed interest rate with full allotment (FRFA) policy during the sample period, the balance sheet of the ECB could rise endogenously when financial market uncertainty increases.

Third, an expansionary *UMP shock* does not increase the EONIA-MRO spread. The motivation of this restriction is that an expansionary balance sheet shock that is the consequence of an unconventional monetary policy action typically increases the liquidity surplus, which exerts downward pressure on the EONIA and thus the spread with the policy rate.[5] The decline in the spread also allows to disentangle supply-driven changes in the ECB balance sheet from changes in the demand for central bank liquidity.[6]

Fourth, since the aim is to estimate the effects of innovations to the ECB's balance sheet that are orthogonal to shifts in the policy rate, the identified shocks have a zero contemporaneous impact on the MRO-rate. This restriction guarantees that the identified balance sheet shocks do not capture conventional interest rate shocks. Elbourne and Ji (2019) do not exactly reproduce the Boeckx *et al.* (2017) model as they exclude the MRO-rate and its restriction. If anything, this would imply that unconventional and conventional policy shocks cannot be disentangled.

Finally, all sign restrictions are imposed on impact and the first month after the shock and implemented in a weak form; that is, as smaller/larger than or equal to zero. This allows for the possibility that an unconventional monetary policy measure, for example, influences the CISS-indicator immediately but central bank assets only with a lag. Hence, it accommodates for the fact that some measures were announced (1-2 months) before they were implemented. On the other hand, this implies that balance sheet policies that were announced more than 1-2 months in advance are captured by the other innovations in the VAR model.

By imposing these restrictions, it is possible to isolate unconventional monetary policy measures that have increased or decreased the balance sheet of the ECB in the aftermath of the financial crisis, and estimate their macroeconomic consequences. The sample period for the analysis is 2007M1-2014M12. In particular, the identification scheme is not valid for the period

[5] Elbourne and Ji (2019) interpret changes in the EONIA-MRO spread (and this restriction) as another indicator of financial stress (i.e. in the same spirit as the restrictions on the CISS). However, in contrast to longer-term money market rates, the EONIA rate was hardly influenced by financial stress during the financial crisis period.

[6] This restriction is also motivated by the fixed-rate full allotment (FRFA) policy and the accompanying unlimited access of banks to central bank liquidity. Specifically, there could have been (exogenous) shocks to the demand for bank reserves without a policy action from the ECB, which have lowered the CISS-indicator and augmented the size of the central bank balance sheet during the sample period. A rise in the demand for bank reserves, however, typically raises the EONIA, and hence also the EONIA-MRO spread for a given policy rate (see Boeckx *et al.* (2017)).

covering the ECB's Expanded Asset Purchase Program (EAPP) since January 2015 because the volumes of the purchases under this program were announced several months in advance (and were thus not unanticipated), which can be considered as a structural break in the balance sheet reaction function. The choice of the sample period and its importance for the validity of the analysis is explained in detail in Boeckx *et al.* (2017).[7]

2.2. *Sign switch of the balance sheet restriction*

We start by re-estimating the SVAR of Boeckx *et al.* (2017), switching the sign restriction that is imposed on the balance sheet (ECB total assets) such that an expansionary unconventional monetary policy shock reduces the size of the balance sheet. This exercise corresponds to *Shock B* in Table 1. Specifically, all restrictions are the same as the original identification scheme, except the one imposed on ECB Total Assets. Based on an inspection of the impulse responses of output and prices, Elbourne and Ji (2019) conclude that they find *"statistically indistinguishable impulse responses and time series of supposed unconventional monetary policy shocks"*. The impulse responses of the other variables that are included in the SVAR are, however, not reported nor discussed in the paper. In addition, they do not conduct any formal test to come to this conclusion; that is, this conclusion is based on the fact that the median impulse response functions of *Shock B* fall within the confidence intervals of the responses of the *UMP Shock*.[8]

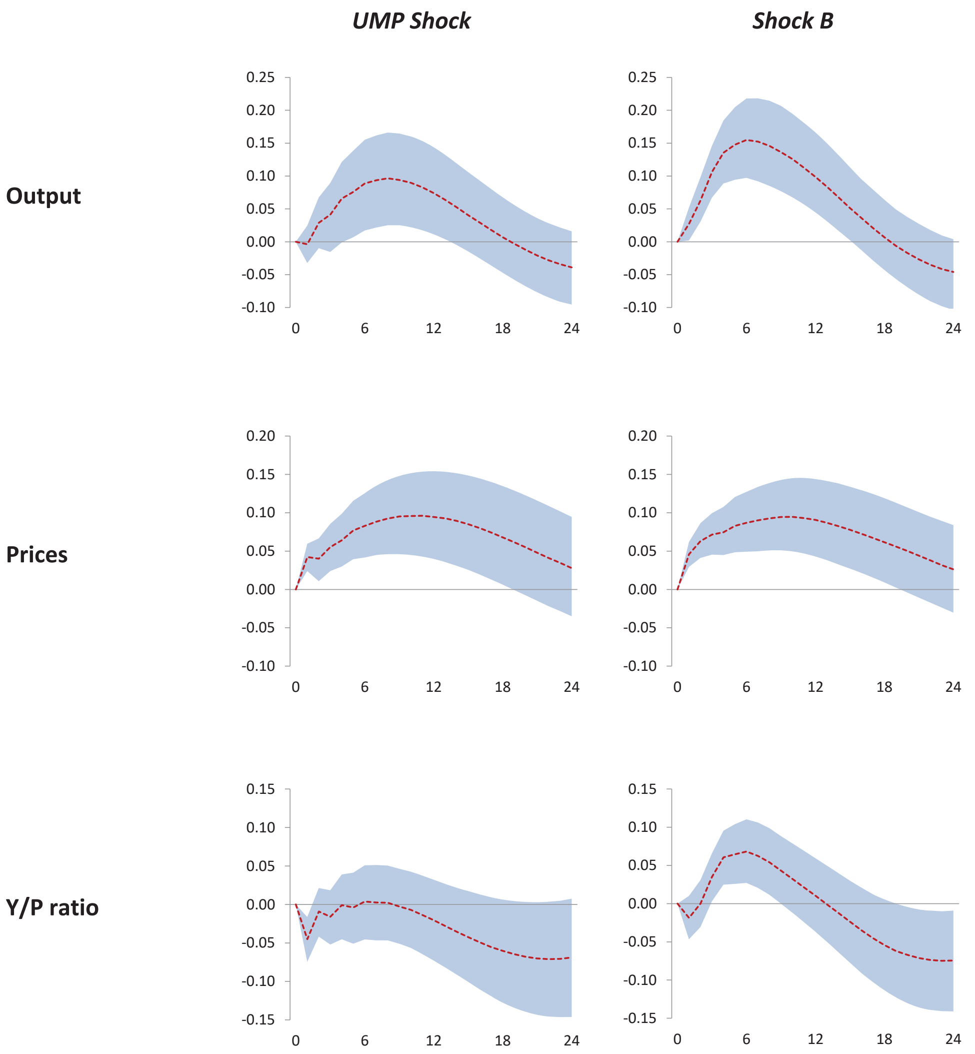
The impulse responses to *Shock B* are shown in the right column of Figure 1, while the left column shows the impulse responses to the original unconventional monetary policy shock (*UMP shock*). Consistent with Elbourne and Ji (2019), we find that there is a rise in output and consumer prices, while the confidence intervals overlap. This finding in itself is, however, not surprising since a shock that is associated with a reduction in the stress indicator, which captures for example a reduction in economic uncertainty and an improvement of macroeconomic conditions, and a decline in the EONIA can be considered as an expansionary aggregate demand shock. More generally, there are numerous types of (demand) shocks that move output and prices in the same direction. It would be surprising if two (different) shocks originating in financial markets and being both associated with improved financial market conditions and a decline in the EONIA would have an impact on output and prices that is considerably different.

Notwithstanding the overlapping characteristics of both shocks, the results reveal that there are relevant differences between the dynamic effects. For example, the peak impact of the (original) *UMP Shock* on output is a couple of months later. The output effects are also much stronger for *Shock B*; that is, the (median) peak effect of the *UMP Shock* is 0.096%, compared to 0.155% for *Shock B*. Relatedly, it appears that the relative effects of both shocks on output versus prices are very different. This is illustrated in the third row of Figure 1, which shows the impact of the shocks on the output-price ratio based on the VAR-model. Specifically, the output response of

[7] Elbourne and Ji (2019), by contrast, conduct their analysis over the period 2009M1 until 2016M12, which includes the EAPP. Furthermore, the later start of the sample does not include the collapse of Lehman Brothers (summer of 2008) and the financial stress in the summer of 2007, as well as the response of the ECB to these events, which implies that substantial useful information to identify the shocks is excluded.

[8] This issue is commonly known in econometrics: if confidence intervals (standard errors) of two coefficients in a regression overlap, this does not necessarily imply that the coefficients are statistically not different from each other. The latter also depends, for example, on the covariance of the coefficients.

Figure 1 – Impulse responses to an unconventional monetary policy shock – Part I



Note: impulse responses with 16th and 84th percentiles error bands. *UMP Shock* is original shock of Boeckx *et al.* (2017), *Shock B* is shock with opposite restriction on balance sheet.

UMP Shocks is significantly smaller than the price response the first month after the shock, while the impact on output is significantly larger than the price response during roughly one year after *Shock B*. Clearly, these differences are economically important and policy relevant.[9]

Another remarkable difference is the impact on the EONIA-MRO spread, shown in Part II of Figure 1. After the *UMP Shock*, the spread gradually returns to its baseline, which is reached after six months. In contrast, despite the negative restriction on impact and one month after the shock, the spread immediately returns to the baseline after *Shock B*, in order to become significantly positive during more than one year. This pattern suggests that the (negative) sign restriction on

[9] For example, it reflects by how much output decreases in order to lower inflation by 1% using balance sheet policies (see e.g. Hofmann and Peersman (2017)).

the balance sheet (central bank liquidity) and the spread in the same direction to identify an expansionary policy shock is not supported by the data. This is not surprising since the spread reflects the presence of excess or shortage of liquidity in the overnight market for central bank liquidity.

Are the differences between the impulse responses statistically significant? An overlap of the error bands does not imply that the differences are statistically insignificant. To address this issue, we re-estimate the SVAR model and identify an *UMP Shock* and *Shock B* simultaneously. By nesting the estimation of both shocks within the same VAR-model, it is possible to calculate the differences between the impulse responses and the confidence bands of the differences. Furthermore, to account for the fact that the variance of both shocks may be different (a one-standard-deviation *UMP Shock* is not the same as a one-standard-deviation *Shock B*), we normalize both shocks based on their contemporaneous impact on the CISS-indicator; that is, the impulse responses (and differences) correspond to a 1bps decline in the CISS-indicator induced by the shock.[10]

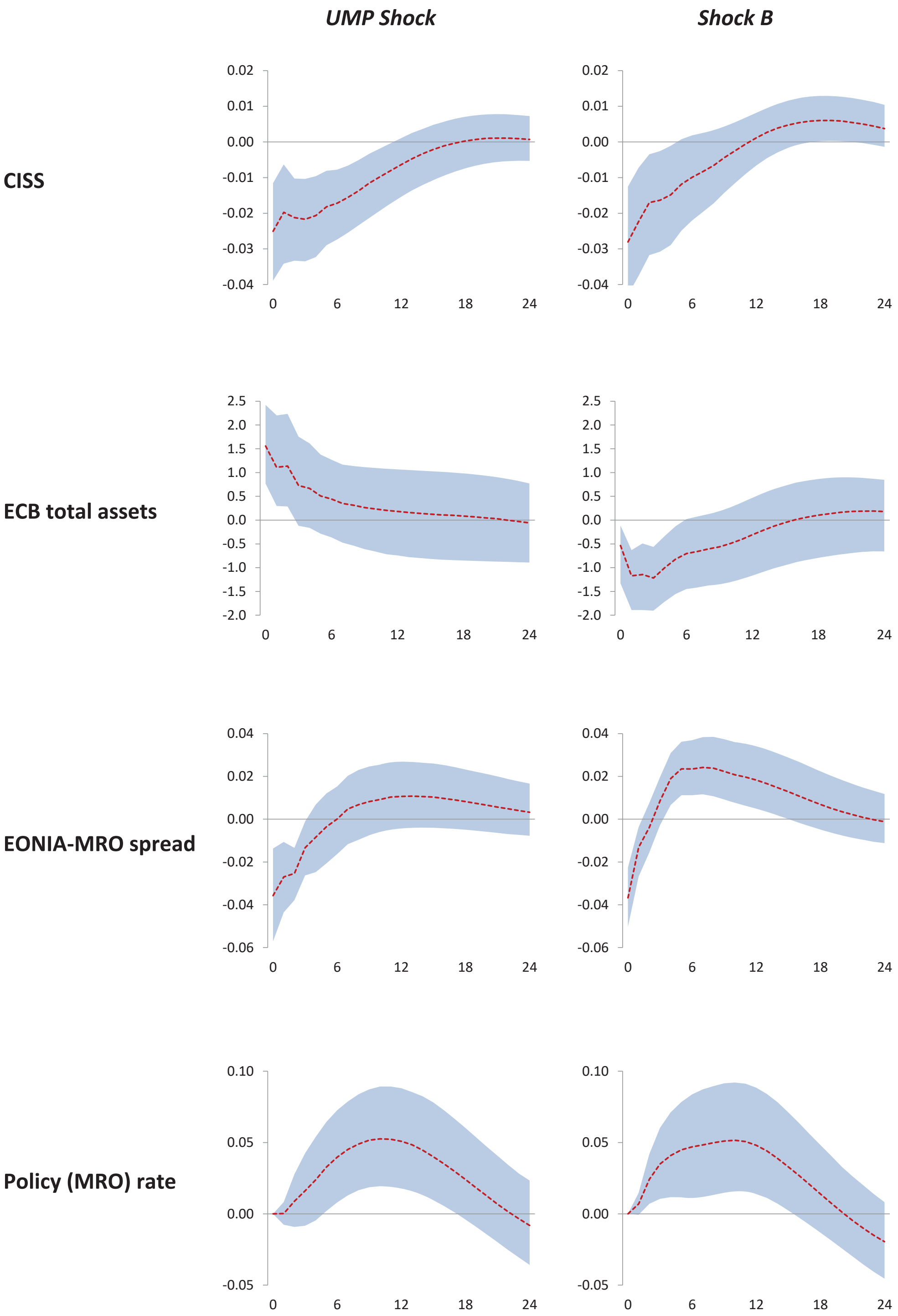
The differences between the impulse responses obtained from this estimation are shown in Figure 2, together with confidence intervals. As can be observed in the figure, several impulse responses are statistically different from each other. For example, the effects on economic activity and output-price ratio are significantly stronger for *Shock B* compared to the *UMP Shock* (supported by more than 95% of the posterior draws), while also the impact on the EONIA-MRO spread is significantly different.

From these results, we can conclude that the sign restriction that is imposed on the balance sheet of the ECB is important for the estimation results. In other words, the balance sheet does contain relevant information for the estimation of the consequences of unconventional monetary policy shocks.

Notice that an implicit assumption of this exercise is that both shocks exist in reality. In particular, if *Shock B* does not exist or is not properly identified, the identification of the *UMP Shock* is distorted by identifying both shocks simultaneously. However, there are good reasons to believe that *Shock B* does not exist in reality. In particular, the ECB did react to financial stress shocks by lowering the interest rate during the sample period (e.g. in response to the collapse of Lehmann). Hence, the zero restriction on the MRO-rate is inconsistent with financial stress shocks. More generally, assuming that the ECB does not immediately react to shocks that have a significant impact on output and inflation is controversial (unless it is a monetary policy shock). Hence, it is more likely that the shocks captured by *Shock B* are a linear combination of several fundamental shock that are forced by the algorithm into a single series of shocks (i.e. shocks that offset each other in order to fulfill the sign and zero restrictions, which may even include monetary policy shocks).

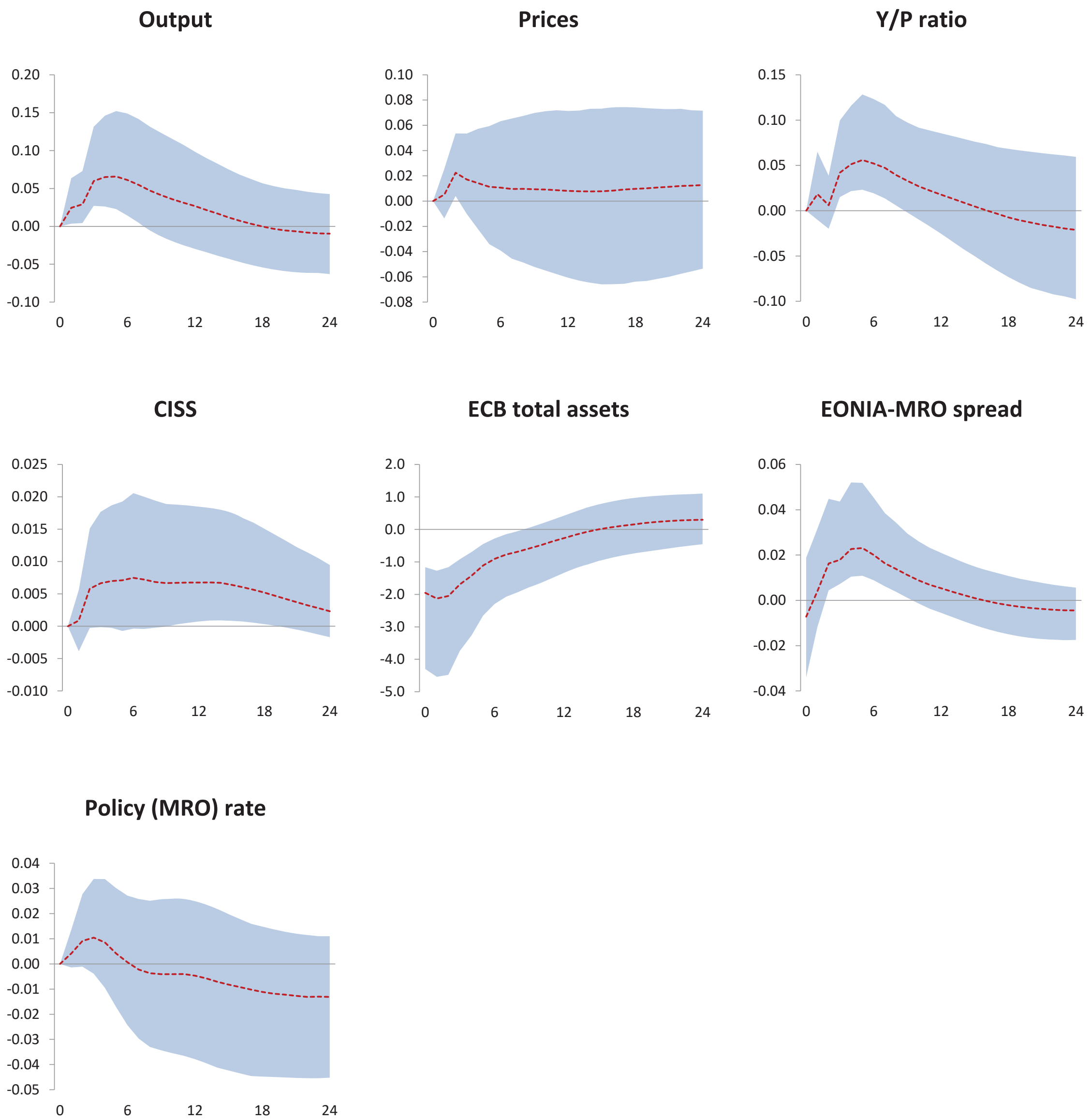
[10] A more natural normalization would be a one percent change in the balance sheet of the ECB (since we want to measure the effects of balance sheet policies). However, due to the opposite restriction that is imposed on the balance sheet, all impulse responses have automatically an opposite sign and are statistically different from each other. When we normalize the shock as a 1bps decline in the EONIA-MRO spread, we find a significant different impact on the spread itself (at longer horizons), the CISS, CB Total Assets and the Y/P ratio (but not on output and prices).

Figure 1 – Impulse responses to an unconventional monetary policy shock – Part II



Note: impulse responses with 16th and 84th percentiles error bands. *UMP Shock* is original shock of Boeckx *et al.* (2017), *Shock B* is shock with opposite restriction on balance sheet.

Figure 2 – Differences between impulse responses of *UMP Shock* and *Shock B*



Note: Differences with 16th and 84th percentiles error bands. *UMP Shock* is original shock of Boeckx *et al.* (2017), *Shock B* is shock with opposite restriction on balance sheet.

2.3. *Replacing the size of the balance sheet by random numbers*

The key result of Elbourne and Ji (2019) is that replacing the size of the balance sheet with a time series of independent random numbers produces very similar impulse responses to those reported in the original studies. In Figure 3, we reproduce this exercise for the SVAR-model of Boeckx *et al.* (2017). While the original results are again shown in the left column, the impulse responses obtained from the VAR-model with random numbers are shown in the right column. These are indeed very similar.[11]

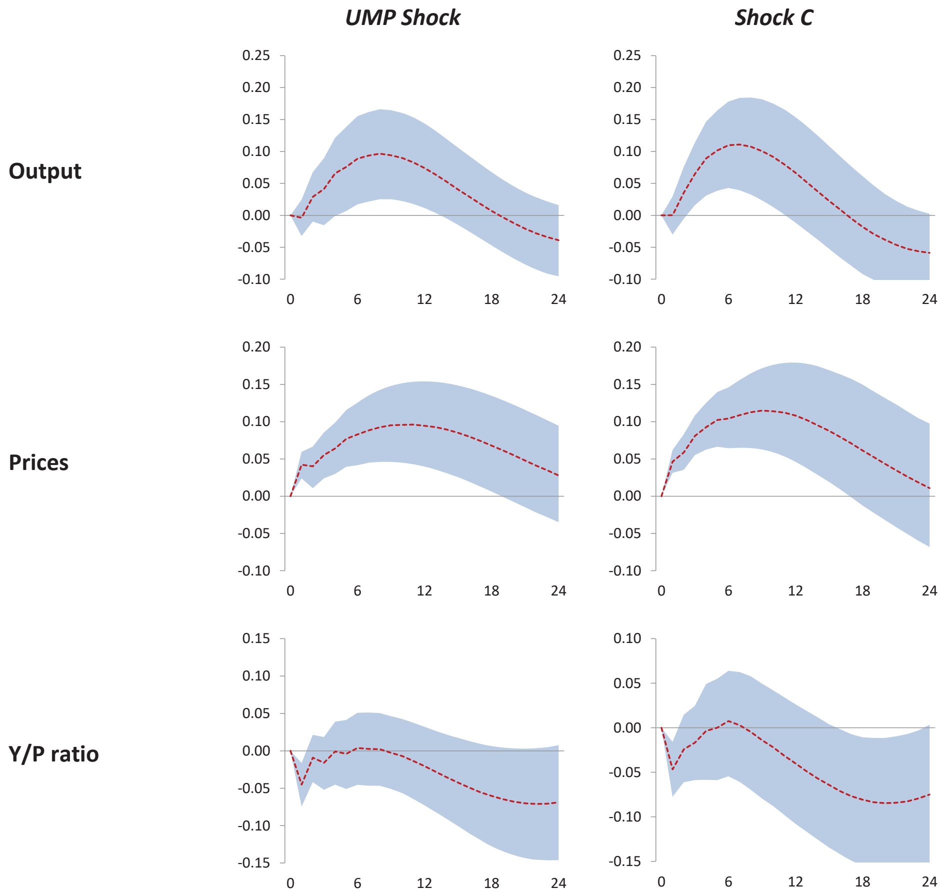
[11] Notice that, in contrast to the estimations reported in Section 2.2, it is not possible to formally test the significance of the difference because the shocks cannot be identified simultaneously due to the different reduced-form specification of the VAR-model.

This finding is, however, not surprising. More specifically, like in any regression analysis, including random numbers as a variable in a VAR-system does not affect any coefficient of the system; that is, the coefficient of a series of random numbers that is included in a linear regression is equal to zero, nor does it affect the estimated coefficients of the other variables in the equations. As a consequence, including a series of random numbers in a regression analysis is pointless and the same as estimating the model without the series of random numbers (besides the fact that it adds some noise to the regressions).

This exercise is thus the same as estimating the VAR without the balance sheet and without the sign restriction on the balance sheet, which corresponds to the identification of *Shock C* in Table 1.[12] In essence, the balance sheet becomes an unobservable variable in the system, which still contributes to the data generating process of all the other variables in the VAR. As a consequence, *Shock C* is a linear combination (weighted average) of the original UMP Shock and a shock that has the same effects except that it decreases instead of increases the central bank balance sheet (*Shock B*). This can be observed in Table 1: the *UMP Shock* and *Shock B* both fulfill all the (sign) restrictions of *Shock C*, while no other shock does. More specifically, *Shock C* can be represented as follows:

$$Shock\ C = \alpha * UMP\ Shock + (1 - \alpha) * shock\ B$$

Figure 3 – Impulse responses to an unconventional monetary policy shock – Part I

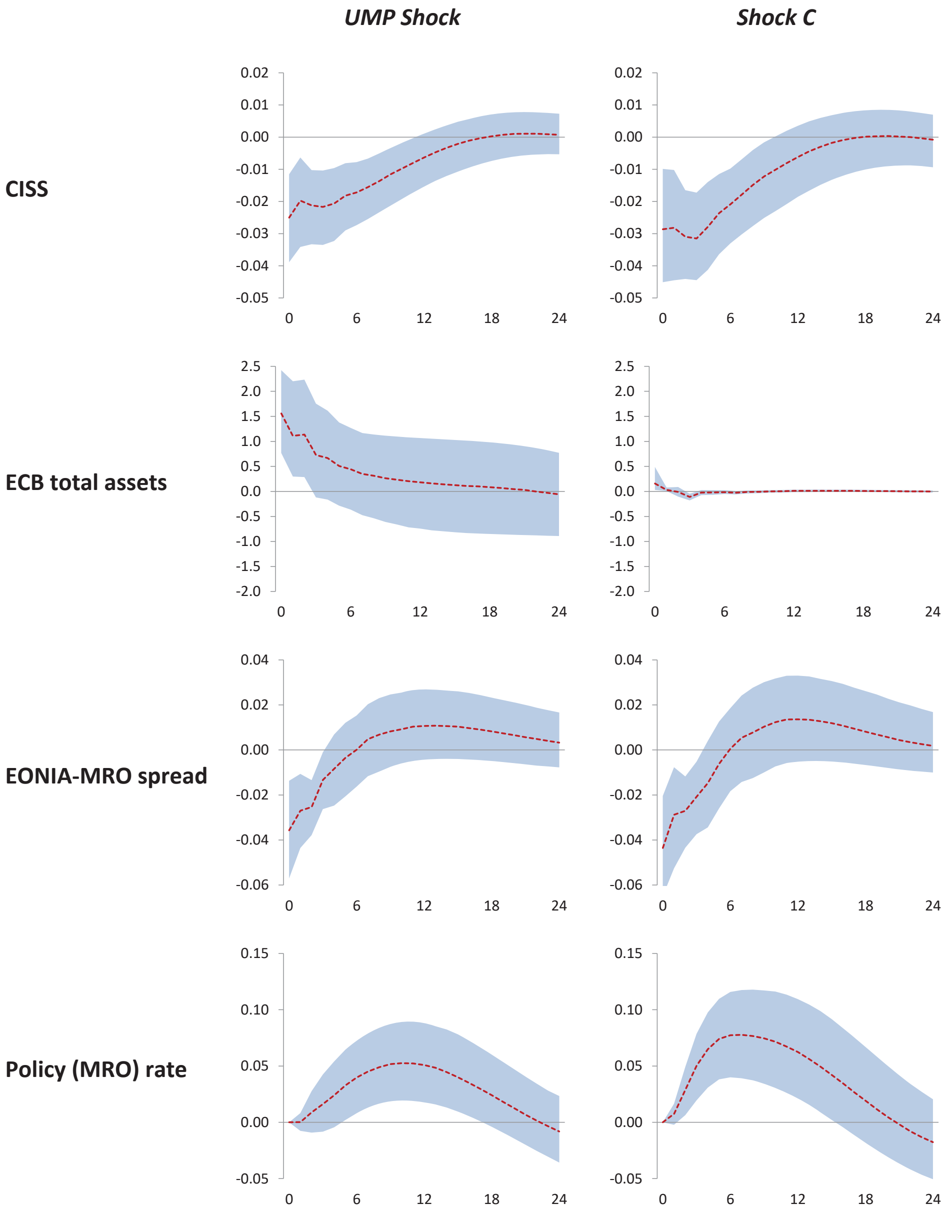


Note: impulse responses with 16th and 84th percentiles error bands. *UMP Shock* is original shock of Boeckx *et al.* (2017), *Shock C* is replacement of balance sheet by random numbers.

[12] Due to its randomness, half of the draws will erroneously fulfill the sign restriction on impact, and the other half will be discarded by the identification scheme.

What determines the size of the weight α? This can easily be explained by the estimation algorithm.[13] More specifically, when sign restrictions are used to identify the shocks, the algorithm draws a large number (e.g. 1,000,000) of possible series of shocks and impulse responses that are consistent with the data. If a draw satisfies the restrictions, the draw is kept. Otherwise, the draw is rejected by giving it a zero prior weight. The draws that are kept are then used to report (the distribution of the) impulse responses to the shocks. Since both the *UMP Shock* and *Shock B* fulfill all the restrictions of *Shock C*, both shocks will be accepted by the algorithm, and α will be the percentage of draws of *UMP Shocks* and *1-* α the percentage of *Shock B* accepted by the algorithm.

Figure 3 – Impulse responses to an unconventional monetary policy shock – Part II



Note: impulse responses with 16th and 84th percentiles error bands. *UMP Shock* is original shock of Boeckx *et al.* (2017), *Shock C* is replacement of balance sheet by random numbers.

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[13] See e.g. Uhlig (2005) or Peersman (2005) for a detailed explanation of the estimation of SVARs that are identified with sign restrictions.

When we return to the original estimations of Boeckx *et al.* (2017), it turns out that for all draws that fulfill the sign restrictions of *Shock C* (i.e. all sign restrictions except the one on the balance sheet), 67% have a positive impact on the balance sheet (i.e. are *UMP Shocks*) and 33% have a negative effect on the balance sheet (i.e. are *Shock B*). Put differently, $\alpha=0.67$, and the correlation between *Shock C* and the *UMP Shock* should be approximately 0.67. Thus, the correlation of 0.61 reported by Elbourne and Ji (2019) is perfectly normal, and a mechanical consequence of the number of draws that fulfill the sign restriction of *Shock B* and the *UMP Shock*, respectively. Obviously, this also implies that the impulse responses of this exercise will be much closer to the *UMP Shock* than *Shock B*: 67% of the draws to construct the impulse responses are *UMP Shocks*, while only 33% of the draws are *Shock B*.

Overall, the relative strong correlation is silent about the successfulness of the identification scheme, it only reflects the much higher number of draws (i.e. double) that are consistent with an increase of the balance sheet; that is, these draws are much more supported by the data. In fact, this finding is not a surprise since *Shock B* does probably not exist in reality, as we have argued above.

2.4. Low correlation with shocks identified from futures rate surprises

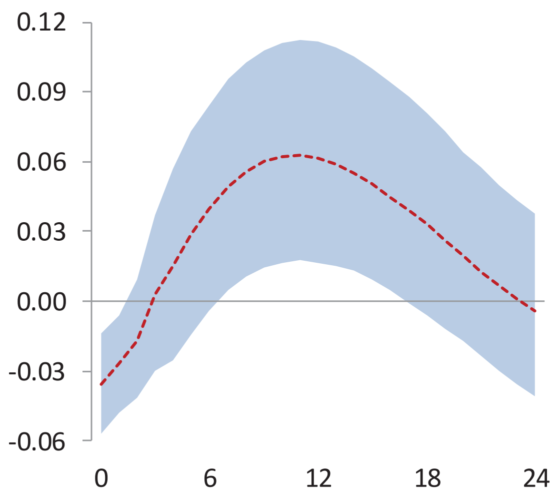
Finally, Elbourne and Ji (2019) document that the shocks that are identified based on SVAR models with a combination of zero and sign restrictions are uncorrelated with alternative credible monetary policy shocks identified from futures rate surprises by Jarocinski and Karadi (2018) and Corsetti *et al.* (2018). More specifically, they obtain a correlation of -0.06 and 0.10, respectively, and conclude based on this observation: *"Not only is it highly implausible that the identification scheme of Gambacorta et al. (2014), Boeckx et al. (2017) and Burriel and Galesi (2018) recovers the true unconventional monetary policy shocks without the information contained in the size of the ECB's balance sheet, the resultant shocks bear no resemblance to other credibly identified monetary policy shocks in this period. As such, the logical conclusion is that the SVAR models are not identifying unconventional monetary policy shocks."*

The low correlation between both shock series is, however, not surprising since both shocks are fundamentally different. More specifically, the unconventional monetary policy shocks that are identified in Gambacorta *et al.* (2014), Boeckx *et al.* (2017) and Burriel and Galesi (2018) are unconventional monetary policy measures that expand the central bank balance sheets and are orthogonal to changes in the policy rate (conventional monetary policy). The latter is reflected in the zero restriction on the policy rate. Overall, the shocks reflect liquidity measures for a given policy rate to influence impaired financial markets and support bank lending.[14] These policy measures are typically transmitted to the real economy via interest rate spreads and risk premia. For example, Boeckx *et al.* (2017) find that expansionary shocks lead to a decline in the spread between Euribor and Overnight Index Swap (OIS) rate and between peripheral and German sovereign bond yields, while bank lending rates decline. There is even a rise in (risk-free) German sovereign bond yields on impact and the policy (MRO) rate after a couple of months.

[14] The ECB, for instance, shifted from a variable rate tender to a fixed rate tender with full allotment, the pool of collateral accepted for refinancing operations has been enlarged and liquidity to banks has been provided at longer maturities than in the pre-crisis period. The ECB also conducted outright purchases of financial assets like covered bonds, asset-backed securities and government bonds of peripheral euro area countries.

The studies of Jarocinski and Karadi (2018) and Corsetti *et al.* (2018), in contrast, identify short-term (risk-free) interest rate surprises. More specifically, both studies first construct an instrumental variable using high-frequency surprises around policy announcements. Corsetti *et al.* (2018), for example, construct an instrument series based on changes in the 1-year EONIA swap rate (i.e. the OIS rate) around a narrow window of policy announcements.[15] The underlying idea is that any surprises occurring within the window are most likely the consequence of monetary policy shocks. In particular, while expectations about economic activity and future policy rate changes are already priced in, unexpected changes in the policy rate should shift the swap instantly when the announcement is made. Similarly, any policy action that affects expectations about future rate movements should have an immediate impact on the swap.

Figure 4 – Impact on EONIA in Boeckx *et al.* (2017) VAR-model



Is it possible that the instrument of Jarocinski and Karadi (2018) and Corsetti *et al.* (2018) captures a mixture of interest rate and unconventional monetary policy announcements? Even though the ECB also announced several credit support measures at its press conferences in the period after the financial crisis, there is no reason why the latter should affect the 1-year EONIA swap rate, which is the average of the overnight rates for the subsequent year. This can be observed in Figure 4, which shows the impact of an expansionary unconventional monetary policy shock on the EONIA for the Boeckx *et al.* (2017) VAR-model. While the EONIA decreases on impact (as a result of the sign restriction on the spread), the impact on the EONIA very quickly becomes positive due to the endogenous rise in the policy rate. Hence, there is no reason to expect a (meaningful) decrease in the 1-year or 3-month swap rates in response to the shocks that are identified in Boeckx *et al.* (2017). Put differently, unexpected changes in the swap rates are not valid instruments for ECB balance sheet shocks. The shocks are fundamentally different, which is fully consistent with the (near) zero correlation between the series. In fact, a high correlation would be problematic for the identification strategy.

[15] In a similar way, Jarocinski and Karadi (2018) construct an instrument based on changes in 3-month EONIA swaps.

Finally, notice that even a low correlation between the same type of shocks does not tell whether an identification scheme has been successful or not, or whether the entire methodology is flawed. Sims (1998), in his comment on Rudebusch (1998), explained that the low correlation of (conventional) monetary policy shocks identified through different VARs at that time did not mean that any of the models was not successful or that VARs do not successfully identify monetary policy shocks more generally. Instead, Sims (1998) showed that it reflected differences in the specification of models. Furthermore, the series of policy surprises constructed by Jarocinski and Karadi (2018) and Corsetti *et al.* (2018) are only an instrumental variable for a monetary policy shock while it is well-known that the correlation between an instrumental variable and the underlying shock has been shown to be very often quite low (see e.g. Montiel Olea *et al.* (2016) and Peersman (2018)). In contrast, Boeckx *et al.* (2017) directly identify the UMP shock. A proper comparison would therefore need to be based on the monetary policy shock series, rather than on the instruments from one study and the shocks from another.

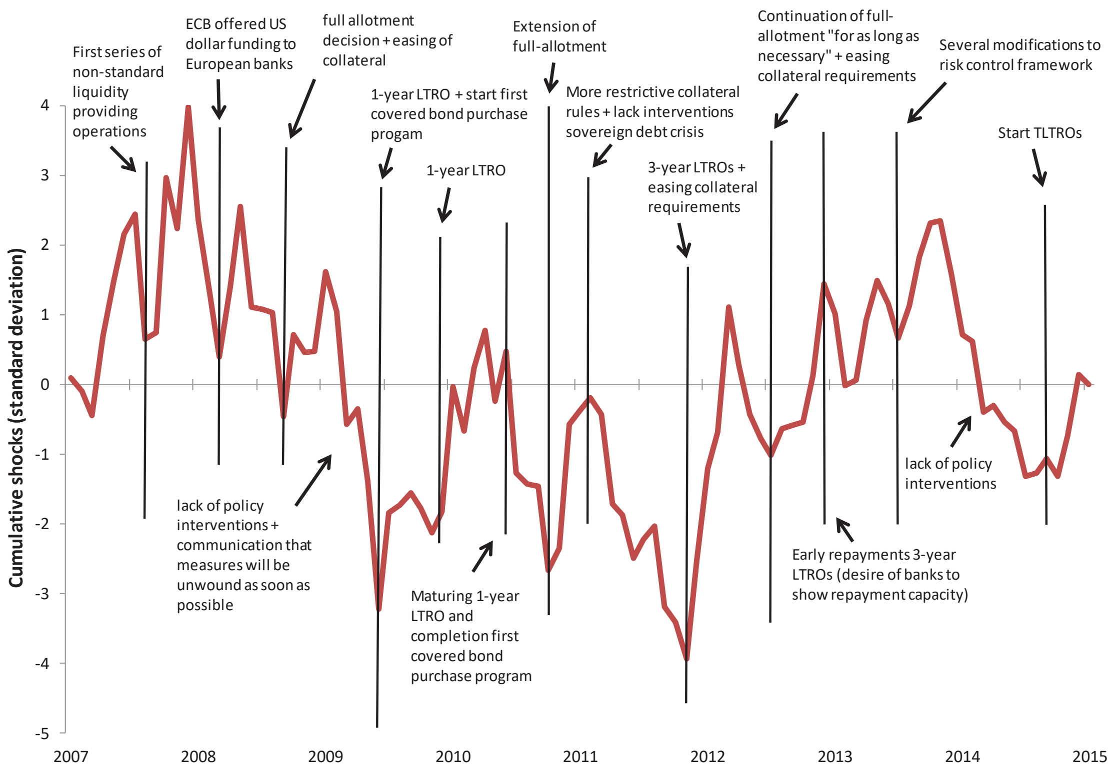
3. Do SVARs identify unconventional monetary policy shocks in the euro area? A narrative perspective

The analysis of the previous section shows that the observations of Elbourne and Ji (2019) do not imply that previous studies have not successfully identified unconventional monetary policy (or any other type of structural) shocks. That said, this does not mean that the identification strategy of SVAR models cannot be questioned. A conventional approach to justify any identification scheme should follow two steps. First, identification restrictions should be grounded on predictions of standard theoretical models, and possibly supported by other relevant empirical works in the literature. Thus, an identification strategy should be evaluated by the plausibility of the restrictions, as has been done in Section 2.1.

Second, the identified shocks should be consistent with the narrative of the conduct of policy over the period under investigation. In our specific case, the identified unconventional monetary policy shocks should capture major measures undertaken by the ECB between 2007 and 2015. In this respect, Boeckx *et al.* (2017) have already documented that the estimated time series of shocks captures fairly well these measures, as shown in Figure 5.

Consider, for example, the collapse of Lehman Brothers in September 2008. Elbourne and Ji (2019) argue that the identified expansionary (restrictive) unconventional monetary policy shocks are in practice expansionary (restrictive) financial stress shocks. If so, one would expect a considerable restrictive shock in September 2008. However, the SVAR of Boeckx *et al.* (2017) identifies a shock in the month of the collapse which dampened financial stress (and increased the balance sheet of the ECB). This is the opposite of an unfavorable financial stress shock. On the other hand, such a shock is consistent with the ECB's full allotment decision and easing of collateral requirements in September 2008. Overall, the chart shows that major balance sheet policies launched by the ECB between 2007 and 2015 were followed by expansionary UMP shocks, while periods of more restrictive balance sheet policies or policy action were associated with contractionary UMP shocks, which indicates that the identification based on a combination of zero and sign restrictions is plausible.

Figure 5 – Time series of cumulative identified balance sheet shocks of Boeckx *et al.* (2017)



4. Conclusions

In a recent paper that has received widespread international media attention, Elbourne and Ji (2019) have argued that studies based on SVAR models identified using a combination of zero and sign restrictions fail to plausibly identify true unconventional monetary policy shocks in the euro area. Their conclusion is based on the observation that they find indistinguishable impulse responses and time series of unconventional monetary policy shocks when they replace the balance sheet in the SVAR with random numbers, and when they impose the opposite restriction on the balance sheet in the identification scheme. In addition, they find that the shocks of these studies are uncorrelated with shocks that are obtained using high-frequency data in other studies.

In this note, we come to different conclusions. First, we show that finding qualitatively similar macroeconomic effects when switching the sign of the restriction of the balance sheet is not surprising since both shocks are associated with improved conditions in financial markets. At the same time, we show that important qualitative and statistical differences exist between this shock and the original unconventional monetary policy shock, implying that the sign restriction on the central bank balance sheet is important when identifying unconventional monetary policy shocks. Second, we have demonstrated that finding impulse responses and shock series that are very similar to those of an UMP shock when the balance sheet is replaced by random numbers is also not surprising. In particular, the thus identified shock is a linear combination of the original UMP shock and another shock that eases financial conditions, both shocks that would be expected to have expansionary macroeconomic effects. We further show that the high similarity between the shocks identified in a model with random numbers instead of the ECB's balance sheet reflects the greater importance of the unconventional monetary policy shock in the data relative to the other shock during the sample period. Finally, the low correlation between unconventional monetary policy shocks with shocks obtained from high-frequency data reflects the fact that the two shocks capture different dimensions of monetary policy, balance sheet policies in the case of the former, and conventional monetary policy and forward guidance in the case of the latter.

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