

FISCAL EXPENDITURE SPILLOVERS
IN THE EURO AREA: AN EMPIRICAL
AND MODEL-BASED ASSESSMENT

2020

BANCO DE **ESPAÑA**
Eurosistema

Documentos Ocasionales
N.º 2012

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This paper has also been published as an ECB Occasional Paper with number 240, April 2020.

Documentos Ocasionales. N.º 2012

2020

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ISSN: 1696-2230 (on-line edition)

Abstract

The paper describes the main transmission channels of the spillovers of national fiscal policies to other countries within the euro area and investigates their magnitude using different models. In the context of Economic and Monetary Union (EMU), fiscal spillovers are relevant for the accurate assessment of the cyclical outlook in euro area countries, as well as in the debates on a coordinated change in the euro area fiscal stance and on a euro area fiscal capacity. The paper focuses on spillovers from expenditure-based expansions by presenting two complementary exercises. The first is an empirical investigation of spillovers based on a new, long quarterly dataset for the largest euro area countries and on new estimates based on annual data for a panel of 11 euro area countries. The second uses a multi-country general equilibrium model with a rich fiscal specification and the capacity to analyse trade spillovers. Fiscal spillovers are found to be heterogeneous but generally positive among euro area countries. The reaction of interest rates to fiscal expansions is an important determinant of the magnitude of spillovers.

Keywords: fiscal spillovers, fiscal policy, monetary policy, VAR, DSGE.

JEL classification: F42, F45, H50, E62, E63.

Resumen

Este documento describe los principales canales de transmisión de los efectos desbordamiento (*spillovers*) de las políticas fiscales nacionales a otros países de la zona del euro y analiza su magnitud utilizando diferentes modelos. En el contexto de la Unión Económica y Monetaria (UEM), los efectos desbordamiento de las políticas fiscales son relevantes para la evaluación precisa de las perspectivas económicas en los países miembros, así como en los debates sobre un cambio coordinado en el tono de la política fiscal de la zona del euro y sobre su capacidad fiscal. El documento se centra en los efectos indirectos de las expansiones basadas en el gasto público, presentando dos ejercicios complementarios. El primero es una investigación empírica de los efectos desbordamiento basada en un novedoso y amplio conjunto de datos trimestrales para los países más grandes de la zona del euro, y en nuevas estimaciones basadas en datos anuales para un panel de 11 países de la misma zona. El segundo ejercicio utiliza un modelo de equilibrio general de varios países con una especificación fiscal detallada y la posibilidad de analizar los efectos desbordamiento basados en el comercio entre países. Los resultados sugieren que los efectos desbordamiento derivados de las políticas fiscales de gasto son heterogéneos —pero, en general, positivos— entre los países del área del euro. La reacción de los tipos de interés a las expansiones fiscales es un determinante destacado de la magnitud de estos efectos desbordamiento.

Palabras clave: efectos desbordamiento, política fiscal, política monetaria, vector autorregresivo, modelos de equilibrio general.

Códigos JEL: F42, F45, H50, E62, E63.

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2 Executive summary

Fiscal spillovers across countries have received increasing attention in recent years. Understanding the impact of one country's fiscal policies on output in other Member States of the monetary union is of interest to a central bank setting a single monetary policy, as this feeds into the assessment of the risks to price stability. Fiscal spillovers should also be taken into account when assessing the aggregate euro area fiscal stance. Finally, the size of the fiscal spillovers is important when assessing the stabilisation effects of national fiscal policies. If the fiscal spillovers are small, then the existence of a central fiscal stabilisation function that can support national economic stabilisers in the presence of large economic shocks would make Economic and Monetary Union (EMU) more resilient.

This paper provides new estimates – based on a suite of models – of fiscal expenditure spillovers in the euro area, as well as simulations to promote a better understanding of their driving factors. Our first empirical approach consists of an estimate of the average spillover effect among euro area countries, using a panel vector autoregressive model. The second approach focuses on the individual spillovers among the four largest euro area countries using vector autoregressive models. Finally, a multi-country DSGE model that was specifically calibrated to simultaneously analyse the four largest euro area countries is used to investigate the factors influencing the magnitude of fiscal spillovers, in particular the interaction with monetary policy.

The empirical results confirm the existence of positive fiscal spillovers within euro area countries. New estimates based on a panel of euro area countries with annual data, as well as new estimates for the four largest euro area countries individually that are based on a new quarterly dataset, confirm the findings of earlier studies that fiscal expenditure has positive spillovers across countries.

The reaction of interest rates is an important determinant of the magnitude of spillovers. The dynamic stochastic general equilibrium (DSGE) model simulations illustrate that the composition of government expenditure has implications for the magnitude of spillovers, with productive government investment providing larger spillovers than consumption. The model simulations also explore the relationship between the reaction of interest rates and spillovers, as the empirical results suggest that spillovers are higher when interest rates react less to the government expenditure shock.

All in all, spillovers within the euro area are higher when interest rates are not increased in response to an increase in government expenditure, but remain below the domestic impact of fiscal expenditure. This suggests that fiscal spillovers could play a greater stabilising role in the euro area cycle if the efficacy of monetary policy instruments is less than during normal times.

3 Introduction

Fiscal spillovers across countries have received increasing attention in recent years. Understanding the impact of a country's fiscal policies on output in other Member States of the monetary union is naturally of considerable interest to a central bank setting a single monetary policy. This allows the bank to better gauge the euro area's economic developments, and in turn feeds into the assessment of risks to price stability. Moreover, fiscal spillovers should be taken into account when assessing the aggregate euro area fiscal stance. Finally, the size of fiscal spillovers is important when assessing the stabilisation effects of national fiscal policies. If fiscal spillovers are small, then the existence of a central fiscal stabilisation function that can support national economic stabilisers in the presence of large economic shocks would make EMU more resilient.

National fiscal policies spill over to other countries through different channels. Trade is an important transmission channel between countries, whereby a fiscal expansion in one country increases its imports from other countries. Fiscal expansion could also increase domestic prices and the real effective exchange rate, reinforcing spillovers, as the stimulating country loses competitiveness vis-à-vis the other countries. Given the implications for prices, it is important to take into account the monetary policy response. Interest rates may occasionally fail to react to price changes stemming from fiscal action, for instance, if the economy is constrained by the effective lower bound.

This paper provides new estimates of fiscal spillovers in the euro area and simulations using a suite of multi-country models to better understand the driving factors. Our first empirical approach consists of an estimate of the average spillover effect among 11 euro area countries, using a panel vector autoregression (PVAR) model based on annual data since 1972. The second approach focuses on the individual spillovers among the four largest euro area countries, using VAR models which are based on a new quarterly dataset. Comparing up-to-date estimates based on different data and using different estimation methods enhances the robustness of our findings. By employing a multi-country DSGE model that was specifically calibrated to analyse the four largest euro area countries simultaneously, we are able to investigate the factors influencing the magnitude of fiscal spillovers, in particular their interactions with monetary policy. Both the empirical estimates and the DSGE simulations focus on an expenditure-based fiscal expansion.

The empirical literature on fiscal spillovers is relatively underdeveloped. While the number of empirical studies estimating the size of fiscal spillovers has grown in recent years, it is limited, and results are not easily comparable. The differing identification of fiscal shocks and presentation of the results according to different metrics makes generalising the findings from the literature all the more complex. In addition, there are few papers that focus on the euro area.

Spillover estimates of public spending tend to be positive but generally small. A number of studies have estimated fiscal spillovers from an increase in public spending through the trade channel for a panel of countries. For example, based on annual data from 1965 to 2004, Beetsma et al. (2006) estimate that a spending-based fiscal

expansion of 1% of GDP in Germany would lead to an average increase in the output of other EU economies by 0.15% after two years; for an expansion originating in France, the impact is 0.08%. Using quarterly data from 2000 to 2016 for 55 countries, the International Monetary Fund (IMF) reports that an increase in government spending by 1% of GDP in an average major advanced economy has a spillover effect of 0.15% of GDP on an average recipient country within the first year (IMF (2017) and Blagrove et al. (2017)). When restricting the sample to Europe, the IMF estimates the one-year spillover of 1% government spending shock in Germany and in France to be 0.26% and 0.14%, respectively (Blagrove et al. (2017)). Auerbach and Gorodnichenko (2013), who in contrast to the abovementioned studies normalise spillovers to the recipient country's GDP, find fiscal spillovers from large OECD economies that are broadly comparable with the IMF's findings (see Annex 6 in Blagrove et al. (2017) for a comparison).

Spillover estimates are heterogeneous. The estimated magnitude of spillovers varies, with the heterogeneity related to the trade links, the state of the economy and the reaction of monetary policy. Beetsma et al. (2006) find spillovers from Germany to be around 0.4% of GDP after two years in small open economies sharing a land border with the country, such as Austria, Belgium and the Netherlands. Auerbach and Gorodnichenko (2013) find spillovers that are particularly high in recessions and more modest in expansions.¹ The IMF study finds that spillovers are up to four times as large when monetary policy is at the effective lower bound (0.3% after one year), compared with normal times (0.08%).

Additional insight into fiscal spillovers is provided by a number of studies using theoretical DSGE models. Rich DSGE multi-country models can provide more insight into the determinants of the fiscal spillovers than empirical methods such as vector auto-regressions (VARs), which encompass a variety of contributing effects that are difficult to disentangle.² However, DSGE models may come at the price of imposing restrictive assumptions, which may not always have strong empirical foundations. Studies based on DSGE models often find spillovers in normal times to be lower than the VAR-based estimates, but higher when interest rates do not react. This is partly explained by the fact that structural models only include spillovers through trade, whereas VARs also include other effects, such as financial spillovers.

Throughout the paper, spillovers are summarised by destination and by origin. Destination spillovers measure the spillover from a spending shock, in all but one euro area country, on the recipient country. This gives an indication of the effect of a simultaneous fiscal stimulus among euro area Member States. Spillover by origin is the impact on the output in the receiving countries of fiscal action in one country. This statistic indicates the magnitude of the spillovers that an individual country is able to generate. In Chapter 2, the empirical results are presented, followed by a chapter demonstrating the DSGE model simulations. Chapter 4 concludes the paper.

¹ For domestic fiscal multipliers, the findings by Auerbach and Gorodnichenko (2012) of higher multipliers in recessions have been shown to be fragile to small changes in specification (see, for example, Alloza (2017)). In an overview paper of the effects of fiscal policy, Ramey (2019) concludes that "most estimates of government spending multipliers for general categories of government spending for averages over samples are in the range of 0.6 to 0.8, or perhaps up to 1. The evidence for multipliers above one during recessions or times of slack is typically not robust. However, some initial explorations suggest that government spending multipliers could be higher at times when monetary policy accommodates fiscal policy, such as during periods at the zero lower bound of interest rates or wartime".

² Examples are In 't Veld (2017) and Blagrove et al. (2018).

4 Empirical estimates of government spending spillovers in the euro area

This section presents new estimates of fiscal spillover effects from the euro area countries. To this end, country-specific exogenous government spending shocks are identified and their dynamic effect on the economic activity of other countries considered.

4.1 PVAR estimates of government spending spillovers

This section provides an estimate for the average government spending spillover for 11 euro area countries using a PVAR model.³ This approach combines the advantages of a VAR model, i.e. the ability to capture dynamic interdependencies in the data by imposing a minimum of restrictions, with a cross-country dimension given by the panel dimension to gauge the average spillover effects across countries and over time.

4.1.1 Data

The panel estimates are based on an annual dataset of 11 euro area countries. The countries covered are the initial euro area countries, excluding Luxembourg, from 1972 to 2017.⁴ The benchmark model includes five variables: trade-weighted foreign real government spending (govfor), i.e. the sum of real government consumption and real government investment,⁵ domestic real government spending (gov), real GDP (gdp), the GDP deflator (def) and the long-term (10-year) nominal interest rate (ltn). An alternative specification adds the real effective exchange rate (reer) to the model as a control for the reaction of relative prices. The variables and data sources are listed in the appendix. All variables are in logs (apart from the nominal interest rate) and in 1st difference.

To calculate aggregate foreign real government spending, real government spending in euro area partner countries is weighted by bilateral import weight.⁶ We adopt a destination country perspective, i.e. we calculate by how much trade-weighted real government spending in euro area source countries affects the

³ For more information on the methodology and results of the estimates presented in this section, see Schmidt (2019).

⁴ Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Netherlands and Portugal. Data limitations do not allow for the inclusion of Luxembourg and later euro area entrants in the estimations.

⁵ A chain-type Fisher index is used to construct real government spending from government investment and government consumption, using the part of each component in total nominal government spending over the years, $t-1$ and t , as weights.

⁶ Although a large part of public expenditure consists of non-traded goods, weighting public expenditure by trade flows provides a synthetic indicator that reflects the relative exposure of the domestic economy to fiscal shocks in other euro area countries, which is standard in the literature (see, for example, Beetsma et al. (2006)).

destination country's output, prices, interest rates, etc. More precisely, the foreign spending variable is calculated as follows:

$$govfor_{i,t} = \sum_{j=1}^{10} \frac{M_{ij,t-1}}{M_{j,t-1}} gov_{j,t}$$

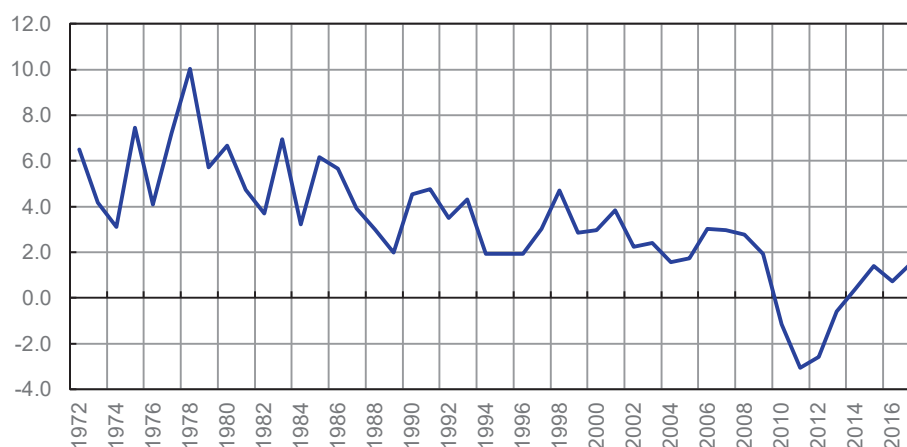
where i denotes the recipient country, j the source country, $M_{ij,t-1}$ country j 's goods imports from i at time $t-1$ (10-year moving average), $M_{j,t-1}$ country j 's total goods imports at $t-1$ (10-year moving average), and $gov_{j,t}$ the government shock in source country j . Import flows are averaged over ten years to avoid endogeneity problems and avoid idiosyncratic shocks to influence the results.

Trade weights sum up to 1 for each country j over i ($i \neq j$), i.e. we presume that euro area countries only trade with each other (government shocks are not exported to non-euro area countries). This assumption is due to the limited availability of bilateral trade data over a long horizon with non-euro area countries. The estimated spillover effects are hence likely to represent upper bounds, as a part of the spending shocks should also be exported to non-euro area countries. Chart 1 shows foreign real government spending fluctuations for the average euro area country for the period from 1972 to 2017. They were higher at the beginning of the period up to the 1990s (average fluctuations of 5.2%), before falling to around 1.9% on average for the period after 1990. A fall in the average foreign (trade-weighted) real government spending is observed following the Great Recession.

Chart 1

Trade-weighted foreign real government spending (euro area average)

(x-axis: years; y-axis: percentage change)



Source: Schmidt (2019).

4.1.2 Methodology

The main structure of the PVAR follows the general form as shown in Canova and Ciccarelli (2013):

$$Y_{i,t} = A_{o,i} + A_i(L)Y_{i,t-1} + u_{i,t}$$

where $Y_{i,t}$ is the vector of endogenous variables

$$Y_{i,t} = (govfor_{i,t}, gov_{i,t}, gdp_{i,t}, def_{i,t}, ltn_{i,t})'$$

in the benchmark specification, $A_i(L)$ is a polynomial in the lag operator L , $A_{o,i}$ is a vector of country-fixed effects, and $u_{i,t}$ are the identically and independently distributed errors. $i = 1; \dots; 11$ and $t = 1; \dots; T$.

The variables enter the model in first differences in order to satisfy the stationarity condition (no root lies outside the unit circle). The benchmark specification is estimated with 2 lags and an alternative specification with 1 lag.⁷

The model is estimated using a least squares dummy variable (LSDV) estimator. Country-specific fixed effects, which capture invariant unobserved country heterogeneity, are obtained by adding dummy variables to the system. The existence of lagged dependent variables in the model introduces a bias into the fixed effects estimator, whose size is however decreasing in terms of the number of time series observations T (see Bun and Kiviet (2006) and Nickell (1981)). The bias should be small here, as T is large for a panel model (46 years).⁸

A recursive identification scheme through a Cholesky decomposition is used to identify structural shocks (see Blanchard and Perotti (2002)). The recursive form determines which variable responds to the structural shocks in time (t). In the benchmark specification, foreign government spending is ordered first, affecting all the other variables contemporaneously. Domestic spending, ordered second, is allowed to have a contemporaneous impact on domestic GDP, prices and interest rates, but would affect foreign government spending only with a lag. This ordering is consistent with other VAR studies and seems plausible in the situation of one-year ahead annual budgetary planning, which leads to a certain inertia in government choices as to macroeconomic conditions (see Beetsma and Giuliodori (2011)). Error bands of the impulse responses are generated by Monte Carlo simulations over 200 draws with confidence bands at 68% and 95%. The impulse response functions (IRFs) are reported for a one-standard deviation shock for a period of over four years.

The robustness of the results is confirmed by a number of alternative model specifications. We test for alternative orderings of the variables, placing foreign government spending last, an alternative lag structure as well as including the real effective exchange rate in the model. The model is also estimated over a shorter time span from 1972 up to the Great Recession in 2007, in order to analyse whether benchmark results are influenced by the simultaneous fiscal action in many euro area countries during the Great Recession, as well as for the four largest euro area countries only.

4.1.3 PVAR results

The estimates provide evidence of a positive average destination spillover effect in the euro area across all countries in the panel. Chart 2 (left panel) plots the (non-cumulative) output response in an average euro area country for a

⁷ The baseline specification of 2 lags is selected by the Hannan-Quinn information criterion and by t -statistics for serial correlations; the alternative specification of 1 lag is based on the Bayesian information criterion.

⁸ Another option would be to use the forward mean-differencing transformation – also known as Helmert transformation – to remove fixed effects and estimate the coefficients by the GMM estimator. However, the GMM estimator is found to only be consistent for panels with a short time dimension, i.e. $N > T$, which is not the case here.

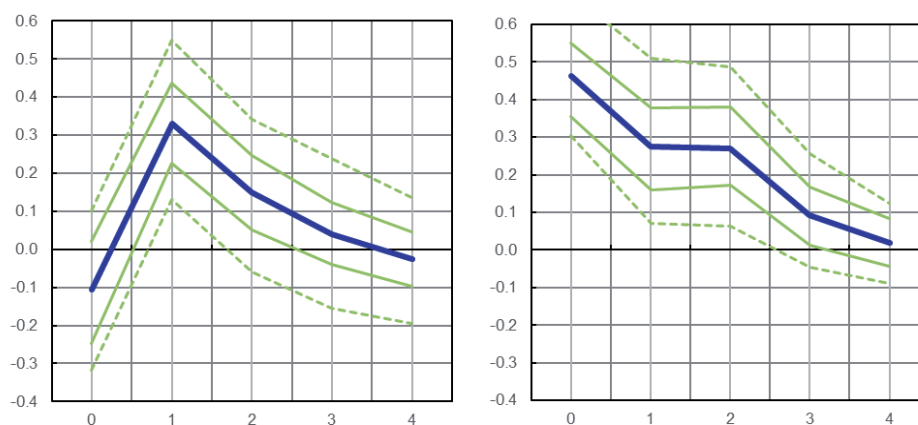
one-standard deviation increase (equivalent to 2.6%) in (trade-weighted) real government spending in the other ten euro area countries. Output in the destination country increases by 0.3 percentage point in the first year and by 0.1 percentage point in the second year after the shock (effects are significant at the 68% level), before decreasing gradually to zero thereafter. Government spending in the destination country does not react significantly to the foreign government shock, which assures that the reaction of domestic GDP is not driven by a simultaneous impulse from domestic government spending (see full set of IRFs in the appendix). For comparison, the domestic output response to a domestic government spending shock is 0.5 percentage point on impact, 0.3 percentage point in the first and second year and 0.1 percentage point in the third year, all significant at the 68% level (Chart 2, right panel).

Chart 2

PVAR estimates of government spending (by destination)

Average (non-cumulative) output response in a euro area country to a trade-weighted increase in government spending in the other euro area countries (left) and to an increase in domestic government spending (right)

(x-axis: years; y-axis: percentage change)



Source: Schmidt (2019).

These results imply domestic spending multipliers just below unity, and across countries of around 0.4. Cumulating these estimated output effects over time and dividing them by the cumulated response of government spending in the stimulating countries transforms these estimates into (cumulative) elasticities. We transform the elasticities into euro multipliers by multiplying them with the sample average GDP-to-government-ratio. For a €1 government spending shock, we find a cumulative destination spillover multiplier of €0.42 after two years, decreasing to €0.32 after four years (see Table 1). The cumulative domestic spending multiplier is 0.87 after two years and 0.84 after four years.

4.1.4 Robustness

The benchmark results are robust to an alternative model specification and other identification assumptions. Table 1 summarises the multipliers estimated in a number of alternative models. It is evident that the benchmark results remain robust

when a different lag structure, a different ordering of variables and a model which includes the real effective exchange rate are used. Cumulative spillover multipliers are quantitatively close, between 0.3 and 0.4 respectively after two and four years, while the time profile of the output reaction varies slightly between these alternative models.

Table 1
Robustness of destination spillovers

Average cumulative multipliers in one euro area country of a trade-weighted €1 increase in government spending in the other euro area countries

Period	Benchmark	Foreign gov. spending ordered last	1 lag	Incl. real effective exchange rate
0	-0.23	0.00	-0.38	-0.26
1	0.33	*0.40	0.07	0.30
2	*0.42	*0.36	0.25	*0.39
3	0.39	*0.31	*0.32	0.34
4	0.32	*0.26	*0.35	0.26

Source: Schmidt (2019).
Note: * denotes significance at the 68% level.

Spillovers are somewhat lower when the years following the financial crisis are excluded from the estimations. Chart 3 (right panel) shows the (non-cumulative) output response to a foreign government spending shock in the estimation for the shorter sample from 1972 to 2007, which excludes the period of the Great Recession, compared to the full sample estimates (left panel). The output response is comparable to the full sample in the first year, but it tends towards zero much faster thereafter (impact close to zero from the second year). Cumulative multipliers are therefore only slightly smaller than in the full sample after two years (0.25 against 0.42) but significantly smaller after four years (0.02 against 0.32). These differences might be related to state dependencies in fiscal spillovers that stem from the cyclical position of the economy, the reaction of monetary policy and/or the negative fiscal shocks that are only observed in the years during and after the financial crisis.

Spillovers are also lower when limiting the panel to the four largest euro area countries (Germany, France, Italy and Spain). For a trade-weighted government spending shock in the three largest countries, output in the remaining country increases on average by only 0.1 percentage point in the first year (not significant at the 68% level) and by 0.2 percentage point in the second year (significant at the 68% level) after the shock. However, owing to a stronger negative output response on impact, cumulative multipliers are close to zero after two years, increasing only to 0.15 after four years (against 0.32 in the full panel). The main reason for this smaller spillover effect for larger countries should be that they are less open than some of the small, open economies included in the main panel set, which, on average, generate much larger spillover effects.⁹

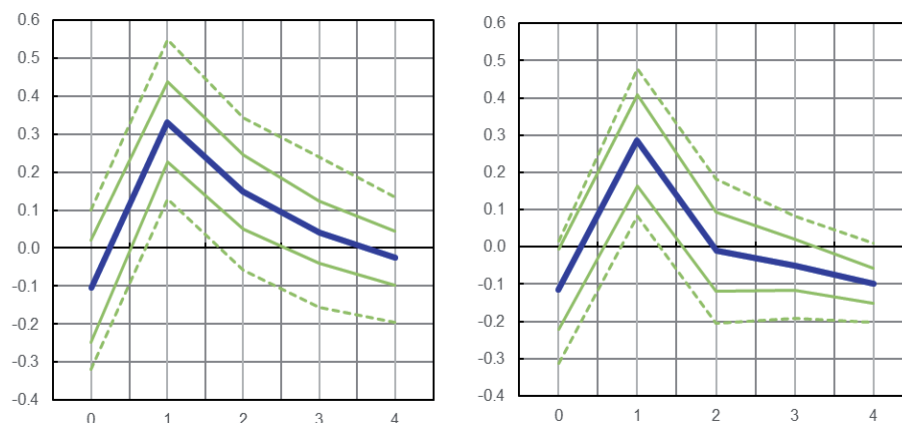
⁹ The four largest euro area countries have an import-to-GDP ratio (imports from the euro area) of 10% over the 1972-2017 period against 26% for the smaller countries in the panel. Other factors such as differences in the composition of public spending across countries or a stronger response of interest rates to fiscal shocks in large countries might also explain some of the differences.

Chart 3

PVAR estimates of government spending (by destination), sample robustness

Average (non-cumulative) output response in a euro area country to a trade-weighted spending increase in the other euro area countries, full sample (left panel) and sample ending 2007 (right panel)

(x-axis: years; y-axis: percentage change)



Source: Schmidt (2019).

4.2 Structural vector autoregression estimates of government spending spillovers

This section provides individual estimates of government spending spillovers for the four largest euro area countries using structural vector autoregression (SVAR) models.¹⁰ This disaggregated approach allows us to understand the potentially heterogeneous effects between countries and gain an insight into the transmission mechanisms of fiscal spillovers.

4.2.1 Data

Estimates are based on a new dataset for euro area countries. An analysis of the effects of fiscal spillovers based on time series methods requires the use of comparable, long and detailed data. However, for euro area countries, data on many of the necessary fiscal variables are only available at a quarterly frequency from the mid to late 1990s. This issue is addressed by assembling a new dataset for Germany, France, Italy, Spain and the euro area as a whole, from the first quarter of 1980 to the fourth quarter of 2015 at a quarterly frequency, consistent with Eurostat data (in the current ESA 2010 accounting framework). In particular, using an unobserved component model that combines both annual and quarterly national accounts, as well as monthly indicators, it is possible to estimate fiscal variables at a quarterly frequency, while maintaining coherence with official annual aggregates. This

¹⁰ For further information on the methodology and results of the estimates presented in this section, including the construction of the new quarterly dataset, see Alloza et al. (2019a).

framework takes into account important features of the data, such as different seasonal patterns.¹¹

The resulting dataset contains disaggregated measures of fiscal spending (and revenues) for each of the four countries and the euro area aggregate. This disaggregation allows the separation of components of government spending depending on their sensitivity to economic conditions. To support the empirical strategy described in the next section, the government spending aggregate comprises government consumption and investment, while cyclically sensitive items such as transfers are excluded.¹²

4.2.2 Methodology

The empirical strategy follows three steps. First, country-specific VARs are estimated based on (the logs of) real net tax revenues, government spending, output, the GDP deflator and the level of the 10-year interest rate. The identifying assumption is that it takes longer than one quarter to implement fiscal policies in response to a change in the economic environment. This facilitates the identification of structural shocks to government spending, i.e. fiscal actions are contemporaneously unrelated to the economic conditions (see Blanchard and Perotti (2002)). Second, local projections are used to trace the dynamic response of economic activity in a country to a government spending shock originating in another country (see Jordà (2005)). This framework permits the estimation of the bilateral effect of fiscal action for each two-country combination. Third, these pair-wise estimates are combined into two statistics that summarise the results.

The dynamic effects of the shocks are estimated using local projections. In particular, we estimate the following regressions for output (Y) and government spending (G) for each country i :

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \alpha_{i,h} + \beta_{i,j,h} \frac{shock_{j,t}}{Y_{i,t-1}} + \delta_{i,h}(L)X_{i,t-1} + \xi_{i,t+h}$$

$$\frac{G_{i,t+h} - G_{i,t-1}}{Y_{i,t-1}} = \lambda_{i,h} + \gamma_{i,j,h} \frac{shock_{j,t}}{Y_{i,t-1}} + \rho_{i,h}(L)X_{i,t-1} + \varepsilon_{i,t+h}$$

where $shock_{j,t}$ is a government spending shock in country j identified in a previous step, and $X_{i,t-1}$ is a vector of control variables that includes real net tax revenues, government spending, output, the GDP deflator and the level of the 10-year interest rate in countries i and j . The above equations are estimated for each quarter (h) of the response horizon (which extends to 12 periods). The sequence of coefficients $\beta_{i,j,h}$ for each h of the response horizon represents the dynamic effect of a government spending shock in country j on output in country i at period h . These coefficients can be combined for various countries, to form spillovers by origin or by destination.

¹¹ For Germany and Italy, we combine official information from the quarterly non-financial accounts for general government statistics (ESA 2010 and ESA 95) and extend it backwards using intra-annual monthly fiscal information and annual official statistics. For Spain and the euro area, we obtain our data from updated versions of de Castro et al. (2018) and Paredes et al. (2014) respectively, which were constructed according to the methodology described above and are also consistent with national accounts. Data for France are obtained directly from Eurostat.

¹² Nominal variables are converted to real terms using the GDP deflator.

4.2.3 Structural vector autoregression results

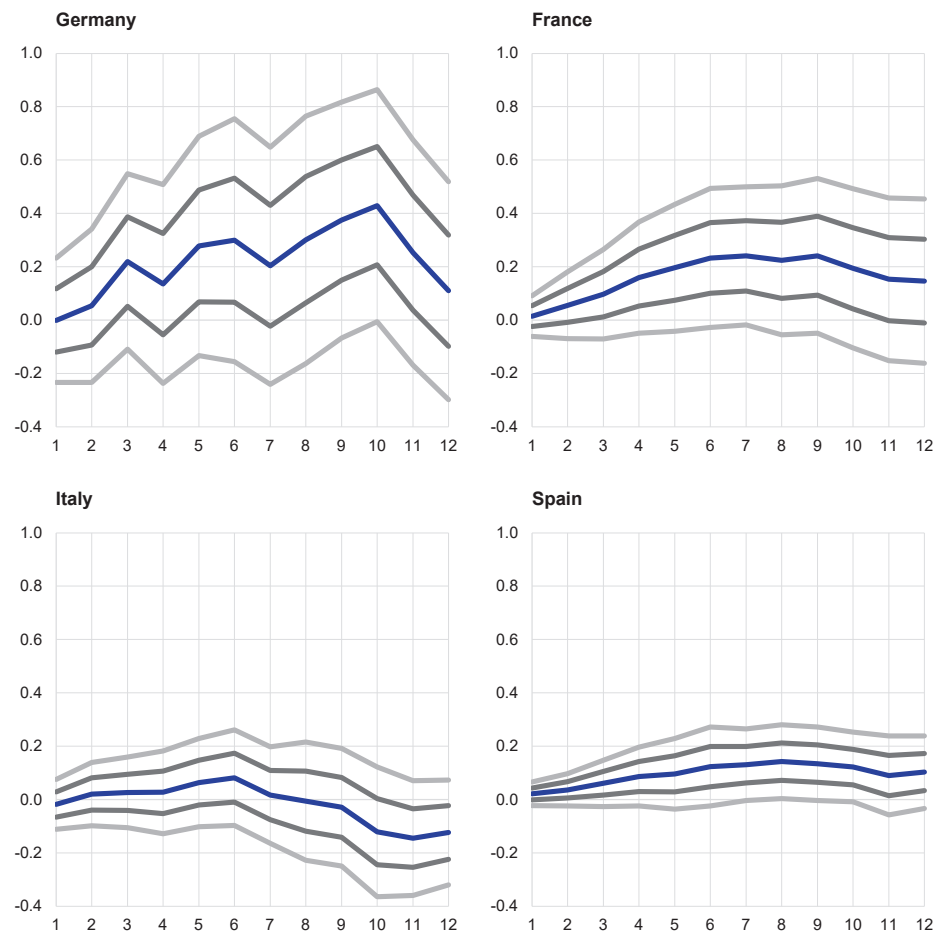
The results provide additional support for the existence of positive fiscal spillovers in the euro area. Chart 4 plots the GDP response in each of the four economies to increases in government spending in the remaining countries (i.e. the destination spillover). The blue line shows the output response in the receiving country to the government spending shocks in the source countries, using the coefficients $\beta_{i,j,h}$ estimated above. Cumulating these output effects and dividing them by the cumulated response of government spending ($\gamma_{i,j,h}$) in the stimulating countries (not shown) converts them into a measure that is directly comparable with the multiplier of a domestic fiscal expansion. For example, France has a cumulative destination spillover of 0.72 after two years. This means that a simultaneous (initial) €1 increase in government spending in Germany, Italy and Spain would increase French output by €0.72 after two years.

There are differences in dynamics, magnitude and significance of destination spillovers across countries. France and Spain show a similar pattern, with the

Chart 4
SVAR estimates of spillover effects (by destination)

Output response to a simultaneous increase in government spending in the rest of the countries

(x-axis: quarters; y-axis: percentage change)



Source: Alloza et al., 2019a.

Note: The blue line shows the output response. The dark grey and light grey lines represent Newey-West confidence intervals at 68% and 95%.

spillover becoming positive and significant at the 68% level by the end of the first year. In both cases, the dynamics are similar: around 0.2-0.3 in the first year and cumulatively around 0.6-0.7 in the second year. Germany also shows an increasing positive spillover, but with significant values at the 68% level, only in the third year. While only marginally significant, the magnitude of the effect in Germany seems to be larger than in the rest of the countries considered, with a cumulative destination spillover of 0.6 at the end of the first year. The spillover in Italy is estimated to be the lowest and not significantly different from zero. If the 95% confidence level were applied, then fiscal spillovers would only be significant in the case of Spain.

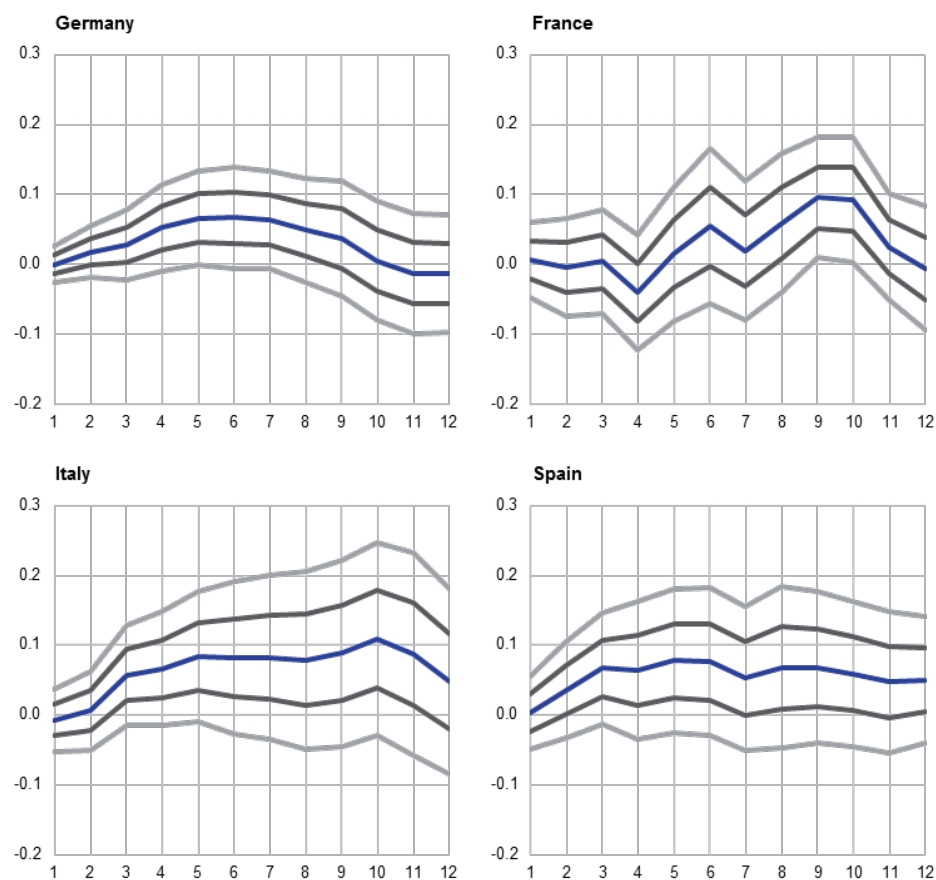
Positive spillovers are also found for spending increases in one country. When looking at the spillover effect from the point of view of the country conducting the fiscal expansion, i.e. spillovers by origin, the results are heterogeneous but also provide evidence of positive fiscal spillovers among large euro area countries. This effect is calculated as an output-weighted average of the cross-country spillovers that country j generates on the rest of countries $i \neq j$ (the cumulated sum of the ratio of $\beta_{i,j,h}$ to $\gamma_{i,j,h}$). In particular, government spending spillovers by origin are estimated to be stronger in Italy and Spain than in Germany, but not significant for France (Chart 5).

Chart 5

SVAR estimates of spillover effects (by origin)

Output response to an increase in government spending in one country in the other euro area countries

(x-axis: quarters; y-axis: percentage change)



Source: Alloza et al., 2019a.

Note: The blue line shows the output response. The dark grey and light grey lines represent Newey-West confidence intervals at 68% and 95%.

Additionally, spillovers by origin are found to be stronger for public investment than consumption.

4.2.4 Potential sources of country heterogeneity

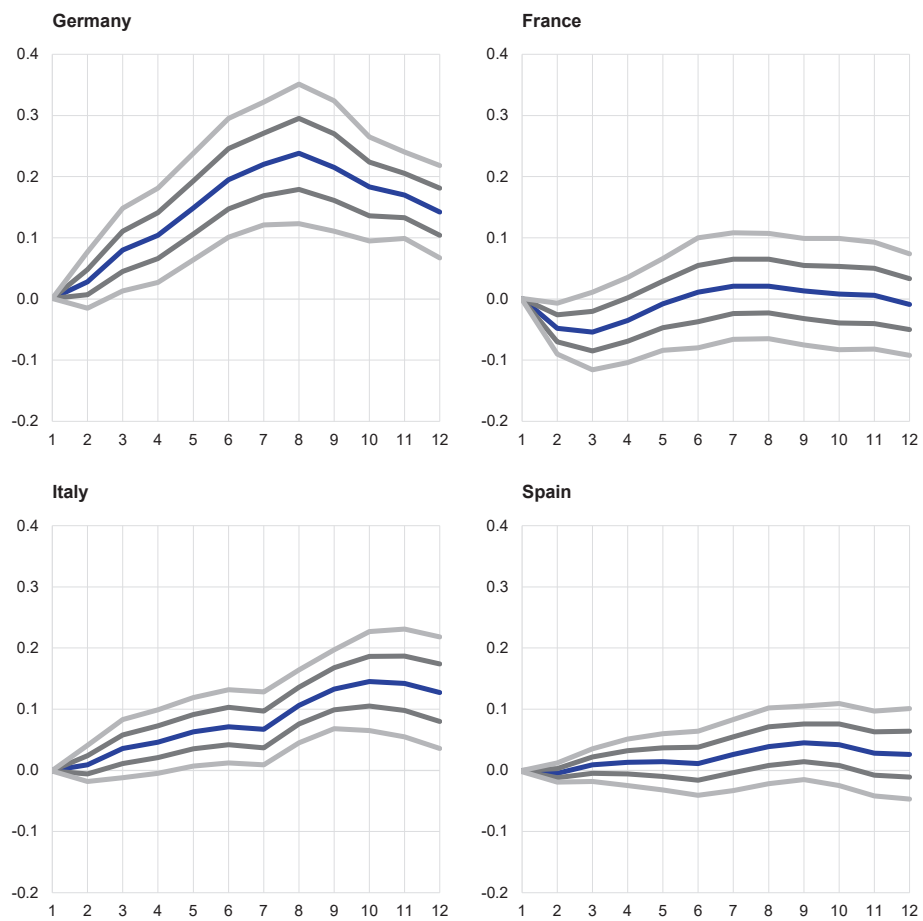
Differences in trade intensity between countries are likely to be an important driver of transmissions of fiscal stimuli. An increase in government spending in a country raises both the domestic aggregate demand and the imports from a different country. A pair of countries with a tight trade relationship is likely to experience larger fiscal spillovers.¹³

Chart 6

Response of euro area-wide interest rate to (domestic) government spending shock

Euro area-wide interest rate response to an increase in government spending in one country

(x-axis: quarters; y-axis: percentage change)



Source: Alloza et al., 2019a.

Note: The blue line shows the interest rate response. The dark grey and light grey lines represent Newey-West confidence intervals at 68% and 95%.

4.2.5 Comparison of PVAR and SVAR results

The results from the PVAR and SVAR estimates broadly show a similar picture. The abovementioned SVAR destination spillovers measure the impact of a

¹³ Alloza, et al. (2019a) show that there is a substantial and positive relationship between the size of cross-country government spending spillovers and their corresponding share of bilateral imports.

€1 increase in government spending in each of the other euro area countries.¹⁴ An alternative measure is the effect of an average €1 spending increase in the other three euro area countries, which results in lower spillovers on the remaining country but with a similar heterogeneity across countries (see Table 2). For the four largest euro area countries, the output-weighted average spillovers are around 0.09, 0.46 and 0.60 in the first, second and third years respectively. These figures are broadly comparable to the results of the PVAR estimates described in Section 2.1, which are based on annual data for 11 euro area countries: 0.33, 0.42 and 0.39. The similarity between both sets of results is confirmed with PVAR multipliers estimated on a sample with the same starting year as the SVAR estimates (0.22, 0.38 and 0.43). The differences become somewhat larger when compared with the PVAR estimates, which include only the four largest euro area countries, and show smaller spillover effects (0.02 after two years, 0.23 after three years).¹⁵ When comparing the benchmark results, both analyses suggest that the average destination spillover during the first two years is close to 0.4.

Table 2
Comparison of destination spillovers

Cumulative multiplier (two-year)								
Method	SVAR					PVAR		
	Countries	DE	FR	IT	ES	EA#	EA	DE, FR, IT, ES
Sample	1980Q1-2016Q4					1972-2017	1980-2017	1980-2017
Average destination spillover	0.73	**0.50	0.00	**0.32	0.46	*0.42	*0.38	0.02
Simultaneous destination spillover	1.72	*0.72	0.16	*0.61				

Source: Alloza et al. (2019) and Schmidt (2019).

Notes: Average destination spillover measures the output response to a €1 average government spending increase in the other euro area countries; simultaneous spillovers measure the output response to a €1 increase in each of the other countries. # EA average based on the output-weighted average of the SVAR results; * denotes significance at the 68% level; ** at the 95% level.

The results are broadly comparable with previous empirical studies. Different data samples, fiscal identification and estimation methods make a comparison with other papers somewhat complicated. However, our baseline results are close to PVAR estimates found by Beetsma and Giulliodori (2011) and Dabla-Norris et al. (2017). Their magnitude is at the lower end of estimates by Auerbach and Gorodnichenko (2013) and Blagrove et al. (2017).¹⁶

The effect of fiscal spillovers is smaller than domestic fiscal spending. The domestic multipliers found in both approaches are very similar. The second-year cumulative multiplier for the euro area is 1.1 in the SVAR, with estimates for individual countries varying between 1.1 and 1.4 (Alloza et al. (2019a)). The PVAR estimate is 0.9 (see Section 3.1.3). These results suggest that the spillover effect of fiscal expenditure across euro area countries is below half of the effect of domestic fiscal expenditure.

¹⁴ Since this spillover is based on adding the estimated effects of fiscal shocks that might not have taken place at the same moment in time, the results are likely to represent an upper bound.

¹⁵ However, there is a higher degree of uncertainty surrounding the PVAR estimates for the sample restricted to the four largest euro area countries, and the spillover multipliers are not significant (at the 68% level).

¹⁶ The average three-year spillover multipliers reported in these papers differ between 1.4 and 2.0, depending on the identification of fiscal shocks and estimation methods (see Annex 6 in Blagrove et al. (2017)). The difference in results may be due to differences in the data used (shorter time samples and covering OECD countries). The reported uncertainty bands do not allow us to conclude that our results are significantly lower.

5 Spillover analysis based on a multi-country DSGE model

This section provides simulations using a multi-country DSGE model: the Euro Area and Global Economy (EAGLE) model.¹⁷ The model is calibrated with the euro area split into five blocs – Germany, France, Italy, Spain and the rest of the euro area – while the sixth bloc covers the rest of the world.¹⁸ Like the ECB’s New Area-Wide Model, EAGLE is micro-founded and features nominal price and wage rigidities, capital accumulation, and international trade in goods and bonds. Given its global dimension, the model is particularly well suited to assess cross-border spillovers. All regions trade with each other in intermediate goods, with estimates of bilateral trade flows based on recent historical averages. International asset trade is limited to nominally non-contingent bonds denominated in US dollars.

The version used here embeds an extended fiscal bloc.¹⁹ Households are assumed to derive utility from the consumption of a composite good consisting of public and private consumption goods. Following Clancy et al. (2016) and Coenen et al. (2012), government consumption $C_{G,t}$ enters as a partial complement to private consumption C_t in the utility function. Utility depends on aggregated consumption CC_t :

$$CC_t = \left[\omega \frac{1}{\theta} (C_t)^{\frac{\theta-1}{\theta}} + (1 - \omega) \frac{1}{\theta} (C_{G,t})^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \quad (1)$$

The share of the government consumption good in the composite good is determined by ω , while θ determines the degree of complementarity. Therefore, changes in government consumption directly affect optimal private consumption decisions, as opposed to the indirect wealth effect when government consumption is separable (see Clancy et al. (2016)).

It is also assumed that government capital stock affects the production process. The model also explicitly accounts for the fact that government investment, $I_{G,t}$ is assumed not to be wasteful and contributes to public capital, $K_{G,t}$ as in Leeper et al. (2010):

$$K_{G,t+1} = (1 - \delta)K_{G,t} + I_{G,t} \quad (2)$$

where δ is the depreciation rate. In each sector, $K_{G,t}$ enters the production function as follows:

$$Y_t = z_t K_{G,t}^\epsilon K_t^\alpha L_t^{1-\alpha} \quad (3)$$

where z_t is the exogenous technological progress, K_t the private capital and L_t labour (with share α and $1-\alpha$ respectively). Government capital enhances the productivity of

¹⁷ The model simulations in this chapter were previously published in Alloza et al. (2019b).

¹⁸ The Euro Area and Global Economy (EAGLE) model is a multi-country dynamic stochastic general equilibrium model of the euro area developed by an ESCB team composed of staff from the Banca d’Italia, the Banco de Portugal and the ECB. See Gomes et al. (2012).

¹⁹ See Clancy et al. (2016).

private capital in a similar manner to technological progress (with productivity ε). This implies that an increase in government capital will reduce the marginal costs, MC_t , of the intermediate goods sector:

$$MC_t = (z_t K_{G,t}^\varepsilon \alpha^\alpha (1 - \alpha)^{1-\alpha})^{-1} (R_{K,t})^\alpha (W_t(1 + \tau_{L,t}))^{1-\alpha} \quad (4)$$

Moreover, in each country, public debt (B_t) is stabilised through a fiscal rule that induces the endogenous adjustment of fiscal instruments when the public debt ratio deviates from its target (BY).

$$\tau_t = \varphi_B \left(\frac{B_t}{P_t Y_t} - BY \right) \quad (5)$$

Members of the euro area share a common nominal exchange rate and a common nominal interest rate. The central bank sets the domestic short-term nominal interest rate (i_t) according to a standard Taylor-type rule, by reacting to area-wide consumer price inflation and real activity.

$$i_t = \rho i_{t-1} + (1 - \rho) \varphi_\pi (\pi_t - \pi^*) + \varphi_Y \left(\frac{Y_t}{Y_{t-1}} - 1 \right) \quad (6)$$

The rest of the world has its own nominal interest rate and nominal exchange rate. When forward guidance is implemented, the given monetary policy authority announces that nominal interest rates will be fixed for a certain time period.

The calibration of parameters that determine the aggregation of private and government consumption expenditure follows Coenen et al. (2012). The elasticity of substitution between private and government consumption (θ) is set to 0.30, and the quasi-share of government consumption expenditure in the aggregator ($1 - \omega$) is equal to 0.20. This ensures that the observed responses of consumption to government spending shocks are in line with either country-specific or euro area evidence (e.g. Kirchner et al. (2010); Coenen et al.(2012)). As such, government and private consumption are strong, but not perfect, complements, in line with the evidence in Karras (1994) and Fiorito and Kollintzas (2004). On the supply side, the bias towards public (ε) capital in the production function of intermediate goods sectors is equal to 0.10.

The coefficients of the fiscal rule and the monetary policy rule use standard values from the literature and are in line with the New Area-Wide Model (Christoffel et al. (2008)) and the original EAGLE (Gomes et al. (2012)). The coefficient in the fiscal rule (φ_B) is equal to 0.1. For the monetary policy rule, the steady-state level of inflation (π^*) is equal to the inflation target, set to 2%, while parameters of the rule take the values ρ , φ_π and φ_Y equal to 0.87, 1.70, and 0.10 respectively.

The simulations focus on government consumption and public investment separately. The following two sections show the spillovers of a two-year spending-based fiscal stimulus, which is debt-financed, for two alternative specifications: first, with interest rates set according to the Taylor rule; second, with unchanged interest rates. The results are shown for government consumption and public investment separately.

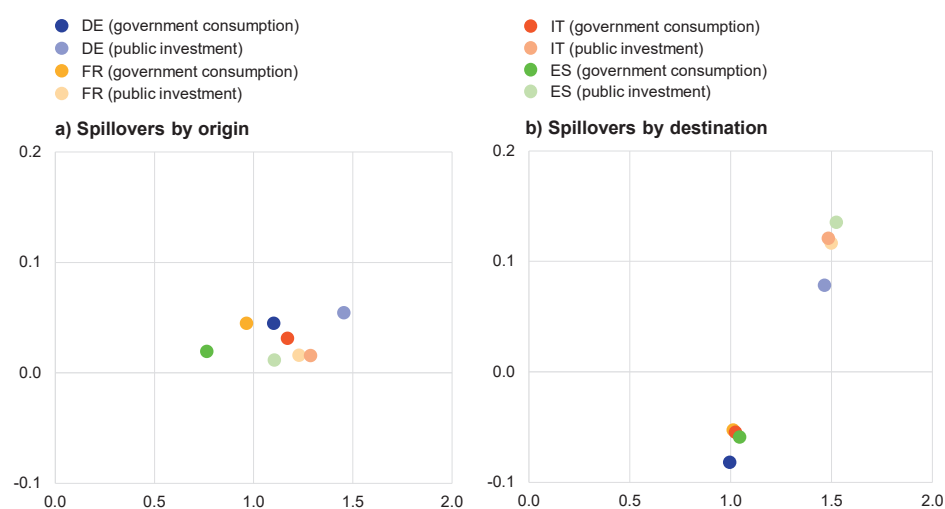
5.1 Spillovers with reactive and non-reactive monetary policy

When interest rates respond to the fiscal shock, spillovers by origin are positive but small. The left-hand panel in Chart 7 shows the spillovers from a fiscal stimulus of 1% of nominal GDP over two years in one large euro area country to the rest of the euro area, both for government investment and for consumption.²⁰ While there is some cross-country heterogeneity, both in the domestic effect (shown on the x-axis) and the effect on the other countries (y-axis), the spillovers (computed as the ratio of the GDP reaction of destination to source) are below 0.1 on average in the two years after the shock.

Chart 7

Model simulations of fiscal spillovers (with reactive interest rates)

(x-axis: two-year average percentage change in GDP in country(-ies) propagating the fiscal stimulus; y-axis: two-year average percentage change in GDP in recipient country)



Source: EAGLE model.

Notes: The left-hand panel shows the spillover by origin, i.e. the impact of an increase in government consumption or public investment by 1% of GDP for two years in one country on its own output (x-axis) and the output of the other countries (y-axis). The right-hand panel shows the spillover by destination, i.e. the impact of a simultaneous increase in government consumption or public investment by 1% of GDP for two years in all but one country on the countries' output (x-axis) and the country receiving the spillovers (y-axis).

Spillovers by destination are also small. The right-hand panel in Chart 7 shows the spillovers in one large country from a simultaneous fiscal stimulus of 1% of GDP over two years in the other countries. For public investment, the spillovers come out at just above 0.1. For public consumption, the destination spillovers are on average slightly negative during the first two years, mainly because the demand effect of the fiscal stimulus is offset by the contractionary impact of higher interest rates that applies to all countries in the monetary union. Relative country size is also important: the destination spillover in Spain is somewhat larger than the destination spillover in Germany. This is because the former results from a 1% of GDP stimulus in all countries but Spain and the latter from a 1% of GDP fiscal expansion in all countries but Germany.

Destination spillovers are not identical to an aggregation of the spillovers by origin. Both the spillovers and the domestic effect on output in the countries

²⁰ In this and the following model simulations, the size of the stimulus (1% of GDP of the country or countries conducting the stimulus) is chosen for convenience in the interpretation of the results.

conducting the stimulus are more clustered. One explanation is that the impact of a simultaneous stimulus on prices and economic activity is larger and triggers a relatively stronger monetary reaction than a stimulus in one large euro area country.

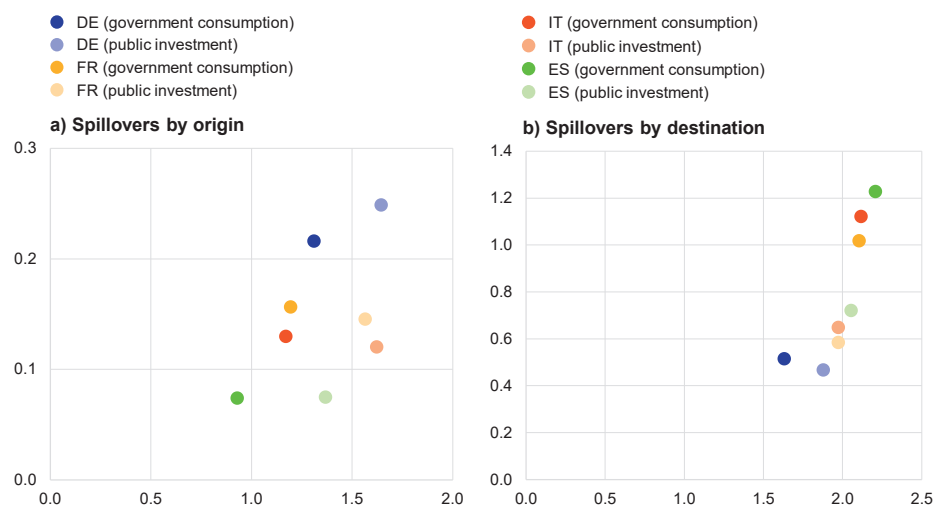
When interest rates in the euro area do not respond to the fiscal shock, spillovers by origin and by destination are positive, and much larger than in the case of reactive monetary policy. Without a reaction from interest rates for two years, spillovers by origin vary between 0.07 for an increase in government consumption in Spain by 1% of GDP and 0.25 for a similar increase in German public investment (see the left-hand panel in Chart 8). These spillovers are around six times as large as those with responsive interest rates. A similarly strong increase can be seen for investment-based spillovers by destination (see the right-hand panel in Chart 8). The sensitivity of destination spillovers to France, Italy and Spain to the reaction of interest rates is even stronger for a public consumption-based stimulus, with the effect increasing from a negative value to above 1.²¹

The model simulations largely confirm the empirical estimates presented above. When interest rates react, spillovers are generally positive but small, and higher for investment than for consumption. When comparing the model simulations with the empirical estimates of the destination spillovers, it should be taken into account that the empirical estimates are based on data covering different monetary policy regimes and without coordinated fiscal policies (except in the 2009-10 period of

Chart 8

Model simulations of fiscal spillovers (with reactive interest rates)

(x-axis: two-year average percentage change in GDP in country(-ies) propagating the fiscal stimulus; y-axis: two-year average percentage change in GDP in recipient country)



Source: EAGLE model.

Notes: The left-hand panel shows the spillover by origin, i.e. the impact of an increase in government consumption or public investment by 1% of GDP for two years in one country on its own output (x-axis) and the output of the other countries (y-axis). The right-hand panel shows the spillover by destination, i.e. the impact of a simultaneous increase in government consumption or public investment by 1% of GDP for two years in all but one country on the countries' output (x-axis) and the country receiving the spillovers (y-axis).

²¹ The exercise is restricted to fiscal shocks and does not take into account other shocks that would have led to forward guidance, such as depressed private demand and credit-constrained households and firms following an economic crisis. From a longer-term perspective, an increase in public investment could generally be expected to contribute more to the productive capacity of the economy than government consumption. Non-standard monetary policy measures that can lessen the constraints of the effective lower bound are also not considered in this analysis.

the crisis). The relatively high empirical destination spillovers for Germany might partially reflect the fact that fiscal stimulus episodes in the other large euro area countries resulted less often in an increase in interest rates, on account of exchange rate pegs to the Deutsche Mark prior to EMU, or their smaller weight in the euro area economy since the introduction of a common monetary policy.

5.2 Sensitivity analysis

Structural models are sensitive to the assumptions regarding future developments in monetary policy. The simulations above are conducted under the assumptions of perfect foresight and complete financial markets. The implication of these assumptions is that the monetary authority, firms and households all know of and are able to completely adjust to future changes in the monetary and fiscal policy stances. Through these features, structural models are known to be very sensitive to the announcement of future interest rates, which is known in the theoretical literature as the “forward guidance puzzle”.²²

As indicated by McKay et al. (2016): “Standard monetary models imply that far future forward guidance is extremely powerful: promises about far future interest rates have huge effects on current economic outcomes, and these effects grow with the horizon of the forward guidance.” The solution to the forward guidance puzzle is either making the model less forward-looking or altering expectations (e.g. so that the announcement is not partially misperceived). As an illustrative example, let us consider the standard IS curve:

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_{n,t}) \quad (7)$$

where x_t is the output gap, i_t is the nominal interest rate, π_t is CPI inflation and $r_{n,t}$ is the real natural rate of interest. When the equation is intertemporally solved, it implies:

$$x_t = -\sigma \sum_{j=0}^{\infty} E_t (i_{t+j} - E_{t+j} \pi_{t+j+1} - r_{n,t+j}) \quad (8)$$

We can see that there is no discounting in the sum on the right-hand side of this equation. This means that after a stimulating monetary policy shock, the output gap will increase immediately and will stay at that higher level until the low interest rate period passes. One possibility to smooth out this strong effect would be discounting the equation by a β parameter:

$$x_t = \beta E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_{n,t}) \quad (9)$$

This would mean that after resolution, the equation becomes:

$$x_t = -\sigma \sum_{j=0}^{\infty} E_t \beta^j (i_{t+j} - E_{t+j} \pi_{t+j+1} - r_{n,t+j}) \quad (10)$$

²² See McKay et al. (2016) or Del Negro et al. (2015).

In this way, the forward guidance puzzle is mitigated. Close to the value proposed by McKay et al. (2016), β is calibrated to 0.98. An alternative strategy entails considering that economic agents might be myopic, thus revising their perception of the monetary policy on a regular basis (e.g. annually). In order to obtain realistic results, the model has been adjusted to take the forward guidance puzzle into account. The two types of adjustments were implemented in our simulation exercises.

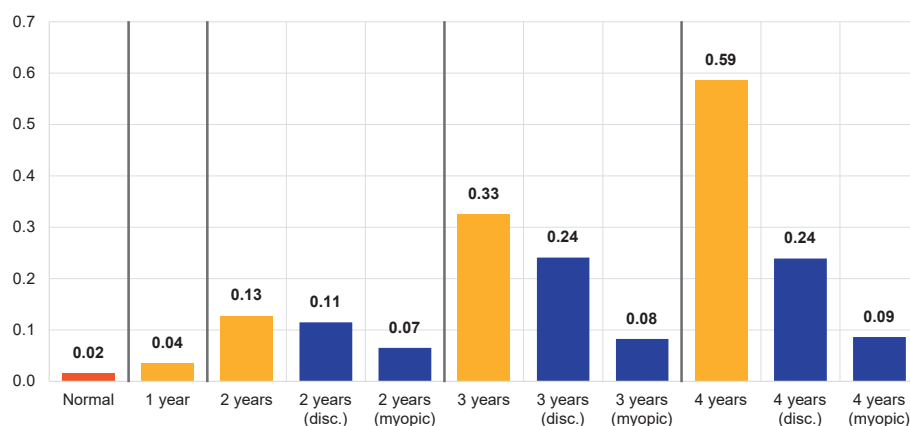
Spillovers are also affected by the forward guidance puzzle. The sensitivity to future interest rates does not only apply to the domestic effect of a fiscal stimulus but also to the spillover ratio – the ratio of the average percentage change in GDP in the recipient country to the percentage change in GDP in the stimulating country. An illustration for a public investment-based stimulus in Germany shows that the spillover ratio increases more than proportionally when the announced path of future interest rates is extended by one year (see Chart 9). The effect becomes much smaller when the interest rate path is modelled as a series of one-year announcements (bars labelled “myopic”) or when households and firms in the model discount the future impact of the expected real interest rate on current consumption and investment decisions (bars labelled “disc.”).²³ This sensitivity analysis suggests that the size of spillovers under an expected path of unchanged interest rates are sensitive to the specification of the monetary policy rule, which should avoid the results being driven by the forward guidance puzzle. The simulations shown in Section 3.1 are modelled with the stable interest rate path as a series of one-year announcements.

Chart 9

Model simulations of fiscal spillovers (with different monetary policy rules)

Spillover ratios from an increase in public investment in Germany to other euro area countries

(percentage change in GDP in recipient country as a ratio of the percentage change in German GDP)



Source: EAGLE model.

Notes: The chart shows four-year average spillover ratios of an increase in German public investment by 1% of GDP for four years, with different monetary policy rules: with responsive interest rates (bar labelled “normal”) and with no expected change in interest rates over different time horizons (bars labelled by the number of years that interest rates do not react). The expected unchanged interest rates are modelled as a one-time announcement (yellow bar), a series of one-year announcements (bars labelled “myopic”), or a one-time announcement with households and firms discounting the future impact of the real interest rate on current consumption and investment decisions (bars labelled “disc.”).

²³ See McKay et al. (2017).

6 Conclusions

Our paper combines empirical estimates of fiscal expenditure spillovers between euro area countries using model simulations which illustrate the main transmission channels. This approach helps us to understand the effect of fiscal action in one or more euro area countries on the other economies. This is important from a monetary policy perspective as well as in the discussion on the usefulness of a central fiscal capacity. Spillovers are expressed as destination spillovers, which measure the spillover from a spending shock in all but one euro area country on the recipient country. We also measure spillovers by origin, which measure the impact on the output in the receiving countries of one country's fiscal action.

Our empirical results confirm the existence of positive fiscal spillovers within euro area countries. The findings of earlier studies suggesting that fiscal action has positive spillovers across countries are confirmed by new estimates, which are based on a panel of euro area countries with annual data, and new individual estimates, which are based on a new quarterly dataset. Average destination spillover multipliers (the effect of an average €1 increase in fiscal expenditure in the other euro area countries) are estimated to be around 0.4 over a two-year horizon, albeit with considerable heterogeneity across countries. If all but one of the euro area countries were to simultaneously engage in a fiscal expansion, the spillovers to the receiving country would be higher but still remain below the estimated domestic multipliers of fiscal expenditure, which are around unity.

The reaction of interest rates is an important determinant of the magnitude of spillovers. The DSGE model simulations illustrate that the composition of government expenditure has implications for the magnitude of spillovers, with productive government investment providing larger spillovers than consumption. The model simulations also explore the relationship between the reaction of interest rates and spillovers, as the empirical results suggest that spillovers are higher when interest rates react less to government expenditure shocks. In particular, the PVAR estimates of spillovers are higher when including years during which monetary policy was at the lower bound. In the SVAR estimates, the common euro area interest rate reacts the most to expenditure shocks in Germany, which is the country with the lowest spillovers by origin. Spillovers are small if interest rates react to the changes in inflation and output induced by fiscal policy, but the effects are amplified if interest rates are not expected to react to a fiscal shock.

All in all, spillovers within the euro area are higher when interest rates are not increased in response to an increase in government expenditure, but remain below the domestic effect of fiscal expenditure. This suggests that fiscal spillovers could play a greater stabilising role in the euro area cycle if the efficacy of monetary policy instruments is less than during normal times. However, even if the magnitude of spillovers is higher in these circumstances, it remains below the possible stabilising effect of a central fiscal capacity, assuming that the spending multiplier of such a capacity were to be comparable to domestic fiscal multipliers. In addition, the stabilising effect of coordinated fiscal policies across countries depends fundamentally on the availability of fiscal space, political willingness and timely implementation. Well-designed fiscal capacity might be better suited than coordinated fiscal policies in delivering the right amount and the right timing of fiscal action in the euro area.

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8 Appendix

Table A.1
Data sources PVAR

Variable	Source	Starting date	Comment
Real government spending	AMECO	1971	Sum of government consumption and investment, obtained by a chain-type Fisher index
Real government consumption	AMECO	1971	
Real government investment	AMECO	1971	Up to 1994, deflated with the total investment deflator, from 1995 government investment deflator
Real GDP	AMECO	1971	
GDP deflator	AMECO	1971	
Real effective exchange rate	AMECO	1971	Against former EU-15, based on unit labour costs for the total economy
Nominal 10-year interest rate	IMF, Eurostat	1971	Eurostat when available, otherwise IMF. For countries where the series starts after 1971 (Spain, Finland, Greece and Italy), the average spread of the first three available years is applied to the euro area average rate
Bilateral imports	Eurostat	1988	10-year moving averages

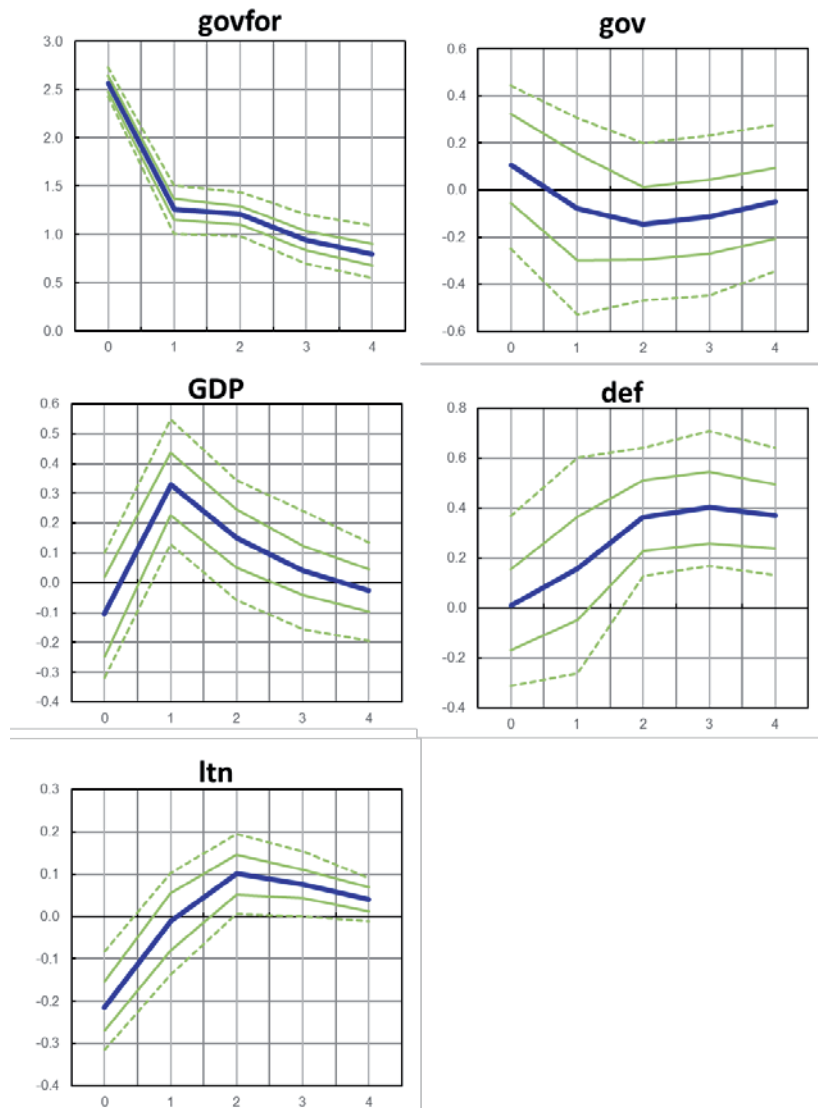
Source: Schmidt (2019).

Chart A.1

IRF for PVAR estimates of foreign government spending (by destination)

Average (non-cumulative) output response in a euro area country to a trade-weighted spending increase in the other euro area countries

(x-axis: years; y-axis: percentage change)



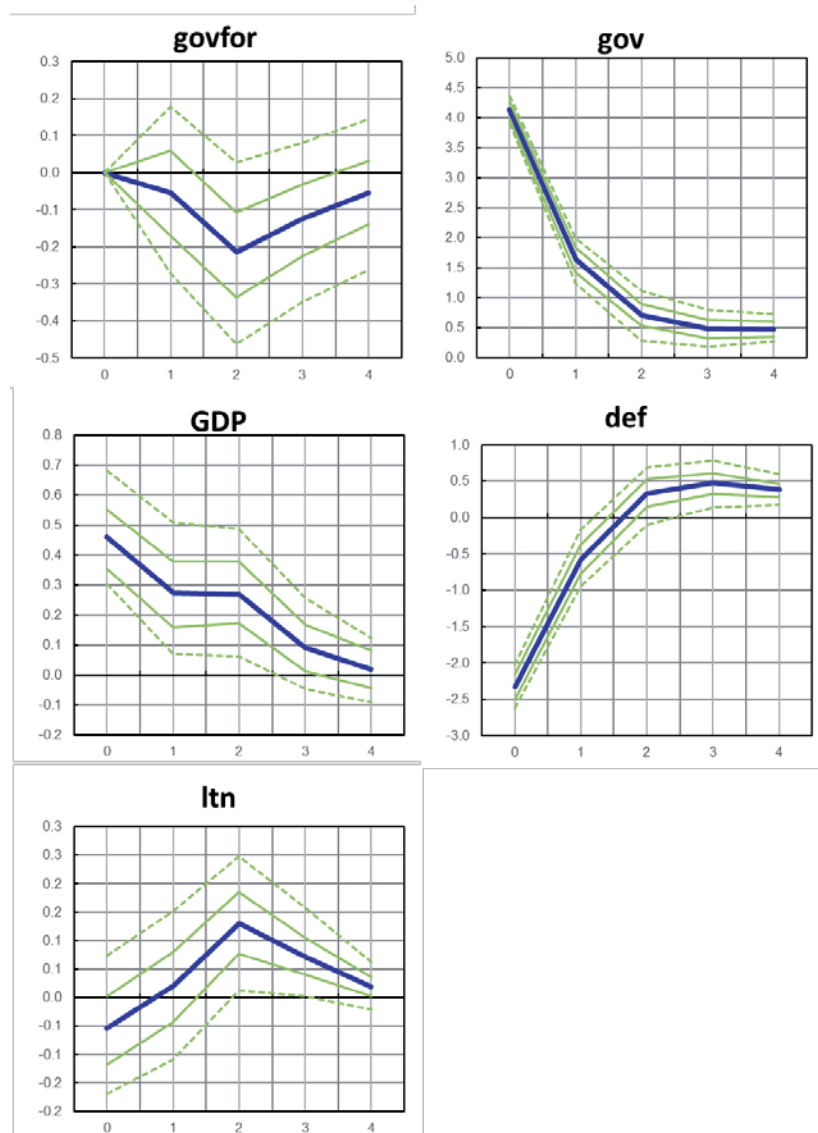
Source: Schmidt (2019).

Chart A.2

IRF for PVAR estimates of domestic government spending

Average (non-cumulative) output response in a euro area country to a domestic spending increase

(x-axis: years; y-axis: percentage change)



Source: Schmidt (2019).

Acknowledgements

The authors thank members of the ESCB Working Group on Public Finance, Pablo Burriel, Bogdan Cozmanca, Christophe Kamps, Ricardo Mestre, Javier J. Pérez, Philipp Rother, João Sousa, Milan Vaňko and Isabel Vansteenkiste for their useful comments.

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PDF ISBN 978-92-899-4246-1, ISSN 1725-6534, doi:10.2866/931020, QB-AQ-20-003-EN-N

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