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Abstract:

This paper analyzes the international transmission effects of euro area monetary policy shocks in to other western European countries, namely the United Kingdom, Sweden, Switzerland, Denmark, and Norway. For this purpose, we use a structural VAR model of the euro area and augment it consecutively by the foreign variables of interest. We find that a monetary policy shock in the euro area leads to a largely similar change in the interest rate and in GDP in these other western European countries. The effects on their exchange rates are limited and their trade balances usually are unaffected. Our results suggest that the income absorption effect to be more important than the expenditure switching effect in the international transmission of monetary policy and that exchange rate stabilization seems to be of some concern to monetary policy makers in small open economies.

Keywords: Monetary policy, international transmission, euro area, vector autoregression.

JEL classification: C32, E52, F41

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The International Transmission of Euro Area Monetary Policy Shocks

Nils Jannsen and Melanie Klein[*]

1. Introduction

The international transmission effects of monetary policy shocks have been extensively analyzed theoretically and empirically. From a theoretical perspective, international transmission effects of a foreign monetary policy shock, in our case the euro area, on a domestic economy are ambiguous. Two important international transmission effects are the income absorption effect, which captures the change in foreign demand for domestic products due to changes in foreign economic activity, and the expenditure switching effect, which captures the change in the domestic trade balance due to adjusted terms of trade as a consequence of exchange rate movements. These two effects move the trade balance in opposite directions. The strength of these effects depends on whether domestic monetary policy reacts to a foreign monetary policy shock, which is directly related to the question whether monetary policy allows the exchange rate to float freely or whether it tries to stabilize the exchange rate. However, if domestic monetary policy reacts to foreign monetary policy, it influences domestic economic activity through the well-known transmission channels of monetary policy.

While theory in general tends to advise monetary policy not to react directly to exchange rate fluctuations (Taylor and Williams 2010), the empirical literature, which estimates monetary policy reactions functions based on Taylor (1993), frequently finds exchange rates to be directly relevant for monetary policy in small open economies (Clarida and Gertler 1997, Clarida et al. 1998, Gerlach and Smets 2000). Therefore, the results of the empirical literature lead to the hypothesis that the effects of foreign monetary policy shocks on the exchange rate are only limited and, consequently, that the expenditure switching effect is of less importance for the international transmission effects of monetary policy.

A number of studies have investigated the international transmission effects of monetary policy shocks empirically. Kim (2001) and Mackowiak (2007), for example, investigate the international transmission effect of the monetary policy of the United States on the other G7

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countries and East Asian countries. The influence of Japanese (Mackowiak 2006) and Chinese monetary policy (Kozluk and Mehrotra 2008) on East Asian countries has also been investigated. Overall, these studies find a symmetric change in the interest rate and in GDP in the respective countries (and regions) after a monetary policy shock. One exception is Mackowiak (2006), who finds that the output of Japan's East Asian trading partners is likely to decrease after an expansionary monetary policy shock in Japan. Further, the exchange rate is usually found to respond to a monetary policy shock by moving significantly in the expected direction. The results concerning the trade balance are mixed. While Mackowiak (2006) finds significant changes in the trade balance of Japans' East Asian trading partners, Kim (2001) shows that the trade balance in the other G7 countries does not change significantly after a monetary policy shock in the United States. Overall, the empirical literature finds significant international transmission effects of monetary policy shocks.

In this paper, we add to the literature by investigating the international transmission effects of monetary policy shocks in the euro area. We build on a structural VAR model for the euro area developed by Weber et al. (2011) and augment it consecutively by the variables of interest in line with Kim (2001). We investigate the international transmission of euro area monetary policy shocks to western European countries that have not adopted the euro, namely the United Kingdom, Denmark, Sweden, Norway, and Switzerland. These countries exhibit the strongest trade and financial linkages with the euro area and are therefore likely to be influenced the most by monetary policy shocks in the euro area. We investigate the effect of a euro area monetary policy shock on a series of variables, namely GDP, the short-term interest rate, the deflator of GDP, consumer price inflation, real exports, real imports, trade balance relative to GDP, the euro exchange rate, and the effective exchange rate. In doing so, we are able to determine not only the strength of possible business cycle transmission effects, but also which transmission mechanisms proposed by theory are the most important. We account for a structural break in the mid-1990s found by Weber et al. (2011) and therefore estimate the model for two different subsamples, one that covers the pre-euro period and one that covers the euro period.

We find that that a monetary policy shock in the euro area has significant effects in the five western European countries investigated here. The short-term interest rate usually moves in the same direction as in the euro area. Exchange rates usually only depreciate significantly during the euro period after a contractionary monetary policy shock in the euro area. However, the depreciation usually is small in magnitude and lasts only for a short period. Further,

a contractionary euro area monetary policy shock frequently leads to a symmetric change in GDP, exports, and imports in the five western European countries. The trade balance usually does not change significantly. The international transmission effects of euro area monetary policy are more pronounced during the euro period, even though the effects are often qualitatively similar to the pre-euro period.

Our results are in line with the previous empirical literature analyzing the international transmission effects of monetary policy in other regions with respect to the importance of the income absorption effect. However, in contrast to the previous literature, we usually find no significant, or only a limited change, in the exchange rate and therefore only little relevance of the expenditure switching effect. Given that the transmission of the monetary policy rate to the short-term interest rate of the interbank market works, our finding of a significant change in the short-term interest rate in combination with a usually limited change in the exchange rate gives rise to the hypothesis that exchange rate stabilization is to some extent a concern to monetary policy makers.

The remainder of this paper is structured as follows. Section 2 describes the data set. Section 3 presents our estimation methodology. Section 4 reports our findings and Section 5 presents a discussion of these results. Finally, Section 6 summarizes our results and concludes.

2. Data

Data for the euro area were taken from the Area Wide Model Database, which includes quarterly data from 1980q1 to 2009q4 (10th update). One exception is the data for the effective exchange rate, which was taken from the ECB database. Data for the short-term interest rate for the United States is taken from the Federal Reserve Bank from St. Louis. Data for the United Kingdom, Switzerland, Sweden, Norway, and Denmark were taken mainly from the OECD Economic Outlook database. Exceptions are data for the exchange rates (foreign currency against the euro) which were from the Swiss National Bank for Switzerland and from Eurostat for the other countries. Data for the effective exchange rate for Denmark were taken from the International Financial Statistics of the International Monetary Fund.

3. Estimation Methodology

First, we introduce the structural VAR used to identify monetary policy shocks in the euro area, which was developed by Weber et al. (2011), and then show how we augment the model to estimate the international transmission effects.

3.1 Monetary Policy Shocks in the Euro Area

The effects of monetary policy shocks in the euro area have been analyzed frequently in the literature. Most of the literature analyzes the effects of a monetary policy shock in the euro area for the time before the euro was adopted by means of synthetic euro area data (see, e.g., Peersman 2004, Peersman and Smets 2003). Weber et al. (2011) is one of the first attempts to estimate a structural VAR to analyze the effects of monetary policy in the euro area that includes the period after the euro was introduced. Their baseline model consists of four endogenous and two exogenous variables. The endogenous variables gross domestic product GDP_t, deflator of gross domestic product $PGDP_t$, effective exchange rate EX_t, and short-term interest rate RS_t depend on their own lags and a constant term.[1] Further, a commodity price index PCM_t and the short-term interest rate of the United States RS_t^{US} are included as exogenous variables in the model, in particular to mitigate the price puzzle that usually emerges when the effects of monetary policy shocks are estimated. The exogenous variables are assumed to have a contemporaneous impact on the endogenous variables. All variables except for the interest rates are transformed into logarithms. In its reduced form, the VAR model is represented by

$$y_t = \begin{pmatrix} GDP_t \\ PGDP_t \\ RS_t \\ EX_t \end{pmatrix} = d + A(L) \cdot y_{t-1} + B \cdot \begin{pmatrix} PCM_t \\ RS_t^{US} \end{pmatrix} + u_t \qquad (1)$$

Based on the reduced form VAR, a monetary policy shock is identified by imposing a recursive structure on the instantaneous relations between the variables. We interpret the short-term interest rate as the relevant policy instrument of the ECB. Since, we are exclusively interested in the analysis of monetary policy shocks, it is sufficient for identification to presume whether a variable is affected contemporaneously by a monetary policy shock or not (Chris-

[1] In their baseline model, Weber et al. (2011) use housing wealth instead of the exchange rate as a variable. However, they find that their results are valid for specifications that include the exchange rate.

tiano et al. 1999). We assume that a monetary policy shock has no contemporaneous effect on GDP and the GDP deflator, but has a contemporaneous effect on the exchange rate.[2] These assumptions are widely accepted in the literature. Weber et al. (2011) find a structural break around the year 1996, based on Chow stability tests for dynamic models, and also find some evidence for a second break in the year 1999. Thus, we divided the estimation period in two subsamples: 1980 to 1996 and 1999 to 2009.

3.2 The Extended Model

Basically three approaches have been employed in the literature to estimate the international transmission effects of foreign monetary policy shocks on domestic economies. Kim (2001) added the domestic variables of interest consecutively to the baseline SVAR model of the foreign economy, in his case the U.S. economy. Kozluk and Mehrotra (2009) built a SVAR model for each respective domestic economy and included the foreign monetary policy instrument. A drawback of their approach is that it only focuses on the effects of short-term interest rate shock, which does not necessarily only reflect monetary policy shocks (Kim and Roubini 2000). Mackowiak (2007) estimated a SVAR model including two "blocks", one describing the domestic economy and one describing the foreign economy, assuming exogeneity for the latter block. However, this approach that increases the number of parameters to be estimated dramatically is only feasible when the estimation period is sufficiently long. Therefore, we follow the methodology applied by Kim (2001) in order to estimate a parsimonious model that allows us, given the relatively short estimation periods, to appropriately identify a monetary policy shock in the euro area.

Accordingly, the baseline model for the euro area - described in equation (1) – is extended consecutively by a single domestic variable V_t^d :

$$y_t = \begin{pmatrix} GDP_t \\ PGDP_t \\ V_t^d \\ RS_t \\ EX_t \end{pmatrix} = d + A(L) \cdot y_{t-1} + B \cdot \begin{pmatrix} PCM_t \\ RS_t^{US} \end{pmatrix} + u_t . \qquad (2)$$

[2] Technically, we identify the monetary policy shock by means of the Cholesky decomposition with the variables ordered as given in model (1).

To identify the monetary policy shock, we rely on the standard assumptions described in Section 3.1. With respect to the domestic variables, we assume that a foreign monetary policy shock does not have a contemporaneous impact on the respective domestic variable. This assumption is derived by the standard assumptions in the literature with respect to the effects of a domestic monetary policy shock on the domestic economy. However, we make two exceptions in our identification scheme, which are well-established in the literature as well. We allow the exchange rate to respond contemporaneously to a monetary policy shock, since exchange rates are traded on a daily basis and therefore can respond immediately. Furthermore, we allow the domestic short-term interest rate to respond contemporaneously, because we assume that the domestic short-term interest rate is largely under control of monetary policy and monetary policy is usually conducted on a monthly or quarterly basis.[3] Therefore the domestic central banks usually can react to the monetary policy of the ECB within the same quarter.[4]

We further impose the restriction that the euro area as a large open economy has impact on the other European countries in our sample but not vice versa, i.e., the foreign variables do not have a substantial effect on the euro area economy. As a result, the VARs are not symmetric and are estimated using the Seemingly Unrelated Regressions (SUR) method. We determine the lag length of the models using the Akaike Information Criterion. For the first estimation period between 1980 and 1996, the criterion finds two lags to be appropriate and for the second estimation period between 1999 and 2009, one lag.[5]

Based on our model, we estimate the effects of a euro area monetary policy shock on real GDP, the short-term interest rate, the deflator of GDP, consumer price inflation, real exports, real imports, nominal trade balance relative to GDP (base year 2009), the euro exchange rate, and the effective exchange rate for the following countries: the United Kingdom, Switzerland, Sweden, Norway, and Denmark. We estimate the effects for two subsamples, namely for the pre-euro period from 1980 to 1996 (first subsample) and for the euro period from 1996 to 2009 (second subsample).

[3] As in section 3.1, we use the Cholesky decomposition to identify a monetary policy shock, where the variables that react not contemporaneously are ordered before the short-term interest rate of the euro area and those that react contemporaneously are ordered behind it.

[4] In the five countries investigated here, the central banks usually make their monetary policy decisions according to the following rhythms: in the United Kingdom monthly, in Denmark as required, in Sweden and Norway in the second month of each quarter, and in Switzerland in the third month of each quarter.

[5] Alternative information criteria, such as the Schwarz criterion or the Bayesian criterion, choose the same lag length for nearly all the specifications. For the specification with GDP in Switzerland for the Euro period, we choose a lag length of three, because the result turned out to be non-stationary for shorter lag lengths.

4. Results

The results reflect the response to a contractionary monetary policy shock in the euro area identified as a one-standard-error increase in the short-term interest rate. In general, a contractionary monetary policy shock in the euro area leads, in all the investigated countries and for both subsamples, to a significant increase of the short-term interest rate (Table 1). For the second subsample covering the euro period, GDP usually decreases. Further, the exchange rate depreciates in some countries, even though in most cases only for a very short period.[6] While exports and imports in nearly all the countries decrease, the trade balance in most cases remains unchanged. The fact that consumer prices in four countries increase while this is only the case for one country for the GDP deflator can be explained to some extent by the exchange rate depreciation, because an increase of prices of imported goods due to a depreciation will only show up in consumer prices, while the GDP deflator corrects for this increase.

Table 1:
Overview of the results

	GDP	Interest Rate	GDP Deflator	CPI	Exchange Rate	Exports	Imports	Trade Balance
	1999–2009							
UK	↓	↑↓	↓	↑	↓	↓	↓	-
Denmark	↓	↑	↓	↑↓	↓	↓	↓	-
Norway	↓	↑	-	↑	-	↓	-	-
Sweden	↓	↑	↑	↑	↓	↓	↓	↓
Switzerland	↓	↑	-	↑	-	↓	↓	-
	1980–1996							
UK	-	↑	-	-	-	-	-	-
Denmark	↓	↑	-	-	-	↓	↓	-
Norway	-	↑	-	-	-	↓	↓	-
Sweden	-	↑	↑	↑	-	-	-	-
Switzerland	-	↑	↑	↑	-	-	-	-

Notes: Arrows denote a significant change of the variable in the respective direction according to a contractionary monetary policy shock in the euro area. Bars denote no significant change.

For the first subsample covering the pre-euro period, a monetary policy shock in the euro area leads next to the interest rate increase to considerably less significant effects in the coun-

[6] In the following, the term exchange rate denotes the value of one unit of the currency in terms of euro if not mentioned otherwise. Therefore, an increase in the exchange rate is equivalent to an appreciation of the respective currency.

tries investigated here. Besides that the exchange rate and the trade balance do not respond significantly in any case, also the other variables only respond significantly in two countries at the most.

In more detail, our results are as follows. In the United Kingdom, a contractionary euro area monetary policy shock leads immediately to a significant increase in the short-term interest rate. However, after the first quarter, the interest rate falls and the effect become significantly negative for about 1.5 years (Figure A.1).[7] Furthermore, GDP declines significantly for three years. The exchange rate initially does not change, but afterwards depreciates for around three quarters, whereby, the depreciation is rather small. The GDP deflator and consumer prices respond contrarily - while consumer prices raise temporarily, the GDP deflator, declines permanently. Moreover, exports and imports decrease temporarily and the trade balance remains unchanged. For the first subsample covering the pre-euro period, only the short-term interest rate shows a significant response, which is an increase during the first two quarters (Figure A.2).

In Denmark, the short-term interest rate increases immediately after a monetary policy shock in the euro area and stays significantly above the baseline for one year (Figure A.3). GDP declines significantly for around two years. As in the United Kingdom, consumer prices tend to increase, while the GDP deflator decreases. The exchange rate depreciates significantly for some quarters. Exports and imports decline, as in the United Kingdom, even though the decline in imports is more pronounced. But again the trade balance remains unchanged. In the pre-euro period, most variables respond similarly as in the second subsample (Figure A.4). The main differences are that prices and the effective exchange rate do not exhibit a significant response.

In Sweden, the short-term interest rate increases for two quarters after a contractionary monetary policy shock in the euro area (Figure A.5). GDP declines for roughly two years. A further negative influence may come from the worsening of the trade balance. Apart from that, consumer prices and the GDP deflator increase temporarily, whereby the increase in consumer prices might be explained to some extent by the depreciation in the effective exchange rate. In the pre-euro period, the estimation uncertainty for some variables is remarkably high (Figure A.6). While the short-term interest rate increases for some quarters, GDP does not

[7] The corresponding figures can be found in the Appendix.

change significantly. Consumer prices and the GDP deflator increase. For the external sector, we do not find any pronounced responses after a euro area monetary policy shock.

In Norway, the short-term interest rate increases for roughly six quarters after a contractionary monetary policy shock in the euro area. GDP responds with a delay of around one year and then declines slightly for some quarters (Figure A.7). While the GDP deflator does not change, consumer prices increase temporarily, even though we do not find any significant impact on the effective exchange rate. Although exports decline significantly for some quarters and imports do not change, we find no significant impact on the trade balance. For the first subsample, the short-term interest rate increases for half a year (Figure A.8). Beyond that, only exports and imports show a significant response: both declines temporarily.

In Switzerland, a euro area monetary policy shock has almost no impact on the economy. The short-term interest rate increases slightly, but only for one quarter. Consumer prices rise and imports decrease with a delay, without causing a significant change in the trade balance (Figure A.9). For the pre-euro period, the results are similar (Figure A.10). The short-term interest rate increases only for two quarters as well as the GDP deflator and consumer prices.

5. Interpretation of the Results

Several models explain the international transmission effects of monetary policy theoretically. The standard models are the Mundell-Fleming model and the Mundell-Fleming-Dornbusch model. Obstfeld and Rogoff (1995) introduced the New Open Macroeconomic Economy models with their emphasis on micro-foundation and intertemporal substitution. Finally, New Keynesian DSGE models have been extended to the small open economy case (Gali and Monacelli 2005). Usually, these models differentiate between flexible and fixed exchange rate regimes. Under fully flexible exchange rates, the effect of a foreign monetary shock on domestic GDP in these models usually works through the trade balance and depends on the strength of the income absorption effect compared to the expenditure switching effect. The income absorption effect is caused by a decline in foreign demand for domestic products. A contractionary monetary policy shock in the foreign country would lead to a decrease in domestic GDP via a worsening of the trade balance as a consequence of the slowdown in foreign economic activity. The expenditure switching effect, instead, would lead to an improvement of the trade balance which is attended by an increase in GDP because a depreciation of the

domestic currency leads to a deterioration of the terms of trade.[8] When the expenditure switching effect is sufficiently strong, the effects of foreign monetary policy in both economies would be qualitatively asymmetric. Under fixed exchange rates, foreign monetary policy shocks need to be imitated by domestic monetary policy to ensure a constant exchange rate. The effects of foreign monetary policy are then qualitatively symmetric for both countries.

Our results are closer to the model predictions of fixed exchange rate regimes. We usually observe a similar movement in domestic interest rates but only small effects on the exchange rate after a euro area monetary policy shock. Therefore, the expenditure switching effect is not very pronounced and the trade balance changes significantly in only one case. In contrast, the income absorption effect leads in the case of a contractionary monetary policy shock in the foreign economy to temporarily declining exports in the domestic economy. However, the trade balance does not change significantly because monetary policy in the domestic country reacts symmetrically and thus leads via the temporary moderation of economic activity to a decline in imports

The five countries investigated here did not explicitly follow any exchange rate regime for most of the time during our estimation samples. This holds true in particular for the second subsample. One exception is Denmark, which implemented a floating exchange rate peg against the euro.[9] Otherwise, floating pegs were only introduced for shorter time periods, namely in the United Kingdom between 1990 and 1992 in terms of the ECU (European Currency Unit) and in Norway between 1986 and 1992 in terms of a currency basket. The only strict fixed exchange rate system was implemented by Sweden between 1977 and 1992, when the Swedish krona was fixed in terms of a trade-weighted currency basket.[10]

Even though monetary policy in the five countries was not explicitly committed to ensure fixed exchange rates, exchange rate stabilization, in general, is an important concept for monetary policy, particularly for small open economies. The theoretical literature usually concludes that monetary policy rules that include the exchange rate perform slightly better than standard rules (Ball 1999, Svensson 2000, Batini et al. 2003). Frequently, monetary policy rules that do not include exchange rates are found to be optimal (Clarida et al. 2001, Adolfson 2007) and exchange rate pegs are found to lead to substantial welfare losses. In an overview article, Taylor and Williams (2010) conclude that monetary policy rules that do not

[8] The expenditure switching effect is not working if full pricing-to-market is assumed, which is equivalent to no exchange rate pass-through to export prices (see, e.g. Betts and Devereux 2000).
[9] Before 1999, Denmark had implemented a floating exchange rate peg against the deutsche mark.
[10] From 1991 to 1992, the basket was redefined to equal the ECU.

react directly to the exchange rate are usually superior to those that do. However, the empirical literature that focuses on the estimation of monetary policy rules in the spirit of Taylor (1993) frequently finds that monetary policy reacts significantly to exchange rates (Clarida and Gertler 1997, Clarida et al. 1998, Gerlach and Smets 2000, Lubik and Schorfheide 2007). Overall, the literature has not come to a final assessment of whether central banks should focus on exchange rate stabilization or not.[11] Given that the short-term interest rate is largely influenced by monetary policy, our results indicate—in line with the previous empirical literature—that the central banks in the five countries are concerned with stabilizing exchange rates.

6. Conclusions

We investigate the international transmission effects of euro area monetary policy shocks to other western European non-euro area countries, namely Great Britain, Norway, Denmark, Sweden, and Switzerland. Specifically in the subsample from 1999 to 2009, a contractionary monetary policy shock in the euro area is usually followed by an increase in the short-term interest rate in these five countries. GDP, exports, and imports usually decrease significantly. The response of prices is mixed. While consumer prices increase, the response of the GDP deflator is ambiguous. Even though the increase in consumer prices, given a decline in economic activity measured by GDP, and the often different response of the GDP deflator indicate some influence of exchange rate depreciations, we find a significant depreciation only for some countries, and even in these countries the response is in most cases only slightly different from zero and short-lived, respectively. The trade balance usually remains unchanged. For the subsample from 1980 to 1996, we find a much less pronounced influence of a monetary policy shock in the Euro area on the countries investigated here. The only exception is the interest rate, which changes in the same direction as the short-term interest rate in the euro area does.

Our result that a contractionary euro area monetary policy shock is usually followed by a decline in exports in the investigated countries indicates the importance of the income absorption effect. However, since the trade balance usually does not deteriorate significantly due to

[11] Wollmershäuser (2006) tries to solve the discrepancy between the results of the empirical and the theoretical literature by demonstrating that, under consideration of high exchange rate uncertainty, for monetary policy it might be best to react directly to exchange rate fluctuations. High exchange rate uncertainty has usually been disregarded in the previous literature.

simultaneously declining imports, one important reason for declining GDP in these countries is the increase in the domestic short-term interest rate. The limited response of the exchange rates in the context of declining exports indicates the expenditure switching effect is of only little importance. Further, the limited response of the exchange rate and the increase in the short-term interest rate suggest that exchange rate stabilization is at least to some extent a concern of monetary policy in the countries investigated. Our results are in line with former empirical results that found the income absorption effect to be important in the international transmission of monetary policy shocks and that found exchange rate stabilization to be of some concern to monetary policy makers in small open economies. Overall, the responses to a monetary policy shock in the euro area after the introduction of the euro are more pronounced than before, which suggests that the international transmission effects from the euro area have strengthened.

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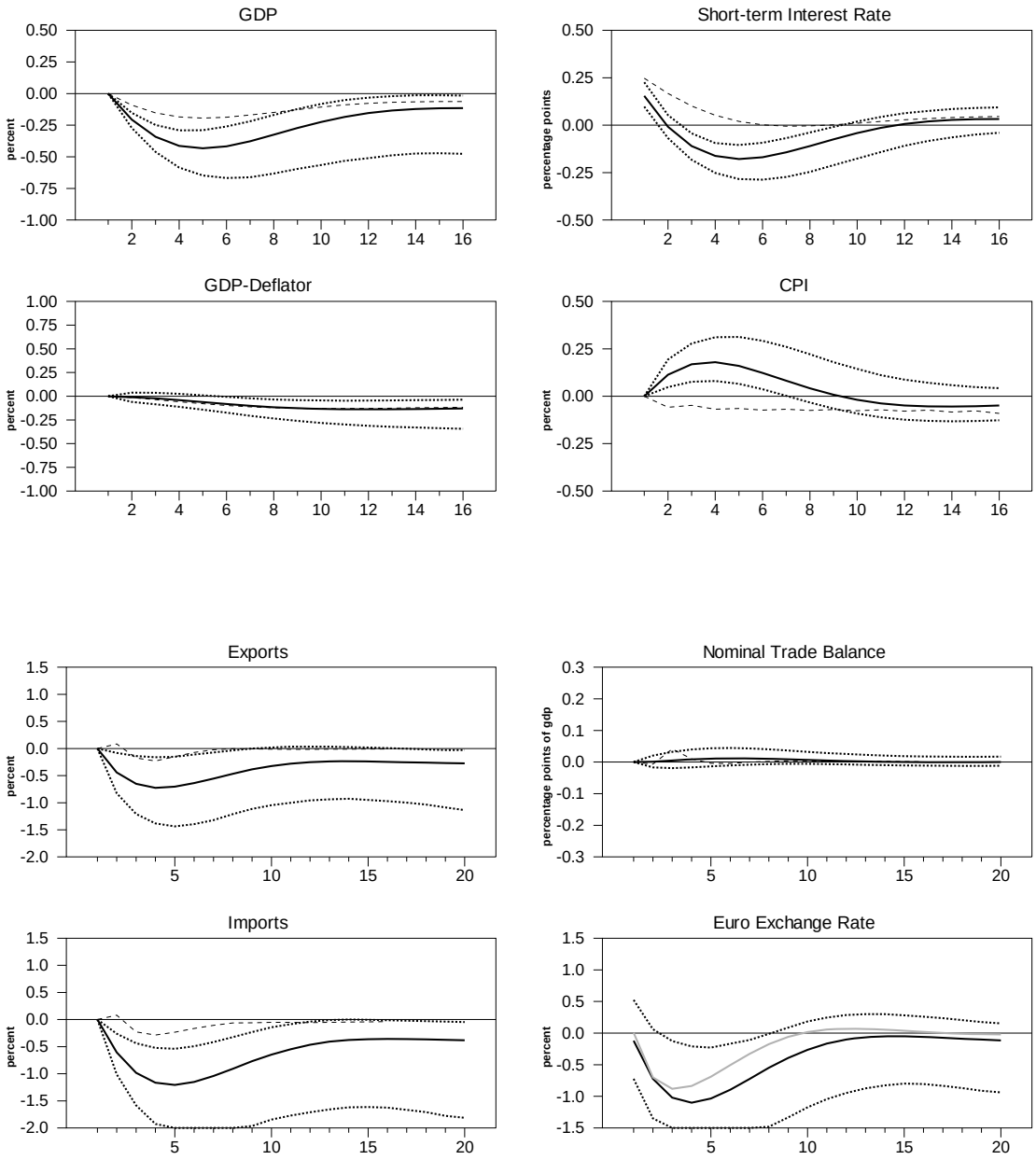
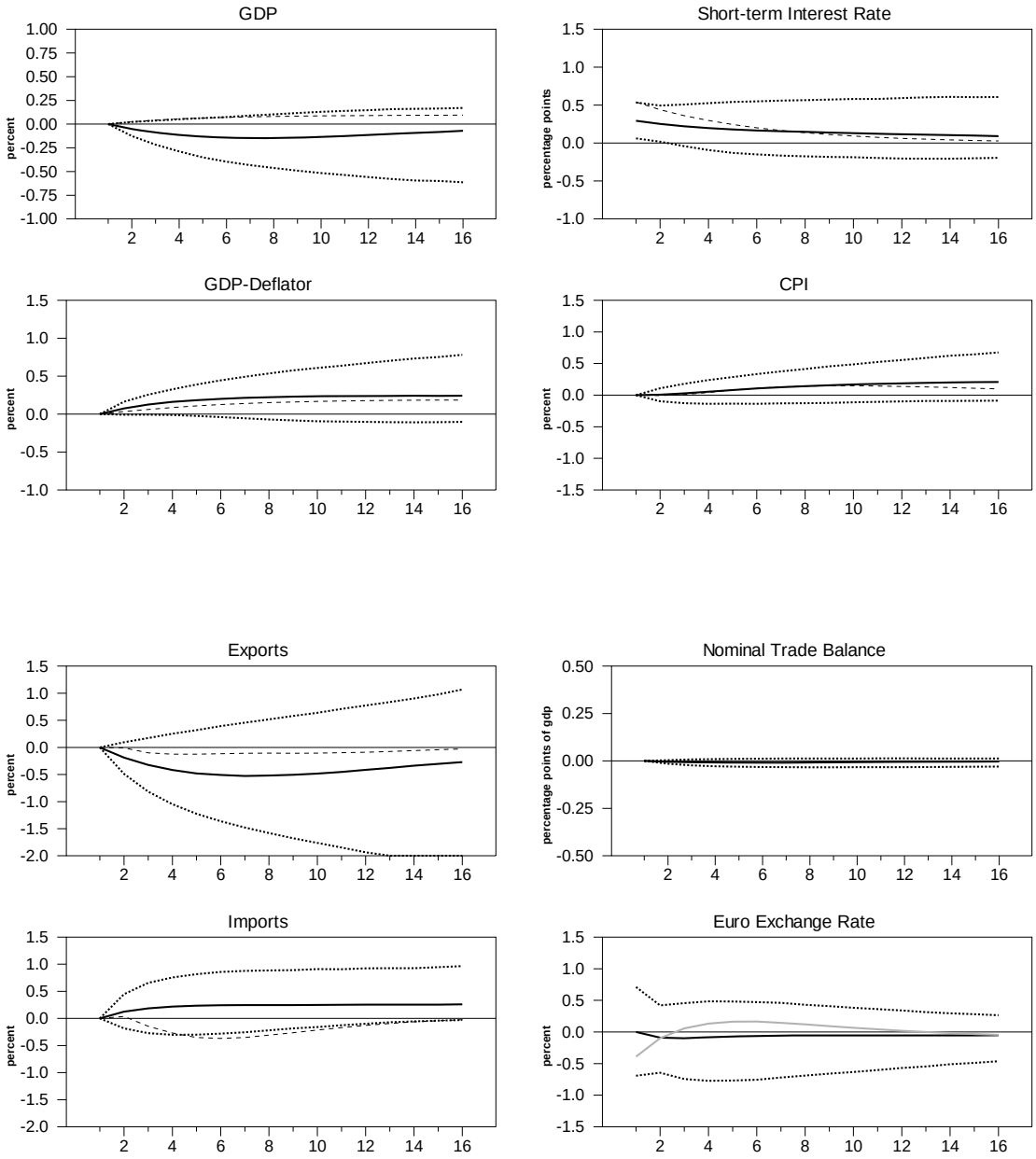
Appendix A: Figures

Figure A.1:
Impact of a Euro Area Monetary Policy Shock on the United Kingdom, 1999–2009



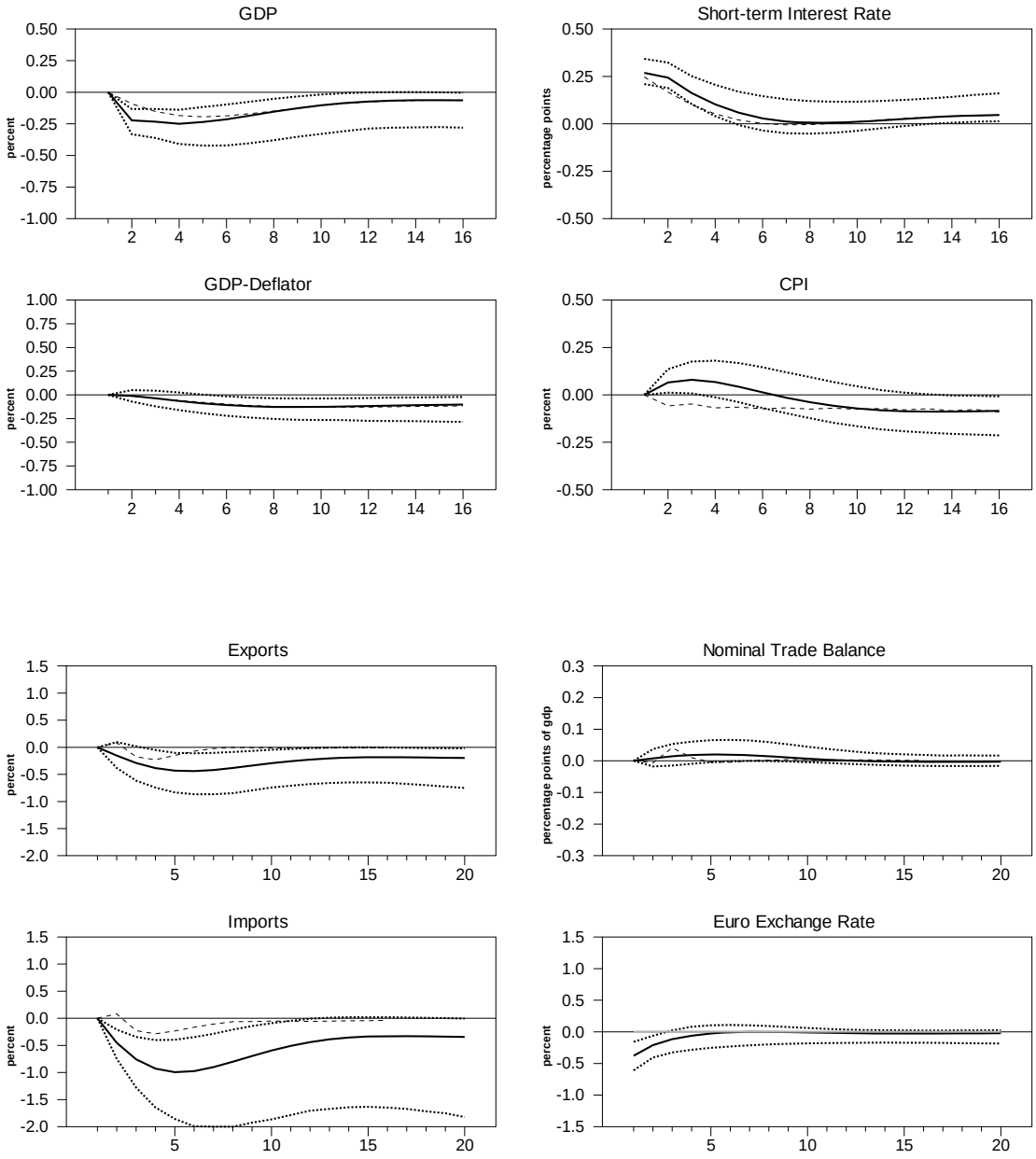
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.2:
Impact of a Euro Area Monetary Policy Shock on the United Kingdom, 1980–1996



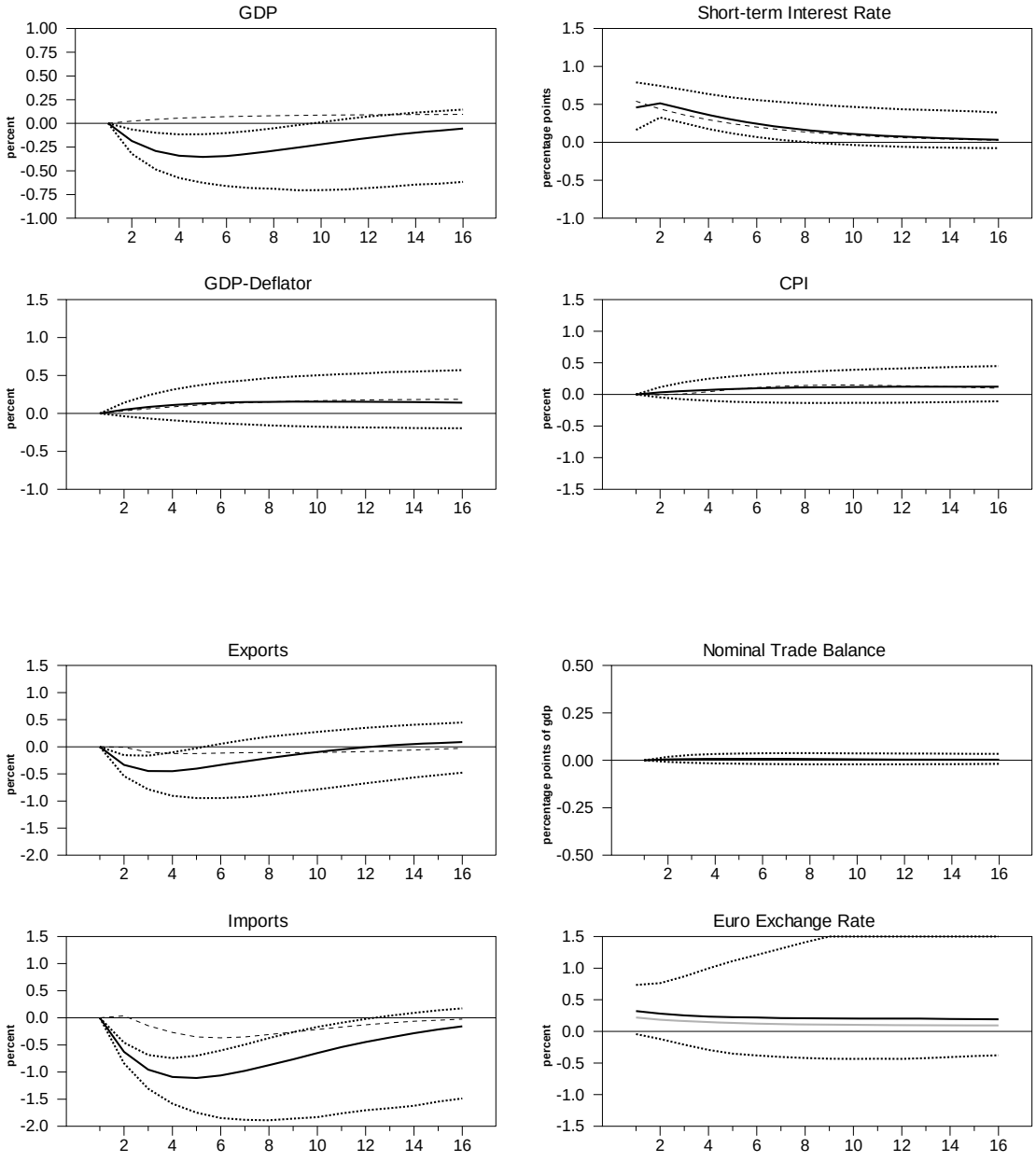
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.3:
Impact of a Euro Area Monetary Policy Shock on Denmark, 1999–2009



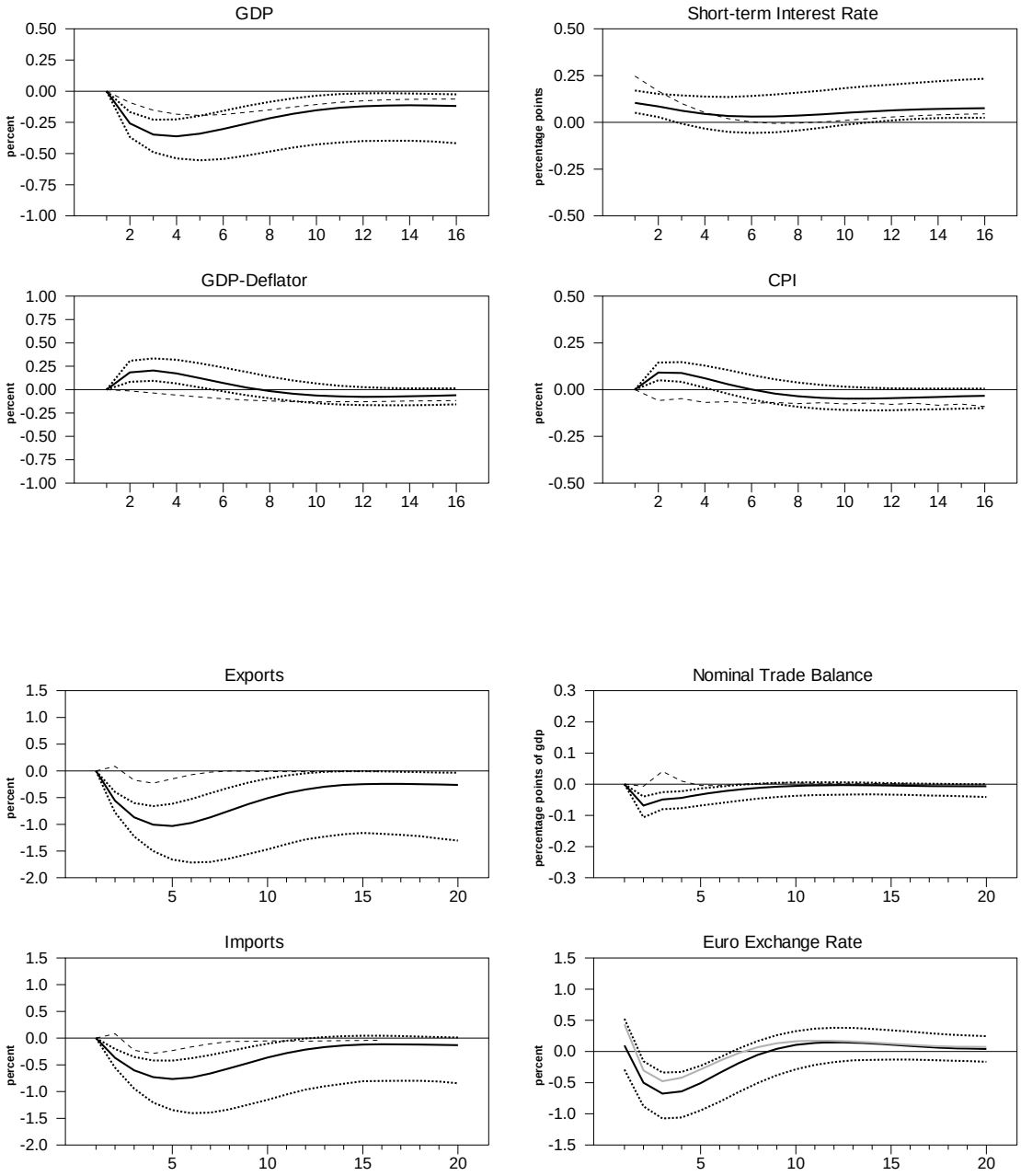
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.4:
Impact of a Euro Area Monetary Policy Shock on Denmark, 1980–1996



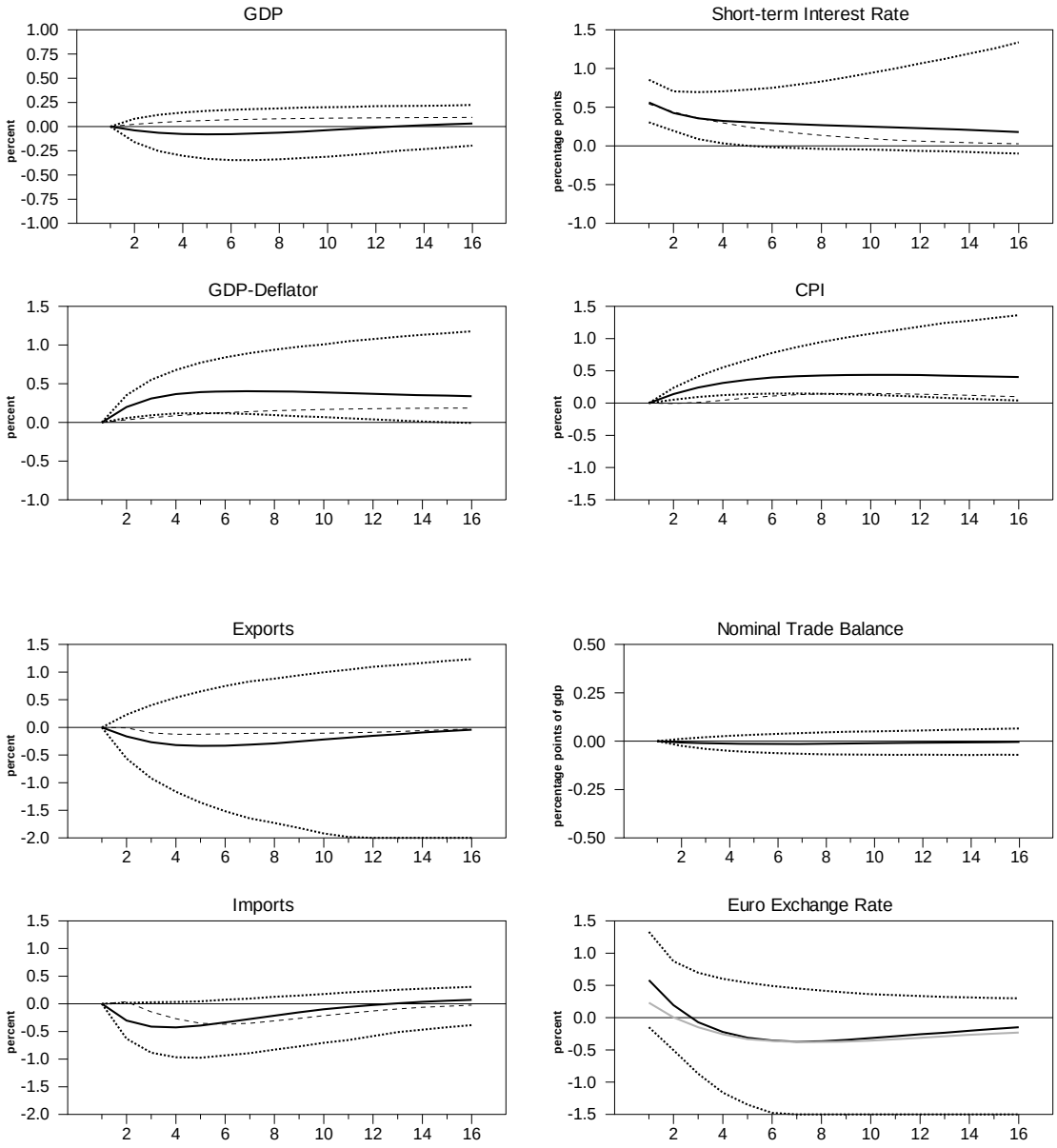
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.5:
Impact of a Euro Area Monetary Policy Shock on Sweden, 1999–2009



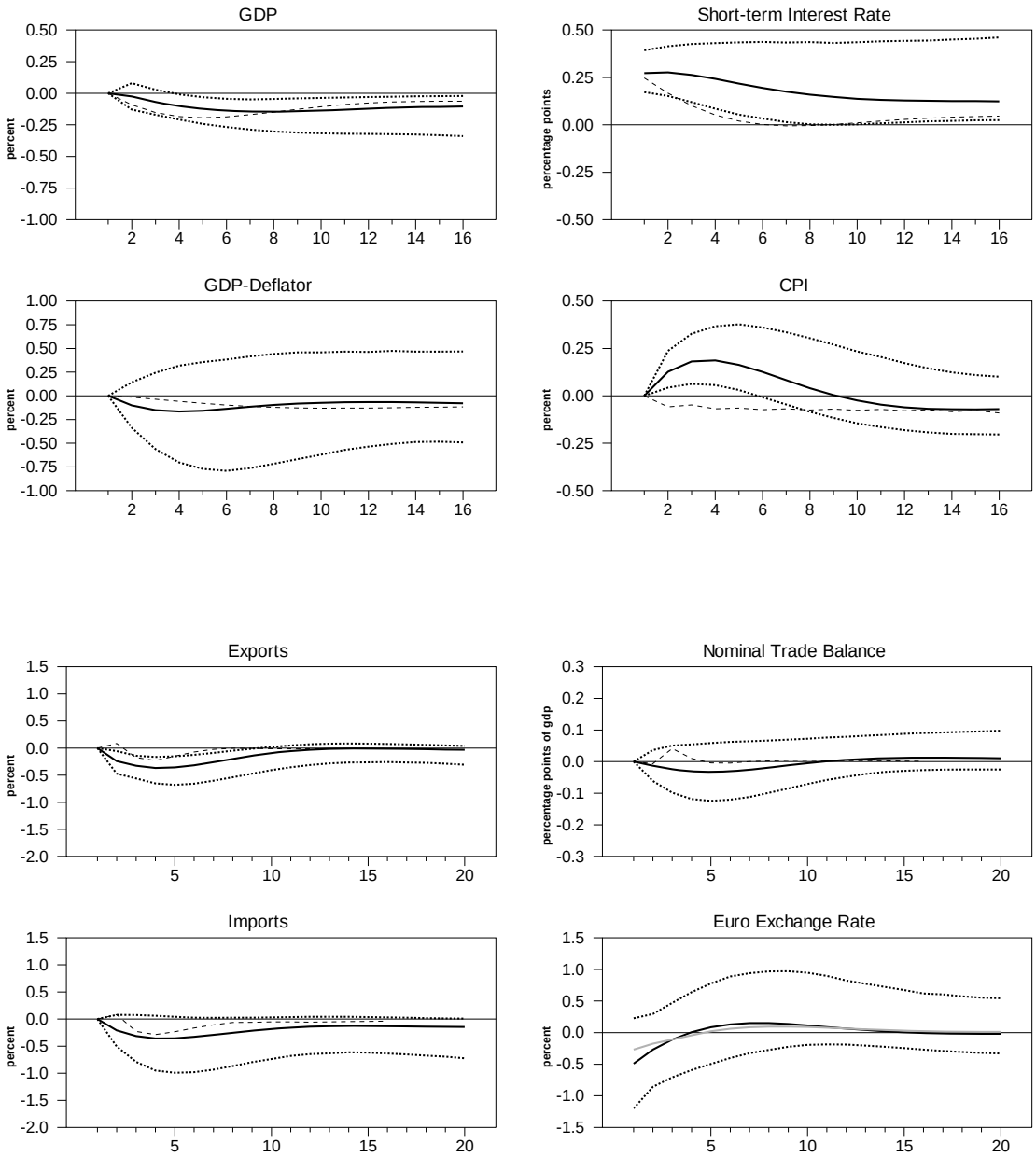
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.6:
Impact of a Euro Area Monetary Policy Shock on Sweden,1980–1996



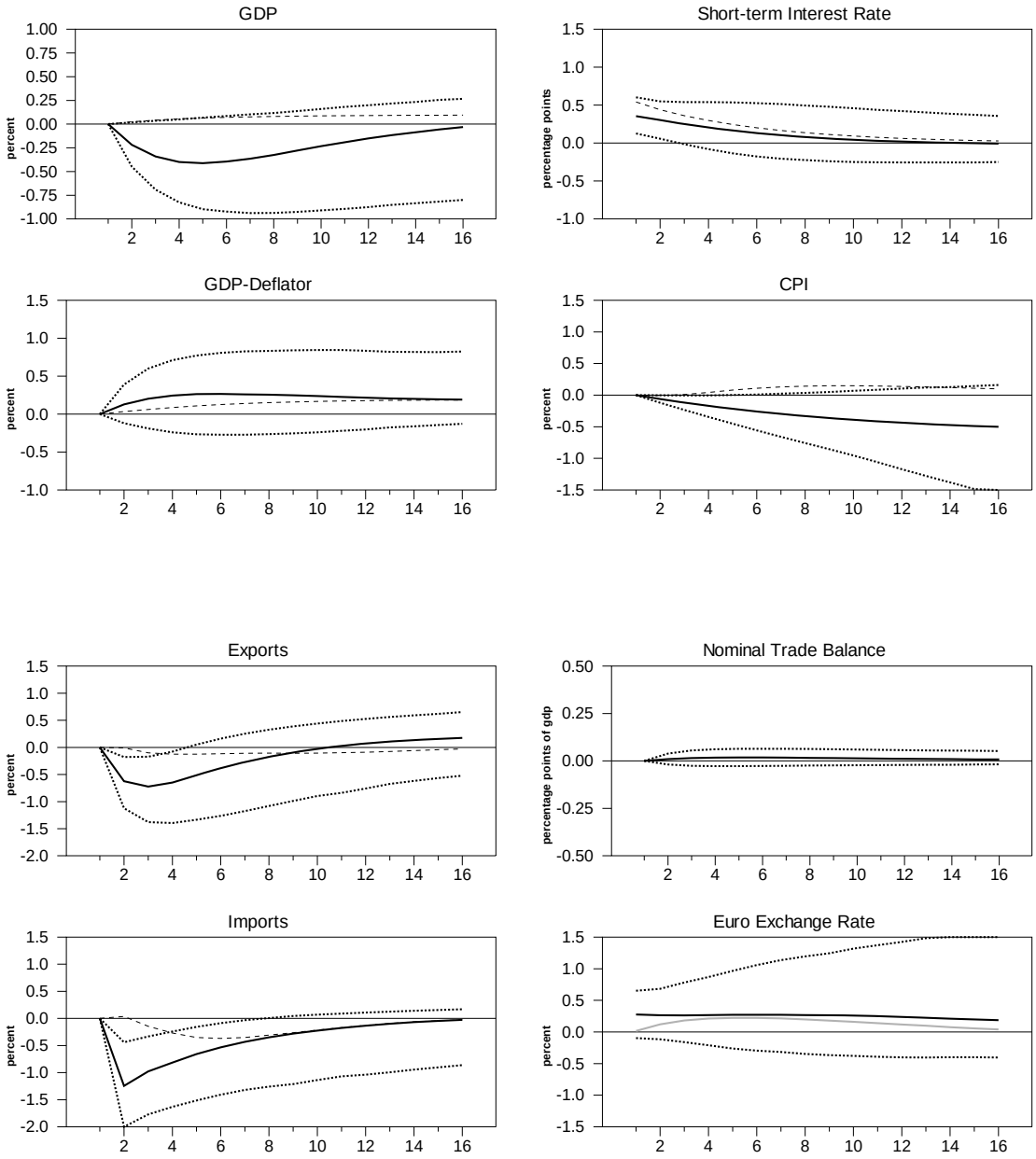
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.7:
Impact of a Euro Area Monetary Policy Shock on Norway, 1999–2009



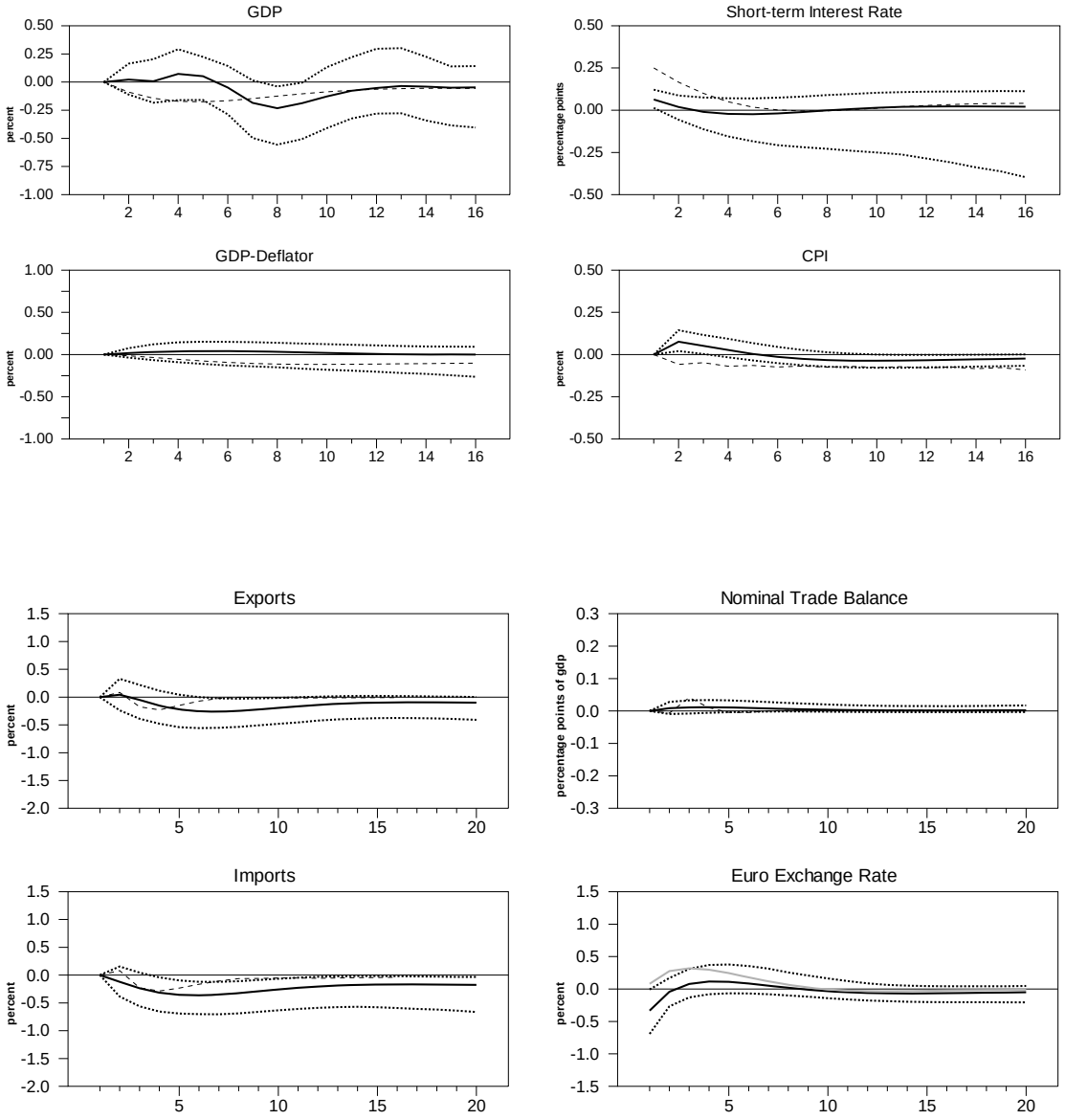
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.8:
Impact of a Euro Area Monetary Policy Shock on Norway, 1980–1996



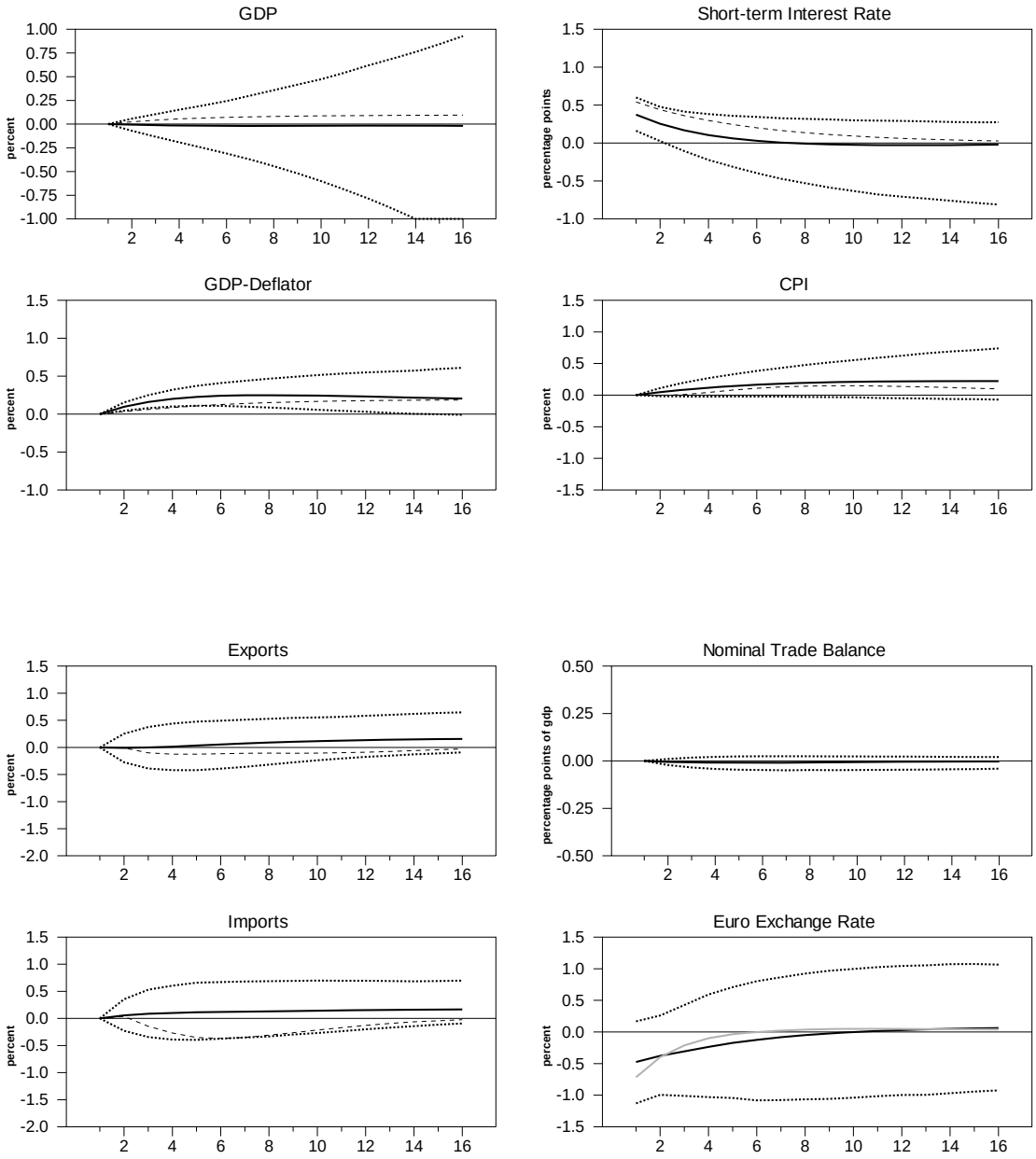
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.9:
Impact of a Euro Area Monetary Policy Shock on Switzerland, 1999–2009



Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure A.10:
Impact of a Euro Area Monetary Policy Shock on Switzerland, 1980–1996



Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Appendix B: Robustness Check

We check for the robustness of our results in two dimensions. First, we change the estimation period for the second subsample. Second, we include the short-term foreign interest rate in our baseline model, which we augment consecutively with the other foreign variables we are interested in.

B.1 Alternative Estimation Period

We estimate our model for the second subsample from 1999 to 2009. However, the global financial crisis of 2008/2009 had significant influence on economic activity and on the monetary transmission mechanism. For example, the interbank market, as an important transmission channel of monetary policy, dried completely out for a considerable degree of time. To ensure that our results are not driven by structural changes triggered by the financial crisis, we estimate our model for an alternative estimation period from 1996 to 2007. We choose 1996 as starting point to still remain with sufficient degrees of freedom for estimation of our model. Choosing a starting point before the introduction of the euro in 1999 can be justified by the fact that due to the convergence process that took place before the introduction of the euro, the interest rate channel of monetary policy worked already similarly in the countries within the euro area before 1999 (Angeloni et al. 2003). Further, Weber et al. (2011) find evidence for a structural break of their model, which serves as our baseline model, in 1996 and therefore estimate their baseline model starting from 1996.

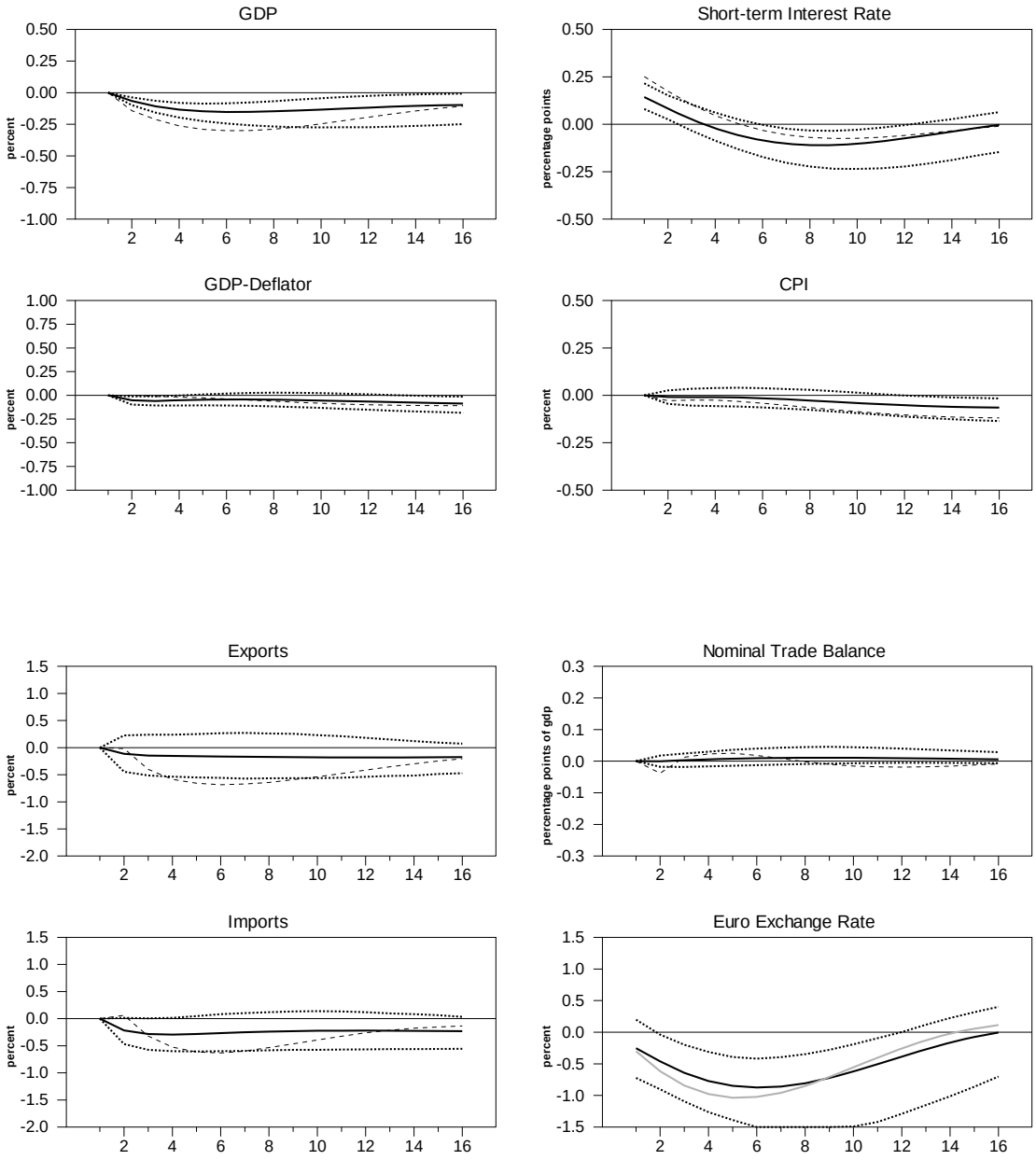
Table B.1.1:
Overview of the Results for the Estimation Period from 1996–2007

	GDP	Interest Rate	GDP Deflator	CPI	Exchange Rate	Exports	Imports	Trade Balance
	1996-2007							
UK	↓	↑↓	↓	↓	↓	-	-	-
Denmark	↓	↑↓	↓	↓	↑	↓	-	-
Norway	↓	↑	-	↓	↑	↓	-	-
Sweden	↓	↑↓	↑↓	↑↓	-	↓	↓	-
Switzerland	↓	↑↓	-	↓	-	↓	↓	-

Notes: Arrows denote a significant change of the variable in the respective direction according to a contractionary monetary policy shock in the Euro area. Bars denote no significant change. Grey shaded areas denote a different result compared to the results obtained for the estimation period from 1999 to 2009.

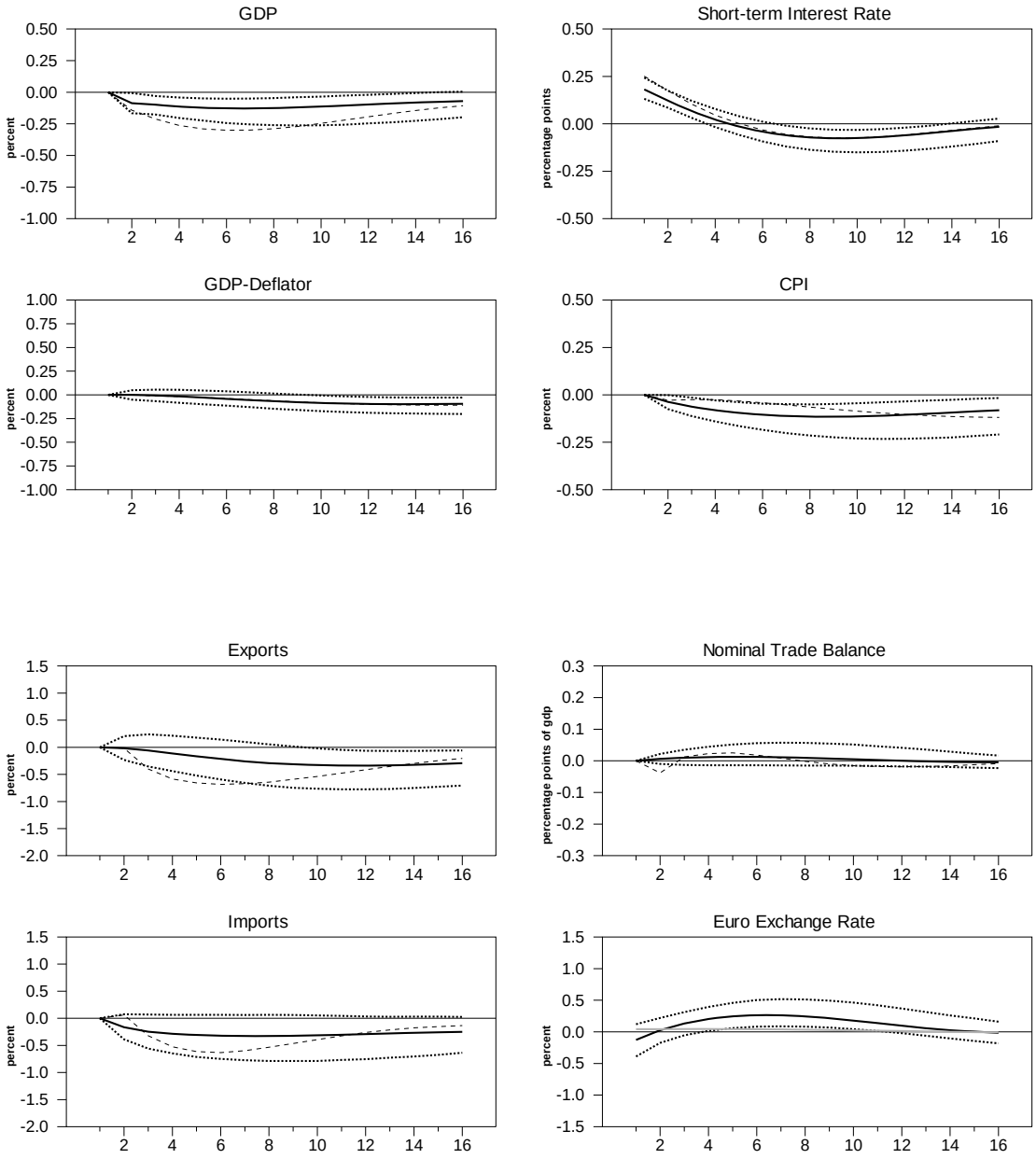
Overall, our results are robust to the change in the estimation period. Even though, we find that the impulse response functions evolves in general in several cases to some extend differently (table B.1.1), a closer look reveals that these differences are in most cases only small in magnitude (figures B.1.1-B.1.5). For example, the exchange rate changes, if significantly at all, only for a short period and small in magnitude to a euro area monetary policy shock. The interest rate still increases in all countries after a contractionary monetary policy shock in the euro area, however, in three cases it decreases later on for some periods. The most striking change, we find for consumer prices, which tend to decrease in all countries for the estimation period from 1996 to 2007, while consumer prices increase in all countries for the estimation from 1999 to 2009. Overall, our conclusions are valid for both estimation periods.

Figure B.1.1:
Impact of a Euro Area Monetary Policy Shock on the United Kingdom, 1996–2007



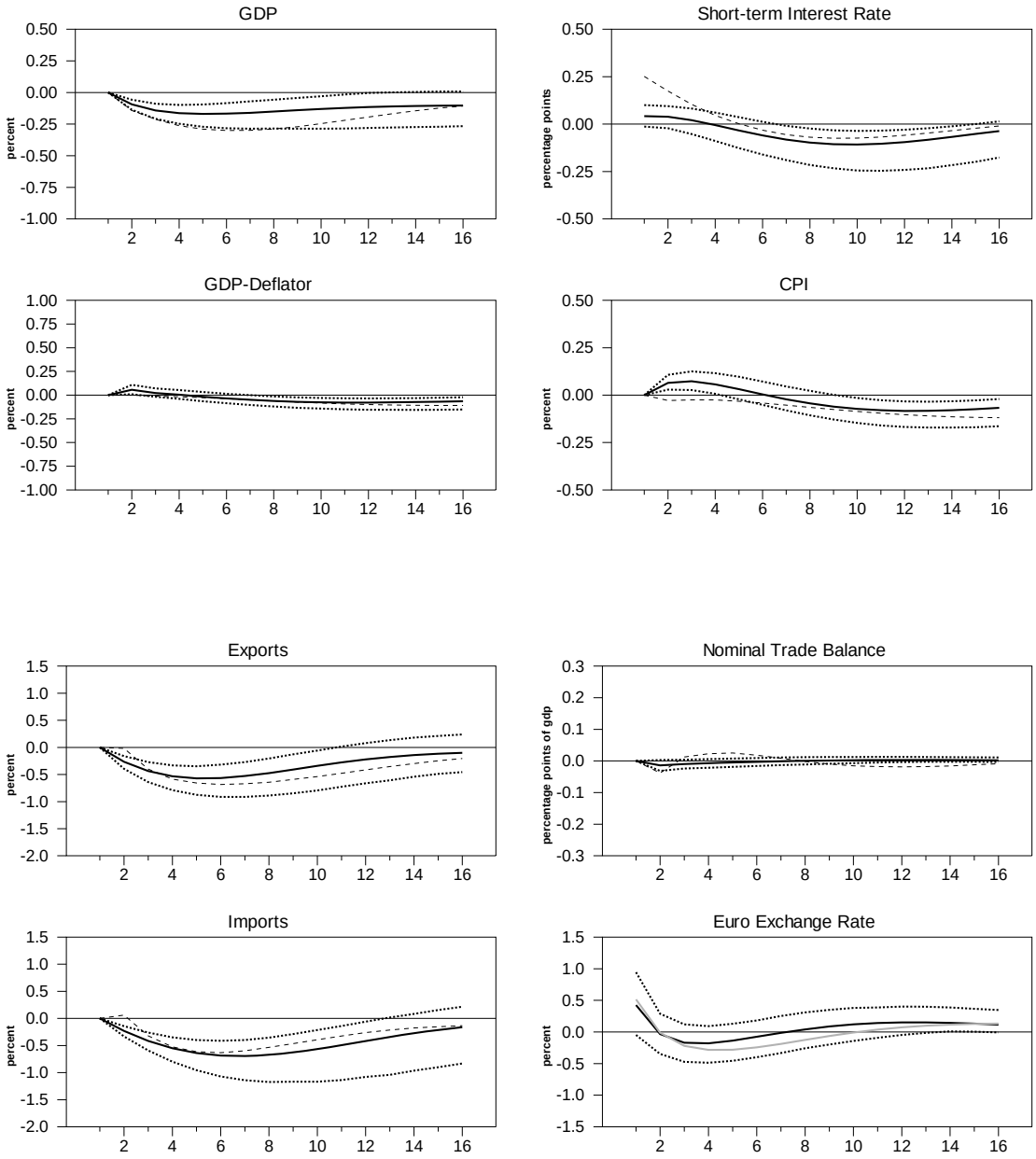
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.1.2:
Impact of a Euro Area Monetary Policy Shock on Denmark, 1996–2007



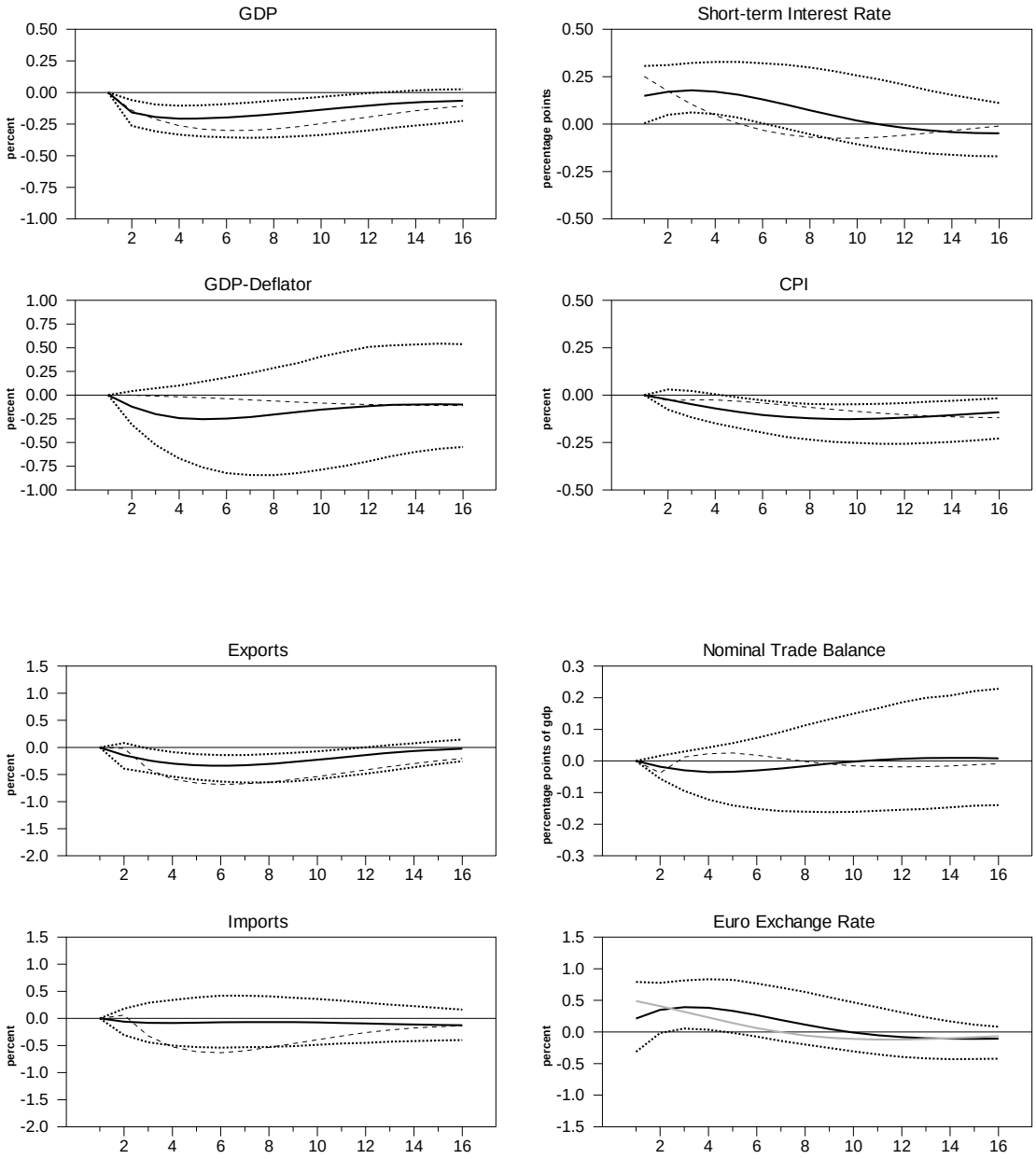
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.1.3:
Impact of a Euro Area Monetary Policy Shock on Sweden, 1996–2007



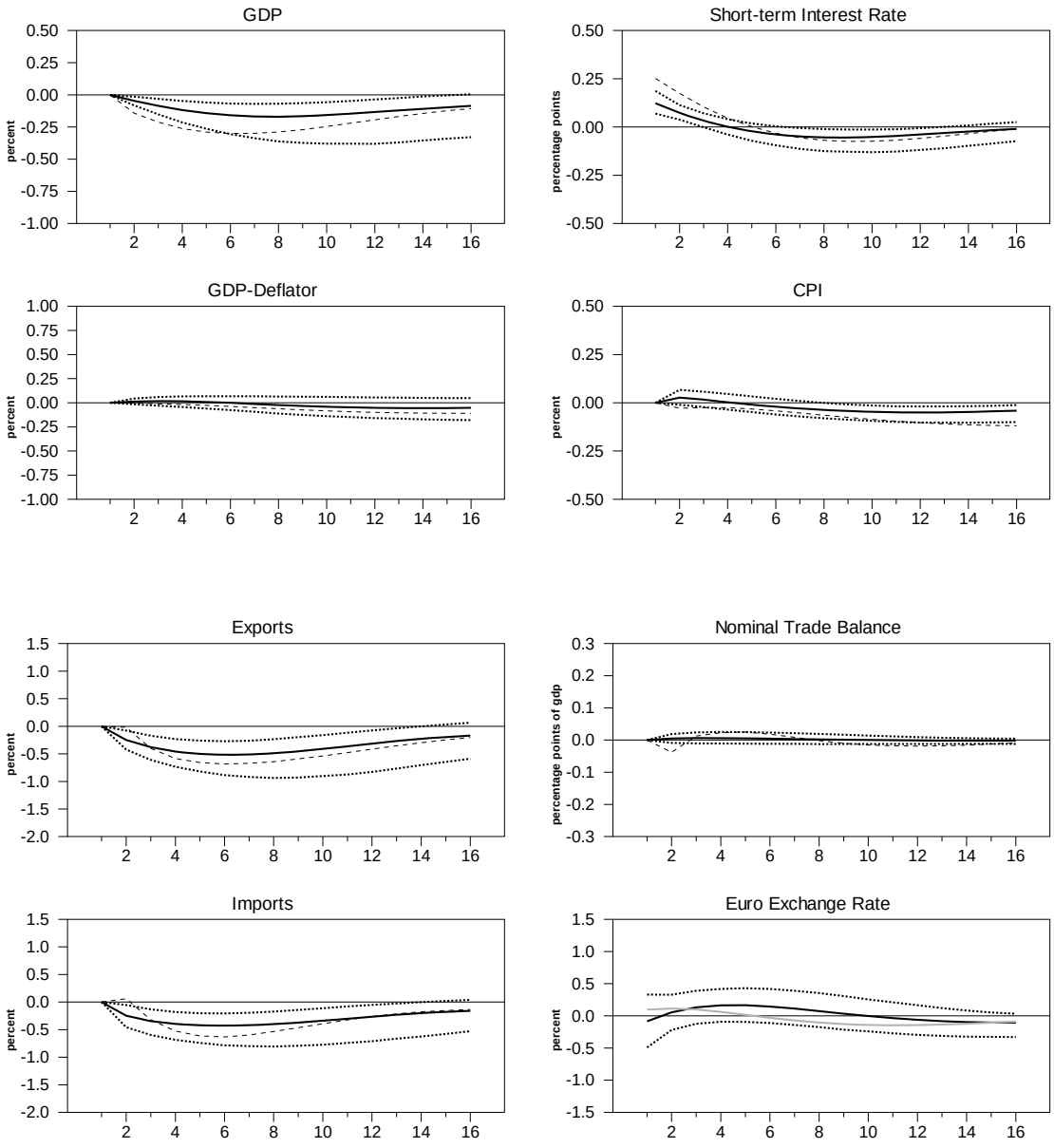
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.1.4:
Impact of a Euro Area Monetary Policy Shock on Norway, 1996–2007



Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.1.5:
Impact of a Euro Area Monetary Policy Shock on Switzerland, 1996–2007



Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

B.2 Including the Foreign Interest-rate in the Baseline Model

As a second robustness check, we include the foreign interest rate in our baseline model before extending it consecutively by the other foreign variables we are interested in. In doing so, we aim to model the consequences of euro area monetary policy shocks in the domestic economies in more detail and check the robustness of our results to an alternative approach used in the literature, which models the domestic economies more explicitly (Mackowiack 2007). We treat our two-variable model of the domestic economy as being block exogeneous, so that it does not has any influence on the euro area.

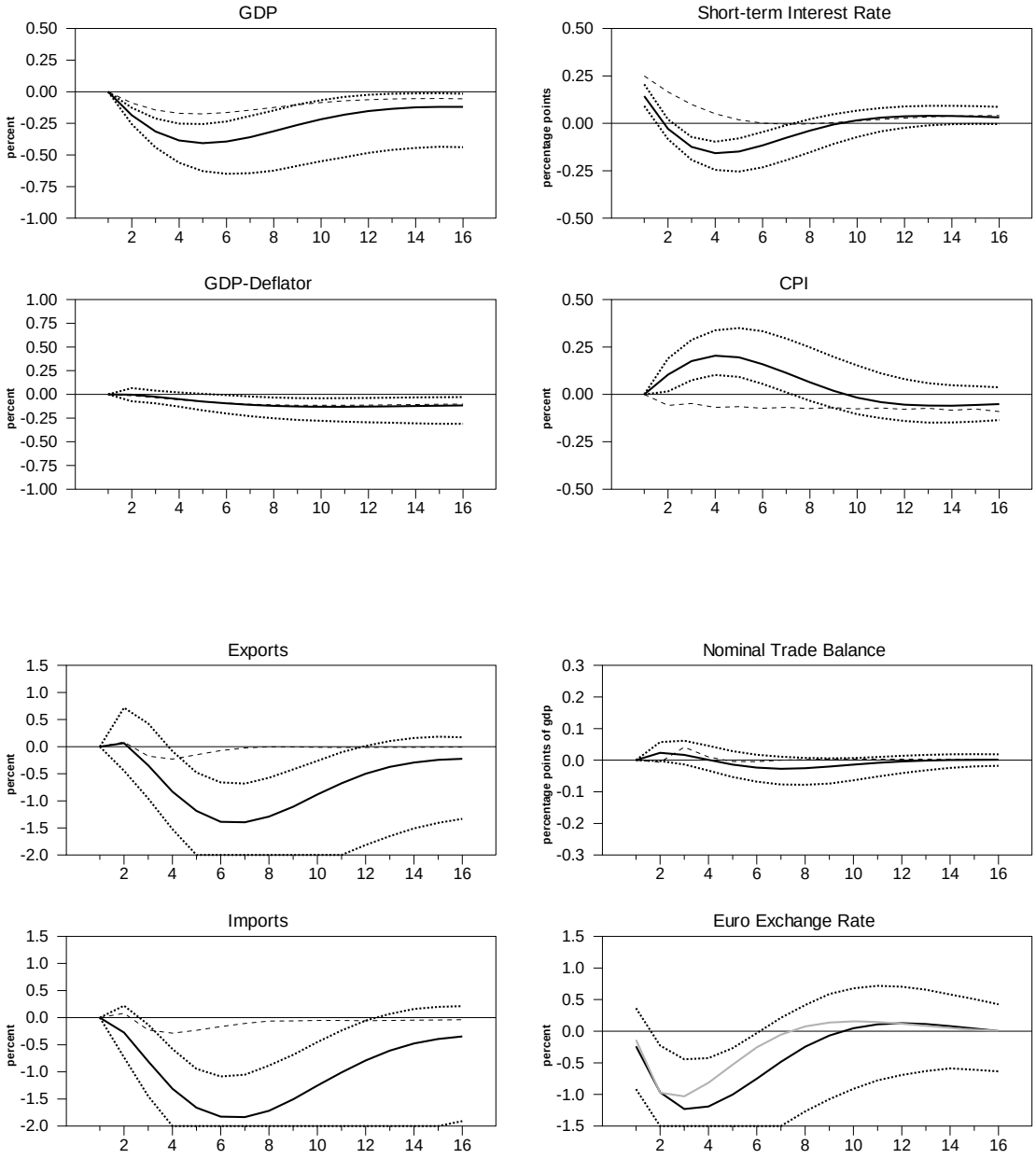
Table B.2.1:
Overview Over the Results for the Model that Includes the Foreign Interest Rate

	GDP	Interest Rate	GDP Deflator	CPI	Exchange Rate	Exports	Imports	Trade Balance
	1999-2009							
UK	↓	↑↓	↓	↑	↓	↓	↓	-
Denmark	↓	↑	↓	↑↓	↓	↓	↓	-
Norway	↓	↑	-	↑	↓	↓	-	-
Sweden	↓	↑	↑	↑	↓	↓	↓	↓
Switzerland	↓	↑	-	-	-	↓	↓	-
	1980-1996							
UK	-	-	-	-	-	-	-	-
Denmark	↓	↑	-	-	-	↓	↓	-
Norway	↓	↑	-	-	↑	↓	↓	-
Sweden	↓	↑	-	-	-	-	↓	-
Switzerland	-	↑	↑	↑	-	-	-	-

Notes: Arrows denote a significant change of the variable in the respective direction according to a contractionary monetary policy shock in the Euro area. Bars denote no significant change. Grey shaded areas denote a different result compared to the results obtained for the estimation period from 1999 to 2009.

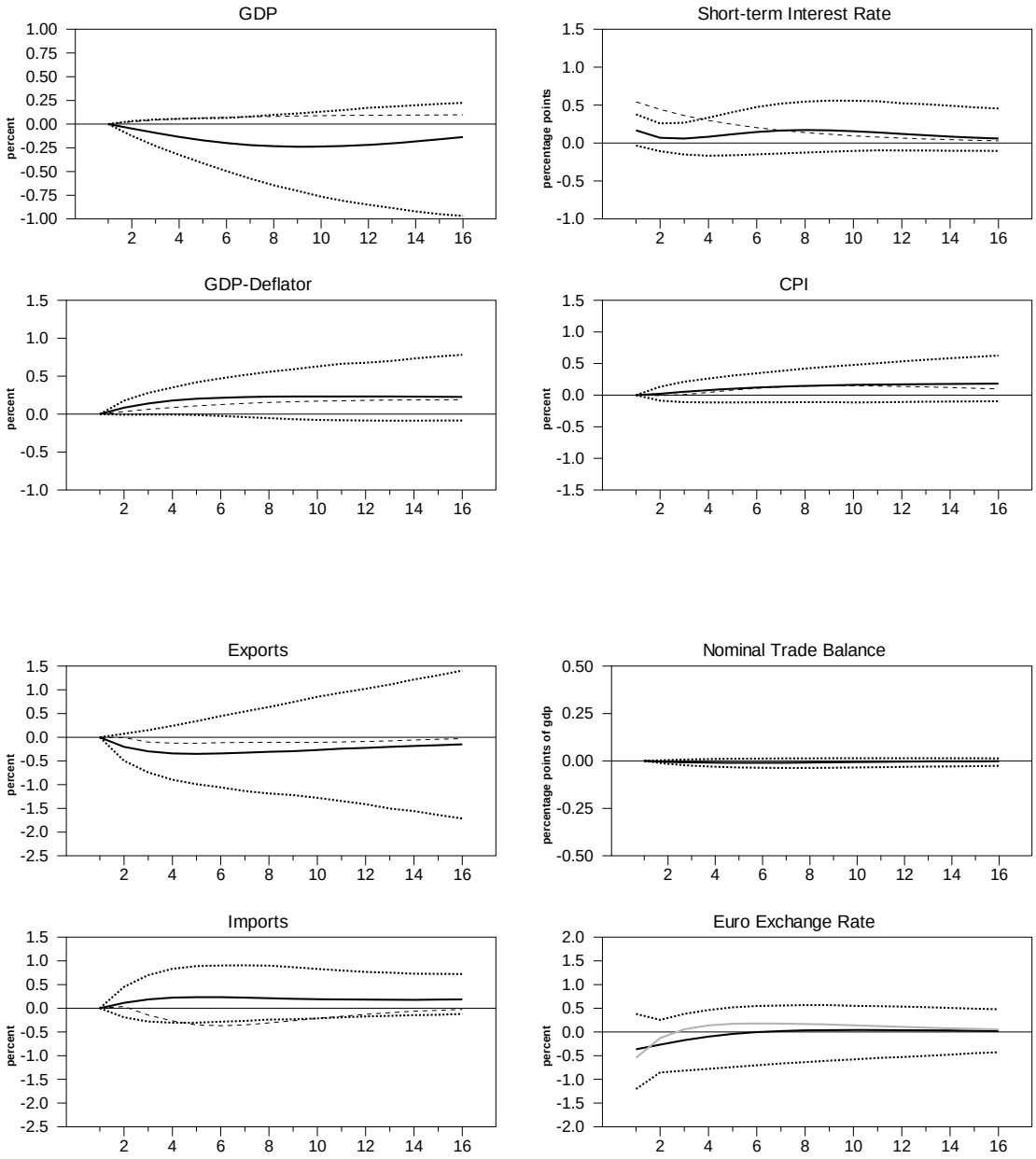
It turns out that our results are robust to using the alternative approach for both estimation periods (table B.2.1). We find more different responses for the pre-euro period. However, the impulse-response functions are nearly identical in all cases (figure B.2.1-B.2.10).

Figure B.2.1:
Impact of a Euro Area Monetary Policy Shock on the United Kingdom, 1999–2009



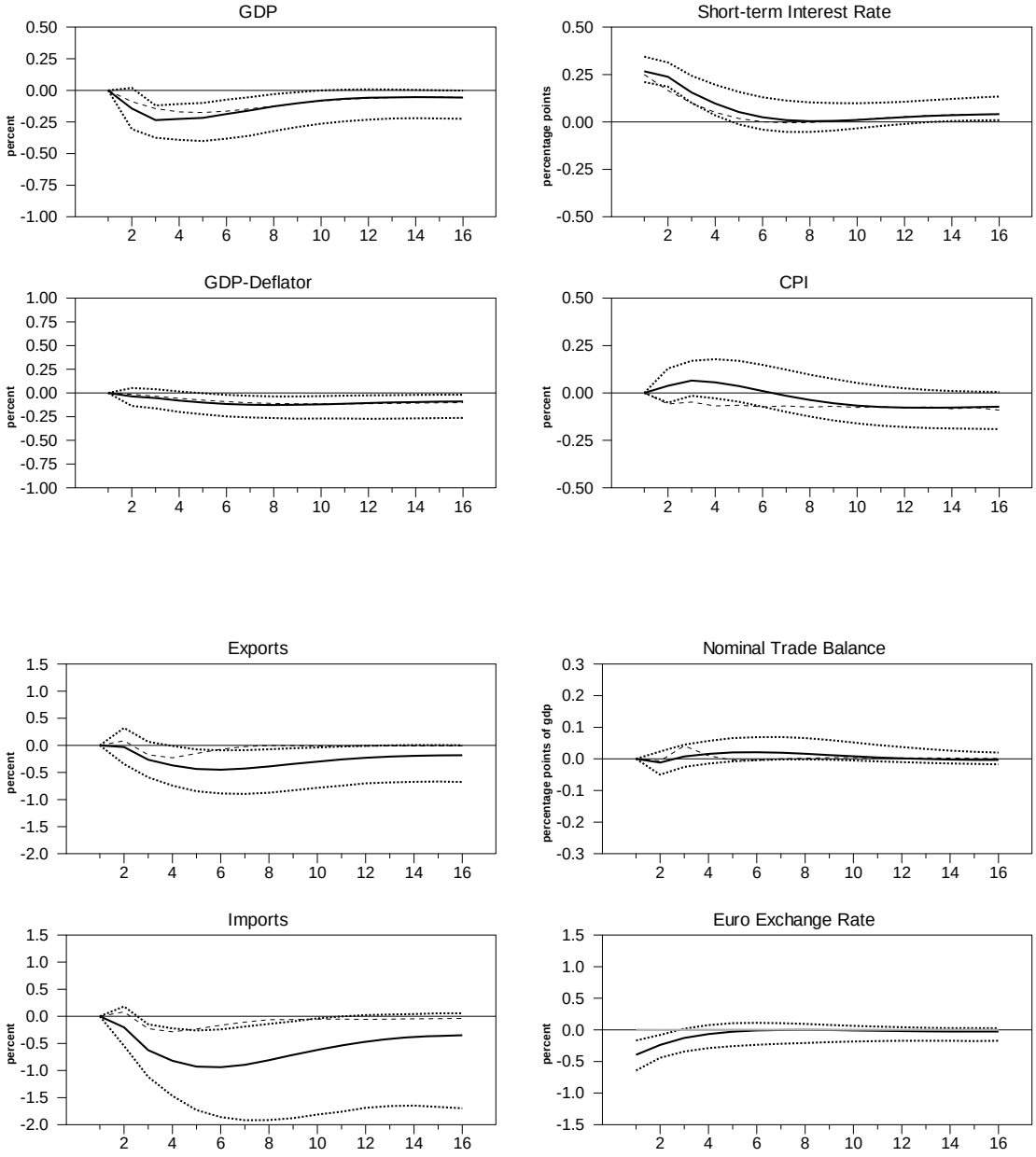
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.2:
Impact of a Euro Area Monetary Policy Shock on the United Kingdom, 1980–1996



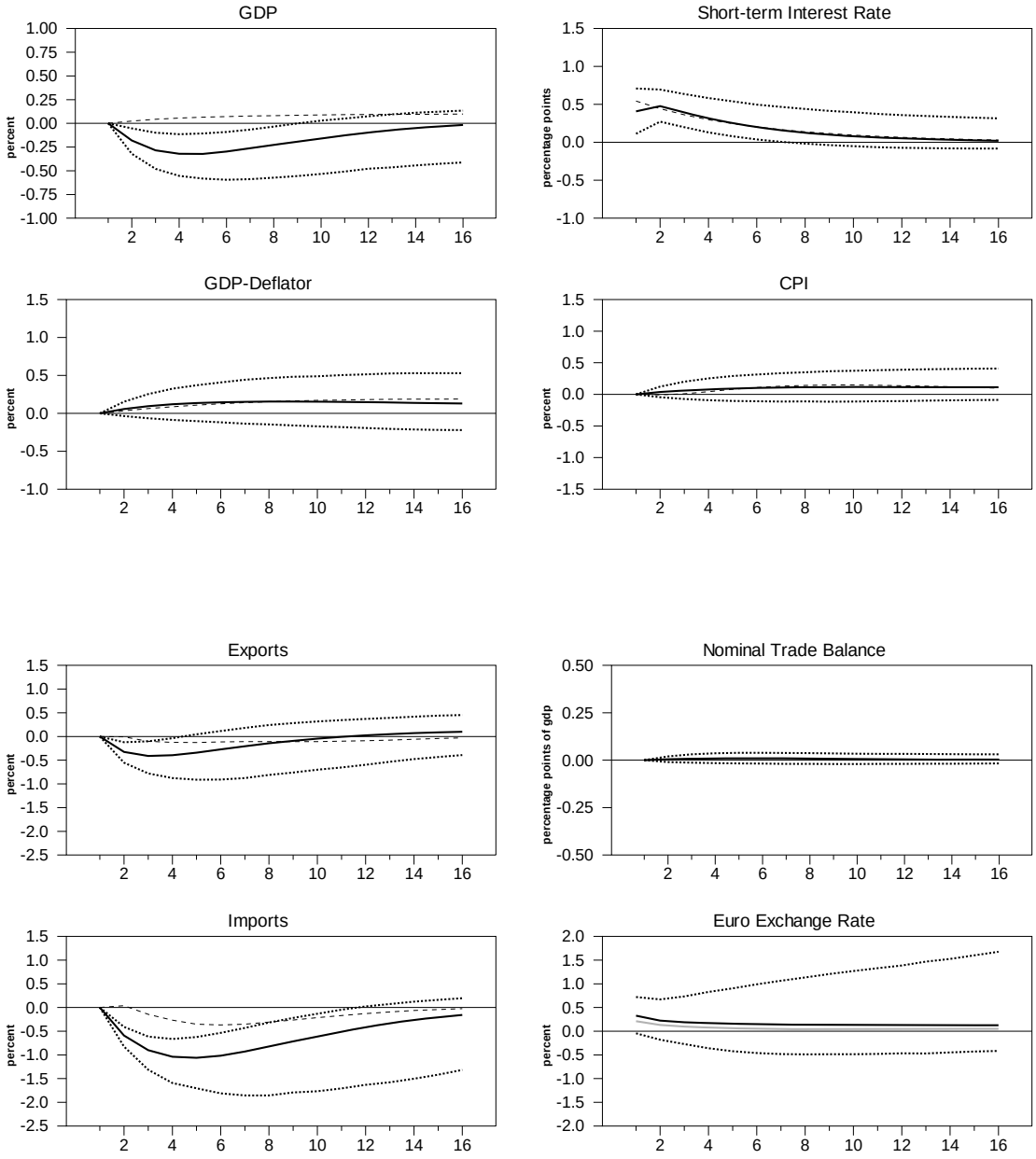
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.3:
Impact of a Euro Area Monetary Policy Shock on Denmark, 1999–2009



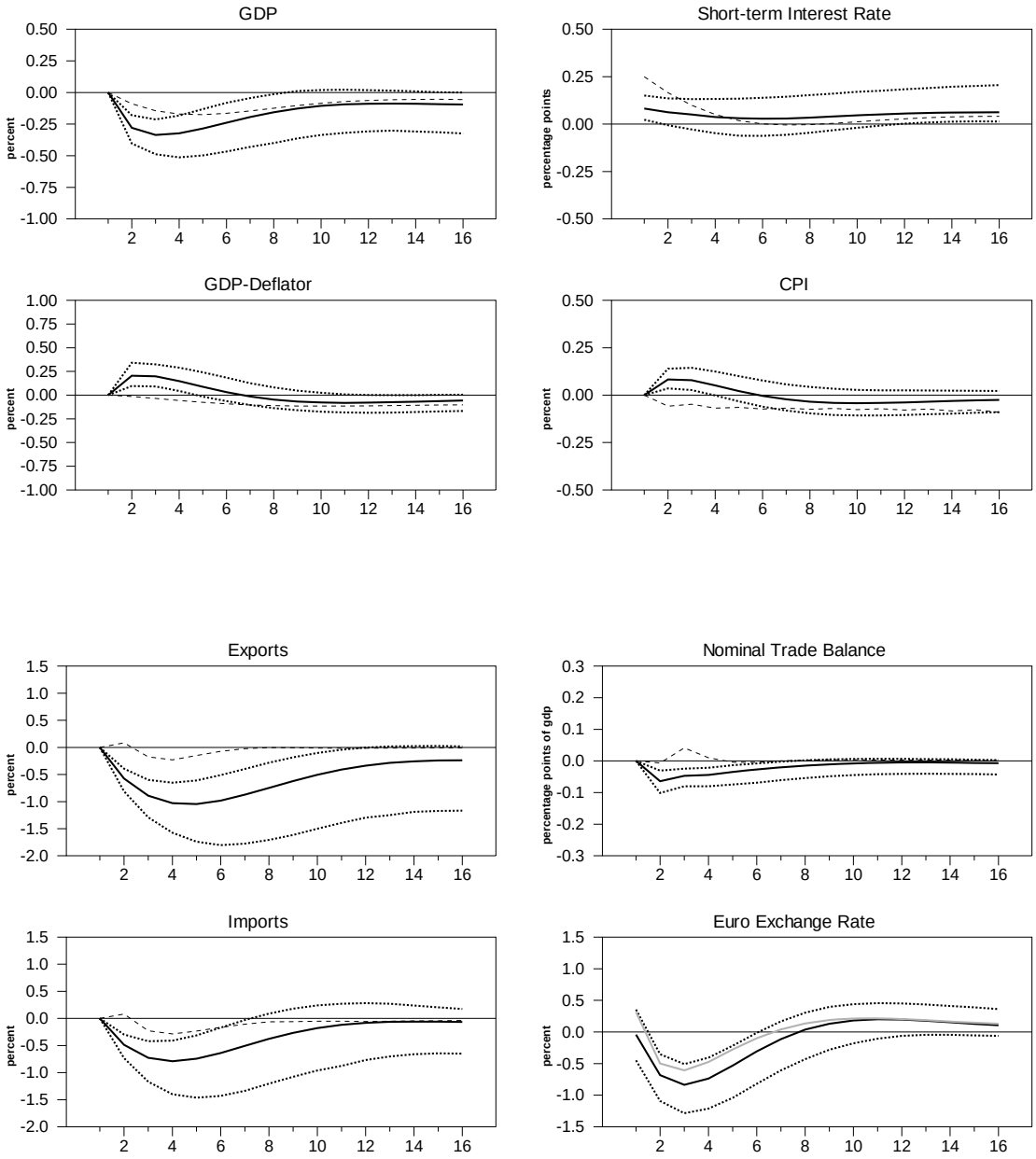
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.4:
Impact of a Euro Area Monetary Policy Shock on Denmark, 1980–1996



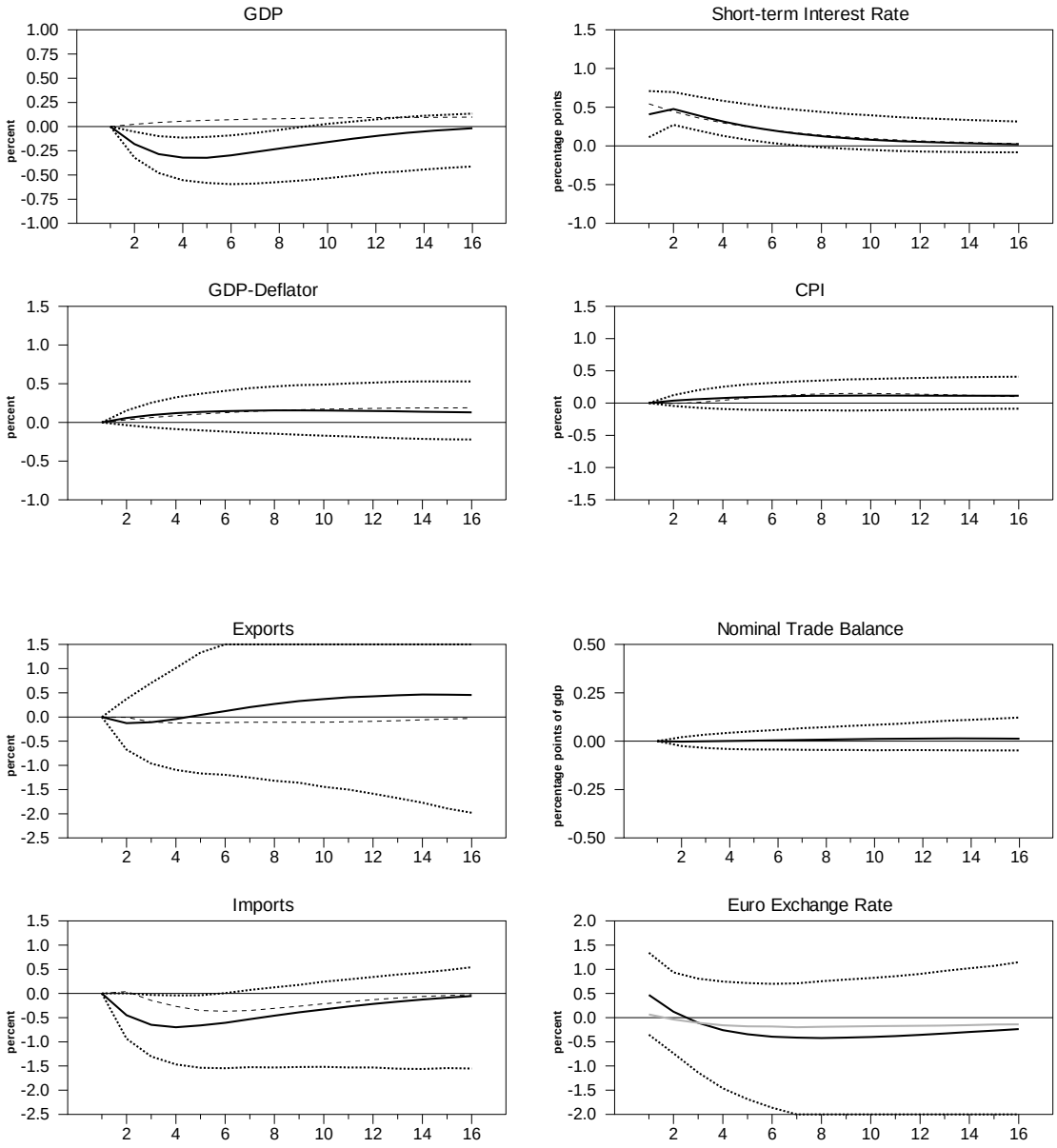
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.5:
Impact of a Euro Area Monetary Policy Shock on Sweden, 1999–2009



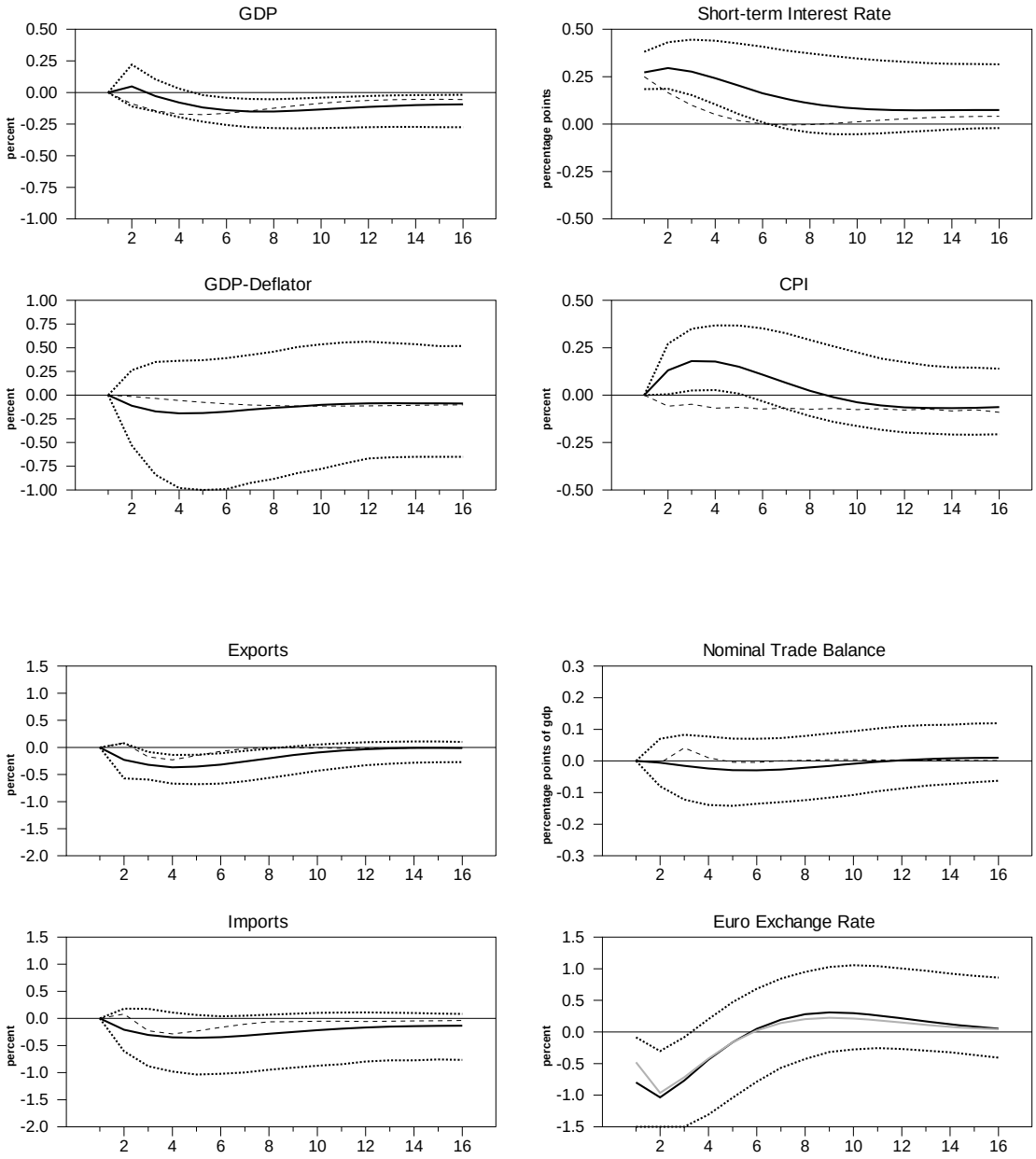
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.6:
Impact of a Euro Area Monetary Policy Shock on Sweden, 1980–1996



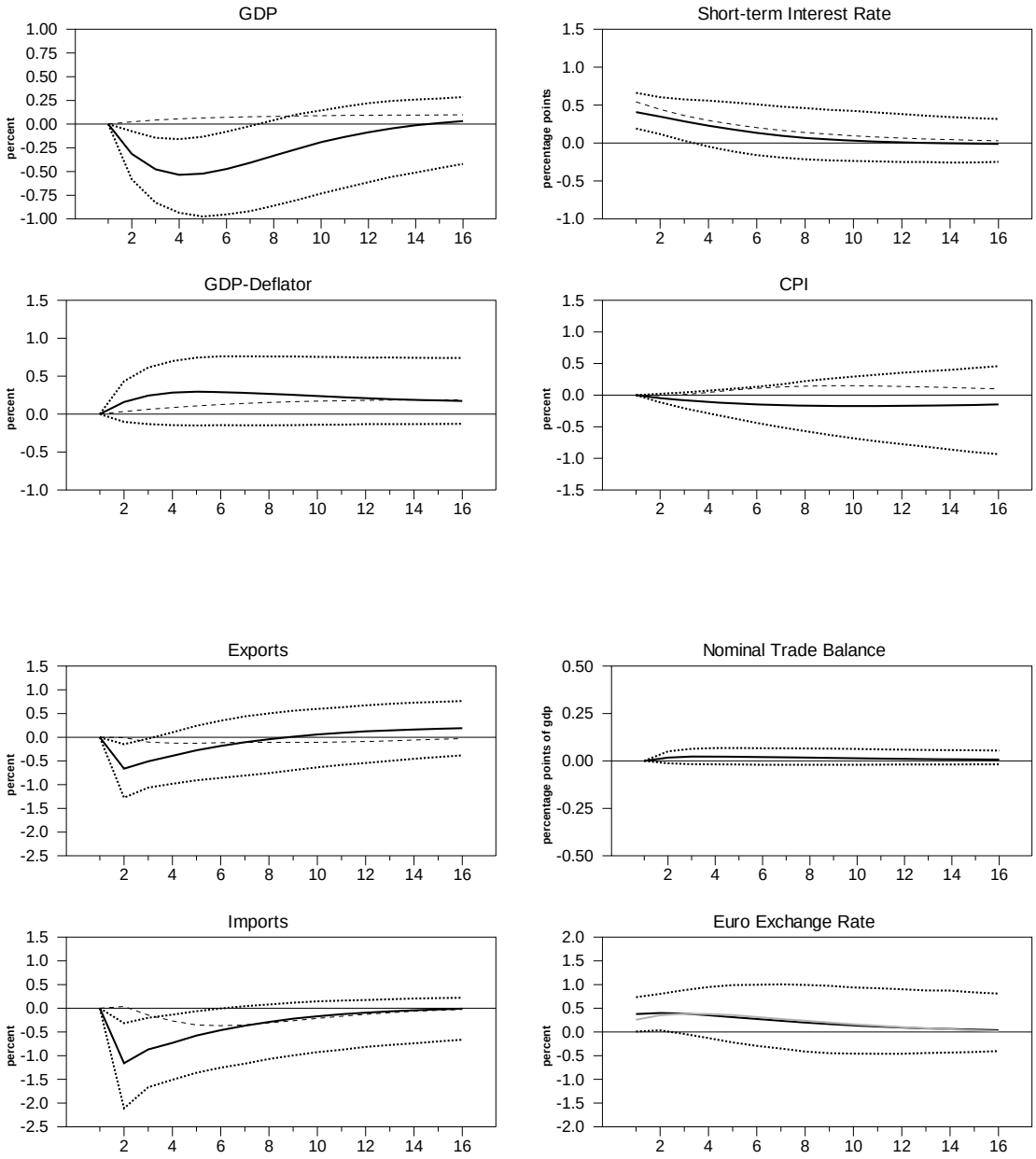
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.7:
Impact of a Euro Area Monetary Policy Shock on Norway, 1999–2009



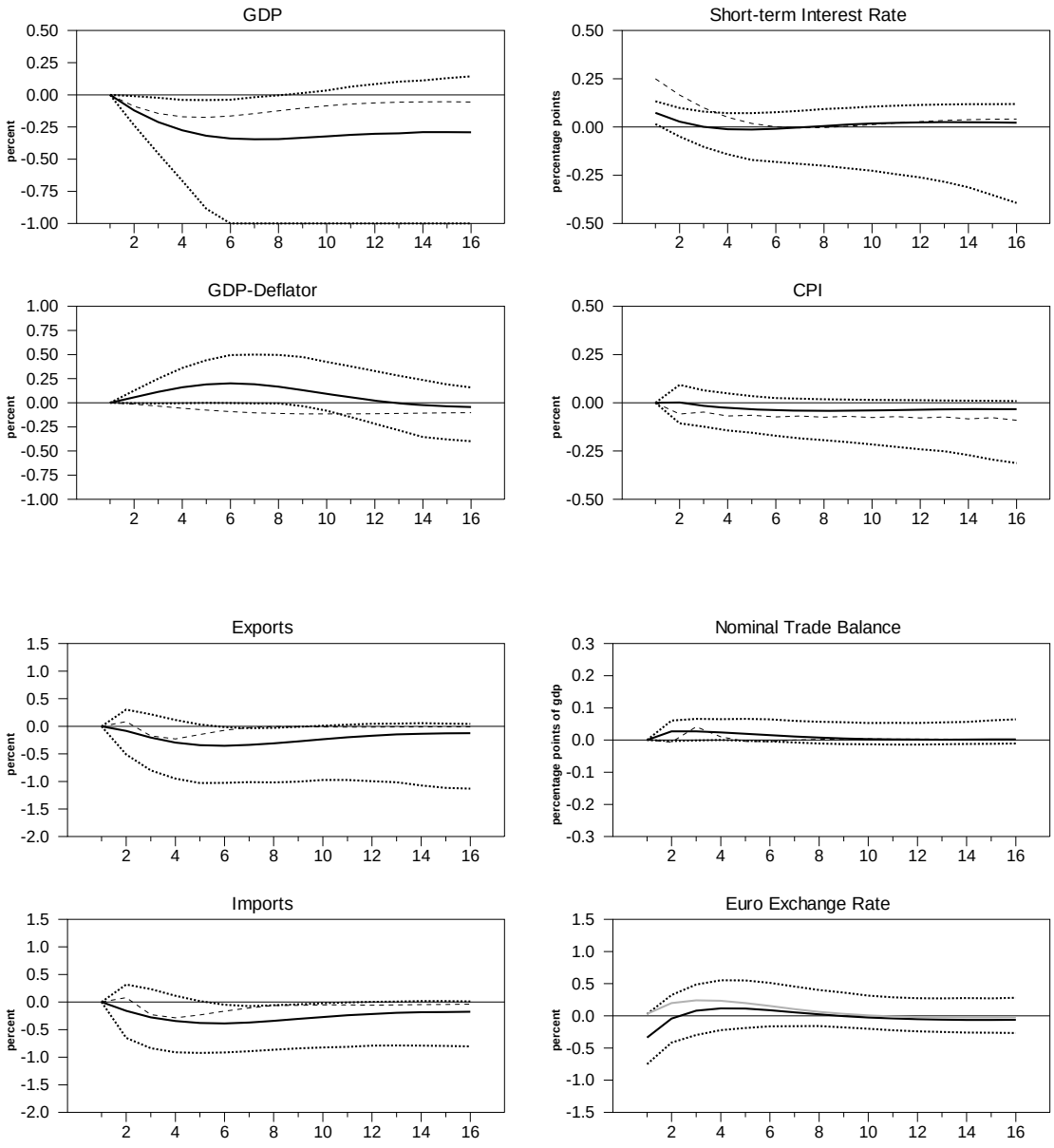
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.8:
Impact of a Euro Area Monetary Policy Shock on Norway, 1980–1996



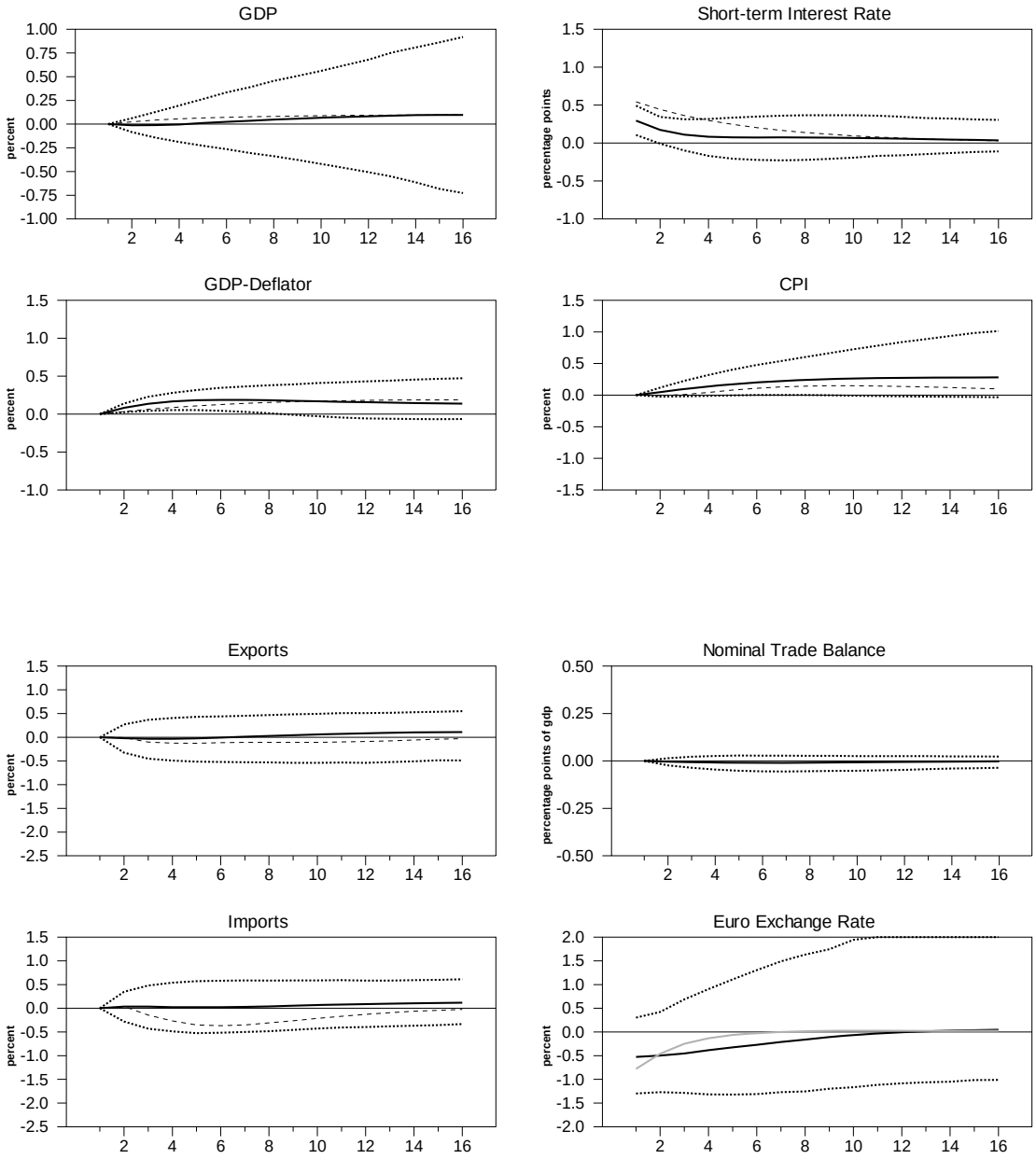
Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.9:
Impact of a Euro Area Monetary Policy Shock on Switzerland, 1999–2009



Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.

Figure B.2.10:
Impact of a Euro Area Monetary Policy Shock on Switzerland, 1980–1996



Notes: Dotted lines show the 90-percent confidence interval based on 5,000 draws from a Monte Carlo simulation. Dashed lines show the impact on each variable in the euro area. Grey lines in the subfigure 'Euro Exchange Rate' show the corresponding impact on the effective exchange rate. Nominal trade balance is expressed in percent of GDP in 2009.