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MASTER'S THESIS

The impact of CNB's exchange rate commitment on Czech exports

Author: **Bc. Jiří Teichman**

Supervisor: **Mgr. Michal Paulus**

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Declaration of Authorship

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Prague, December 27, 2018

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Abstract

The thesis evaluates the effect of Czech National Bank's exchange rate commitment on Czech sectoral exports. Thus, we show how unconventional monetary policies could affect the exports. To assess the impact of interventions, we use Synthetic Control Method. The method constructs synthetic Czech exports from data of comparable countries that were not under the policy of interest and compares them to observed Czech exports following the interventions. We expect a positive effect of Czech National Bank's commitment on Czech exports, because the interventions resulted in the undervaluation of koruna causing a higher demand for Czech goods abroad. Additionally, the exporters should benefit from reduced uncertainty caused by no exchange rate volatility with the euro area. The results showed a positive impact of interventions only in half of the export sectors. The positive effect of a stable exchange rate is not confirmed, because the effect on the euro area countries in some categories was smaller than for the other countries. The results for total sectoral exports were stable across model specifications and confirmed by analysis of Czech bilateral sectoral exports to the largest destinations. The significant contribution of this thesis is application of Synthetic Control Method on total sectoral exports, which was not done before. The method performed well, therefore it gives researchers a useful tool for evaluating the impact of policies and events on exports.

JEL Classification	E42, E52, E58, F14, F17, F31
Keywords	export, fixed exchange rate, monetary policy, synthetic control method

Author's e-mail	`teichji@gmail.com`
Supervisor's e-mail	`michal.paulus@fsv.cuni.cz`

Abstrakt

Diplomová práce vyhodnocuje efekt kurzového závazku České národní banky na český sektorální export. Díky tomu ukazuje, jak mohou nekonvenční měnové politiky ovlivnit export. K vyhodnocení dopadu intervencí používáme metodu syntetických kontrol. Tato metoda sestaví syntetický export pro Českou republiku z dat podobných zemí, které nebyly ovlivněné intervencemi, a porovná je

se skutečnými českými exporty v období po intervencích. Očekáváme pozitivní efekt kurzového závazku České národní banky na český export, protože intervence zapříčinily podhodnocení koruny, které zvýšilo poptávku po českém zboží v zahraničí. Dále očekáváme pozitivní dopad stabilního směnného kurzu s eurozónou, protože exportéři budou vystaveni nižší nejistotě. Pouze pro polovinu exportních sektorů ukazují výsledky pozitivní dopad intervencí. Kladný efekt stabilního směnného kurzu nebyl potvrzen, protože dopad na země eurozóny byl v některých katergoriích nižší než na zbylé země. Výsledky pro celkový sektorální export byly stabilní napříč různými specifikacemi modelu a byly podpořeny výsledky analýz pro české bilaterální exporty do největších destinací. Nejdůležitějším přínosem této práce je aplikace metody syntetických kontrol na celkové sektorální exporty, pro které dříve nebyla využita. Jelikož metoda fungovala dobře, dává výzkumníkům užitečný nástroj pro vyhodnocování dopadu různých zákonů a událostí na export.

Klasifikace JEL	E42, E52, E58, F14, F17, F31
Klíčová slova	export, fixní směnný kurz, monetární politika, metoda syntetických kontrol

E-mail autora	`teichji@gmail.com`
E-mail vedoucí ho práce	`michal.paulus@fsv.cuni.cz`

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Acronyms

CNB Czech National Bank

EMU Economic and Monetary Union

EU European Union

FDI Foreign Direct Investments

FMA Foreign Market Access

GDP Gross Domestic Product

HICP Harmonized Index of Consumer Prices

SCM Synthetic Control Method

SITC Standard International Trade Classification

US United States of America

Master's Thesis Proposal

Author	Bc. Jiří Teichman
Supervisor	Mgr. Michal Paulus
Proposed topic	The impact of CNB exchange rate commitment on trade flows

Motivation As a reaction to the Great Recession central banks throughout the western world conducted variety of novel monetary policies aimed to stimulate the economy and avoid the deflation. The Czech National Bank started exchange rate interventions in November 2013. Its aim was achieving the stated inflation target. This thesis focuses on impact of this unconventional policy on Czech sectoral trade flows as it is crucial to fully understand its effects on both national and global economy. Despite the growing number of studies about CNB exchange rate commitment, only limited attention was given to the sectoral trade flows.

The aim of the thesis is to estimate the effect of exchange rate commitment on sectoral exports of the Czech Republic. The link between trade and exchange rate is quite well explored. Auboin and Ruta (2013) provide summary of both theoretical and empirical studies on this topic. The studies suggest exchange rate misalignment has effect on exports. On the other hand, the researchers found that impact of exchange rate volatility on trade flows is ambiguous. Additionally, the empirical evidence from Nicita (2013) suggests that volatility is of serious concern only for developing countries or cases when there is no volatility as in the case of currency union or currency peg. Because the commitment stabilizes the exchange rate, it decreases the uncertainty. Therefore, we could expect increase in trade with eurozone countries. To evaluate the impact of CNB policy, the synthetic controls method will be used. This method, which was first developed by Abadie and Gardeazabal (2003), allows for comparison of actual development of trade flows with artificial control variable constructed from observations in similar countries. The first study which employed this method for bilateral trade was by Hosny (2012), but it focused on impact of trade agreements on Algeria. Similarly, the work of Hannan (2016) focused on evaluation of trade agreements. The thesis is also related to the study of

Anderson et al. (2013), who estimates the impact of exchange rate on sectoral trade flows between Canada and United States.

Hypotheses

Hypothesis #1: Exchange rate commitment of CNB increased the trade flows

Hypothesis #2: The rise in trade flows to euro area will be higher than with other countries

Hypothesis #3: The impact of interventions varies across the sectors

Methodology The data for bilateral trade flows will be obtained from the UN Comtrade database. To test the hypotheses stated above, I will employ the synthetic controls method developed in Abadie et al. (2010). This allows the comparison between actual Czech trade flows after the CNB exchange rate commitment and theoretical trade flows in absence of the commitment. To identify the potential determinants that influence trade flows, I will follow the Hosny (2012), who uses the variables from gravity model as covariates. As gravity literature puts more weight on theoretical foundations, we should only include variables that are consistent with the theory.

Expected Contribution The main goal of the thesis is to empirically evaluate the impact of CNB interventions on sectoral trade in the Czech republic. As there is limited amount of studies focused on this topic, it could provide additional evidence to policymakers. Moreover, the use of synthetic controls method in trade literature was limited and focused mainly on impact of trade agreement. Thus, the thesis will explore further possibilites of this method and shows how it compares with the frequently used ones, such as gravity models. Additionally, it expands literature studying the effect of exchange rates on trade with the case study of Czech Republic during exchange rate commitment period and gives evidence how much the reduction of volatility and currency misalignment matters.

Outline

1. Introduction
2. Literature review: I will survey the literature about impact of exchanges rate on trade and synthetic controls method literature.
3. Overview of Czech exports: I will provide overview of Czech sectoral exports
4. Data: I will describe how the data were obtained and provide their descriptive statistics

5. Model: I will describe the synthetic controls method and related tests
6. Results: This section will summarize the model results and provides the falsification test to confirm the robustness of results
7. Conclusion

Core bibliography

Abadie, A., Gardeazabal, J., 2003. The economic costs of conflict: A case study of the Basque Country. The American Economic Review, 93(1), 113-132.

Abadie, A., Diamond, A., Hainmueller, J., 2010. Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. Journal of the American statistical Association, 105(490), 493-505.

Anderson, J. E., Vesselovsky, M., Yotov, Y. V., 2013. Gravity, scale and exchange rates (No. w18807). National Bureau of Economic Research.

Auboin, M., Ruta, M., 2013. The relationship between exchange rates and international trade: a literature review. World Trade Review, 12(3), 577-605.

Ahmed Hannan, S., 2016. The Impact of Trade Agreements; New Approach, New Insights (No. 16/117). International Monetary Fund.

Hosny, A. S., 2012. Algeria's trade with GAFTA countries: A synthetic control approach. Transition Studies Review, 19(1), 35-42.

Nicita, A., 2013. Exchange rates, international trade and trade policies. International Economics, 135, 47-61.

Author

Supervisor

Chapter 1

Introduction

The Czech National Bank (CNB) started to use exchange rate commitment on 7th November 2013. At that time the Czech Republic was in recession, facing increasing unemployment and falling household consumption. To maintain the price stability, CNB used its main monetary policy instruments and lowered the interest rates to 0.05%. However, the CNB's stated inflation target of 2% was not reached and CNB decided to use exchange rate commitment to achieve it. Additionally, this action should support the economic policies of government dealing with the recession.

Much of the research has been dedicated to evaluating impact of CNB's exchange rate commitment, but it focused predominantly on macroeconomic variables such as Gross Domestic Product (GDP) and inflation. To my knowledge, this is the first attempt to evaluate the effect of exchange rate interventions on sectoral exports of the Czech Republic. The results might be helpful in understanding the impact of unconventional monetary policies on country's export performance. Examples of such unconventional monetary policies adopted in other countries are quantitative easing, or foreign exchange interventions of Swiss National Bank.

According to theory, an undervalued currency should lead to the higher exports (Krugman *et al.* 2014). Therefore, the decision of CNB to weaken the koruna to CZK 27 per euro should boost the Czech exports. Much of the discussion in the trade literature was about the effect of exchange rate volatility. Theory suggests positive effect of reduced exchange rate volatility on exports due to lower uncertainty (Dixit 1989), but empirical evidence is mixed. The commitment to peg koruna to euro should increase the exports to euro area countries, because there would be no volatility. Because undervaluation of

currency should have a positive effect on exports to all destinations, the first hypothesis is: "Exchange rate commitment of CNB increased Czech exports." We expect additional positive effect on euro area countries. Therefore the second hypothesis is: "Rise in Czech exports to euro area will be higher than to other countries." Empirical studies found various effects across the different product categories. The impact of exchange rate volatility on exports in sectors producing primary goods such as agriculture or basic metals was generally higher (Péridy 2003). This leads to the third hypothesis of the thesis: "The impact of interventions on exports varies across the export sectors." Based on empirical evidence stated above, we expect a higher positive effect on SITC categories 0 to 4, because they contain primary goods. For category 5, there might be larger positive effect, because chemicals are homogeneous products. However, plastic or pharmaceutical products, which are part of this category, are not perfect substitutes. For remaining categories, we expect no additional positive effect from reduced exchange rate volatility, because the categories contain manufactured products that are heterogeneous.

For evaluation of the hypotheses, we will employ the Synthetic Control Method (SCM) which estimates the development of the variable of interest (in our case total and bilateral sectoral exports[1], respectively) for the unit of interest (in our case the Czech Republic or its bilateral trade pairs) in the absence of intervention. The method constructs weighted average from units that are similar to the unit of interest. To test our hypotheses we will use this method on total exports[2] in each of 10 Standard International Trade Classification (SITC) categories and to get a more detailed insight into the development of the exports we will look at bilateral exports to the main trade partners of the Czech Republic. Additionally, we split the total exports to flows to euro area countries and other countries to test our second hypothesis. The use of bilateral exports[3] allows examining the effect of interventions on exports with well described set of variables from gravity model literature as controls in SCM. This complements the model of total trade flows, because there is a small focus on them in literature and suggested models contain only few useful variables.

The main contribution of the thesis is assessing the impact of fixed exchange rate on Czech sectoral exports. This will serve as an additional evidence in evaluating the efficiency of interventions in the improvement of macroeconomic

[1]Sectoral exports are country's exports in certain sector (in our case determined by SITC category).

[2]Total exports are the sum of country's exports to all other countries.

[3]Bilateral exports are country's exports to another country.

conditions. The use of SCM provides a new way for studying the effect of policies on trade flows. There were only several studies using SCM on bilateral exports. Moreover, this is the first study applying the method on total sectoral exports. Therefore, it contributes to literature studying the impact of exchange rate policies in export sectors.

The thesis has the following structure. Chapter 2 gives overview of theory and empirical research of exports, and survey of related SCM studies. The overview of main destinations and commodity structure of Czech exports is presented in this chapter. In Chapter 3, we describe the SCM methodology, selection of covariates used in the model, and estimation strategy. Chapter 4 describes the data used for the estimation of results. In Chapter 5, we provide the results of analysis for each SITC category of exports. In each category, we study the effects on total sectoral exports. Then, we separately evaluate sectoral exports to euro area and outside euro area. Finally, the effect on flows to the largest trade partners in each category is evaluated. Chapter 6 summarizes the results and discusses whether the hypotheses were supported by them. Chapter 7 concludes the thesis.

Chapter 2

Review of literature and theory

This chapter gives an overview of studies, theories, and methods relevant for studying the effect of exchange rate peg of CNB on Czech exports. Moreover, it provides a brief introduction into the structure of Czech exports.

The review of theory has the following structure. At first, we discuss how the exchange rates might influence the export. The literature suggests that two main explanations could be exchange rate volatility and currency misalignments. Also, we show how the hypotheses were derived from those theories. The second part of the theory review is devoted to the overview of Synthetic Control Method. The method aims to compare unit exposed to some event with its theoretical counterpart in the case that the event would not occur. In the third part, we will focus on studies evaluating impact of CNB's exchange rate commitment using SCM and other methods.

2.1 Exchange rate and trade

This part of literature review focuses on literature explaining the link between exchange rate and international trade. The paper of Auboin & Ruta (2013) provides a review of literature studying effects of exchange rate volatility and currency misalignments on trade flows. These two effects are especially relevant for the Czech Republic during the period of exchange rate commitment. The exchange rate floor effectively locked the exchange rate at 27 Czech koruna per euro. Therefore, the volatility was almost removed. The appreciation of koruna following the exit from the exchange rate commitment suggests presence of currency misalignment. The following paragraphs give an overview of the relevant

literature explaining theories and empirical evidence about misalignments and the volatility of exchange rates.

2.1.1 Currency misalignment

At first, we will focus on theory and literature about the impact of currency misalignments on trade. One potential way for currency to influence the trade in the short-term results from sticky prices. The increase of the money supply causes nominal depreciation of domestic currency. This causes the real exchange rate to depreciate due to price stickiness. The demand for domestic goods increases as they are relatively cheaper. The foreign goods are more expensive and demand for them declines. This effect is only temporary, because once the prices are allowed to adjust the home currency will appreciate due to higher demand. This is illustrated in Krugman *et al.* (2014). The findings of Nicita (2013) support this theory. According to his results, currency undervaluation promotes exports and restricts imports. Following from the results of his model, the total trade diversion for the whole world amounted to 120 billion USD in 2008. Further sources of misalignment are mentioned by Auboin & Ruta (2013), who point out that the use of vehicle currencies might result in imperfect pass through between nominal and real exchange rate. Also, the import and export contracts might be done in advance and thus switching from foreign to domestic goods might be slow or limited. In the long run, the misalignments should disappear as explained in Krugman *et al.* (2014). However, in the presence of previously mentioned market imperfections, they might persist.

The results of Baldwin (1988) suggest that under existence of large sunk cost to enter foreign markets, the undervaluation might help the firms to enter those markets. Once the firm is on the market, the appreciation would not force it out of the market, because the entry cost was already paid. This causes higher exports as compared to state without initial undervaluation. This idea is incorporated into the theoretical model of Melitz (2003). According to his model, when fixed entry cost decreases, firms above certain productivity threshold start exporting. This leads to increase of aggregate productivity, if the new exporters are more productive than the average exporter. The new exporters increase their market share and profits at the expense of the least productive firms. As a result, overall welfare in the economy increases. Bernard & Jensen (2004) confirm this theory on US plant level data. Their results

are statistically significant across various estimation methods and suggest that increases in the exchange rate level decreases the probability of exporting for the plant. Berman & Berthou (2009) study how the financial market imperfections in combination with exchange rate movements affect exports. They claim that inefficient financial markets may prevent firm from entering the market in the presence of sunk costs, as their ability to borrow for paying these costs in less developed financial markets is limited. This is supported by their results which show smaller effect of exchange rate depreciation for countries with less efficient financial markets.

The study of Freund & Pierola (2010) points out that firms might not want to export due to uncertain profits. The consumers could prefer the domestic goods rather than imported ones and after the appreciation of home currency they might be reluctant to switch to cheaper imports. Raff & Kim (1999) show the importance of information barriers about the quality of imported goods, because local consumers might have doubts about cheaper imported goods and keep buying the local ones even if substitution would be beneficial for them. Authors suggest the use of export subsidies as one of the possible ways to overcome this asymmetry. Another way to overcome it is undervaluation of exporter currency, because it increases price competitiveness of exported goods. However, the effectiveness of such policies depends on the actions of other competitors. If other exporters react by similar measures or importing country's government decides to support domestic producers, the measures will be ineffective.

The theories presented above suggest higher exports during the periods of undervalued currency caused by the lower price of domestic goods on foreign markets. This effect should be observed only in the short term until the prices adjust. In the long term, the effect might not disappear, because competitive advantage from lower prices might help producers, facing fixed cost of entering the market, to start exporting. Therefore, Czech exports should increase as a result of exchange rate peg of CNB, because Czech koruna became undervalued. From this follows the first hypothesis of the thesis: "Exchange rate commitment of CNB increased Czech exports." As most of the data for the postintervention period were not available and the time after their end is short, the focus of the thesis is on the short term effect. Further study will be needed to evaluate the long term effects of CNB's commitment on exports.

2.1.2 Exchange rate volatility

In the following paragraphs, we will summarize the literature explaining and evaluating the effect of exchange rate volatility on trade. The study of Clark (1973) states reasons why exchange rate volatility might have a negative effect on exports. He argues that risk averse profit maximizing firm which is exposed only to exchange rate risk reduces its exports to avoid it. His results rely on the assumption of no imported inputs. Further studies relaxed this assumption and showed that the lower price of imports from countries with depreciating currency offset the lower profit from exports and vice versa.

The firms could reduce the uncertainty by hedging. Thus, in a perfect world where all firms have access to well-functioning forward markets, there would be no effect of exchange rate volatility on exports. However, this assumption is too strict, because the access to hedging is limited for small firms. For example, Géczy *et al.* (1997) show that smaller firms hedge less which is possibly caused by significant fixed costs of setting the hedge. If the firm faces large sunk costs of entering the market, high volatility can dissuade it from exporting in such currency, because resulting profits might not cover the initial costs. Additionally, the efficiency of financial markets might differ significantly across the countries. The study by Hall *et al.* (2010) shows that there are significant differences even among the developing countries. Their results suggest that the exports from developing economies with open capital markets and higher GDP are more sensitive to exchange rate fluctuations. On the other hand, the exports from developing countries with less open financial markets are negatively affected by the exchange rate fluctuations. This argument is consistent with the view that limited or more costly borrowing limits the access to foreign markets which was presented above.

The decision of firm to export in the presence of volatile exchange rate might be affected by the presence of sunk cost. The paper of Dixit (1989) uses the option theory to show why the firms might decide to postpone their decision to export until a profit opportunity arises. The present value of sunk costs is essentially the exercise price and the present value of potential cash flows is the payoff. When the uncertainty is high, the firm wants to wait until there is a favourable price at which it is profitable to start exporting. The results of Campa (2004) for sample of Spanish firms suggest the importance of sunk costs for decision of firm to participate in foreign market. However, this effect is connected to the level of exchange rate rather than its volatility. The

estimated effect is relatively small as 10% depreciation increases the exports only by 1.4%. Also, the number of exporting firms increases only slightly, because most of the additional exports are from current exporters. Das *et al.* (2007) report similar results on Colombian firm level data for the increase of export level, but the long-term effect on the number of firms is substantial. The payoff from exporting significantly varies across different industries. Thus, the effect of exchange rate level and volatility on exports is industry dependent. This shows why studying industries separately might be beneficial and give further insight in into how exchange rate influences trade.

Although the evidence from the articles above suggest only limited changes in the effect of exchange rate volatility on exports across the sectors. Other empirical studies provide support for this relationship. Péridy (2003) uses the sample of bilateral trade flows of G-7 countries in the period 1975-2000. The study covers 20 industries. In the aggregate model, exchange rate volatility has statistically significant negative impact across all the countries in the sample, when the industry specific factors are included. Moreover, he estimates the model for each industry in every country. The results show considerable differences between the industries irrespective of the country. Industries producing homogeneous or crude products are very sensitive to the exchange rate fluctuations. Among those industries are petroleum, coke, tobacco, wood, paper, textiles, and metals. On the other hand, technologically advanced industries such as electrical machinery, computing machinery, radio, television, communication equipment, medical, optical and precision instruments have low sensitivity to exchange rate fluctuations. Author suggests that higher degree of differentiation and focus on innovation are main driver of low sensitivity to prices and exchange rate factors.

More frequently, studies evaluating the effect of exchange rate volatility on sectoral trade flows focused on a single country or bilateral pair. For example, Wang & Barrett (2007) found a significant negative impact of high frequency exchange rate volatility on Taiwanese agricultural exports to the United States. Trade in other sectors was unaffected by the volatility. Their results are supported by the study of Kandilov (2008) who focuses solely on agricultural data. His findings are similar, but the effect depends on the level of country development. Developing countries exports are much more influenced by exchange rate volatility, but the results of the paper show that significant factor is the volatility of the currency in which the trade is denominated. Additionally, the agricultural exports are 20% of total country exports for developing countries

in the sample. Thus, higher sensitivity of developing countries' exports to exchange rate volatility frequently observed in papers with aggregate data might be caused by their higher exposure to the agricultural exports. Kandilov & Leblebicioğlu (2011) estimate the effects of exchange rate volatility on Colombian plant-level data. Their results show that fabricated metal products and basic metals are most affected by exchange rate volatility. For other industries, the negative effects are not statistically significant. Bahmani-Oskooee & Hegerty (2009) found negative effect of currency fluctuations on Mexican agricultural, textile, and clothing exports. The statistically significant positive effect of volatility on some industries is puzzling, because in most of other studies the positive coefficients are usually insignificant. This might be caused by detailed division of industries, which might capture effects that studies with broader groups of products might ignore.

Further theoretical explanations are provided by Broll & Eckwert (1999), who develop model of exchange rate uncertainty and trade. They show that the studied relationship depends on degree of relative risk aversion. The decreasing risk aversion leads to decrease of the negative effects of volatility on exports and for relative risk aversion smaller than unity the exports are shown to increase with rising volatility. Bredin *et al.* (2003) found positive effect of exchange rate volatility on Irish exports to EU countries. The possible explanation might be an increase in risk aversion with decreased exports. This will lead firms to export more to maintain their export earnings.

The following paragraphs will summarize the branch of literature focusing on effect of fixed exchange rates and currency unions on trade flows. This topic is related to both exchange rate misalignments and volatility, because pegging the currency removes the fluctuations and might result in exchange rate misalignments, if the peg is set at the incorrect level of exchange rate. This is closely related to the topic of the thesis, because CNB committed to maintain the exchange rate at 27 Czech koruna per euro or higher.

Klein & Shambaugh (2006) use dataset of 181 countries in the period 1973-1999 to study the effect of different exchange rate regimes. The authors intentionally use the period after the break-down of the Bretton-Woods system, because in the previous period the capital controls and pegged exchange rates were dominant. Their results show positive effect of direct pegs and currency unions on trade. The estimated increase of trade from pegging is 35%, which is large impact, but the authors argue that it might not be sufficient to offset the cost of fixing the exchange rate.

The meta-analysis by Rose & Stanley (2005) surveys the articles about the impact of currency union on trade. The meta-regression estimates 47% increase in trade, which is statistically significant after controlling for publication bias. The publication selection is present in this branch of literature, because the authors found statistically significant bias towards publication of positive trade effects. However, the authors stress that meta-analysis cannot distinguish between the authentic empirical effect and common systematic bias, which could be caused by common misspecification. Berger & Nitsch (2008) question the effect of adoption of euro and argue that the increase of trade attributed to the creation of the Economic and Monetary Union (EMU) is caused by the gradual trade integration between those countries. Their results show a significant effect of linear trend for EMU11 countries. They suggest that intra-EMU trade followed a similar pattern as their index of institutional integration. Moreover, the periods of increasing trade coincide with low exchange rate volatility, thus the adoption of euro could be seen as the last step towards internal exchange rate stability.

The theory presented above suggested a positive effect of reduced exchange rate volatility on the export performance of a country. On the other hand, the empirical studies show mixed results. Because the CNB pegged koruna to euro, the exchange rate volatility between euro area countries and the Czech Republic was zero. This observation leads to the second hypothesis of this thesis: "Rise in Czech exports to euro area will be higher than to other countries." Many empirical studies suggest a varying effect of reduced volatility across the export categories. Therefore, we state the hypothesis the third hypothesis: "The impact of interventions on exports varies across the export sectors."

2.2 Synthetic Control Method literature

This section summarizes the main studies of Synthetic Control Method and papers using this method on trade variables. The method tries to compare the unit (e.g. country or region) under some effect we want to study, with an artificially constructed unit of interest that is unaffected by it. This artificial comparison unit is constructed from other units which are not influenced by this effect, but are otherwise comparable to the original unit of interest.

The key study is Abadie & Gardeazabal (2003), which develops Synthetic Control Method. It evaluates the effect of terrorism in the Basque country on the economic performance of the region. Constructing the synthetic Basque

country from other Spanish regions, the results suggest that the GDP without the terrorist attacks would be 10% higher than the actual GDP between 1975 and 1997. Abadie *et al.* (2010) studies how the tobacco consumption was affected by the large-scale tobacco control program in California. The amount of purchased packs in year 2000 was lower by 26 packs per capita than it would be without the introduction of this program. The article was important from a methodological perspective, because it confirms the robustness of results by new inferential technique, which relies on iterative application of Synthetic Control Method on donor countries. This technique allows the researcher to determine whether the results were driven by chance or not.

Despite the popularity of Synthetic Control Method, its application in the international trade literature is relatively new. At first, we will summarize the studies using SCM on bilateral trade flows. Those studies focused mainly on the impact of trade agreements on bilateral exports and imports. Hosny (2012) was the first to use this method on bilateral trade flows. The study evaluates how the trade with Greater Arab Free Trade Agreement countries would developed, if Algeria decided to join the agreement at the time it was signed in 1998. The synthetic control was constructed from signatory countries of Greater Arab Free Trade Agreement and it employed the variables from gravity model as the covariates of SCM. If Algeria would have signed the agreement in 1998 rather than in 2005, its trade would increase with nine countries which constituted 96% of its pre-1998 trade.

Hannan (2016) uses SCM to study the effect of regional trade agreements signed between 104 bilateral pairs in the period between 1983 and 1995. The results show that the increases in gross exports for countries which signed a trade agreement were larger by 80% after 10 years since the agreement was signed as compared to the synthetic unit without the agreements. The gains were even larger for emerging economies which signed trade agreement with the developed ones. Additionally, he found that the trade diversion was limited in the sample and was relevant only for imports. The recent study by Hannan (2017) evaluates the impact of trade agreements on exports of Latin American countries in the period 1989-1996. The average gross exports increased by 76.4% in ten years after signing the trade agreement in comparison with average synthetic counterpart. Moreover, the study suggests that joining NAFTA had a much larger impact than membership in Mercosur or Group of Three. Also, the variation of export gains is shown to be relatively large across the trade agreements. Surprisingly, only 51% of Latin American countries showed export

gains after signing trade agreement which is much smaller than world average of 77%.

Demko & Jaenicke (2017) evaluate the effect of EU-US bilateral organic equivalency agreement on US exports of selected organic products. The agreement was signed in 2012 and EU and US were the largest organic markets at that time. The authors suggest that due to the agreement the organic exports of US to EU increased by 9.3% as compared to the synthetic unit constructed without the agreement. To my knowledge, this is the first study using SCM, which focuses on trade in a specific sector. During the observed period, US signed similar agreements with other states, which are excluded from donor pool. The specification of SCM is similar to the one used in articles surveyed above. However, authors in addition to the frequently used placebo test perform sensitivity analysis to the changes in matching criteria, alternative lengths of post treatment periods, and the start of the policy effect. The results of those alternative specifications suggest that their results are robust.

2.3 CNB's exchange rate commitment

Following paragraphs focus on studies using SCM to evaluate the impact of CNB's exchange rate commitment on various macroeconomic variables. Caselli (2017) evaluates the efficiency of CNB's exchange rate floor in preventing the deflation in the Czech Republic. The exchange rate commitment was effective in increasing inflation, because the actual inflation was higher by 0.4 to 1.1 percentage points than the synthetic series. The donor pool in this study consists of EU countries that are not members of eurozone. The resulting weights suggest that the best group of countries for the creation of synthetic unit is combination of Denmark, Slovakia, and Slovenia. Alternatively, if the countries that adopted the euro during the period were excluded, the best fit is obtained from the combination of Bulgaria, Croatia, and Denmark.

The results of Opatrný (2016) suggest a significant positive impact of interventions on unemployment, because the synthetic variable shows there would be 95 600 more unemployed people without the interventions. Also, the study found a statistically significant positive effect on GDP. The impact on HICP was statistically insignificant. The set of control units is broader than in the previous study and includes 22 European states.

Brůha & Tonner (2017) applied both DSGE and SCM model on macroeconomic variables of the Czech Republic. They confirm that the interventions

were effective in preventing the deflation. Other macroeconomic variables were positively affected, but the significance of effect is low for them. Among the variables is export growth for which they find a small positive effect that is on border of significance.

Other studies focusing on CNB's interventions include Malovaná (2015), who extended new keynesian DSGE model with foreign exchange dealers and occasionally binding constraints in order to assess the impact of exchange rate commitment. Her results show that commitment mitigated deflationary pressures and helped in the improvement of economic activity. Skořepa *et al.* (2016) focused on pass through of exchange rate commitment to inflation. They found out that the pass through of inflation from euro area was lower than initially expected by CNB. They identify three reasons that could cause imperfect pass through. The first is an initial overvaluation of koruna. The second is the assymetric effect of shocks on the euro area and the Czech Republic. The third reason might be that markets did not believe CNB that the commitment would persist. Franta *et al.* (2014) discussed reasons to adopt the exchange rate commitment and provides practical finding helpful for application of similar measures by other central banks. Moreover, they show that recovery from recession was faster than expected.

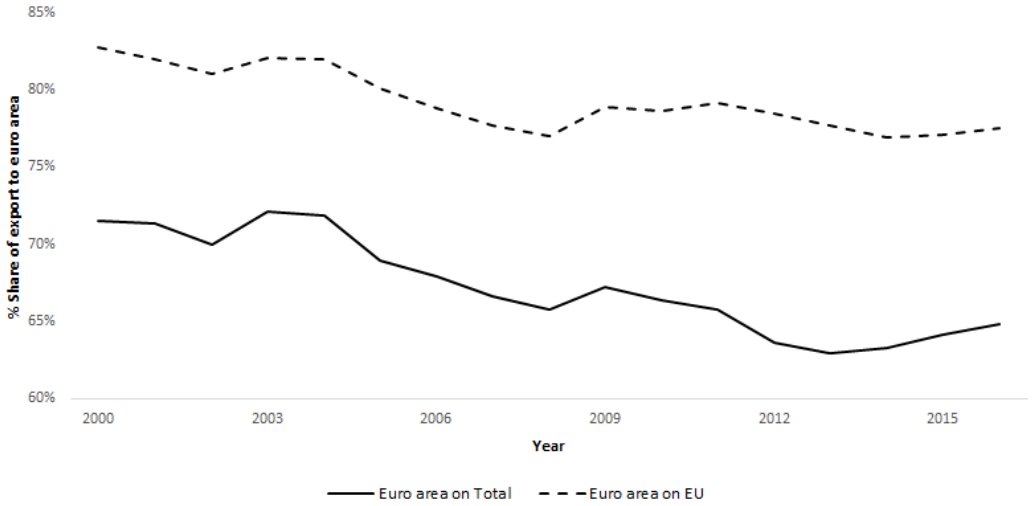
2.4 Overview of Czech exports

This section presents basic information about Czech exports, which should help the reader understand their geographical and sectoral structure. This is crucial, because the main goal is evaluating the effect of CNB's exchange rate commitment on Czech total and bilateral sectoral exports.

The euro value of Czech aggregate exports is presented in Figure A.1 (in the Appendix). The European Union is a crucial export destination for the Czech Republic as shown in Figure A.2. In the evaluation of hypotheses one and three, we will focus on exports to the euro area. There might be some positive effect of interventions on export to those countries, because from Figure 2.1 we see that their share increased following year 2013. More details about main destinations of Czech exports and its regional structure can be found in Tables A.1 and A.2.

Table A.3 shows importance of SITC categories in Czech exports. Machinery and Transport equipment, and manufactured goods and articles form more than 80% of them. Because theory suggests no or very small positive effect of

Figure 2.1: Share of euro area countries on Czech exports



Euro area on total shows percentage share of Czech exports to euro area on Czech total exports. Euro area on EU shows percentage share of Czech exports to euro area on Czech exports to EU.

reduced exchange volatility on more sophisticated products, we expect smaller impact of interventions on main export categories of the Czech Republic.

Chapter 3

Methodology

This chapter describes the methodology we use to evaluate the effect of CNB's interventions on exports. The first part of the chapter describes the general version of Synthetic Control Method. The second part presents the estimation strategy, which we will use for assessing the hypotheses. The third part shows the selection of covariates and donor pools we use in SCM for sectoral exports.

3.1 Synthetic Control Method

The model used in this thesis is based on the one developed in the paper of Abadie *et al.* (2010). The method of application of the model to the international trade is described in Hosny (2012). As the authors describe in their paper, Synthetic Control Method is useful for comparative case studies, where our main goal is to compare the units exposed to the event or intervention of interest with unaffected units. Such event should be large in magnitude relative to other factors. This idea suits well the goal of the thesis, because we want to explore the effect of exchange rate commitment of Czech National Bank on Czech sectoral trade flows. This policy fixed the exchange rate with major export destinations of the Czech Republic, thus the magnitude of the impact on exports should be large, if the theories explaining the link between exchange rate and international trade are correct.

SCM assumes there is $J + 1$ observed units. Without loss of generality, the intervention of interest occurs only in the first region. This region is exposed to the intervention continuously after certain starting period without the intervention. The remaining J units are usually referred to as donor pool, those are units which were not exposed to the event of interest and form a group

of potential controls. More details about the construction of the donor pool for this study are given later in this chapter. Y_{it}^N is the observed outcome in the absence of intervention for unit i and time t, where $i = 1, \ldots, J+1$ and $t = 1, \ldots, T$. $T_0 \in \langle 1, T)$ is the number of periods before the intervention. Y_{it}^I is the observed outcome for the unit i at the time t when the unit is exposed to the intervention in periods $T_0 + 1$ to T. The intervention is assumed to have no effect on the outcome before the period of implementation. To assure that there is no effect before the implementation T_0 could be defined so that it is the first period when the outcomes might react to the intervention. Under those assumptions $Y_{it}^I = Y_{it}^N$ for $t \in \{1, \ldots, T_0\}$ and $i \in \{1, \ldots, N\}$. The observed outcome for unit i in time t is $Y_{it} = Y_{it}^N + \alpha_{it} D_{it}$, where $\alpha_{it} = Y_{it}^I - Y_{it}^N$ denotes the intervention effect for unit i at time t and D_{it} is the indicator variable equal to one if at time t the unit i is affected by the intervention and zero otherwise. Under the assumptions we made earlier, D_{it} equals one for $i = 1$ and $t > T_0$, and 0 otherwise. The effect of interest is α_{1t} for $t > T_0$. Y_{1t}^I is observed and Y_{1t}^N needs to be estimated in order to obtain the effect of interest. Y_{it}^N is assumed to be determined by the following factor model:

$$Y_{it}^N = \delta_t + \theta_t \mathbf{Z}_i + \lambda_t \mu_i + \epsilon_{it} \tag{3.1}$$

Where δ_t is an unknown common factor, Z_i is a vector of observed covariates, which were not affected by the treatment, θ_t is a vector of unknown parameters, λ_t is a vector of unobserved common factors, μ_i is the vector of unknown factor loadings and ϵ_{it} is the error term. The synthetic control is constructed as a weighted average of units from donor pool, the vector of weights $\mathbf{W} = (w_2, \ldots, w_{J+1})'$ satisfying $w_j \geq 0$ for $j = 2, \ldots, J+1$ and $w_2 + \ldots + w_{J+1} = 1$ is defined. These assumptions on weights are imposed to avoid extrapolation outside of the donor pool. As Abadie *et al.* (2010) point out, each of the possible vectors $\mathbf{W}$ is representation of potential synthetic control. The outcome variable for each synthetic control indexed by $\mathbf{W}$ is

$$\sum_{j=2}^{J+1} w_j Y_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j \mathbf{Z}_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \epsilon_{jt} \tag{3.2}$$

Assuming that optimal weights $(w_2^*, \ldots, w_{J+1}^*)$ exist, then the following equations are satisfied:

$$\begin{aligned} &\sum_{j=2}^{J+1} w_j^* Y_{j1} = Y_{11}, \qquad \sum_{j=2}^{J+1} w_j^* Y_{j2} = Y_{12}, \ldots, \\ &\sum_{j=2}^{J+1} w_j^* Y_{jT_0} = Y_{1T_0}, \quad \textit{and} \quad \sum_{j=2}^{J+1} w_j^* \mathbf{Z}_j = \mathbf{Z}_1 \end{aligned} \tag{3.3}$$

Then, we could use the following equation as the estimator of the treatment effect:

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt} \tag{3.4}$$

for $t \in \{T_0 + 1, \ldots, T\}$. The optimal set of weights is in practice chosen so that the set of equations 3.3 holds only approximately, because there might not be any set of weights assuring that equations hold exactly given the data. The optimal vector w^* minimizes the distance $\|\mathbf{X}_1 - \mathbf{X}_0\mathbf{W}\|$, where $\mathbf{X}_1 = (\mathbf{Z}'_1, \bar{Y}_1^{\mathbf{K}_1}, \ldots, \bar{Y}_1^{\mathbf{K}_m})'$ represents the characteristics of the treated unit before the intervention and $\mathbf{X}_0$ contains the pre-intervention characteristics of the control units. The column j of $\mathbf{X}_0$ has the following form $(\mathbf{Z}'_j, \bar{Y}_j^{\mathbf{K}_1}, \ldots, \bar{Y}_j^{\mathbf{K}_m})'$.

Because the traditional inferential techniques are inappropriate for synthetic controls estimates, the following paragraph provides overview of inferential methods used in SCM literature to confirm validity of results. First method called placebo or falsification test is used by Abadie *et al.* (2010). This method has two variations. We could either vary the units and use the Synthetic Control Method on each unit in the donor pool. Then, we compare whether the impact of treatment for the treated region is large in comparison with synthetic unit for non-treated regions. In optimal case, we want to have a large effect for the treated region and small for the untreated ones. If the differences are small, then the effect of the treatment is probably low. In the second variation, we vary the time of the intervention and recalculate synthetic control method for more time periods. If we observe similar impact of another time period similar to the time of the intervention, we should be suspicious about our results, given that there was no similar intervention to the one which we study. To use this test, we should have sufficiently long period without shocks to use the placebo test with changes of a time period as suggested by Abadie *et al.* (2015). Additionally, the data in some categories are very volatile so the fit might vary significantly based on last observed exports. To verify the robustness of the results, Demko & Jaenicke (2017) add more variables into their model to verify

that they take into account all relevant factors influencing agricultural exports. This thesis uses a similar approach as we will construct synthetic controls with several specifications of the model. The specifications we consider are defined in the following sections of this chapter.

3.2 Estimation strategy

For each SITC category, we start by using SCM on total sectoral exports. The results will tell us whether the CNB's commitment had a positive effect on them as expected by first hypothesis. Then, we will evaluate the results of SCM for total sectoral exports to euro area and non-euro area countries. If the increase of exports is higher for the euro area, then the second hypothesis would be corroborated for given category. In both cases, we will use the results of all specifications described in Table 3.1 to assess the validity of hypotheses and robustness of results. Once we have all results, we could see whether the impact of interventions varied across sectors and evaluate the third hypothesis.

As complement to analysis on total sectoral data, we use SCM on bilateral sectoral exports. The main reason to consider them is robustness, because most of international trade research focused on bilateral data. Therefore, there is better theoretical background for them. For each SITC category, we will provide results for main export destinations. They are the EU countries whose share on Czech exports in given category over the period 2000-2016 was 2% or more. In evaluation of results, we will use the specifications (1) and (2) from Table 3.2. Other specifications control for the robustness of results. Also, we use SCM with covariates from specification (1) and donor pool constructed by Euclidean distance to check whether our results are sensitive to altering the donor pool.

To confirm the robustness of all results, we will use the placebo study for changing the unit of interest. This will show us whether the effect of interventions was large or not. Because this is most frequently used form of placebo study, we will call it simply placebo study. In the placebo study where the time of intervention changes, we will use a similar approach as Opatrný (2016), who chooses first quarter of 2010 as a new period of interventions. Because the datasets used in this thesis do not have very long preintervention periods, this test serves only as supplementary robustness check.

3.3 Selection of covariates and donor pool for sectoral exports

As mentioned in the first part of this chapter, we need a suitable set of covariates for SCM to construct synthetic outcome variable. The choice of such sets of covariates for total and bilateral sectoral exports is described in following paragraphs. The sources of data for those covariates are provided in Chapter 4.

3.3.1 Selection of covariates for SCM of total sectoral exports

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To my knowledge, there was no attempt to use SCM on total sectoral exports. Therefore, unlike in the case of bilateral trade flows there is no SCM literature suggesting potential covariates suitable for the model. From literature studying the aggregate exports, we will borrow the covariates for the base specification of the model. Redding & Venables (2004) provide the simple model explaining the country's export performance and UNCTAD (2005) extend this model further with additional variables. The covariates we will use are GDP and Population for measuring the size of the country. Foreign Market Access (FMA) measures the market capacities of the rest of the world weighted by the accessibility of the trade partners (bilateral distances and other similar measures). Its calculation is described further in this section. The institutional variables are used as an additional factor capturing the comparative cost of exporting across the countries. UNCTAD (2005) suggests using index from Country risk guide for measuring the risk of expropriation and labour market institutions index to reflect the labour costs. Real exchange rate, which is frequently used in modelling aggregate exports, captures macroeconomic environment. The share of Foreign Direct Investments on capital is used as a proxy for technological environment and imports of new technologies from other countries.

In order to confirm the robustness of the results, we consider two additional specifications with more covariates. Additionally, the results for those specifications will show whether the new variables are helpful in explaining total sectoral exports. The macro specification adds unemployment and Harmonized Index of Consumer Prices (HICP) as new covariates in order to have a broader range of country's macroeconomic performance indicators. In the institutions specification, we use the covariates from macro specification and add the Economic freedom of the world indices. Also, the infrastructure variables such as

share of individuals using the internet or telephone subscriptions are added. Table 3.1 gives overview of variables used in each specification.

Table 3.1: Aggregate exports – Covariates

Base	Macro	Institutions
GDP	GDP	GDP
Population	Population	Population
Foreign market access	Foreign market access	Foreign market access
Country risk index	Country risk index	Country risk index
Labour market index	Labour market index	FDI share
FDI share	FDI share	Real exchange rate
Real exchange rate	Real exchange rate	HICP
	HICP	Unemployment
	Unemployment	Size of government
		Legal system
		Sound money
		Freedom to trade
		Regulation
		Broadband subscriptions
		Internet share
		Telephone subscriptions

We follow approach of Redding & Venables (2004) in construction of FMA. As mentioned earlier, the export capacity of partner country is weighted by distance and border effects both used as measures of export destination accessibility. The equation below shows the computation of FMA:

$$FMA_i = \sum_{i \neq j} e^{\hat{\lambda} I_j} dist_{ij}^{\hat{\gamma_1}} e^{\hat{\gamma_2} contig_{ij}} \tag{3.5}$$

The I_j is an indicator variable equal to 1 for country j and 0 otherwise. Where coefficients λ, $\hat{\gamma_1}$,$\hat{\gamma_2}$ are retrieved from the following regression:

$$ln(X_{ij}) = \alpha + \lambda I_j + \beta I_i + \gamma_1 ln(dist_{ij}) + \gamma_2 contig_{ij} + u_{ij} \tag{3.6}$$

Where X_{ij} is the value of exports from i to j and u_{ij} is the stochastic error.

3.3.2 Selection of covariates for SCM of bilateral sectoral exports

To evaluate the effect of exchange rate commitment on exports to main Czech destinations, we need suitable independent variables explaining the bilateral sectoral exports. Hosny (2012) suggests using covariates similar to the regressors from the gravity model which is used widely in literature explaining the nature and development of bilateral trade flows. The name of the gravity model is based on the fact that it resembles the Newton's law of gravity, because the trade between the countries is proportional to the GDP of exporting and importing country (economic "mass" of the countries) and inversely related to the distance between the countries. The relationship is based on the notion that larger countries will trade more with each other, but the distance between them increases the costs and discourages the trade. The model was further expanded with additional variables that could be useful in explaining bilateral trade flows.

We will borrow the covariates from Hannan (2016), who uses gravity variables in his SCM model explaining the effect of trade agreements on exports. This specification is denoted as (1). Because inclusion of lagged variable of interest is not standard in studies using SCM, we consider specification that excludes lagged exports (denoted as (2)). Francois & Manchin (2013) show that institutions and infrastructure have significant effect on bilateral exports, thus we expand the previous specifications with them and denote this specification as (3). However, we should be careful what variables are included in the gravity model, because study of Anderson & Van Wincoop (2003) showed that use of variables without foundations in economic theory leads to biased estimates and incorrect comparative statistics in that model. In our case, it might cause incorrect construction of synthetic counterpart. To avoid this, we consider specification (4) which includes the key variables which are distance between the bilateral trade pair, GDP of the exporting country, importer expenditures, and proxy variables for multilateral trade resistance of both exporter and importer, real exchange rate, and institutions. For more details about the specifications, see Table 3.2.

The multilateral trade resistance terms, which is mentioned in the previous paragraph, captures the cost of exports to foreign market. Yotov *et al.* (2016) suggest using remoteness indices as one of the alternatives to capture the multilateral trade resistance. Hannan (2016) used remoteness indices as covariates

in his SCM model explaining the effect of trade agreements on exports. The equation of remoteness index we use is following:

$$REM_{i,t} = \sum_{j} \frac{Y_{jt}}{Y_t} DIST_{ij} \tag{3.7}$$

Where $REM_{i,t}$ is the remoteness of the country i at the time t, $DIST_{ij}$ is the distance between the countries i and j, Y_{jt} is the GDP of country j at time t and Y_t is the world's GDP at time t. From the definition follows that countries far from big economies have a large remoteness index.

3.3.3 Selection of donor pool

The donor pool we use for SCM on total sectoral exports consits of European Union members excluding Cyprus and Malta, because of the small size of their economies and limited data availability for those countries. They were excluded for similar reasons by Opatrný (2016).

For the bilateral sectoral exports, we will use two alternative strategies for donor pool construction from the EU countries. This is done to avoid inclusion of dissimilar trade pairs, which leads to incorrect results of SCM caused by interpolation bias. Additionally, computational difficulties are encountered when using the large donor pool. The baseline strategy to choose suitable counterparts will be based on their similarity to export origins and destinations. The choice of origin will be driven by the similarity to origin of interest which is in all cases the Czech Republic. We will focus mainly on similarity in terms of GDP, population, location of the country, and historical development (e.g. being part of the Eastern Bloc). Moreover, in cases where the destination is neighbouring country, we will include its neighbours as additional origins, because studies of bilateral exports frequently found a significant realtionship between trade and contiguity. The pool of destinations includes the destination country from the treated trade pair and countries sharing similar characteristics as described above for origins. In case of neighbouring countries, the states contiguous to the neighbours of the destination country. In case of large countries with many neighbours, we will exclude countries that are very dissimilar. Detailed description of origins and destinations for treated trade pairs is provided in Table A.4. We will use Euclidean distance as an alternative method to find trade pairs with characteristics similar to the treated pair and construct the donor

Table 3.2: Bilateral exports – Covariates

(1)	(2)	(3)	(4)
Distance	Distance	Distance	Distance
GDP origin	GDP origin	GDP origin	GDP origin
GDP destination	GDP destination	GDP destination	GDP destination
GDP per capita origin	GDP per capita origin	GDP per capita origin	Real Exchange rate
GDP per capita destination	GDP per capita destination	GDP per capita destination	Remoteness origin
Population origin	Population origin	Population origin	Remoteness destination
Population destination	Population destination	Population destination	Contiguity
Real Exchange rate	Real Exchange rate	Real Exchange rate	Common currency
Remoteness origin	Remoteness origin	Remoteness origin	EFW index origin
Remoteness destination	Remoteness destination	Remoteness destination	EFW index destination
Contiguity	Contiguity	Contiguity	Internet share origin
Common currency	Common currency	Common currency	Internet share destination
Trade value (t-1)		EFW index origin	Telephone subscriptions origin
		EFW index destination	Telephone subscriptions dest.
		Internet share origin	
		Internet share destination	
		Telephone subscriptions origin	
		Telephone subscriptions dest.	

pool from them. We use all variables from given specification to calculate the Euclidean distance for given pair.

Chapter 4

Overview of data

For the analysis of total sectoral exports, we use quarterly data in the period between 2005 and 2016. The observed period was restricted by availability of Foreign Direct Investments and infrastructure indicators before 2005. The period ends in 2016, because the institutional indicators for the subsequent years were unavailable. In the analysis of Czech exports on a bilateral level, we use yearly data in the period 2000-2016. The year 2000 is chosen as a starting period,because it was the last year of recession following the currency crisis in the Czech Republic. The year 2016 is the last year for similar reasons as in the previous case.

The variable of interest is the value of Czech exports expressed in millions of euros. The data for both total and bilateral sectoral exports were obtained from Eurostat. The quarterly total sectoral exports are deseasonalised. The macroeconomic data and population statistics are retrieved from Eurostat as well. Economic freedom of the world indicators were obtained from the website of the Fraser institute[1]. Political risk index was obtained from website of World Bank[2] which took it from International Country Risk Guide published by Political Risk Service. The infrastructure variables were obtained from World development indicators available in World Bank databases. Institutional and infrastructure variables are available only on a yearly basis, therefore we used the value for a given year in each of its quarters. This is a reasonable assumption, because we focus on EU members, which are developed countries with stable institutions. The bilateral distances, contiguity, and other variables for bilateral pairs were obtained from GeoDist and Gravity datasets available at

[1] https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=0

[2] https://info.worldbank.org/governance/wgi/pdf/prs.xlsx

websites of CEPII[3]. To measure distances we use population weighed averages of distances between the agglomerations. The bilateral exchange rate data were obtained from the World Bank databases.

[3] http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp

Chapter 5

Estimated effects of CNB's exchange rate commitment on exports

This chapter presents the results of empirical analysis, which studied the influence of CNB's interventions on Czech exports. The chapter is divided into ten parts, one for each SITC category. In each part, we will start with the results for aggregate exports in given category, then we evaluate the difference between the impact of interventions on euro area and non-euro area countries. The part is concluded by assessing the effect of CNB's commitment on exports to main destinations. Due to the large quantity of results, placebo studies for sectoral exports to euro area and outside are presented in Appendix A. The same is true for results from bilateral sectoral exports to main destinations. Presented results of placebo studies show only donors with mean squared prediction error in the preintervention period, that is at most five times higher than for Czech exports. Other specifications and robustness checks, which we defined in Chapter 3 and use in evaluation of CNB's interventions' impact on exports are available in electronic sources appended to the thesis.

5.1 SITC category 0

The following paragraphs will describe the exports of the Czech Republic in the SITC Category 0 – Food and live animals. The total exports in this category increased as a result of the interventions. This is visible from Figures 5.2(a) and 5.2(b), where for both dispalyed sets of explanatory variables, the synthetic

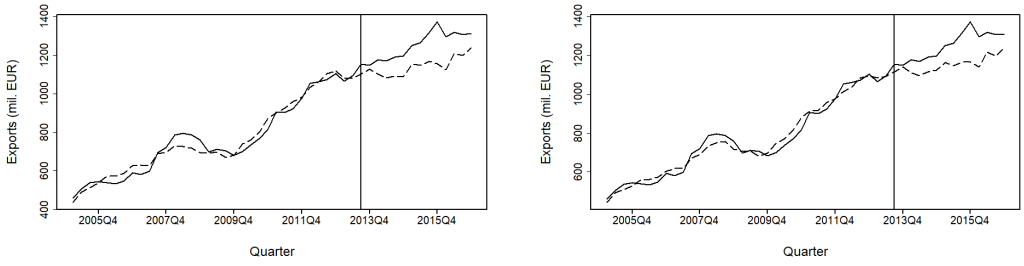
exports are below the real ones. The effect of interventions took place almost immediately, because the lines start to diverge after the first postintervention period and the effect increases over time until the end of year 2015. In the base specification, all of the variables except FMA and Country risk had similar importance. The main donor countries are Spain, Romania, Latvia, Greece, and Denmark. Here stands out the share of Spain of 85.6%. This is confirmed by other model specifications where it has also very large shares. The development of exports across the specifications is almost unchanged and they vary only slightly in terms of effect's size and timing. The placebo study confirms that this effect is not a random occurrence, because it is much higher than for other countries as could be seen in Figures 5.2(d) and 5.2(e). Also, the results seem to be quite robust to shifting the start of postintervention period. The shifting of preintervention period start to the first quarter of 2010 resulted in divergence between the synthetic and actual exports, but the effect has a much higher magnitude in the real postintervention period.

Table 5.1: Category 0 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	21.20%	67.36%	0.01%
Population	13.60%	4.27%	0.03%
Foreign market access	1.62%	2.14%	10.56%
Country risk index	6.86%	9.28%	1.28%
Labour market index	18.22%	0.03%	
FDI share	20.11%	5.13%	2.37%
Real exchange rate	18.39%	9.87%	30.62%
HICP		0.00%	10.07%
Unemployment		1.92%	1.45%
Size of government			1.26%
Legal system			4.78%
Sound money			1.79%
Freedom to trade			8.11%
Regulation			15.83%
Broadband subscriptions			0.02%
Internet share			2.35%
Telephone subscriptions			9.47%

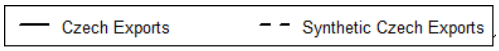
Synthetic exports to euro area countries are relatively close to observed exports and placebo study confirms this. There seems to be a positive effect on exports to countries outside the euro area, because the synthetic counterpart is below the unit of interest. However, the size of effect immediately after the

Figure 5.1: Czech exports – Category 0

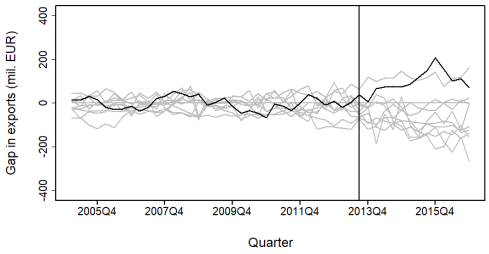


(a) Base

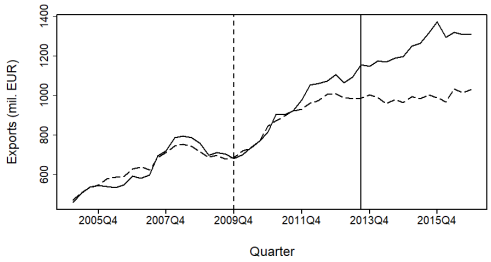
(b) Institutions



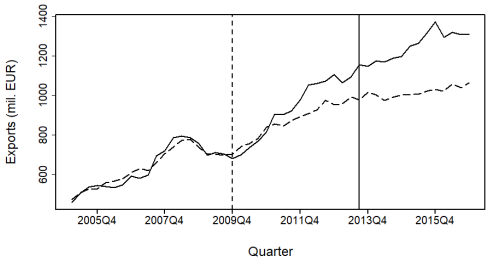
(d) Base – Placebo study



(e) Institutions – Placebo study



(g) Base – Time sensitivity



(h) Institutions – Time sensitivity

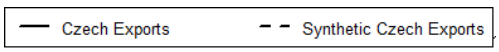
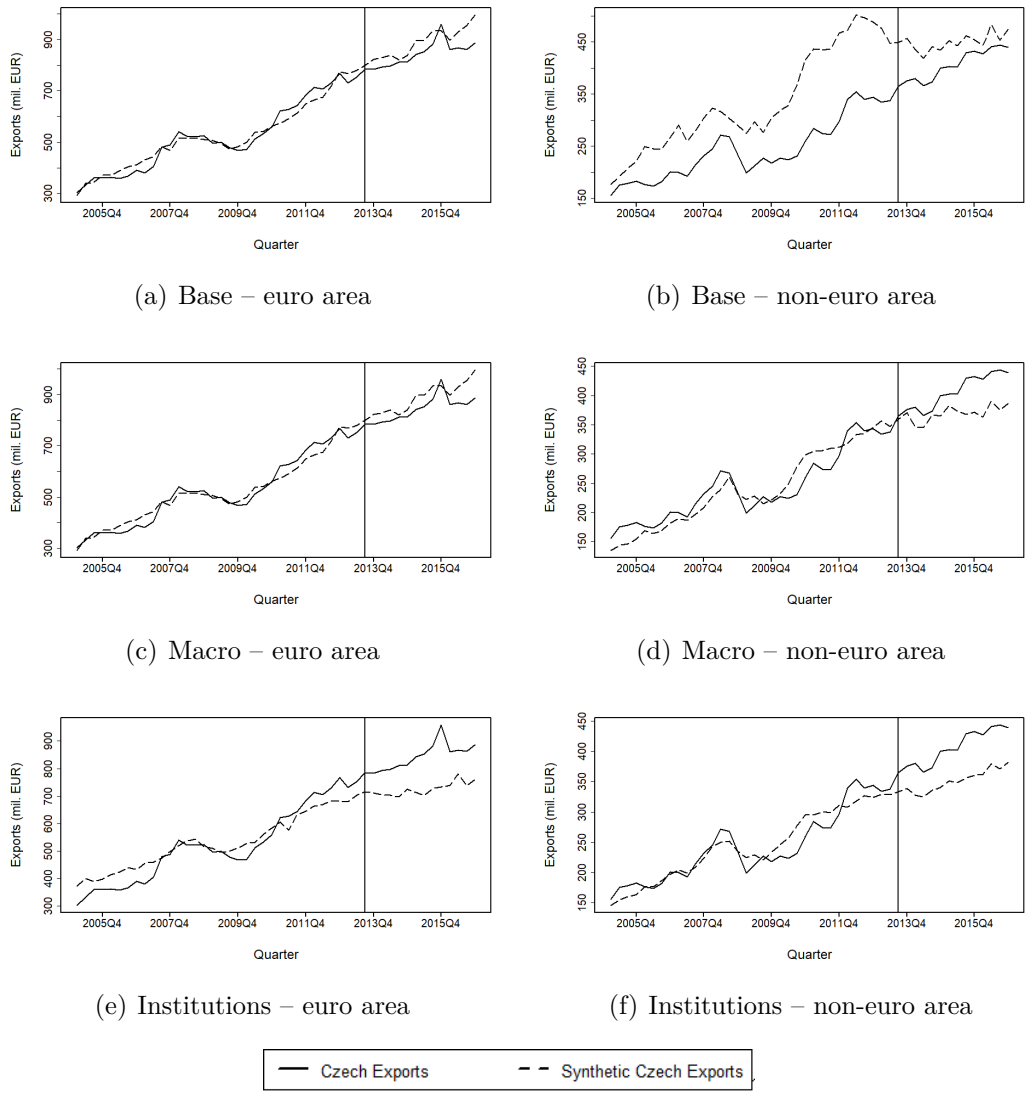


Table 5.2: Category 0 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.08%	25.67%	18.35%
Belgium	0.51%	0.00%	0.00%
Bulgaria	0.00%	31.80%	14.40%
Croatia	0.01%	1.18%	0.00%
Denmark	1.26%	0.02%	0.00%
Estonia	0.02%	0.00%	0.00%
Finland	0.02%	0.00%	0.00%
France	0.01%	0.00%	0.00%
Germany	0.05%	0.02%	0.00%
Greece	1.04%	0.00%	0.00%
Hungary	0.01%	0.00%	0.00%
Ireland	0.03%	0.00%	0.00%
Italy	0.08%	0.00%	0.00%
Latvia	1.08%	0.00%	0.00%
Lithuania	0.08%	0.00%	0.00%
Luxembourg	0.04%	0.00%	0.00%
Netherlands	0.03%	0.92%	3.89%
Poland	0.05%	0.00%	0.00%
Portugal	0.13%	0.01%	0.00%
Romania	9.81%	0.00%	8.10%
Slovakia	0.01%	0.00%	0.00%
Slovenia	0.04%	0.00%	0.00%
Spain	85.58%	40.38%	55.25%
Sweden	0.02%	0.00%	0.00%
United Kingdom	0.02%	0.00%	0.00%

start of interventions is dependent on the model specification and the placebo study shows that it is close to the effects on donor pool for a large part of the postintervention period. The overall positive effect of interventions on exports of food and animals is driven by increase for non-euro area countries. This is surprising, because empirical findings in other studies show positive effect of fixed exchange rate on exports. The results are displayed in Figure 5.2.

Figure 5.2: Category 0 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

The synthetic Czech exports to the main trade partner, the Slovak Republic, decreased as a result of the interventions. The effect is very strong in 2014, because the placebo study shows it is much larger compared to other donors. The effect in subsequent years varies among specifications, in the specification

(1) it is relatively small. The results are reliable, because they show low sensitivity to change in preintervention period. The synthetic exports to Germany are very close to real exports. The fit in the preintervention period is not particularly good. The results of the placebo study show that the effect for the remaining donors is much higher. Thus, interventions did not have any effect on exports to Germany in this category. The synthetic exports to Poland fluctuate around the true ones. The placebo study confirms large negative effect of interventions in 2013, while the differences in the following years are close to effects on other pairs. Setting the start of the postintervention period to 2010 had almost no effect in most specifications. The interventions had a small positive effect on exports to Austria in 2014, which is likely insignificant, because the size of the effect is comparable to the rest of the donor pool in the placebo study. There was no effect in the following years. The exports to Hungary were most likely unchanged, because the effects across all specifications are small and close to the size of fluctuations in the preintervention period. Although, there is a large difference between synthetic and treated unit for Italy after 2013, the poor preintervention fit in combination with results of placebo study suggest no effect of CNB's actions. The fit for the United Kingdom is poor in most specifications, but the results from specification (3) suggest no effect. The synthetic exports to France are above the observed ones and the gap increases over time. This suggests a significant negative effect of interventions. The exports to Romania follow the same pattern. For both countries, placebo study confirms the significance of the effect. The synthetic exports to the Netherlands closely follow the true ones, therefore interventions had no effect on this bilateral pair.

The share of main export partners on total exports in this category over the whole observed period is 63.4%. The findings seem to be consistent with the results for total exports and the euro area countries, because there was no or slightly negative effect and most of the countries with negative effect were from this area. There is no strong evidence supporting the positive impact on non-euro area destinations, because the Hungary and United Kingdom were unaffected, and exports to Poland and Romania were affected negatively.

5.2 SITC category 1

In this paragraph, we will provide the results for Czech synthetic exports in the SITC Category 1 – Beverages and tobacco. The results from SCM suggest

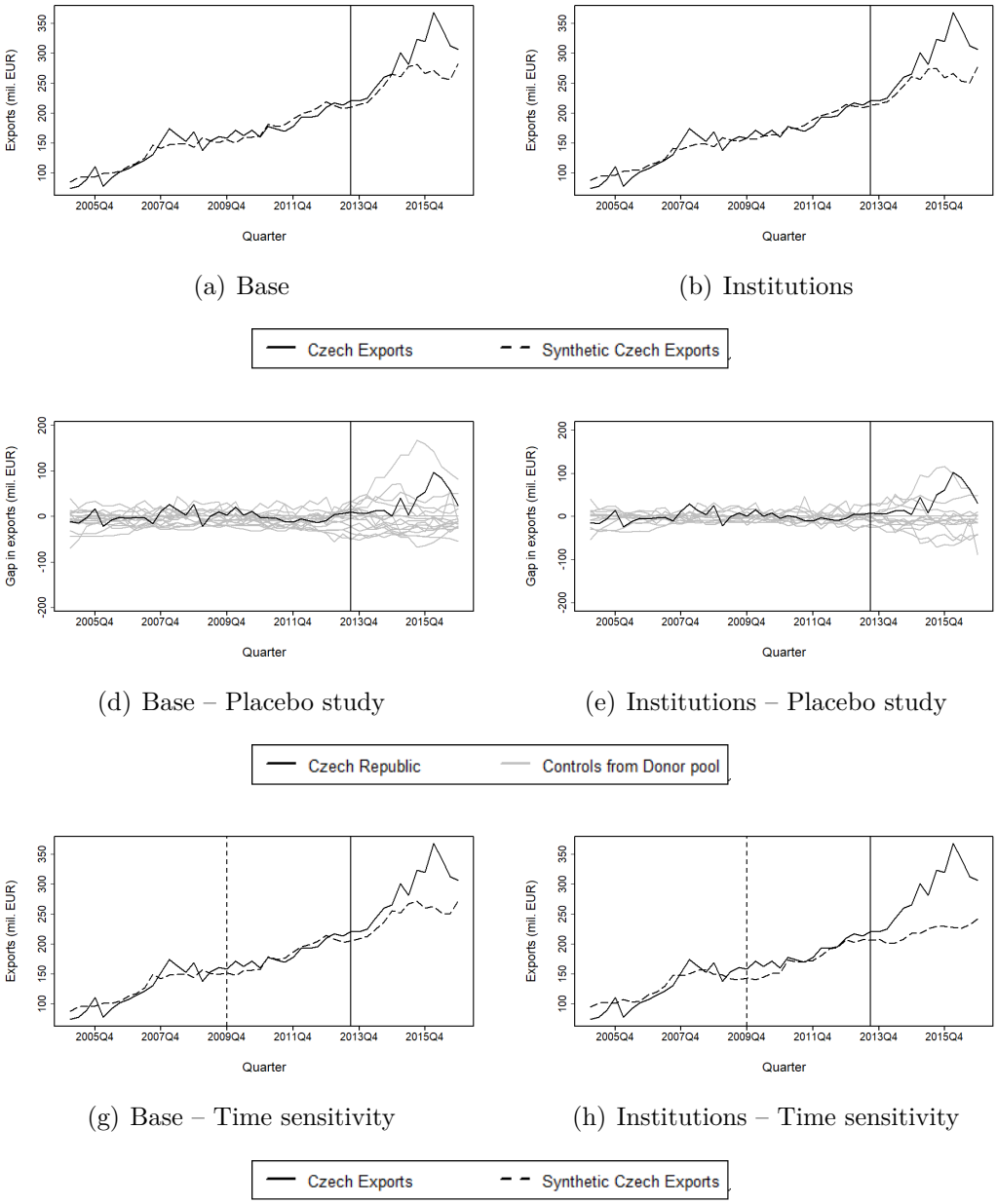
positive effect of the CNB's exchange rate commitment on Czech exports in this category. The large positive effect on export is visible from year 2015. Relatively long period of time between the start of interventions and the effect suggests that it could be caused by some other events. The most important explanatory variables in the base model were country risk index, population, and labour market institutions index in that order. For the weights in other models see Table 5.3. The countries with the largest share are Spain, Romania, and Belgium. Similarly to the previous category, the share of Spain is much higher than shares of other countries. For more details see Table 5.4. The results are similar among all considered combinations of explanatory variables. The placebo study suggests that the interventions truly had an effect on exports in this category, because only one country has larger effect as could be seen in Figure 5.3. Changing the beginning of the interventions seems to have no effect on the synthetic counterpart. The synthetic exports follow closely the true ones for most of the preintervention period and the positive effect on export starts at the same time as with the preintervention period ending in the third quarter of 2013.

Table 5.3: Category 1 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	13.03%	66.14%	1.55%
Population	20.92%	17.19%	2.69%
Foreign market access	6.74%	2.84%	2.67%
Country risk index	21.50%	4.69%	5.49%
Labour market index	19.96%	3.21%	
FDI share	10.88%	1.02%	9.31%
Real exchange rate	6.97%	4.80%	12.66%
HICP		0.11%	6.38%
Unemployment		0.00%	1.37%
Size of government			6.38%
Legal system			3.60%
Sound money			2.79%
Freedom to trade			19.03%
Regulation			12.42%
Broadband subscriptions			9.25%
Internet share			4.38%
Telephone subscriptions			0.02%

The exports to euro area countries follow very similar pattern as the total. The synthetic counterpart shows positive effect starting in the third quarter of

Figure 5.3: Czech exports – Category 1



(a) Base

(b) Institutions

(d) Base – Placebo study

(e) Institutions – Placebo study

(g) Base – Time sensitivity

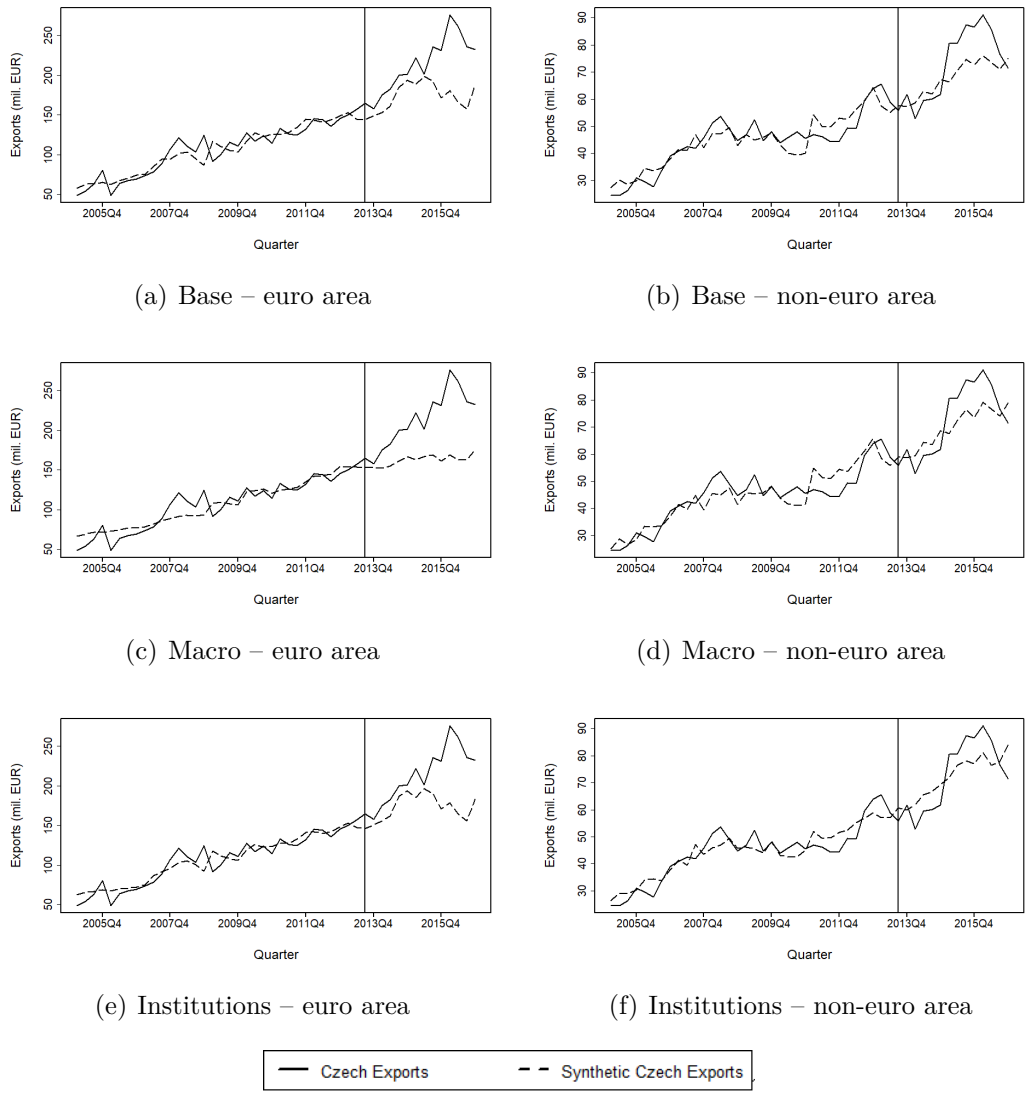
(h) Institutions – Time sensitivity

Table 5.4: Category 1 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.00%	0.00%	0.00%
Belgium	13.98%	14.40%	10.19%
Bulgaria	0.00%	0.00%	10.89%
Croatia	0.00%	0.00%	0.00%
Denmark	0.00%	0.00%	9.47%
Estonia	0.00%	0.00%	0.00%
Finland	0.00%	0.00%	0.00%
France	0.00%	0.00%	0.00%
Germany	0.00%	0.01%	0.01%
Greece	0.00%	0.00%	0.00%
Hungary	0.00%	0.00%	0.00%
Ireland	0.00%	0.00%	0.28%
Italy	0.00%	0.00%	0.00%
Latvia	0.00%	0.00%	0.00%
Lithuania	0.00%	0.00%	0.00%
Luxembourg	0.00%	0.00%	0.00%
Netherlands	0.00%	0.00%	0.06%
Poland	0.00%	0.00%	0.00%
Portugal	0.00%	0.00%	0.00%
Romania	15.43%	14.49%	15.54%
Slovakia	0.00%	0.00%	0.00%
Slovenia	0.00%	0.00%	0.00%
Spain	70.59%	71.09%	39.33%
Sweden	0.00%	0.00%	14.22%
United Kingdom	0.00%	0.00%	0.00%

2015. Placebo study confirms the size of the effect, which is higher and less volatile than for the remainder of the donor pool. The gap between synthetic counterpart and unit of interest for countries outside the euro area follows a similar pattern, but the relative increase depends on model specification. Moreover, the size of the effect is close to gaps in preintervention periods. More details are available in Figure 5.4. The results confirm the positive effect of CNB's commitment on exports of beverages and tobacco, which could be attributed to higher flows to euro area. The findings contradict the results of previous category and serve as additional evidence for positive effect of fixed exchange rates on exports of primary goods.

Figure 5.4: Category 1 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

The exports in this category are relatively small and for many trade partners they were very volatile during the observed period. The exports to Slovakia slightly increased after the interventions and the positive effect lasted until 2015. The significance of the effect is confirmed by the placebo study, where the gap is much larger than for most of the donors. This is derived from results of specification (1), because other suffer from the poor fit. The synthetic exports to Italy are close to the observed ones after the start of interventions and only after 2015 there is a positive effect, but with such lag it is improbable that it is caused by interventions. The specification (1) shows the negative effect directly after interventions, but other specifications do not support this. The interventions had a negative effect on exports to Germany. Large gap between treated and synthetic unit in the placebo study confirm the significance of this result. Sensitivity to preintervention period change shows a very large increase following the new start of the interventions. Thus, the effect might be overestimated, because models seem to overpredict the synthetic export to this destination. The synthetic unit for Poland is above the treated one, but the size of the effect is only slightly higher than gaps in the preintervention period. Moreover, the placebo study shows that it does not differ from the impact on donors. The synthetic exports to the United Kingdom are much higher than the observed ones. However, the increase in the postintervention period might be some anomaly, because the exports increased only until 2008 and started to decline slowly afterwards. The interventions had a positive effect on exports to Hungary, which is visible from the large difference between observed and synthetic exports. The observed exports to France risen sharply after the interventions, while the synthetic ones remained low. This suggests a large effect of interventions for this trade partner. The results suggest a large negative effect on exports to Sweden, supported by results of placebo study showing much larger gap compared to donors. However, the findings are not reliable due to poor preintervention fit and sensitivity to changes of intervention timing. The interventions had no impact on exports to Austria, because the differences are small compared to their volatility in preintervention period. The observed exports to Belgium are much higher than synthetic ones, but it is likely unrelated to interventions, because it starts in 2015 and we observe similar effects in the placebo study for donors.

There is a very high share of the main trade partners in this category as they account for 80.6% of total exports in the period 2000-2016. The results from individual export destinations confirm the positive effect on Czech exports

observed on the total exports in this category. Additionally, most of the countries positively affected by the interventions were from the euro area, which confirms the findings from the previous paragraph.

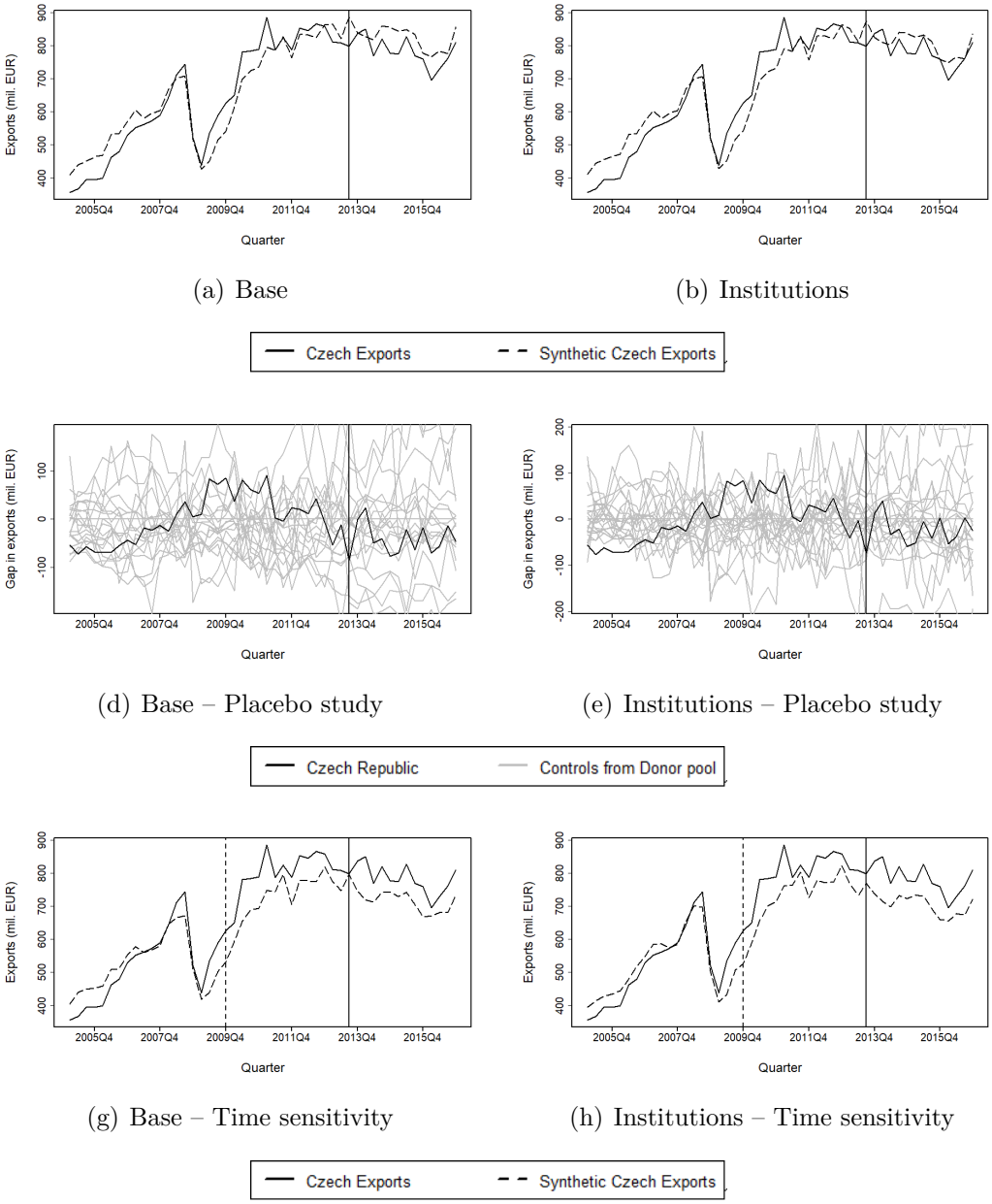
5.3 SITC category 2

The following paragraphs focus on the exports in the SITC Category 2 – Crude materials, inedible, except fuels. The Czech exports in this category were unaffected by the exchange rate commitment, because the synthetic exports are close to the observed exports for the whole postintervention period. The most important explanatory variables for construction of synthetic counterpart were FDI share, Country risk index, and Foreign market access. The results for other specifications are provided in Table 5.5. The Table 5.6 summarizes the weights of the donors in the construction of synthetic counterpart. For most specifications, Spain and Romania had more than 40% weight in the model. Belgium is the only other country with significant share. The results of the placebo study confirm that interventions did not have any effect, because the gap between real and synthetic exports is not larger than for other countries from the donor pool. The results show only a small degree of sensitivity to shifting the start of the intervention period. This change caused a slight downward shift of the synthetic exports across all specifications, but the difference from the observed exports is very small and stable over time.

There might be a slightly negative effect on exports to euro area following the interventions, because the synthetic counterpart is above the treated unit. The size of the effect varies depending on specification. Due to large volatility, the placebo studies are not very helpful, but in cases where the impact is relatively large, they show that the gap is larger than for most of the countries in the donor pool. The synthetic exports are lower than the observed ones for non-euro area countries. Placebo study confirms the positive effect of interventions. The results are summarized in Figure 5.6. Combining the positive and negative effect yields no impact on the Czech exports in this category. The findings for euro area contradict the empirical findings of positive effect of lower volatility on exports in primary products. The positive effect for non-euro area countries could be attributed to undervalued currency.

The interventions had a negative effect on Czech exports to Germany, because the synthetic exports are above the observed ones. Observed differences for treated unit were much larger compared to those of donors in the placebo

Figure 5.5: Czech exports – Category 2

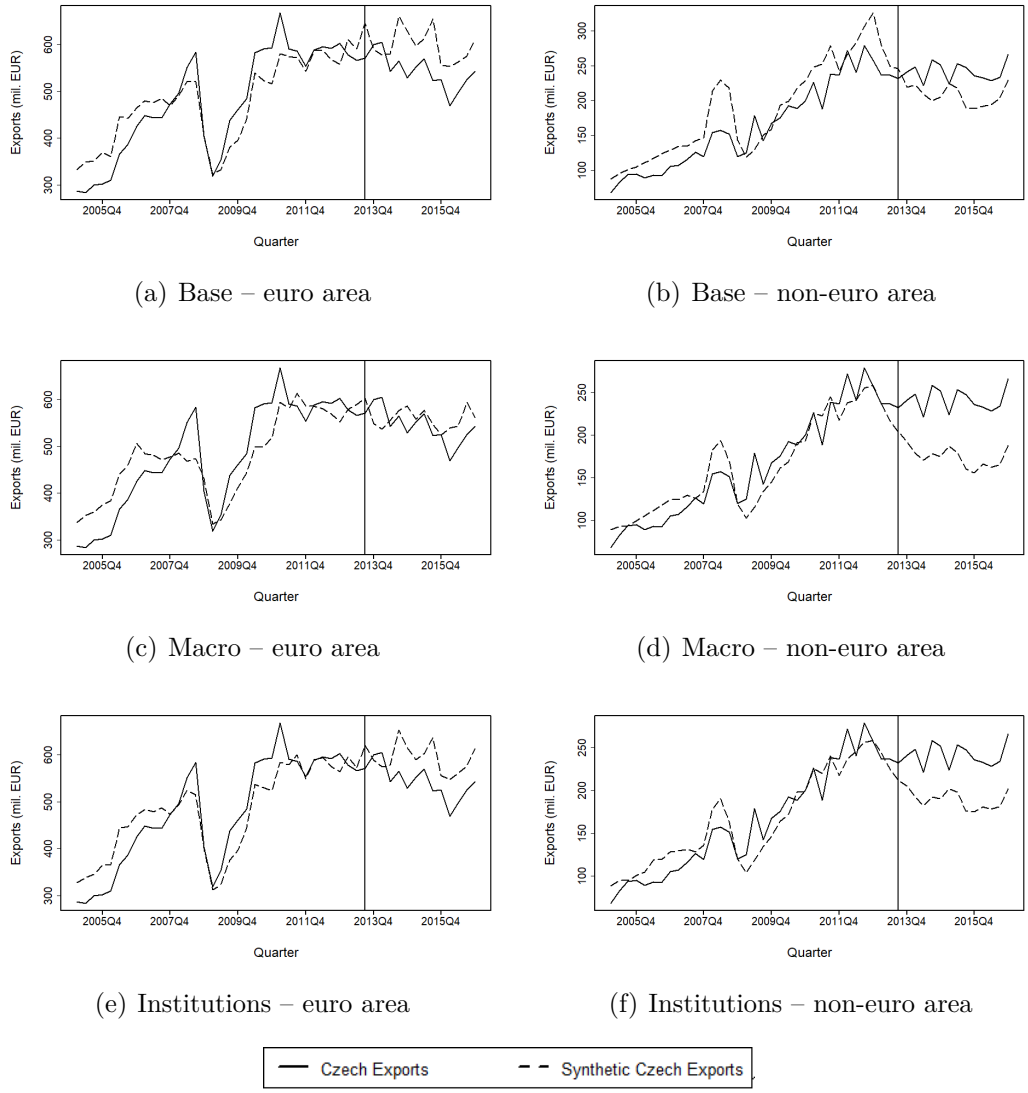


(a) Base (b) Institutions

(d) Base – Placebo study (e) Institutions – Placebo study

(g) Base – Time sensitivity (h) Institutions – Time sensitivity

Figure 5.6: Category 2 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Table 5.5: Category 2 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	3.97%	27.44%	3.87%
Population	2.83%	3.14%	3.27%
Foreign market access	10.14%	17.84%	17.35%
Country risk index	24.09%	33.10%	1.25%
Labour market index	4.23%	5.00%	
FDI share	52.95%	5.61%	3.22%
Real exchange rate	1.79%	2.79%	13.02%
HICP		5.04%	12.47%
Unemployment		0.04%	0.10%
Size of government			2.87%
Legal system			12.81%
Sound money			7.63%
Freedom to trade			3.51%
Regulation			9.61%
Broadband subscriptions			0.14%
Internet share			8.87%
Telephone subscriptions			0.01%

study, which confirms the significance of the results. The estimates are robust, because the effect remained the same after changing the preintervention period. Although the results for Austria show the positive impact of CNB's commitment, the fit in preintervention period is bad. Further evidence suggesting no impact on this destination is presented by placebo study showing only a small difference from SCM results for donors. The exports to Poland were unaffected by the interventions, because model specifications with a good preintervention fit show that synthetic exports closely follow the observed ones. The results show some sensitivity to altering the preintervention period. There is mixed evidence for the impact on exports to Italy as specifications (1) and (3) suggest a negative effect of intervention, while specifications (2) and (4) show no effect. All specifications have a good preintervention fit and the direction of effect is confirmed in the placebo study, thus we cannot determine whether interventions had some effect. All results are not sensitive to shifting the start of the preintervention period. The synthetic exports to Slovakia are above the observed ones. However, the placebo study suggests the effect might be driven by chance, because it is close to SCM estimates for donors. The results for France show large negative effect of interventions on exports, which increased during the whole postintervention period. The impact is close to size of effects

Table 5.6: Category 2 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.00%	0.00%	0.01%
Belgium	11.83%	11.34%	12.84%
Bulgaria	0.88%	0.00%	0.00%
Croatia	0.00%	0.00%	0.00%
Denmark	0.00%	0.00%	0.00%
Estonia	0.01%	0.00%	0.00%
Finland	0.01%	0.00%	0.00%
France	0.00%	0.00%	0.00%
Germany	0.00%	0.00%	0.05%
Greece	0.00%	0.00%	0.00%
Hungary	0.01%	0.00%	0.00%
Ireland	0.01%	0.00%	0.10%
Italy	0.01%	0.00%	0.00%
Latvia	0.00%	0.00%	0.00%
Lithuania	0.01%	0.00%	0.00%
Luxembourg	0.03%	0.00%	0.00%
Netherlands	0.03%	0.00%	0.04%
Poland	0.02%	0.00%	0.00%
Portugal	0.00%	0.00%	0.00%
Romania	41.33%	43.40%	35.93%
Slovakia	0.00%	0.00%	0.00%
Slovenia	0.01%	0.00%	0.00%
Spain	45.78%	45.26%	51.02%
Sweden	0.01%	0.00%	0.00%
United Kingdom	0.00%	0.00%	0.00%

on donors from placebo study. Thus, the effect might be purely random.

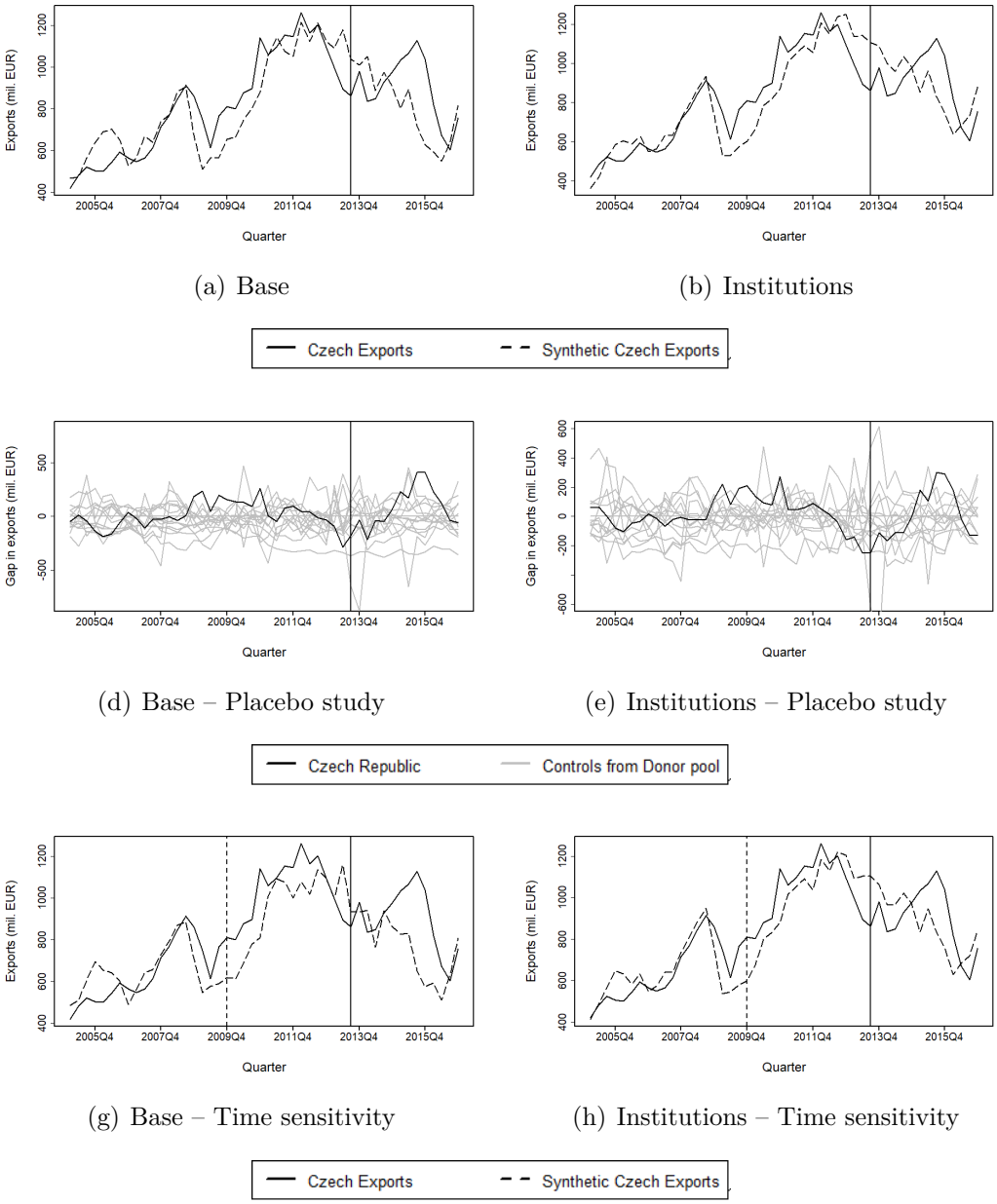
The exports to the main trade partners in this category account for 76.32% of exports over the observed period. The exports in most cases slightly decreased or remained the same, which gives partial support to no effect of interventions we observed for total sectoral exports. These results contradict the literature which suggests a positive effect on exports in primary products. The results for bilateral exports confirm the negative effect for euro area countries, which were probably caused by the adverse impact on Germany, France, and Italy.

5.4 SITC category 3

The development of Czech exports in the SITC Category 3 – Mineral fuels, lubricants and related material will be studied in the following paragraphs. The exports in this category are quite volatile. As a result, the fit in the preintervention period is worse than for previous categories. In most specifications, there is a large positive effect on exports between the first quarter of 2015 and the second quarter of 2016. The impact at the beginning of the postintervention period is less clear. The synthetic exports are higher than the observed ones, but the size of the effect varies across the model specifications. The exception is the first quarter of 2014 where most of them show large negative effect of the interventions. The Table 5.7 shows the weights of the explanatory variables. Spain, Latvia, Romania, and Greece are the countries whose weighted average best reproduces the Czech Republic in the base model. As could be seen from Table 5.8, there is some variation in donor weights across the specifications. The placebo study suggests that the positive effect on export was larger than for the rest of the donor pool and the negative impact directly after the start of the interventions was close to synthetic results for other countries. The sensitivity to changing the start of interventions is low, because the results remained virtually unchanged and all of the specifications show the positive impact that we observed with the original start of interventions.

The CNB's commitment had a large positive effect on exports to euro area. The synthetic counterpart is much lower between the fourth quarter of 2014 and the second quarter of 2016. The results of the placebo study confirm this, because the gap is much larger compared to donors. We could not evaluate the impact on countries outside the eurozone due to poor fit in the preintervention period. The results and export path for the euro area was close to the total

Figure 5.7: Czech exports – Category 3



(a) Base (b) Institutions

(d) Base – Placebo study (e) Institutions – Placebo study

(g) Base – Time sensitivity (h) Institutions – Time sensitivity

Table 5.7: Category 3 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	63.74%	9.16%	9.39%
Population	13.55%	13.19%	6.98%
Foreign market access	0.24%	20.41%	0.00%
Country risk index	0.02%	10.03%	18.58%
Labour market index	17.49%	9.03%	
FDI share	4.63%	4.90%	0.79%
Real exchange rate	0.34%	22.21%	1.95%
HICP		6.29%	5.46%
Unemployment		4.77%	2.49%
Size of government			0.65%
Legal system			36.31%
Sound money			1.07%
Freedom to trade			4.59%
Regulation			0.01%
Broadband subscriptions			6.93%
Internet share			2.82%
Telephone subscriptions			1.96%

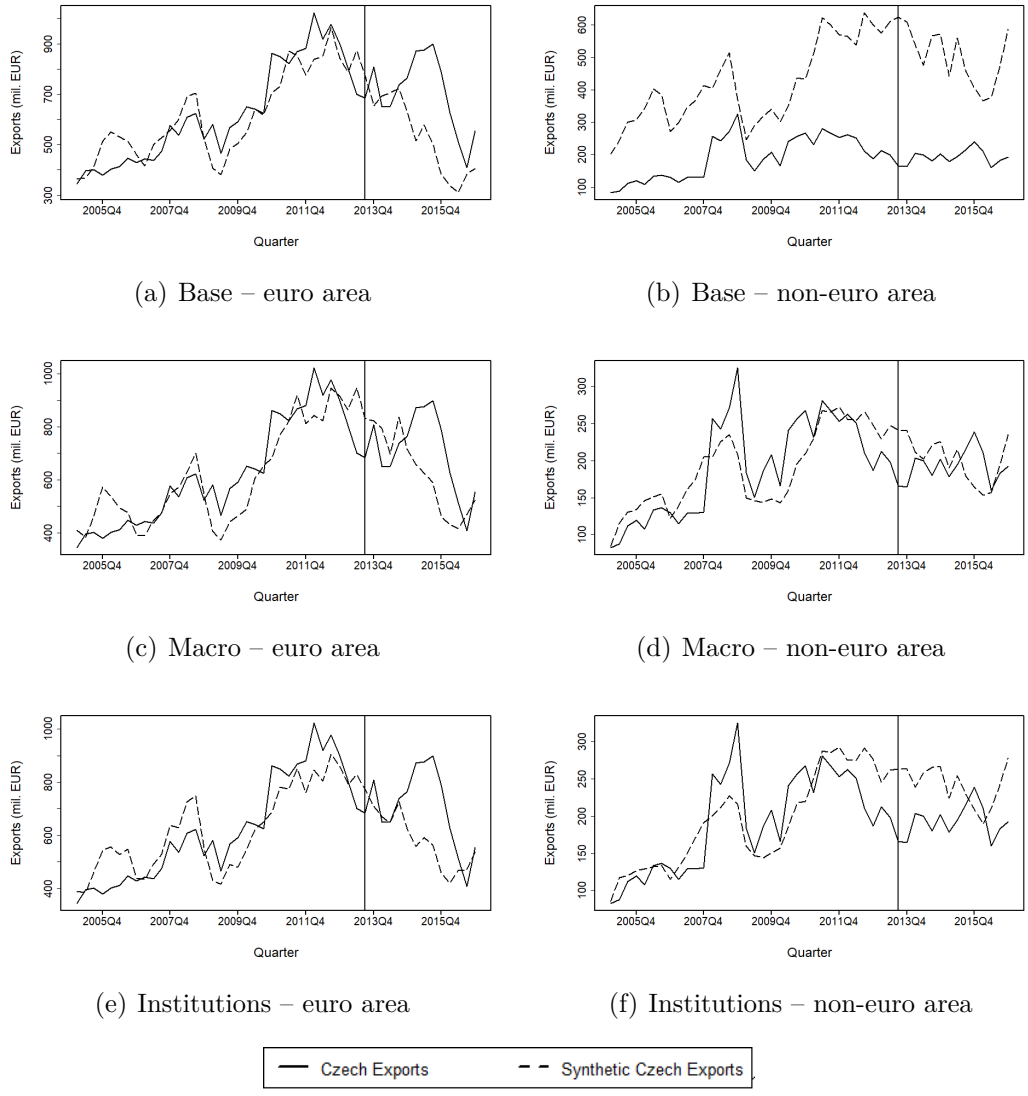
of this category. Therefore, it is very likely that they caused the positive aggregate effect. Also, the results for the euro area in this category confirm the findings relating lower volatility of the exchange rate to higher exports of crude products. The results discussed above are in Figure 5.8.

The volatility of exports in this category resulted in a poor preintervention fit for most of the largest trade partners. The exports to Germany were most likely unaffected by CNB's interventions. There is negative effect immediately after the start of interventions and positive one in year 2015, but those effects are close in size to gaps between observed and synthetic exports during the preintervention period. Moreover, the results are very sensitive to altering the preintervention period. Due to poor fit, we could not determine the effect on exports to Slovakia. There is an immediate negative effect of interventions on exports to Austria as could be seen from the large gap between observed and synthetic exports, which is much larger than the gaps for donors estimated in placebo study. Similarly, the interventions had a large negative effect on exports to Poland, but here the placebo study shows some units in the donor pool with similar impacts. Both results are robust to altering the preintervention period and showed simillar effect after its change. Although the results suggest a positive effect on exports to Hungary in all specifications, the placebo

Table 5.8: Category 3 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.00%	27.75%	0.12%
Belgium	0.00%	0.72%	0.01%
Bulgaria	0.00%	11.04%	1.46%
Croatia	0.00%	0.06%	0.02%
Denmark	0.00%	0.22%	0.01%
Estonia	0.00%	0.00%	0.00%
Finland	0.00%	0.01%	0.00%
France	0.00%	0.01%	0.00%
Germany	0.00%	0.32%	0.00%
Greece	2.73%	0.00%	0.00%
Hungary	0.00%	0.00%	0.00%
Ireland	0.00%	0.00%	0.00%
Italy	0.00%	0.02%	0.00%
Latvia	26.67%	0.02%	0.00%
Lithuania	0.00%	0.05%	7.85%
Luxembourg	0.00%	0.00%	0.00%
Netherlands	0.00%	0.06%	4.76%
Poland	0.00%	0.00%	0.00%
Portugal	0.00%	0.06%	1.16%
Romania	5.13%	4.91%	0.31%
Slovakia	0.00%	0.00%	0.00%
Slovenia	0.00%	0.01%	0.00%
Spain	65.47%	54.72%	24.31%
Sweden	0.00%	0.01%	59.99%
United Kingdom	0.00%	0.01%	0.00%

Figure 5.8: Category 3 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

study shows it is comparable to SCM estimates for donors from the placebo study. Additionally, the poor fit and very different results when the start of intervention period is altered suggest that the estimate is not reliable.

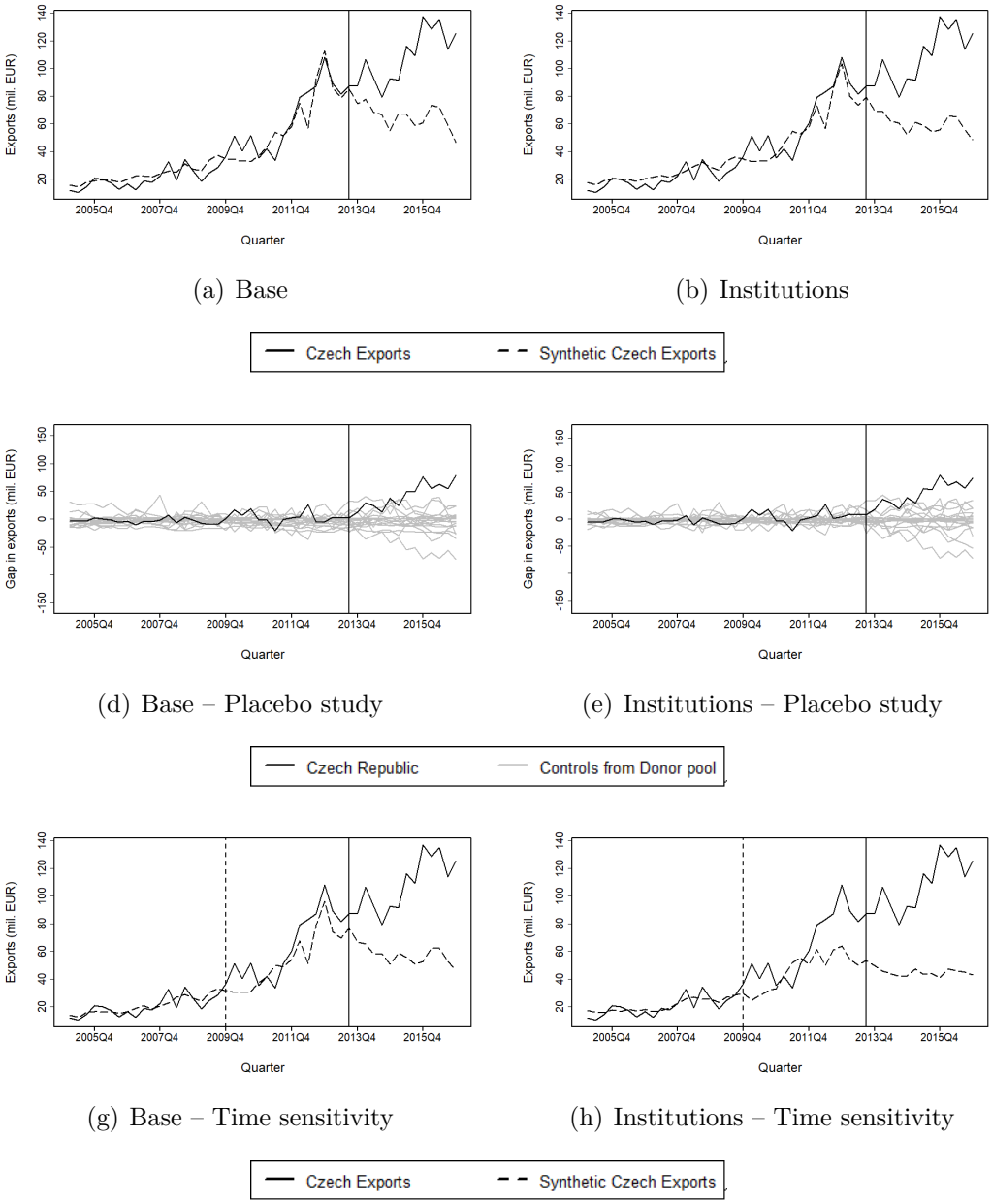
In this category, the Czech Republic exported mostly to countries mentioned above as their share is 87.93% in the period 2000-2016. The results for individual trade partners confirm some of the findings on total sectoral exports. The observed negative effect shortly after the start of the interventions is likely caused by the negative effects on Austria and Poland. The positive effect in 2015 could be driven by the increase of exports to Germany, but the volatility of results makes this less clear.

5.5 SITC category 4

The following paragraph will focus on the effect of CNB's interventions on the development of the Czech exports in the SITC Category 4 – Animal and vegetable oils, fats and waxes. There is large effect on exports directly after the start of the interventions. As could be seen from the path of synthetic and observed exports in Figure 5.9, the effect increases over time. In the base specification, the most important explanatory variables are GDP, FDI share, and real exchange rate. Weights for other specifications are shown in Table 5.9. The countries from which the synthetic counterpart is constructed are in Table 5.10. Across all specifications Spain, Romania, and Austria were among the countries with the largest weights. The placebo study confirms that the results are not caused by randomness, because the gap for the Czech Republic is much larger than for other countries from the donor pool. The results after shifting preintervention period vary across the specifications. The base one suggests almost no change in the synthetic exports. On the other hand, the specifications including more variables show large effect prior the true start of interventions. Adding more variables, which change slowly over time, could result in poor predictions for the postintervention period, because the exports in this category are volatile.

The results for exports to euro area and, other countries are in Figure 5.10. Although the exports to euro area countries show high volatility the resulting fit is relatively good and synthetic exports are relatively close to the observed ones. No effect of interventions is confirmed by the placebo study, where the gap is similar to the rest of donors. The positive impact of interventions on total exports in this category is driven by a large increase of exports to non-euro

Figure 5.9: Czech exports – Category 4



(a) Base

(b) Institutions

(d) Base – Placebo study

(e) Institutions – Placebo study

(g) Base – Time sensitivity

(h) Institutions – Time sensitivity

Table 5.9: Category 4 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	46.59%	0.73%	4.94%
Population	0.00%	3.90%	7.31%
Foreign market access	8.06%	24.68%	6.54%
Country risk index	1.78%	8.43%	2.59%
Labour market index	0.00%	11.71%	
FDI share	21.92%	1.73%	4.88%
Real exchange rate	21.65%	27.80%	18.33%
HICP		20.88%	17.49%
Unemployment		0.15%	0.76%
Size of government			1.48%
Legal system			7.86%
Sound money			3.32%
Freedom to trade			9.61%
Regulation			9.51%
Broadband subscriptions			2.38%
Internet share			0.02%
Telephone subscriptions			2.97%

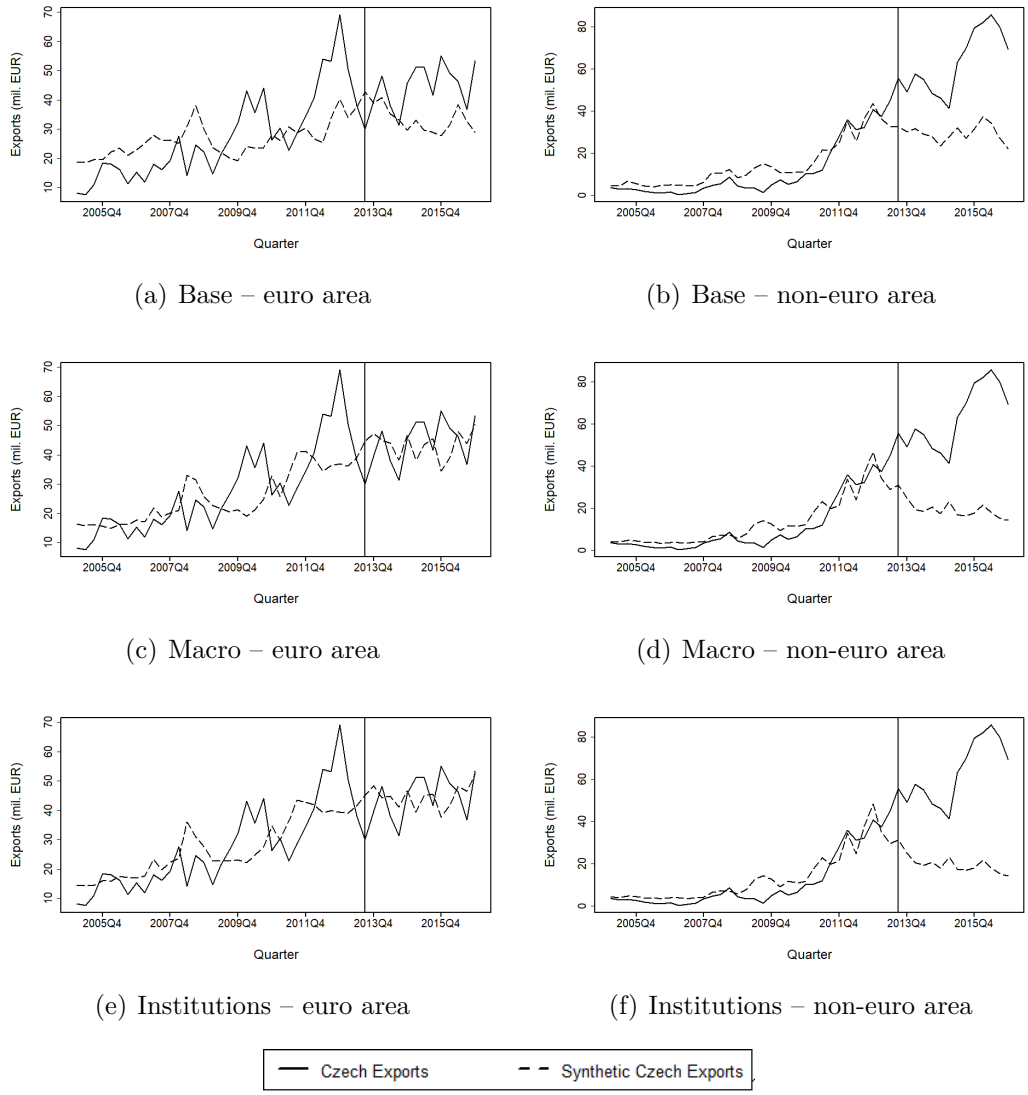
area countries. The difference between treated unit and synthetic counterpart is very large and placebo study confirms the size of the effect. We should be cautious, because there was some difference already two quarters before the start of the interventions. Therefore, the size of the effect might be smaller. The findings in this category again contradict the empirical results of higher exports to countries where the exchange rate is less volatile.

The results suggest that interventions had a large positive effect on exports to Poland. There is some uncertainty, because the gap between synthetic and observed exports is present already in 2012 and shifting the preintervention period leads to a large decrease in synthetic exports. The reason might be inability of SCM to capture increasing trend starting in 2010. The synthetic exports to Slovakia closely follow the observed ones at the beginning of the preintervention period and since 2015 there is a small positive effect, which is not significant as shown by the placebo study. The results are sensitive to change of the preintervention period caused by a large increase between 2010 and 2012. The impact on Austria vary across the model specifications, but placebo studies show that only in specifications (2) and (3) the positive effect is bigger than for donors during year 2015. Additionally, the fit is not very good, because synthetic exports were unable to replicate large volatility at the

Table 5.10: Category 4 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.00%	4.71%	10.31%
Belgium	0.08%	0.06%	0.69%
Bulgaria	0.00%	0.00%	3.35%
Croatia	0.12%	0.00%	0.02%
Denmark	0.03%	0.00%	1.91%
Estonia	0.02%	0.00%	0.00%
Finland	0.01%	0.00%	0.00%
France	0.02%	0.00%	0.00%
Germany	0.57%	0.43%	0.77%
Greece	0.00%	0.00%	0.00%
Hungary	0.02%	0.00%	0.00%
Ireland	0.01%	0.00%	0.14%
Italy	0.02%	0.00%	0.00%
Latvia	0.02%	0.00%	0.00%
Lithuania	0.03%	0.00%	0.03%
Luxembourg	0.02%	0.00%	0.04%
Netherlands	0.18%	0.00%	2.38%
Poland	0.01%	0.00%	0.00%
Portugal	0.03%	0.00%	0.02%
Romania	29.53%	32.31%	19.21%
Slovakia	0.01%	0.00%	0.00%
Slovenia	0.01%	0.00%	0.00%
Spain	69.22%	62.48%	60.96%
Sweden	0.02%	0.00%	0.14%
United Kingdom	0.01%	0.00%	0.01%

Figure 5.10: Category 4 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

end of preintervention period, leading to significant sensitivity to change of preintervention period. We could not determine the effect of interventions for exports to Germany, because the fit in the preintervention period is poor. There is a large positive effect on exports to Hungary starting in 2014. However, the impact could be caused by another event or driven by randomness, because from placebo study we see that SCM results for some donors give similar or even larger effects. The exports to Bulgaria increased sharply in 2015 and 2016, but it is questionable whether we could attribute this to interventions as they started much earlier. The synthetic exports to Italy are much smaller than the observed ones from the start of the postintervention period until 2015. In both cases, the large effects are confirmed by results of the placebo study.

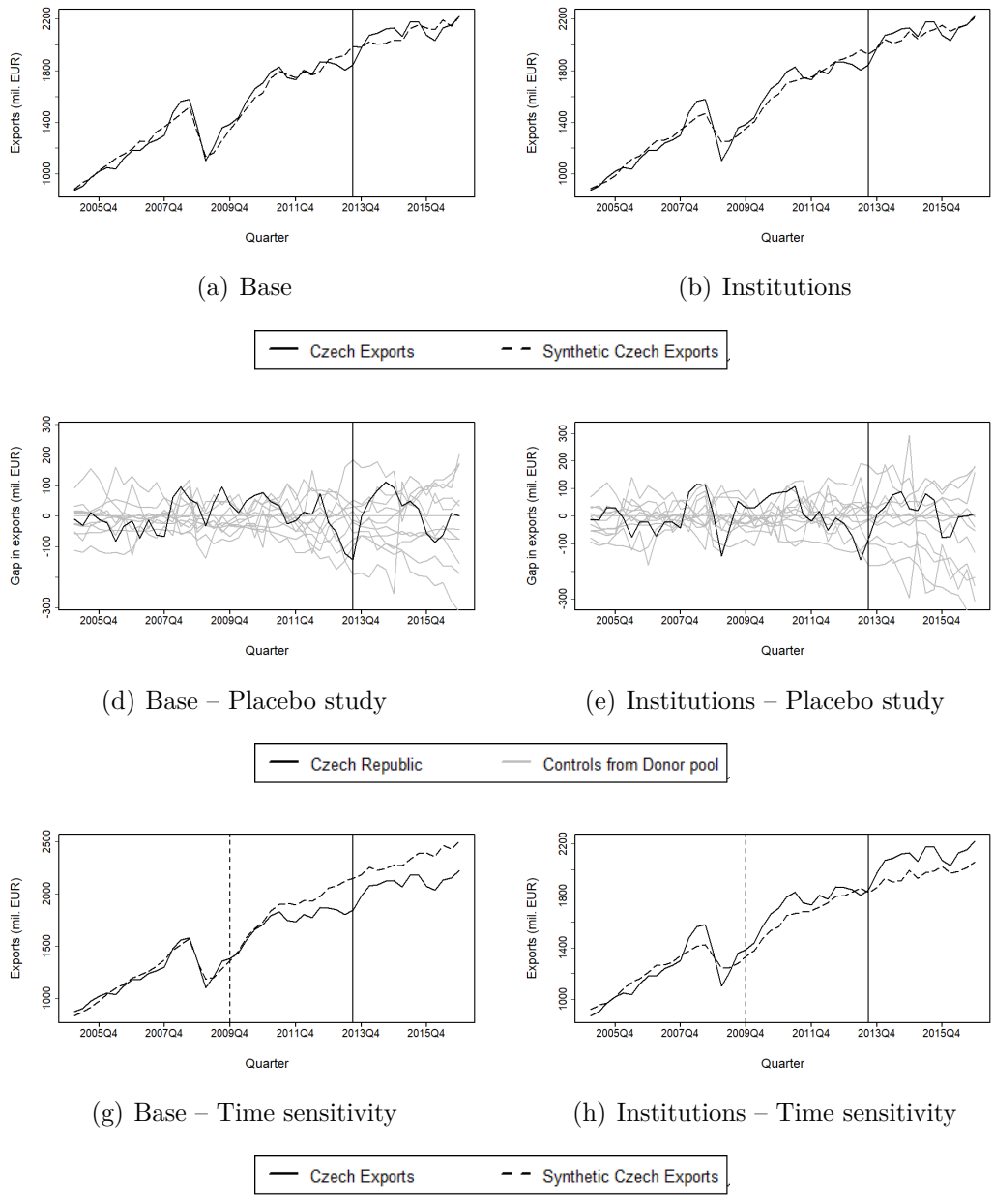
Similarly to previous categories, exports to main trade partners form very significant part of total, in this case 92.32%. The results for individual trade partners confirm our findings from analysis of total exports in this category. For most countries, there was an increase of exports immediately after the start of the interventions. The exports increased to all trading partners outside the euro area, while the effect on euro area countries was mixed. This supports the results for categories 0 and 2, which contradicts the third hypothesis of positive effect from reduced exchange rate volatility on exports of primary goods.

5.6 SITC category 5

This paragraph describes the effect of CNB's interventions on Czech exports in SITC category 5 – Chemicals and related products. The synthetic counterpart closely follows the Czech exports for most of the specifications, which suggests no effect of exchange rate commitment on exports in this category. The placebo study confirms this, because in specifications which showed small positive or negative effect, its size was comparable to the remaining countries from the donor pool. In the baseline specification, all of the explanatory variables, with exception of population and foreign market access, had share over 10%. Moreover, their shares are quite close to each other. The details for remaining specifications are in the Table 5.11. From Table 5.12, we can see a large variation across the models in weights of the donor countries. The most important ones are Spain, Romania, Sweden and Austria, where only the first two have weights over 1% in all specifications. The change in the postintervention period start resulted in small changes of the synthetic counterpart for most

specifications. However, there is some effect in the base specification shortly after the start of the new postintervention period.

Figure 5.11: Czech exports – Category 5



(a) Base (b) Institutions

(d) Base – Placebo study (e) Institutions – Placebo study

(g) Base – Time sensitivity (h) Institutions – Time sensitivity

Czech exports of chemicals to euro area increased following the interventions. The synthetic counterpart is below the treated unit for two model specifications, which is visible from Figures 5.13(a) and 5.13(e). The placebo study shows the effect is large compared to other donors in the period between the second quarter of 2014 and the fourth quarter of 2015. Results for non-eurozone

Table 5.11: Category 5 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	16.80%	0.14%	0.66%
Population	2.71%	7.91%	1.92%
Foreign market access	8.22%	23.65%	9.27%
Country risk index	13.19%	16.36%	4.67%
Labour market index	21.07%	8.56%	
FDI share	18.73%	1.22%	3.52%
Real exchange rate	19.28%	23.31%	5.13%
HICP		16.14%	15.38%
Unemployment		2.71%	18.87%
Size of government			1.59%
Legal system			4.96%
Sound money			8.70%
Freedom to trade			0.03%
Regulation			0.09%
Broadband subscriptions			15.41%
Internet share			6.93%
Telephone subscriptions			2.87%

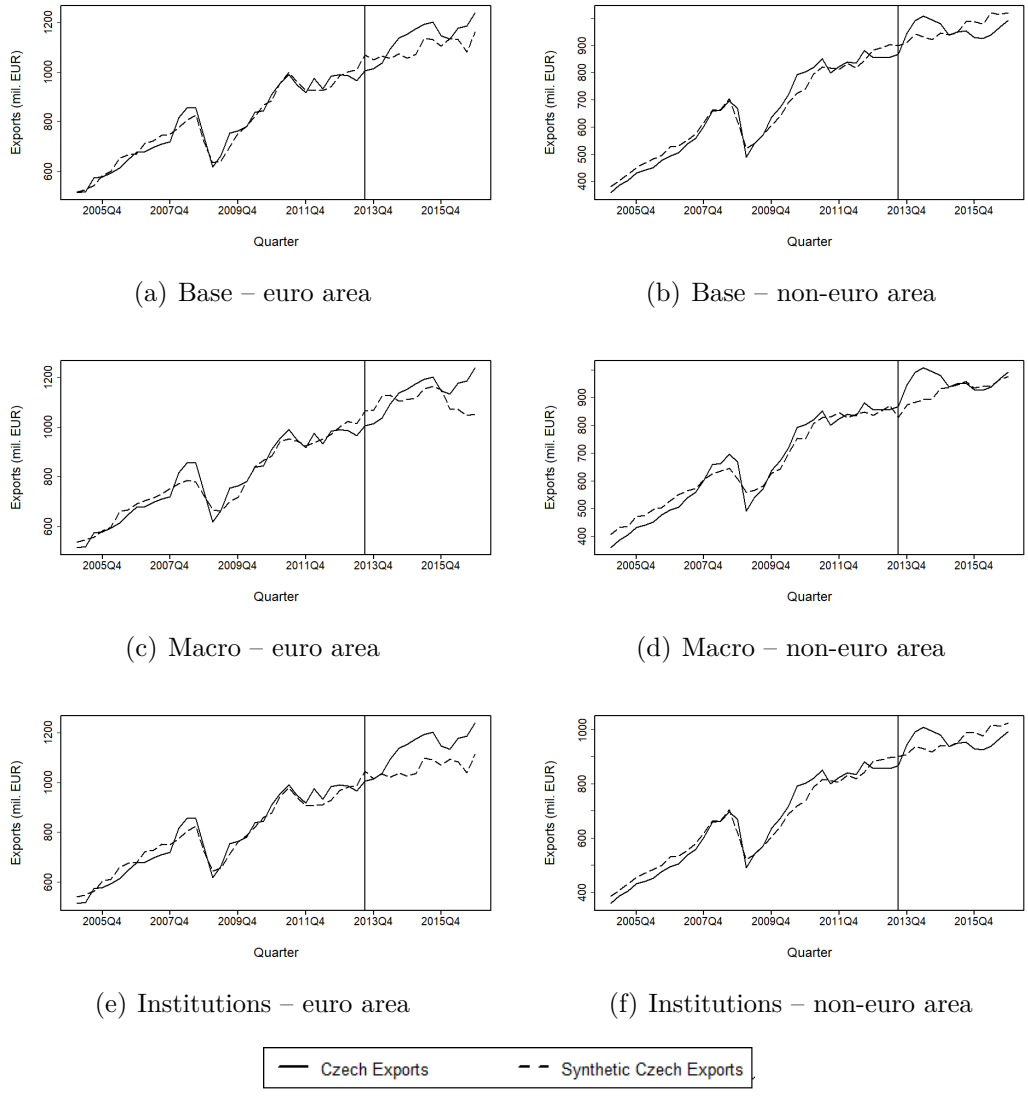
countries suggest a positive impact immediately after the start of interventions. However, in all specifications the resulting gap between synthetic counterpart and treated unit is only slightly higher than for rest of the donors. As discussed in Introduction, the positive effect on exports to the euro area is likely caused by the positive effect from reduced exchange rate volatility on homogeneous chemical products contained in this category. In future, more detailed research of exports in this category might show how effects differ between basic chemicals and more sophisticated products such as pharmaceuticals. The results contradict no effect found in the total sectoral exports.

The synthetic exports of chemicals to Germany stayed close to the observed ones in first two postintervention years and the positive effect is visible since 2015. However, due to delay the change is likely not caused by interventions. There is a poor preintervention fit across the model specifications for Slovakia. Only in specification (1), we see small and decreasing difference from 2012 onwards. Thus, we believe there was no effect, because there was a similar development in synthetic and observed exports. The interventions had a negative effect on exports to Poland, because the synthetic exports are above the observed ones for the whole period and the negative impact increase until 2016. Significance of results is confirmed by placebo study where gaps from SCM for

Table 5.12: Category 5 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.01%	19.24%	20.89%
Belgium	1.92%	0.22%	0.00%
Bulgaria	0.00%	0.10%	7.12%
Croatia	0.00%	0.01%	0.00%
Denmark	0.04%	0.02%	0.00%
Estonia	0.00%	0.00%	0.00%
Finland	0.00%	0.00%	0.00%
France	0.00%	0.00%	0.00%
Germany	0.00%	0.03%	0.01%
Greece	0.00%	0.00%	0.00%
Hungary	0.00%	0.00%	0.00%
Ireland	0.00%	0.00%	0.00%
Italy	0.00%	0.01%	0.00%
Latvia	0.01%	0.00%	0.00%
Lithuania	0.00%	0.01%	0.00%
Luxembourg	0.00%	0.00%	0.00%
Netherlands	0.00%	0.01%	0.01%
Poland	0.00%	0.00%	0.00%
Portugal	0.00%	0.01%	0.00%
Romania	25.47%	16.20%	10.69%
Slovakia	0.00%	0.00%	0.00%
Slovenia	0.00%	0.00%	0.00%
Spain	72.54%	64.12%	4.31%
Sweden	0.00%	0.01%	56.97%
United Kingdom	0.00%	0.00%	0.00%

Figure 5.12: Category 5 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

donors were smaller. The exports to Hungary were unaffected by the interventions, because the differences were relatively small and close to estimates for donors in the placebo study. The observed exports to Italy are slightly bellow the synthetic ones for the whole postintervention period. The evidence for negative impact is weak because the observed difference between synthetic and treated unit is close to results for donor pool in placebo study. The interventions have large negative effect on exports to Austria which increases over time. However, unlike in the previous cases where the effect of changing the preintervention period was small, the effect on synthetic exports to Austria was substantial and the impact of interventions diminished. As a result, the effect for this trade partner is unclear. Although the differences between treated unit and synthetic counterpart have large variation across the specifications for France, the placebo study shows none of them differs from SCM estimates for donors. The exports to Belgium were much lower than predicted by synthetic counterpart. The exports to the Netherlands were unaffected by the actions of CNB, because the synthetic counterpart closely follows the observed ones.

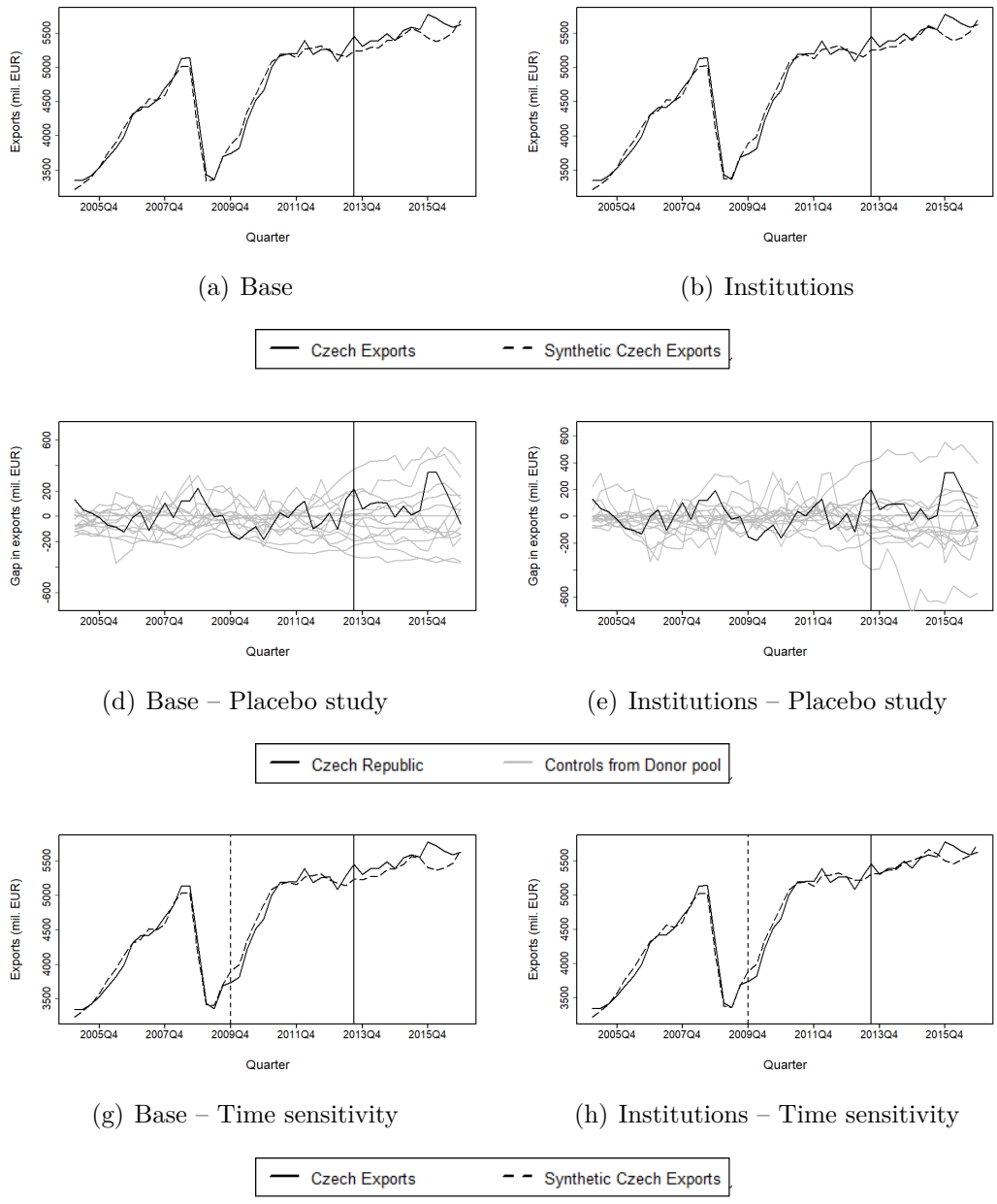
In this category, 66.9% of the exports over the period 2000-2016 is from the main partners mentioned above. The results for individual bilateral pairs confirm no effect of CNB's commitment, because most of the partners discussed above showed no significant change after the interventions. A more detailed study would be needed to evaluate why the exports to the euro area, and outside were positively affected, because exports to none of the destinations discussed above were positively influenced.

5.7 SITC category 6

This paragraph focuses on exports in the SITC category 6 – Manufactured goods. From the Figure 5.13, we see that the fit in the preintervention period is very good. The synthetic exports continue to follow closely the observed ones in the postintervention period. Therefore, the exports of manufactured goods seem to be unaffected by the CNB's commitment. The only variable with a large share across all specifications is foreign market access. More details on weights of explanatory variables across the specifications are in Table 5.13. The synthetic counterpart for this category is constructed from Spain, Romania, and Austria. From Table 5.14, we see that in most specifications the Spain has a weight of over 40% and the two other countries around 20% each. The placebo study confirms no effect of interventions, because the estimated effect is close

to the countries from the donor pool. Only in the fourth quarter of 2015 and the first quarter of 2016, there seems to be some positive effect, but it is not far from the remaining countries and some of them had larger difference between observed and synthetic exports. The estimated effect of interventions seems to be robust, because synthetic counterfactuals were unaffected by moving the start of the intervention period for most of the specifications.

Figure 5.13: Czech exports – Category 6



(a) Base (b) Institutions

(d) Base – Placebo study (e) Institutions – Placebo study

(g) Base – Time sensitivity (h) Institutions – Time sensitivity

The synthetic counterpart is slightly above the unit of interest for exports

Table 5.13: Category 6 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	20.60%	2.14%	1.99%
Population	11.71%	0.00%	1.00%
Foreign market access	48.69%	40.82%	36.00%
Country risk index	0.08%	19.79%	2.57%
Labour market index	6.54%	8.80%	
FDI share	1.87%	2.03%	0.02%
Real exchange rate	10.50%	14.35%	12.04%
HICP		8.12%	19.16%
Unemployment		3.96%	2.25%
Size of government			0.01%
Legal system			5.89%
Sound money			2.78%
Freedom to trade			2.37%
Regulation			8.45%
Broadband subscriptions			0.00%
Internet share			5.20%
Telephone subscriptions			0.28%

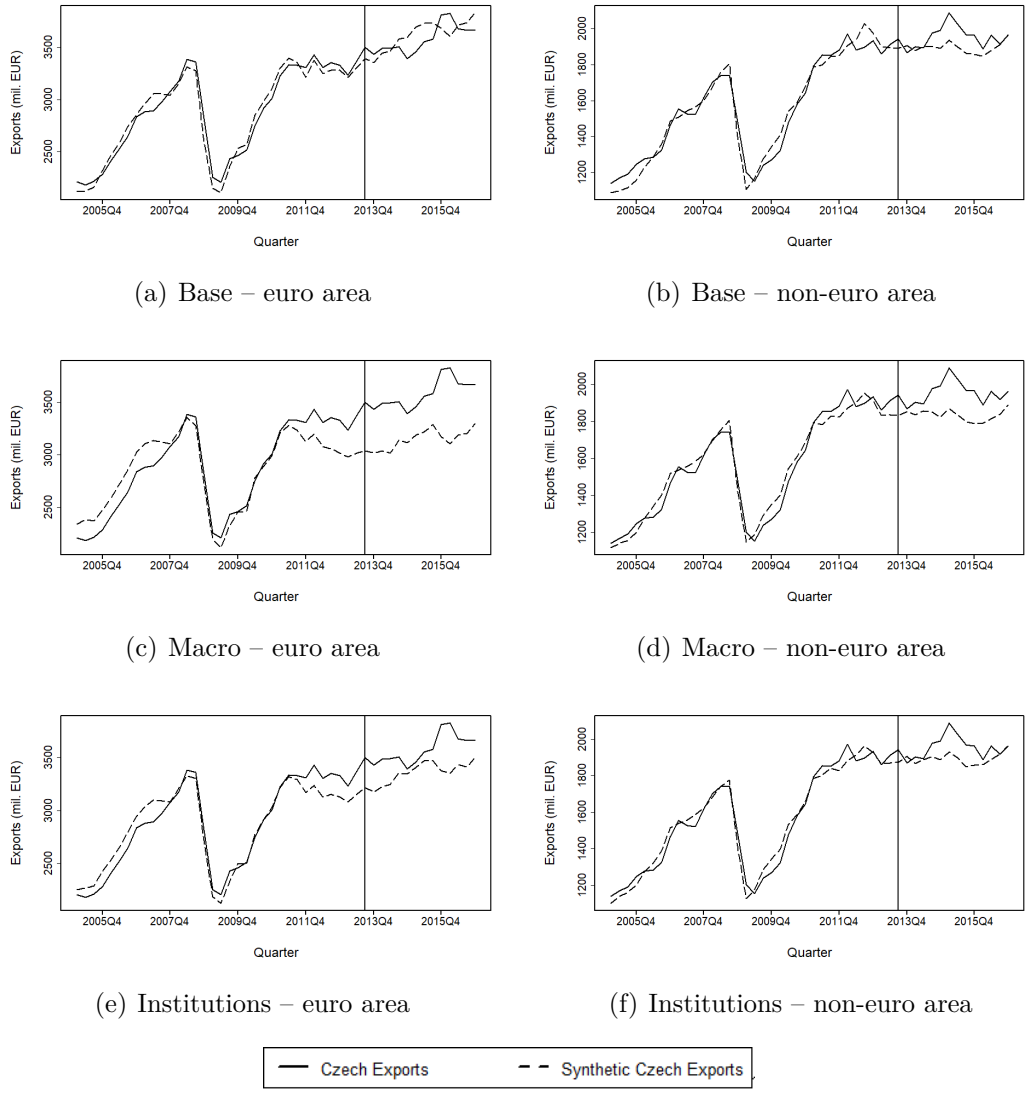
to euro area between the third quarter of 2014 and the third quarter of 2015. The gap between synthetic and observed exports is slightly larger compared to donor countries during this period and comparable afterwards as shown by the placebo study. For countries outside the euro area, the interventions had only a small positive effect, which is not larger than differences between treated and synthetic unit in the preintervention period. Moreover, the effect might be purely random, because the effects for donor countries in the placebo study are comparable to the treated unit. Interventions seem to have small effect on exports to both groups of countries. This confirms no effect found on total data in this category and serves as evidence for no effect of undervalued currency on exports in this category. Figure 5.14 provides more details.

There was a negative impact on exports to Germany, which increases from year 2014 onwards. The size of the effect differs across the model specifications, but placebo studies confirm significance in all cases. The interventions had a large negative effect on exports to Slovakia starting in the year 2014. SCM results for donors in placebo study are lower for the whole postintervention period, which confirms the significance of the impact. The effect of CNB's actions had a small positive effect on exports to Poland. Placebo study shows the gap between synthetic and treated unit is slightly larger than for most

Table 5.14: Category 6 – Donor weights

Donor	Base	Macro	Institutions
Austria	20.98%	19.91%	19.82%
Belgium	2.57%	3.21%	0.10%
Bulgaria	0.02%	7.76%	2.87%
Croatia	0.02%	0.00%	0.02%
Denmark	0.03%	0.00%	0.03%
Estonia	0.01%	0.00%	0.01%
Finland	0.01%	0.00%	0.02%
France	0.01%	0.00%	0.01%
Germany	0.05%	0.00%	3.11%
Greece	0.00%	0.00%	0.00%
Hungary	0.01%	0.00%	0.01%
Ireland	0.01%	0.00%	0.03%
Italy	0.01%	0.00%	0.02%
Latvia	0.02%	0.00%	0.02%
Lithuania	0.02%	0.00%	0.04%
Luxembourg	0.01%	0.00%	0.05%
Netherlands	0.02%	0.00%	0.08%
Poland	0.01%	0.00%	0.02%
Portugal	0.02%	0.00%	0.03%
Romania	24.73%	27.08%	26.43%
Slovakia	0.01%	0.00%	0.01%
Slovenia	0.01%	0.00%	0.01%
Spain	51.41%	42.03%	47.19%
Sweden	0.01%	0.00%	0.06%
United Kingdom	0.01%	0.00%	0.01%

Figure 5.14: Category 6 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

of the donors. The negative effect of interventions on exports to Italy might be driven purely by randomness, because the placebo study shows it is close to effect on donors in specifications (2) and (3), while in specification (1) the difference is larger. The synthetic exports to Austria are relatively close to the observed ones for the whole postintervention period and differences are similar to the size of fluctuations in the preintervention period. The exports to France were unaffected, because the synthetic and treated unit are close to each other for entire observed period. The results for the United Kingdom show small positive impact on export, but the placebo study shows SCM results are comparable to effect on donors. There was no impact on exports to Hungary. The results are based on the specification (1), because the sensitivity to change of the preintervention period show larger instability for specifications (2), (3) and (4). The trade with the Netherlands was likely unaffected, but the fit was not perfect, because there was difference already before the start of the intervention period. The exports to Belgium were positively affected by the interventions. Although, the difference is small, the significance is confirmed by placebo study. In most cases the results were not sensitive to changes of postintervention period, but for Germany, Poland, and the Netherlands, there was some changes caused likely by sharp changes at the start of the new postintervention period.

Over the observed period, the main export partners accounted for 75.57% of Czech exports in manufactured goods. No effect on exports to majority of the main destinations confirms the findings from total sectoral data, but the negative impact on the largest trade partners is puzzling. No impact of interventions could be explained by lower influence of stable exchange rate for products with higher added value. Similarly, the undervalued currency might not increase exports of heterogeneous products, because manufactures from different countries might not be perfect substitutes, due to differences in quality or specifications.

5.8 SITC category 7

The effect on exports in the SITC category 7 – Machinery and transport equipment are discussed in the following paragraph. The fit of the synthetic counterpart is not particularly good directly before the start of interventions for almost all of the specifications. As we see from Figure 5.15, the exports increased as a result of the CNB's interventions, but the synthetic counterpart is bellow the

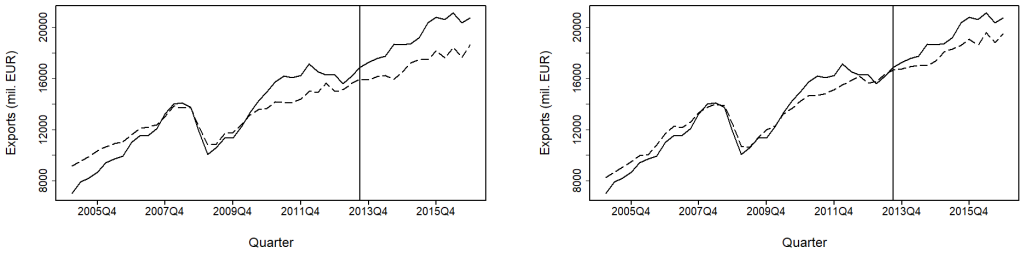
true exports for a large part of the preintervention period. For the model specifications with the good preintervention fit, the placebo study shows that the effect on Czech export is large, but it is close to effects on some other countries in the donor pool. Therefore, the results might be driven by imperfect fit or some other event occurring in the same period. Another problem arises in the sensitivity to start of interventions, where the synthetic exports shift down in all specifications and follow the observed ones only in the new preintervention period. In the base model, the most important explanatory variables are FDI share, Country risk index, and FMA. For details of other specifications, see Table 5.15. The weights of countries in the construction of the synthetic counterfactual are in Table 5.16. Across the specifications, Spain and Romania have large shares, but some countries such as Greece or Belgium have large shares in some cases.

Table 5.15: Category 7 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	0.00%	0.05%	0.93%
Population	0.00%	13.36%	0.08%
Foreign market access	22.41%	26.92%	4.07%
Country risk index	32.16%	6.39%	36.70%
Labour market index	1.22%	0.20%	
FDI share	36.69%	20.17%	8.93%
Real exchange rate	7.51%	19.52%	10.96%
HICP		13.40%	13.01%
Unemployment		0.00%	0.11%
Size of government			0.00%
Legal system			6.81%
Sound money			1.68%
Freedom to trade			14.26%
Regulation			0.00%
Broadband subscriptions			0.19%
Internet share			0.35%
Telephone subscriptions			1.91%

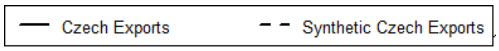
The synthetic counterpart of exports to euro area failed to fit them well and the difference is large during the whole preintervention period. However, the difference seems to be stable over time and both observed and synthetic unit do not change their trend following CNB's commitment. Thus, it likely has no effect on exports of machinery and transport equipment to those countries. Czech exports to countries outside the euro area might slightly increase as a re-

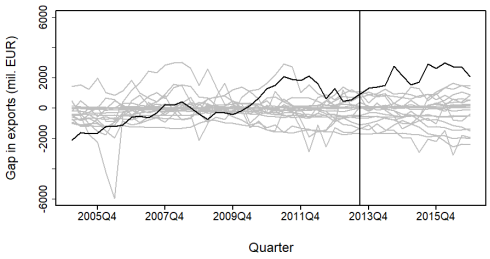
Figure 5.15: Czech exports – Category 7



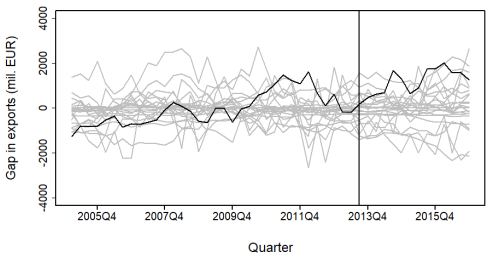
(a) Base

(b) Institutions

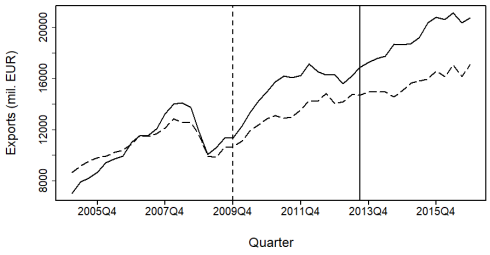




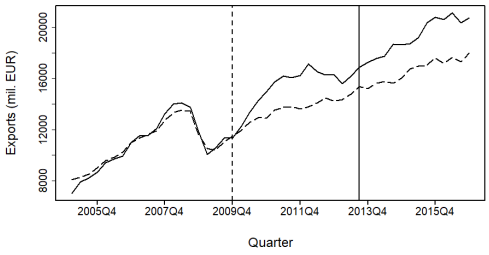
(d) Base – Placebo study



(e) Institutions – Placebo study



(g) Base – Time sensitivity



(h) Institutions – Time sensitivity

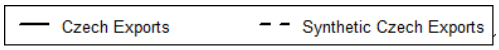
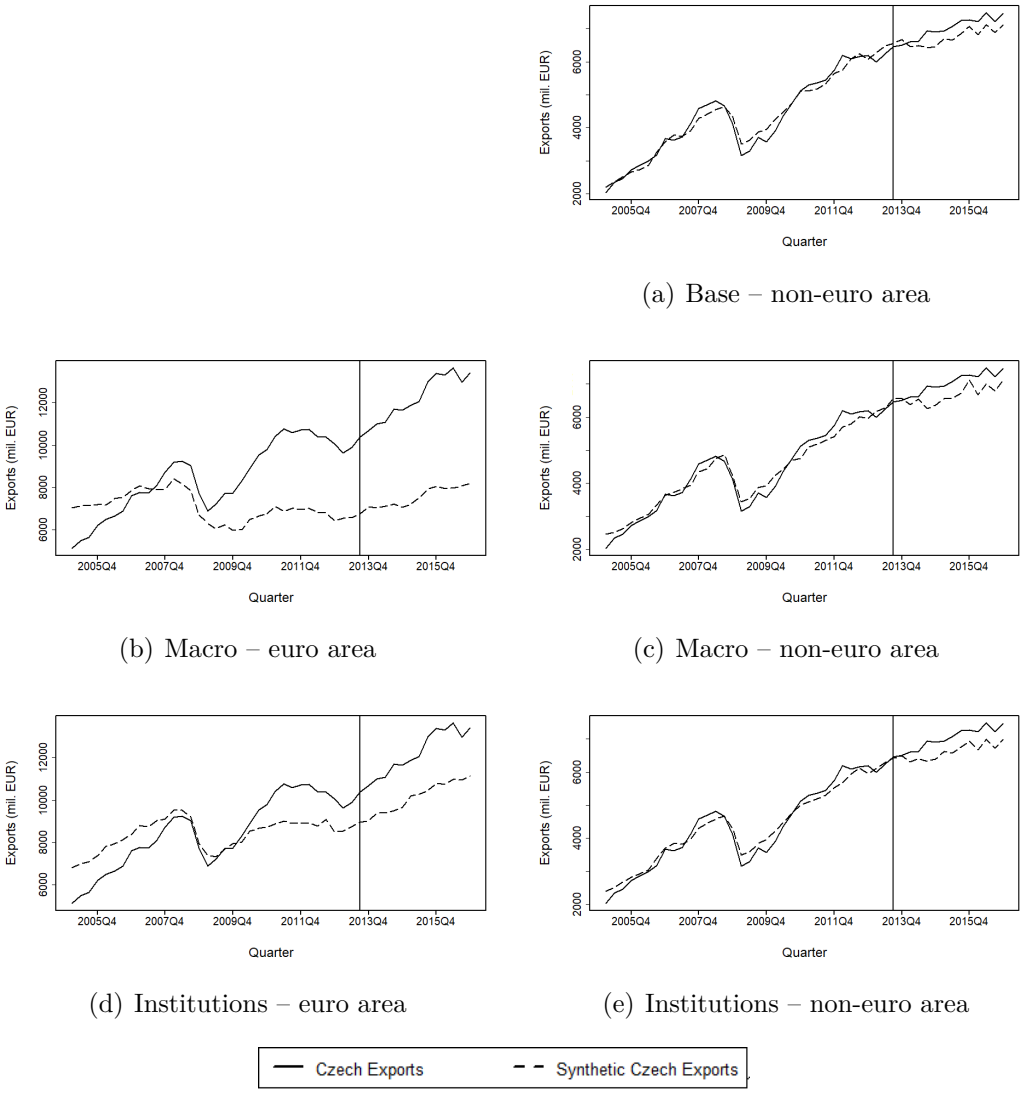


Table 5.16: Category 7 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.05%	17.77%	2.76%
Belgium	0.01%	0.05%	0.02%
Bulgaria	0.00%	0.00%	0.00%
Croatia	0.00%	0.01%	4.58%
Denmark	0.00%	0.00%	0.00%
Estonia	0.00%	0.00%	0.01%
Finland	0.00%	0.01%	0.01%
France	0.00%	0.00%	0.00%
Germany	14.43%	12.92%	0.47%
Greece	0.00%	0.00%	0.00%
Hungary	0.00%	0.00%	0.03%
Ireland	0.00%	0.00%	0.05%
Italy	0.00%	0.01%	0.01%
Latvia	0.00%	0.00%	0.01%
Lithuania	0.00%	0.01%	0.60%
Luxembourg	0.00%	0.01%	0.96%
Netherlands	0.04%	0.17%	0.56%
Poland	0.00%	0.01%	0.00%
Portugal	0.00%	0.01%	0.01%
Romania	35.47%	0.35%	25.76%
Slovakia	0.00%	0.00%	0.01%
Slovenia	0.00%	0.00%	0.00%
Spain	49.99%	68.66%	64.13%
Sweden	0.00%	0.01%	0.03%
United Kingdom	0.00%	0.00%	0.00%

sult of CNB's actions. Since the first quarter of 2014, the synthetic counterpart is bellow the treated unit, but the difference is only slightly higher than preintervention volatility and SCM in the placebo study shows even larger effect for some donors. The results for euro area countries explain the poor preintervention fit of the total exports in this category and in combination with an increase in exports outside the euro area explain the positive effect we estimated on the total in this category.

Figure 5.16: Category 7 – Exports to euro area and outside euro area



(a) Base – non-euro area

(b) Macro – euro area

(c) Macro – non-euro area

(d) Institutions – euro area

(e) Institutions – non-euro area

SCM procedure for base specification on euro area failed. Thus, the results cannot be presented.

We could not evaluate the impact of interventions on exports to Germany, because the synthetic exports diverge from the observed ones throughout the

whole preintervention period. The most likely reason for a poor fit of SCM is the large size of machinery and transport equipment export to Germany. Therefore, the SCM could not find suitable counterpart, because for most countries similar to the Czech Republic the exports to this destination are much smaller. Only exports from France and the Netherlands were higher, but those countries are more developed and their economies are large compared to the Czech Republic. There was no effect on exports to France, because synthetic counterpart is only slightly above the actual exports. The insignificance of the effect is confirmed by the placebo study. Similarly, there is no impact of CNB's commitment on exports to the United Kingdom. In most cases, the synthetic counterpart is close to the actual data and in specifications with poorer fit there is small difference already in 2012, which does not increase in the postintervention period. For Slovakia, only specification (3) has a good preintervention fit. Its results show no effect of interventions on Czech exports to this destination. Due to the volatility of Czech exports to the Netherlands the fit is poor in most cases, but the specification (1) shows large negative effect immediately after the start of interventions. The difference in exports is much larger than in SCM results for donors obtained from the placebo study, confirming the significance of result. The exports to Poland were unaffected, because the synthetic exports are slightly above the observed ones, but the placebo study shows differences are comparable to changes for donors. The synthetic counterpart is smaller than treated unit for Italy, but with exception of the year 2016 the difference is small. Therefore, the interventions had no impact on export to this partner. The results suggest no impact of interventions on trade with Austria. There was a large positive effect for exports to Spain, which rapidly increased in time. The exports to Belgium were probably unaffected by interventions, because the placebo study shows that the gap between synthetic and observed exports is comparable to gaps for donors. There is a large positive impact on exports to Hungary which increased during the whole postintervention period.

The main partners mentioned above form 75.56% of Czech exports in this category. For most of them, the results suggest no change. The results are robust to changes in length of preintervention period, where only for Spain and Italy, the results suggest a larger effect in the same direction, which is likely caused by the volatility between the true and placebo start of interventions. The high uncertainty in total results and exports to euro area countries is likely caused by a large share of this category on aggregate exports. Therefore, the model might encounter difficulties in finding countries similar to the Czech

Republic, which has such a large share in one category. This could be seen from the results for Germany, where the fit from SCM was poor. The results give some evidence for the role of undervalued currency in accessing new markets, because the exports to Hungary and Spain rapidly increase after interventions. The large positive effect for Hungary is causing an increase in exports to non-euro area countries. Additionally, similarly to the previous category, lower volatility does not seem to improve exports for more complex products.

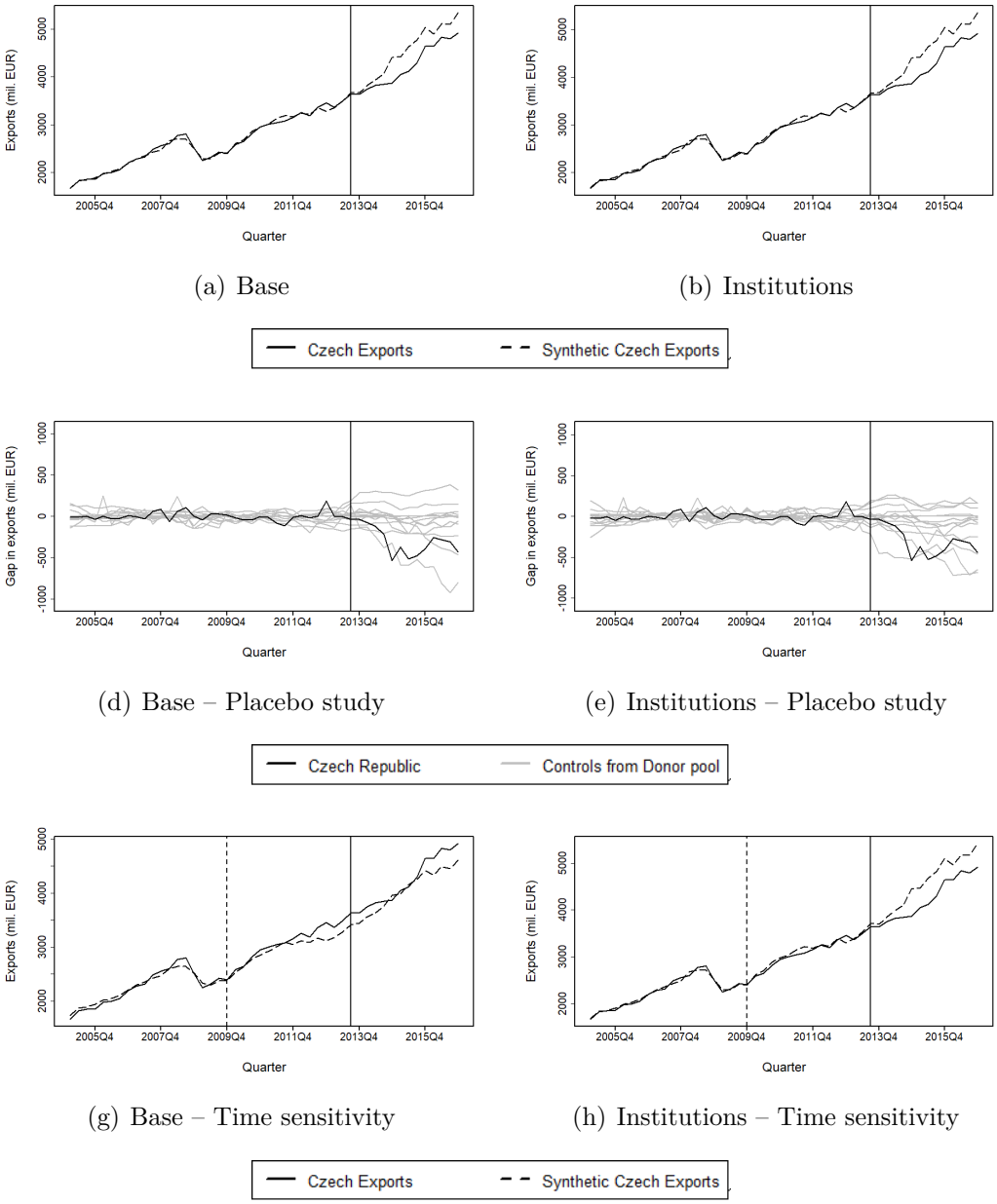
5.9 SITC category 8

The following paragraphs summarize the effect of interventions on Czech exports in the SITC category 8 – Miscellaneous manufactured articles. There seems to be negative effect of the interventions on the exports in this category. The synthetic counterpart is above observed exports and the difference appeared immediately after the start of interventions and increased until the end of 2014. Afterwards, the gap varies in time, but does not change its magnitude significantly. The overview of explanatory variables' weights is in Table 5.17. In the base model, the main ones are Country risk index and FMA. Table 5.18 shows the weights of the units from the donor pool for the construction of the synthetic exports in category 8. Romania and Spain have very large and remarkably stable shares across the specifications. The gap in exports does not differ from gaps for other countries in the donor pool. As a few other countries had larger effects, the impact of interventions on Czech exports was probably modest. Changing the start of the postintervention period resulted in a worse fit for some specifications of the model. In those cases, the results suggest no effect of positive effect, but the fit in the true preintervention period is not particularly good. In other cases, the preintervention fit was still very good and the effect stayed the same.

The interventions seem to have large negative effect on Czech export to the euro area. We could see their impact from large difference between synthetic and observed exports starting from the third quarter of 2014. The difference is much higher than for donor countries in placebo study. Because the synthetic counterpart follows closely the treated unit for countries outside the euro area, the negative impact on total exports of miscellaneous manufactured articles could be explained by the development of trade with the euro area. Additional results are presented in Figure 5.18.

The exports to Germany were negatively affected by the interventions, be-

Figure 5.17: Czech exports – Category 8



(a) Base

(b) Institutions

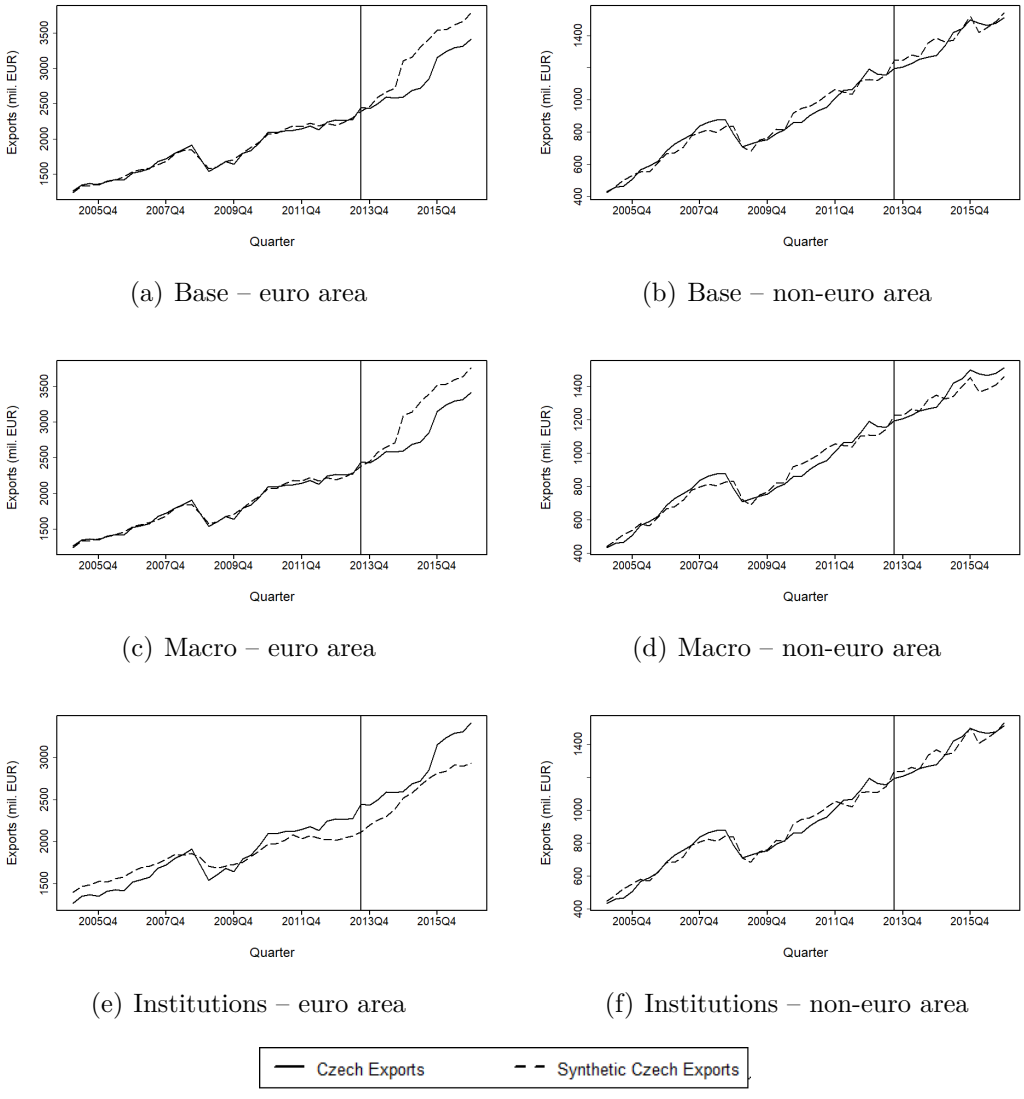
(d) Base – Placebo study

(e) Institutions – Placebo study

(g) Base – Time sensitivity

(h) Institutions – Time sensitivity

Figure 5.18: Category 8 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Table 5.17: Category 8 – Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	2.47%	3.45%	9.70%
Population	1.50%	0.50%	0.10%
Foreign market access	31.73%	42.83%	22.33%
Country risk index	41.93%	5.80%	10.79%
Labour market index	11.83%	1.96%	
FDI share	2.56%	30.87%	0.05%
Real exchange rate	7.98%	14.31%	6.25%
HICP		0.13%	12.85%
Unemployment		0.16%	0.01%
Size of government			1.53%
Legal system			16.12%
Sound money			7.98%
Freedom to trade			0.05%
Regulation			0.66%
Broadband subscriptions			0.01%
Internet share			11.33%
Telephone subscriptions			0.25%

cause the synthetic exports are above the observed ones from 2014 onwards. Similarly, there is a large negative effect of interventions on exports of Czech manufactured goods to Slovakia. In both cases, the impact of interventions is visible from 2014 and increases in time. The placebo study confirms the high significance of the results, because the effect is much larger than for donor pairs. The impact of interventions on Austria is unclear, because specifications (1) and (2) show the negative effect confirmed by placebo study, while (3) and (4) suggest no effect. The difference between synthetic and treated unit is small and comparable to donors in the placebo study for the United Kingdom. Thus, it was unaffected by the CNB's commitment. The results of specification (1) show no impact on exports to France. In remaining specifications, the counterpart was slightly below the observed exports, but the difference was present at the end of preintervention period and remained stable. The exports to Poland were unaffected by interventions, because for the whole observed period they are very close to each other. For both France and Poland, the synthetic exports are sensitive to change in preintervention period due to fluctuations of exports to those countries directly before the start of the alternative preintervention period. The exports to Italy were also unchanged according to results of specifications (2) to (4). The result of specification (1) shows negative impact, but

Table 5.18: Category 8 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.02%	0.36%	0.10%
Belgium	0.60%	0.06%	0.06%
Bulgaria	0.00%	0.01%	0.00%
Croatia	0.00%	0.04%	0.00%
Denmark	0.01%	0.02%	0.01%
Estonia	0.00%	0.01%	0.00%
Finland	0.00%	0.01%	0.00%
France	0.00%	0.01%	0.00%
Germany	0.00%	0.00%	0.38%
Greece	0.00%	0.00%	0.00%
Hungary	0.00%	0.01%	0.00%
Ireland	0.00%	0.01%	0.14%
Italy	0.00%	0.01%	0.00%
Latvia	0.00%	0.01%	0.00%
Lithuania	0.00%	0.01%	0.00%
Luxembourg	0.00%	0.01%	0.00%
Netherlands	0.00%	0.20%	2.99%
Poland	0.00%	0.01%	0.00%
Portugal	0.00%	0.02%	0.00%
Romania	57.09%	57.54%	57.82%
Slovakia	0.00%	0.01%	0.00%
Slovenia	0.00%	0.01%	0.00%
Spain	42.28%	41.61%	38.50%
Sweden	0.00%	0.01%	0.00%
United Kingdom	0.00%	0.01%	0.00%

sensitivity to change of intervention timing suggests its instability. There is an adverse effect of interventions for the Netherlands as visible from the difference between Czech exports to this destination and its synthetic counterpart from 2013 onwards. In the placebo study, we see that the results might be random, because some donors show similar or larger differences. For Belgium, we see similar negative development starting in 2014.

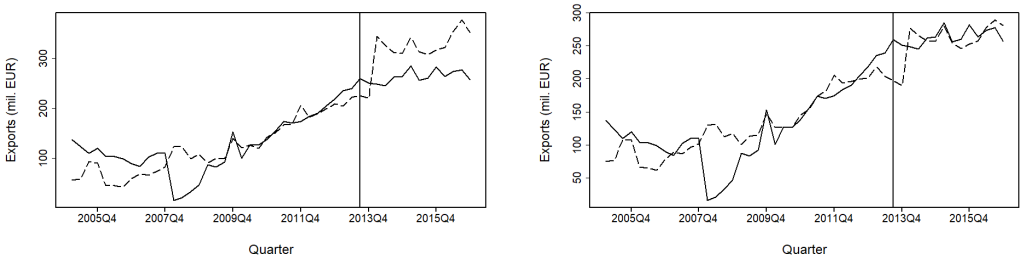
Over the period 2000-2016 the share of main export partners on category's total was 75.35%. The results for individual trade partners confirm the negative effect we found in total sectoral exports. Moreover, most of the negatively affected countries were from the euro area, which supports the finding for this group on total sectoral data. This is unexpected, given that the theory and empirical evidence suggest a positive effect from undervalued currency. The reduced exchange rate volatility should not have any effect in this category, because it consists of complex goods.

5.10 SITC category 9

The exports in the SITC category 9 – Commodities and transactions, n.e.s. were negatively affected by the CNB's exchange rate commitment, because the specifications with good preintervention fit show true exports are well below its synthetic counterpart. In Figure 5.19, we see that the start of effect is close to beginning of postintervention period. The most important explanatory variables in the base model are FDI share, FMA, labour index, and real exchange rate. Table 5.20 shows the importance of donors in construction of the synthetic exports. In the specifications with good fit, the largest weights are assigned to Spain and Romania. The results of the placebo study show that the gap after the interventions is not large compared to gaps for donor countries. This suggests borderline significance of the result. The results in this category are extremely sensitive to change in the preintervention period, because it results in a completely different pattern. This is likely the result of the high volatility of exports and short length of new preintervention period.

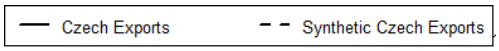
The exports to euro area are extremely volatile and the synthetic counterpart does not fit them well, because they either miss the turning points in specifications where they try to follow the data or they are line following relatively stable path through the middle of observed exports in the preintervention period. Hence, we could not infer the impact of CNB's commitment on those countries. Although, the exports outside the euro area have a relatively stable

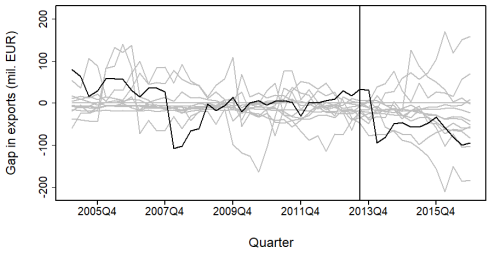
Figure 5.19: Czech exports – Category 9



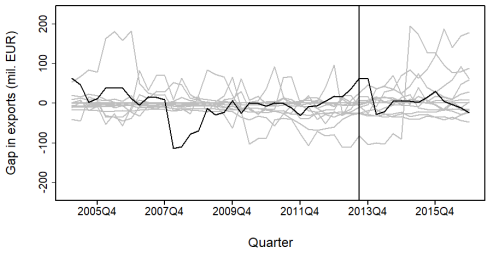
(a) Base

(b) Institutions

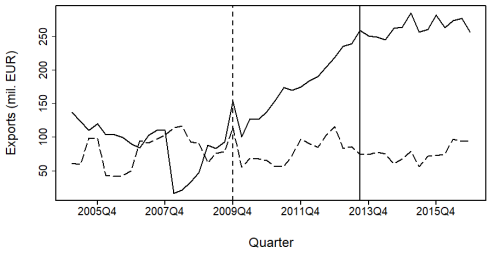




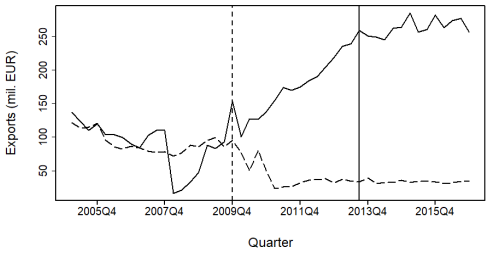
(d) Base – Placebo study



(e) Institutions – Placebo study



(g) Base – Time sensitivity



(h) Institutions – Time sensitivity

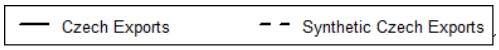


Table 5.19: Category 9 - Weights of explanatory variables

Variable	Base	Macro	Institutions
GDP	0.37%	0.15%	16.84%
Population	5.46%	0.00%	9.81%
Foreign market access	26.05%	22.84%	0.20%
Country risk index	0.81%	4.04%	24.40%
Labour market index	14.48%	16.03%	
FDI share	41.62%	35.52%	1.10%
Real exchange rate	11.20%	16.54%	6.56%
HICP		3.10%	3.54%
Unemployment		1.78%	0.50%
Size of government			2.36%
Legal system			22.30%
Sound money			1.55%
Freedom to trade			5.01%
Regulation			0.28%
Broadband subscriptions			0.26%
Internet share			3.93%
Telephone subscriptions			1.35%

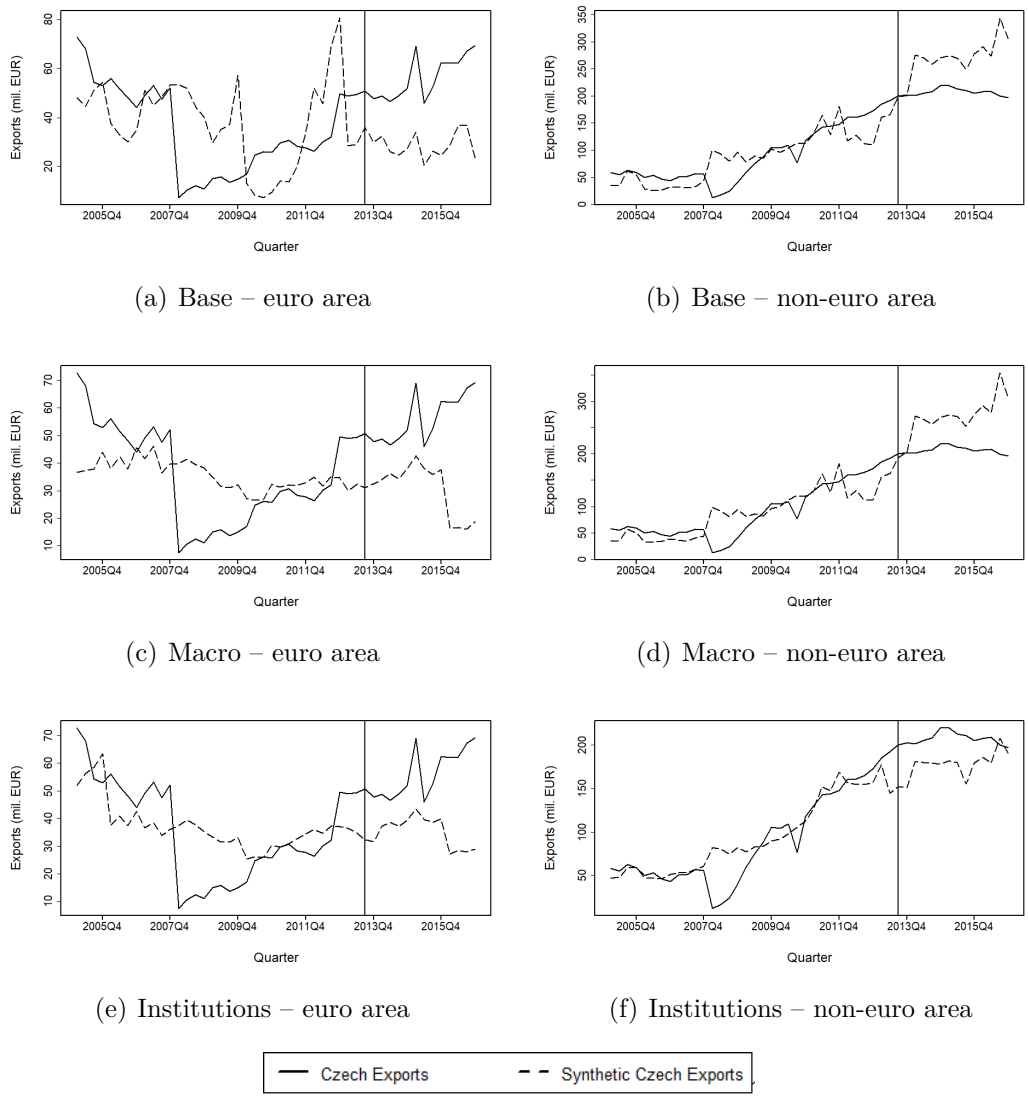
path, the synthetic counterpart is volatile and depending on the specification it suggests either positive or negative effect of the interventions which was in both cases confirmed by the placebo study. This difference is caused by poor fit directly before the start of interventions in both cases. More details are available in Figure 5.20. Better fit in base specification for total sectoral exports is probably caused by large negative gap for the euro area and positive gap for non-euro area countries, which cancel out each other. Thus, this specification does not provide reliable results.

Similarly to other categories with large volatility, the fit here is imperfect for many destinations, leading to difficulties in finding causal relationships. The exports to Germany were most likely unaffected by the interventions. In the postintervention period, the differences between synthetic and treated unit were similar to those before 2013. Placebo study confirms the findings and gives further evidence for no effect on exports to this destination. The exports to Slovakia risen sharply immediately after the start of interventions. The size of the impact is confirmed by the placebo study, where the effect for donor pairs were much smaller. We cannot evaluate the effect of CNB's commitment on exports to Poland, Italy, and Austria, because the synthetic counterpart fails to fit the observed exports well.

Table 5.20: Category 9 – Donor weights

Donor	Base	Macro	Institutions
Austria	0.13%	0.01%	0.00%
Belgium	10.64%	10.80%	6.64%
Bulgaria	0.00%	0.00%	4.98%
Croatia	0.01%	0.00%	0.00%
Denmark	0.01%	0.00%	1.80%
Estonia	0.00%	0.00%	0.00%
Finland	0.00%	0.00%	0.00%
France	0.00%	0.00%	0.00%
Germany	0.02%	0.00%	0.00%
Greece	0.00%	0.00%	0.00%
Hungary	0.00%	0.00%	0.00%
Ireland	0.00%	0.00%	12.63%
Italy	0.01%	0.00%	0.00%
Latvia	0.01%	0.00%	0.00%
Lithuania	0.00%	0.00%	2.12%
Luxembourg	0.01%	0.00%	0.00%
Netherlands	0.02%	0.00%	4.13%
Poland	0.01%	0.00%	0.00%
Portugal	0.01%	0.00%	0.00%
Romania	38.13%	37.60%	9.47%
Slovakia	0.00%	0.00%	0.00%
Slovenia	0.00%	0.00%	0.00%
Spain	50.98%	51.59%	47.09%
Sweden	0.01%	0.00%	11.12%
United Kingdom	0.00%	0.00%	0.00%

Figure 5.20: Category 9 – Exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

This category is characteristic by small share of EU countries thus our main partners from EU account only for 26.28% of the exports during the observed period. The poor fit results in large changes of synthetic exports, when we alter preintervention period. The only exception is Slovakia, where the effect remains unchanged. Because the results for main trade partners were mostly inconclusive, the evidence from bilateral exports does give any support to findings from total exports.

Chapter 6

Discussion of results

This chapter summarizes the results presented in the previous chapter and evaluates whether the stated hypotheses were supported by them.

Table 6.1 serves as a quick overview of the results from chapter Chapter 5. It shows whether the interventions had positive, negative, or no effect on total sectoral exports in each SITC category. Additionally, it includes the impacts on sectoral exports to euro area and non-euro area countries. From the table, we can easily determine the validity of hypotheses. When there is a plus sign in the category's column Total, the first hypothesis of the positive effect of exchange rate commitment on total exports in a given category is supported by the results presented in Chapter 5. The second hypothesis of positive effect of reduced exchange rate volatility on exports could be corroborated, when positive effect on euro area is larger than for countries outside euro area. Finally, the third hypothesis of varying effects of exchange rate volatility across the sectors is supported by our results, because from the table we see changing impact on the euro area and other countries.

Table 6.1: Impact of CNB's exchange rate commitment – Summary

Category	Total	Euro area	Non-euro area
0 - Food and live animals	+	0	+
1 - Beverages and tobacco	+	+	0
2 - Crude materials, inedible, except fuels	0	-	+
3 - Mineral fuels, lubricants and related materials	+	+	?
4 - Animal and vegetable oils, fats and waxes	+	0	+
5 - Chemicals and related products	0	+	+
6 - Manufactured goods	0	0	0
7 - Machinery and transport equipment	+	?	+
8 - Miscellaneous manufactured articles	-	-	0
9 - Commodities and transactions	-	?	-

+ - positive effect, 0 - no effect, - - negative effect, ? - ambiguous effect or could not be evaluated

The CNB's exchange rate commitment had a positive effect on Czech exports in half of the SITC categories. Therefore, the first hypothesis is corroborated for those categories. Categories 8 and 9 show negative effect on total exports in the postintervention period. This contradicts the notion, we described in Chapter 2, that undervalued currency and reduced exchange rate volatility have a positive effect on exports. In category 9, it could be attributed to the high volatility of Czech exports, which resulted into a poor preintervention fit. Additionally, this category contains residual products. The results for category 8 are puzzling, because the fit is very good and impact is supported by robustness checks. We cannot rule out influence of some other event for the exports in this category. Because a large share of export categories were positively affected, the CNB's exchange rate commitment succeeded in its secondary goal of improving the state of the Czech economy. We cannot evaluate the exact size of the positive effect, because there is uncertainty about the size of impact on total exports in category 7.

The findings on exports to euro area and outside contradict the literature on exchange rate volatility and its effect on exports. We expected the effect would be more positive for euro area countries, because there was no exchange rate volatility due to exchange rate commitment. However, the results show that in certain categories, the impact on exports to euro area was large, while in other categories, the effect was reversed. Thus, the second hypothesis holds only for SITC categories 1, 3, and 5.

We found significant differences between the effects of CNB's commitment across the categories, which supports the third hypothesis of varying effect of interventions across the sectors. However, we expected this effect would be caused mainly by higher effect of reduced exchange rate volatility on exports in primary goods. This is not true, because in some categories the exports outside euro area were higher. Those were the countries with higher volatility of exchange rate. Therefore, its reduction is not the sole explanation for different impact across the countries. Theory suggests that barriers to exports could be decreased by undervalued currency. Because Czech Republic traded heavily with euro area countries already in preintervention period, the positive effect from reduction of barriers is likely small. On the other hand, the impact might be substantial for remaining countries, which would explain the phenomenon we observed.

Effects found in total sectoral data are supported by application of SCM on bilateral sectoral data. In the majority of cases, the impact of interventions on

exports in given category has the same direction. Moreover, for Czech sectoral exports to euro area countries we see the same impact as for main trade partners from this area. The same is true for sectoral exports outside this region. The exceptions are category 5 where the effect for euro and non-euro area were different from main destinations, and category 3 where also total sectoral effect differed. The effect we found in bilateral sectoral exports is robust to use of donor pool based by Euclidean distance. In most cases, this method resulted in a worse preintervention fit.

The results for total sectoral exports in each category are similar across the specifications. The category 9 is exception. In category 7, the preintervention fit improves, when we include additional variables. If we divide total sectoral exports to flows into euro area countries and remaining countries, the sensitivity to change of specification increases. The same is true for bilateral sectoral exports. The changes in synthetic exports from using different specification are more frequent, when the data in preintervention period are volatile.

The results from robustness check where we change the time of interventions suggests low sensitivity of estimated effects for synthetic units with good preintervention fit and lower volatility of the data. Similarly to the previous case, the sensitivity is higher with more detailed data. However, the results in most cases stayed remarkably stable even though we have relatively short preintervention periods.

Chapter 7

Conclusion

The thesis studied the effect of CNB's exchange rates commitment on Czech exports divided into sectors. The theory suggests positive impact of interventions. They cause undervaluation of koruna, leading to decrease of relative prices of Czech goods, which promotes exports. Also, the reduction of exchange rate volatility caused by pegging koruna to euro should have a positive effect, because the decrease of uncertainty about profits helps exporters in entering new markets. To evaluate the effect of CNB's commitment we used Synthetic Control Method. The covariates for explaining the total sectoral exports and exports to euro area and non-euro area countries are taken from UNCTAD (2005) based on Redding & Venables (2004). In SCM of bilateral sectoral exports, we used covariates from Hannan (2016).

The results of SCM on total sectoral exports show positive effect of interventions on the following categories: Food and live animals, Beverages and tobacco, Mineral fuels, lubricants and related materials, Animal and vegetable oils, and fats and waxes. These are smaller categories and none of them had a share on Czech exports higher than 4% during the period 2000-2016. The effect on the largest category of Czech exports, Machinery and transport equipment, is uncertain, because the suggested impact is large and positive, but the fit during large part of the preintervention period is not good. The exports of Miscellaneous manufactured articles were negatively affected by the CNB's commitment. Remaining export categories were not influenced by the interventions. The overall effect seems to be positive which supports the first hypothesis that exchange rate commitment of CNB increased Czech exports. However, the size of the effect could not be evaluated, because the size of the impact in the most important category of exports is uncertain.

Our results contradict the second hypothesis, that rise in Czech export to euro area will be higher than to other countries. In some categories, the effect on countries outside the euro area is larger than the impact on euro area countries. Moreover, in some categories the impact of CNB's interventions was negative for euro area countries, while for non-euro area countries there was no such category. One possible explanation is the depreciation of euro during the sovereign debt crisis, which would decrease the competitive advantage of Czech exports to the euro area. Another explanation might be that most of the firms able to export to euro area already did so before the interventions. Therefore, only a small amount of firms used the reduced uncertainty to start exporting to the euro area.

From the results we clearly see large differences on impact for various export categories. This supports our hypothesis that the impact of interventions varies across the sectors. Moreover, we partly confirm the results of previous empirical studies, because the largest variation is observed in categories containing primary goods. However, the reason for changing effects across the categories is not reduced exchange rate volatility, suggested in previous studies, but the theories which explained why results contradicted the second hypothesis.

The thesis contributed current knowledge by using a new approach to evaluating the impact of events and policies on sectoral exports, both total and bilateral. Because SCM performed well on the total sectoral data, the researchers have new usefull tool for evaluating the effect of policies on country's export performance. Inclusion of additional variables improved the fit in most cases, thus in further research we suggest using the specification with additional macroeconomic variables, and institution and infrastructure controls. The method is not suitable for evaluation of impact on volatile data. This is visible on categories with sharp and frequent changes in exports, where fit of SCM is poor and the results are not robust. For this reason, the method is not very good in evaluating the policy effect on bilateral exports, because they are more volatile than total ones. However, SCM performs well for large destinations with stable exports in preintervention period. Another caveat is the restriction of donor weights' sum, because we cannot evaluate the effects for exceptional cases. In our study, we encountered this problem on Czech exports to Germany in category 7, which are very large and we lack suitable donors. Studying the performance of SCM in the absence of this restriction could be an interesting topic for researchers in the future.

Furthermore, this study contributed current research by evaluating the im-

pact of CNB's exchange rate commitment. Additional empirical studies of this topic would be very helpful in determining the long-term effect of the interventions, because the period since their end is very short. Most important insight that could be obtained from such study in future would be the comparison of the effect on euro area countries and remaining countries, because if the effect for non-euro area countries persists, then it is likely that undervaluation helped new exporters in entering the market.

Bibliography

Abadie, A., A. Diamond, & J. Hainmueller (2010): "Synthetic control methods for comparative case studies: Estimating the effect of california's tobacco control program." *Journal of the American statistical Association* **105(490)**: pp. 493–505.

Abadie, A., A. Diamond, & J. Hainmueller (2015): "Comparative politics and the synthetic control method." *American Journal of Political Science* **59(2)**: pp. 495–510.

Abadie, A. & J. Gardeazabal (2003): "The economic costs of conflict: A case study of the basque country." *The American Economic Review* **93(1)**: pp. 113–132.

Anderson, J. E. & E. Van Wincoop (2003): "Gravity with gravitas: a solution to the border puzzle." *the american economic review* **93(1)**: pp. 170–192.

Auboin, M. & M. Ruta (2013): "The relationship between exchange rates and international trade: a literature review." *World Trade Review* **12(3)**: pp. 577–605.

Bahmani-Oskooee, M. & S. W. Hegerty (2009): "The effects of exchange-rate volatility on commodity trade between the united states and mexico." *Southern Economic Journal* pp. 1019–1044.

Baldwin, R. E. (1988): "Hysteresis in import prices: the beachhead effect." *The American Economic Review* **78**: pp. 773–785.

Berger, H. & V. Nitsch (2008): "Zooming out: The trade effect of the euro in historical perspective." *Journal of International Money and Finance* **27(8)**: pp. 1244–1260.

Berman, N. & A. Berthou (2009): "Financial market imperfections and the impact of exchange rate movements on exports." *Review of International Economics* **17(1)**: pp. 103–120.

Bernard, A. B. & J. B. Jensen (2004): "Why some firms export." *The review of economics and statistics* **86(2)**: pp. 561–569.

Bredin, D., S. Fountas, & E. Murphy (2003): "An empirical analysis of short-run and long-run irish export functions: Does exchange rate volatility matter?" *International Review of Applied Economics* **17(2)**: pp. 193–208.

Broll, U. & B. Eckwert (1999): "Exchange rate volatility and international trade." *Southern Economic Journal* pp. 178–185.

Brůha, J. & J. Tonner (2017): "An exchange rate floor as an instrument of monetary policy: An ex-post assessment of the czech experience." *Czech National Bank, Working paper series* **4**: p. 2017.

Campa, J. M. (2004): "Exchange rates and trade: How important is hysteresis in trade?" *European Economic Review* **48(3)**: pp. 527–548.

Caselli, F. G. (2017): *Did the Exchange Rate Floor Prevent Deflation in the Czech Republic?* International Monetary Fund.

Clark, P. B. (1973): "Uncertainty, exchange risk, and the level of international trade." *Economic Inquiry* **11(3)**: pp. 302–313.

Das, S., M. J. Roberts, & J. R. Tybout (2007): "Market entry costs, producer heterogeneity, and export dynamics." *Econometrica* **75(3)**: pp. 837–873.

Demko, I. & E. C. Jaenicke (2017): "Impact of european union–us organic equivalency arrangement on us exports." *Applied Economic Perspectives and Policy* .

Dixit, A. (1989): "Entry and exit decisions under uncertainty." *Journal of political Economy* **97(3)**: pp. 620–638.

Francois, J. & M. Manchin (2013): "Institutions, infrastructure, and trade." *World Development* **(46)**: pp. 165–175.

Franta, M., T. Holub, P. Král, I. Kubicova, K. Smidkova, & B. Vašíček (2014): "The exchange rate as an instrument at zero interest rates: The case of the czech republic." *Technical report*, Czech National Bank, Research Department.

Freund, C. & M. D. Pierola (2010): "Export entrepreneurs: evidence from peru." *Policy Research Working Paper Series* .

Géczy, C., B. A. Minton, & C. Schrand (1997): "Why firms use currency derivatives." *the Journal of Finance* **52(4)**: pp. 1323–1354.

Hall, S., G. Hondroyiannis, P. Swamy, G. Tavlas, & M. Ulan (2010): "Exchange-rate volatility and export performance: Do emerging market economies resemble industrial countries or other developing countries?" *Economic Modelling* **27(6)**: pp. 1514–1521.

Hannan, S. A. (2016): *The Impact of Trade Agreements: New Approach, New Insights*. International Monetary Fund.

Hannan, S. A. (2017): *The Impact of Trade Agreements in Latin America using the Synthetic Control Method*. International Monetary Fund.

Hosny, A. S. (2012): "Algeria's trade with gafta countries: A synthetic control approach." *Transition Studies Review* **19(1)**: pp. 35–42.

Kandilov, I. T. (2008): "The effects of exchange rate volatility on agricultural trade." *American Journal of Agricultural Economics* **90(4)**: pp. 1028–1043.

Kandilov, I. T. & A. Leblebicioğlu (2011): "The impact of exchange rate volatility on plant-level investment: Evidence from colombia." *Journal of Development Economics* **94(2)**: pp. 220–230.

Klein, M. W. & J. C. Shambaugh (2006): "Fixed exchange rates and trade." *Journal of international Economics* **70(2)**: pp. 359–383.

Krugman, P., M. Obstfeld, & M. Melitz (2014): "International economics: Theory and policy." *INSTRUCTOR* **1150**: p. 251.

Malovaná, S. (2015): "Foreign exchange interventions at the zero lower bound in the czech economy: A dsge approach." *Technical report*, IES Working Paper.

Melitz, M. J. (2003): "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica* **71(6)**: pp. 1695–1725.

Nicita, A. (2013): "Exchange rates, international trade and trade policies." *International Economics* **135**: pp. 47–61.

Opatrný, M. (2016): "Quantifying the effects of the cnb's exchange rate commitment: A synthetic control method approach." *Working Papers IES* .

Péridy, N. (2003): "Exchange rate volatility, sectoral trade, and the aggregation bias." *Review of World Economics* **139(3)**: pp. 389–418.

Raff, H. & Y.-H. Kim (1999): "Optimal export policy in the presence of informational barriers to entry and imperfect competition." *Journal of International Economics* **49(1)**: pp. 99–123.

Redding, S. & A. Venables (2004): "Geography and export performance: external market access and internal supply capacity." In "Challenges to globalization: Analyzing the economics," pp. 95–130. University of Chicago Press.

Rose, A. K. & T. D. Stanley (2005): "A meta-analysis of the effect of common currencies on international trade." *Journal of economic surveys* **19(3)**: pp. 347–365.

Skořepa, M., V. Tomšík, J. Vlcek *et al.* (2016): "Impact of the cnb's exchange rate commitment: pass-through to inflation." *BIS Papers chapters* **89**: pp. 153–167.

UNCTAD (2005): "Developing countries in international trade 2005." In "United Nations conference on trade and development," .

Wang, K.-L. & C. B. Barrett (2007): "Estimating the effects of exchange rate volatility on export volumes." *Journal of Agricultural and Resource Economics* pp. 225–255.

Yotov, Y. V., R. Piermartini, J.-A. Monteiro, & M. Larch (2016): "An advanced guide to trade policy analysis: The structural gravity model." *World Trade Organization, Geneva* .

Appendix A

Additional results

Table A.1: Share of main export destinations on Czech aggregate exports in 2016

Destination	Share
Germany	32.22%
Slovakia	8.32%
Poland	5.74%
United Kingdom	5.23%
France	5.12%
Italy	4.23%
Austria	4.21%
Hungary	2.86%
Netherlands	2.86%
Spain	2.78%
Belgium	2.33%
United States	2.12%
Russia	1.88%
Other	19.41%

Figure A.1: Czech aggregate exports

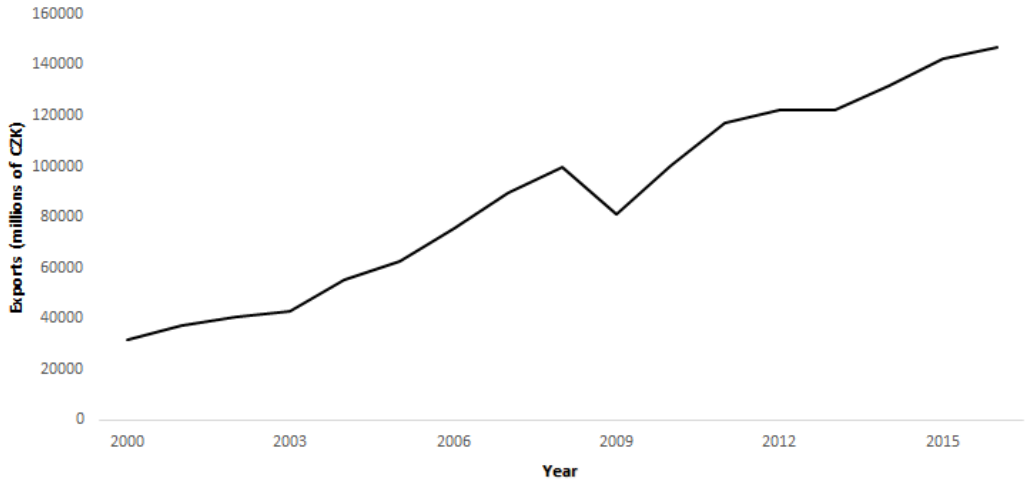


Figure A.2: Share of EU countries on Czech aggregate exports

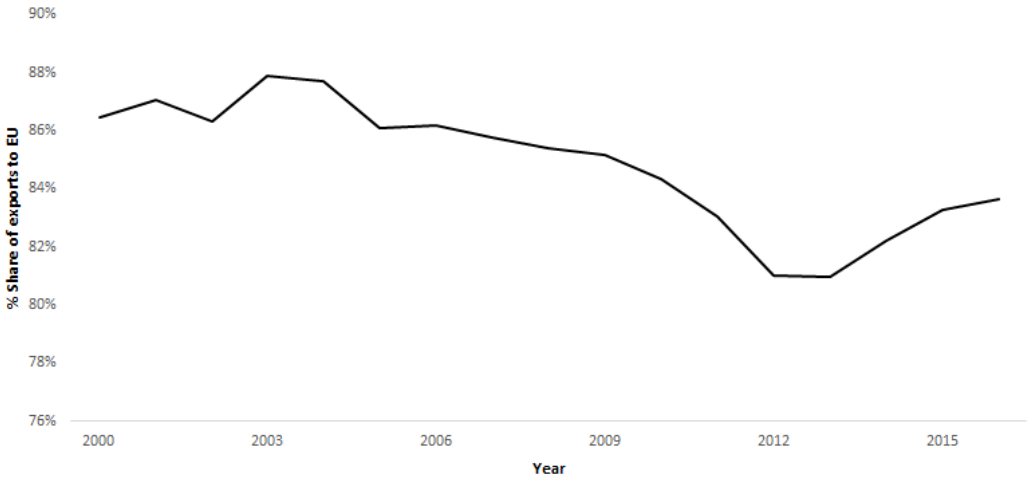


Table A.2: Regional structure of Czech exports

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
East Asia & Pacific	2.17%	1.81%	2.00%	1.90%	1.76%	1.86%	1.87%	2.16%	1.98%	2.20%	2.49%	2.70%	3.13%	3.46%	3.39%	3.40%	3.19%
Europe & Central Asia	91.62%	92.03%	91.67%	92.68%	92.79%	91.85%	92.44%	92.60%	92.21%	91.47%	91.30%	91.23%	90.24%	89.93%	89.81%	89.43%	89.85%
Latin America & Caribbean	0.57%	0.58%	0.48%	0.41%	0.48%	0.62%	0.60%	0.61%	0.58%	0.88%	0.77%	0.74%	0.81%	0.83%	0.85%	0.88%	0.82%
Middle East & North Africa	1.57%	1.55%	1.58%	1.38%	1.40%	1.78%	1.49%	1.51%	1.50%	2.00%	1.86%	1.59%	1.82%	1.79%	2.02%	2.20%	2.25%
North America	3.04%	3.03%	3.03%	2.60%	2.43%	2.86%	2.54%	2.05%	1.86%	1.69%	1.83%	2.07%	2.41%	2.31%	2.34%	2.48%	2.28%
South Asia	0.40%	0.28%	0.46%	0.30%	0.37%	0.40%	0.49%	0.54%	0.55%	0.61%	0.66%	0.58%	0.48%	0.40%	0.39%	0.42%	0.46%
Sub-Saharan Africa	0.19%	0.19%	0.20%	0.16%	0.31%	0.36%	0.40%	0.39%	0.42%	0.43%	0.51%	0.55%	0.50%	0.52%	0.53%	0.51%	0.47%
Others	0.44%	0.54%	0.57%	0.56%	0.45%	0.27%	0.17%	0.13%	0.90%	0.72%	0.58%	0.54%	0.61%	0.75%	0.68%	0.68%	0.69%

The table shows percentage share of each region on Czech aggregate exports in given year.

Table A.3: SITC division of Czech exports

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Food and live animals	2.94%	2.72%	2.48%	2.65%	2.71%	3.27%	2.93%	2.90%	3.13%	3.45%	3.01%	3.17%	3.52%	3.65%	3.59%	3.65%	3.56%
Beverages and tobacco	0.75%	0.69%	0.67%	0.60%	0.51%	0.57%	0.51%	0.58%	0.66%	0.76%	0.66%	0.59%	0.65%	0.71%	0.75%	0.86%	0.90%
Crude materials, inedible, except fuels	3.53%	3.05%	2.80%	2.80%	2.60%	2.41%	2.47%	2.55%	2.64%	2.69%	2.99%	2.81%	2.81%	2.67%	2.44%	2.21%	2.04%
Mineral fuels, lubricants and related materials	3.05%	3.01%	2.87%	2.88%	2.85%	3.07%	2.91%	2.73%	3.40%	3.63%	3.71%	3.81%	3.86%	3.05%	2.72%	3.00%	1.94%
Animal and vegetable oils, fats and waxes	0.11%	0.11%	0.08%	0.07%	0.06%	0.09%	0.09%	0.08%	0.11%	0.13%	0.18%	0.16%	0.29%	0.28%	0.28%	0.32%	0.34%
Chemicals and related products	7.10%	6.44%	5.94%	5.88%	5.58%	6.00%	5.79%	5.57%	5.99%	6.24%	6.34%	6.06%	5.98%	6.12%	6.39%	5.97%	5.81%
Manufactured goods	25.43%	24.38%	23.43%	23.08%	22.18%	21.71%	20.85%	20.18%	19.48%	17.53%	17.13%	17.58%	17.26%	17.28%	16.42%	15.76%	15.36%
Machinery and transport equipment	44.46%	47.28%	49.66%	50.13%	51.58%	50.66%	53.03%	54.16%	53.79%	53.46%	54.51%	54.74%	54.12%	53.86%	55.03%	55.43%	56.28%
Miscellaneous manufactured articles	12.43%	12.22%	11.93%	11.78%	11.21%	11.45%	10.89%	10.79%	10.70%	11.61%	10.98%	10.50%	10.86%	11.57%	11.60%	12.03%	13.05%
Commodities and transactions	0.20%	0.10%	0.15%	0.13%	0.73%	0.77%	0.52%	0.47%	0.11%	0.51%	0.49%	0.58%	0.65%	0.80%	0.77%	0.77%	0.73%

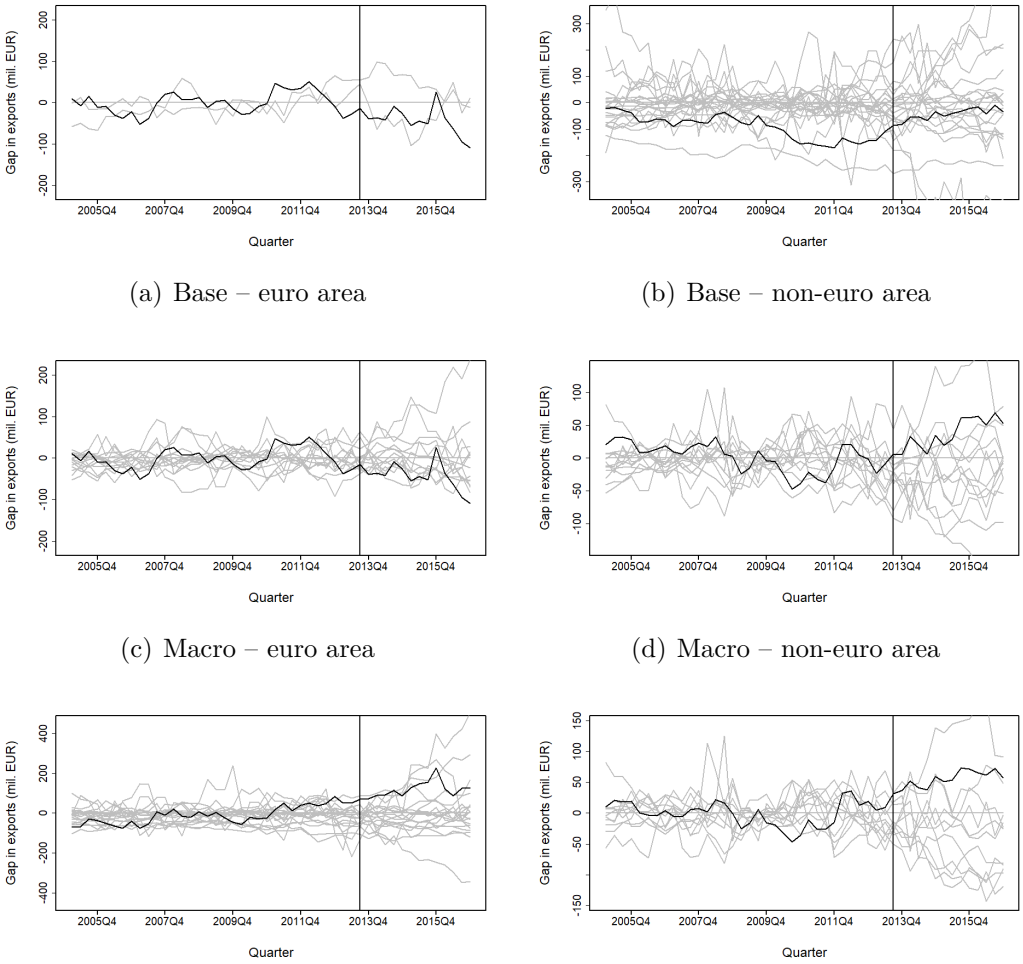
The table shows percentage share of each SITC category on Czech aggregate exports in given year.

Table A.4: Donor pools for Czech export destinations

Destination		
Slovakia	Origins	AUT, POL, HUN, SVK, SVN, ROM, HRV, ESP, PTE, LAT, LTU, EST
	Destinations	SVK, SVN, HUN, AUT, ROM, HRV, ESP, PTE, LAT, LTU, EST, DEU
Germany	Origins	POL, AUT, FRA, BEL, NLD, LUX, DNK, HUN, SVK, SVN, ROM, HRV, LTU
	Destinations	DEU, FRA, ESP, POL, ITA, NLD, GBR, AUT, BEL, SVN, HUN, SVK
Poland	Origins	DEU, SVK, LTU, POL, HUN, SVN, ROM, HRV
	Destinations	POL, AUT, FRA, BEL, NLD, LUX, DNK, HUN, LAT, ROM, SVK, LTU, DEU
Austria	Origins	DEU, SVK, HUN, SVN, ITA, POL, ROM, HRV, LTU
	Destinations	AUT, FRA, BEL, NLD, LUX, DNK, HUN, POL, HRV, SVN, SVK, ROM, ITA, FRA, SWE, FIN, DEU
Hungary	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	SVK, HUN, SVN, POL, ROM, HRV, LTU
Italy	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	ITA, ESP, FRA, DEU, GBR
United Kingdom	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	GBR, ITA, FRA, DEU, ESP, NLD, BEL, IRL
France	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	FRA, GBR, DEU, ESP, ITA, BEL, NLD
Romania	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	ROM, BGR, POL, HUN, GRC, HRV, SVN, SVK
Netherlands	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	NLD, BEL, LUX, SWE, DNK, FRA, DEU, AUT
Sweden	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	SWE, DNK, NOR, FIN, NLD, BEL, IRL
Slovenia	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	SVN, SVK, ROM, HUN, HRV, BGR, LTU
Bulgaria	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	BGR, ROM, POL, HUN, GRC, HRV, SVN, SVK, LTU
Belgium	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	NLD, BEL, LUX, SWE, DNK, FRA, DEU, AUT
Spain	Origins	SVK, HUN, SVN, POL, ROM, HRV, LTU
	Destinations	ESP, FRA, DEU, GBR, PRT

A.1 SITC category 0

Figure A.3: Category 0 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

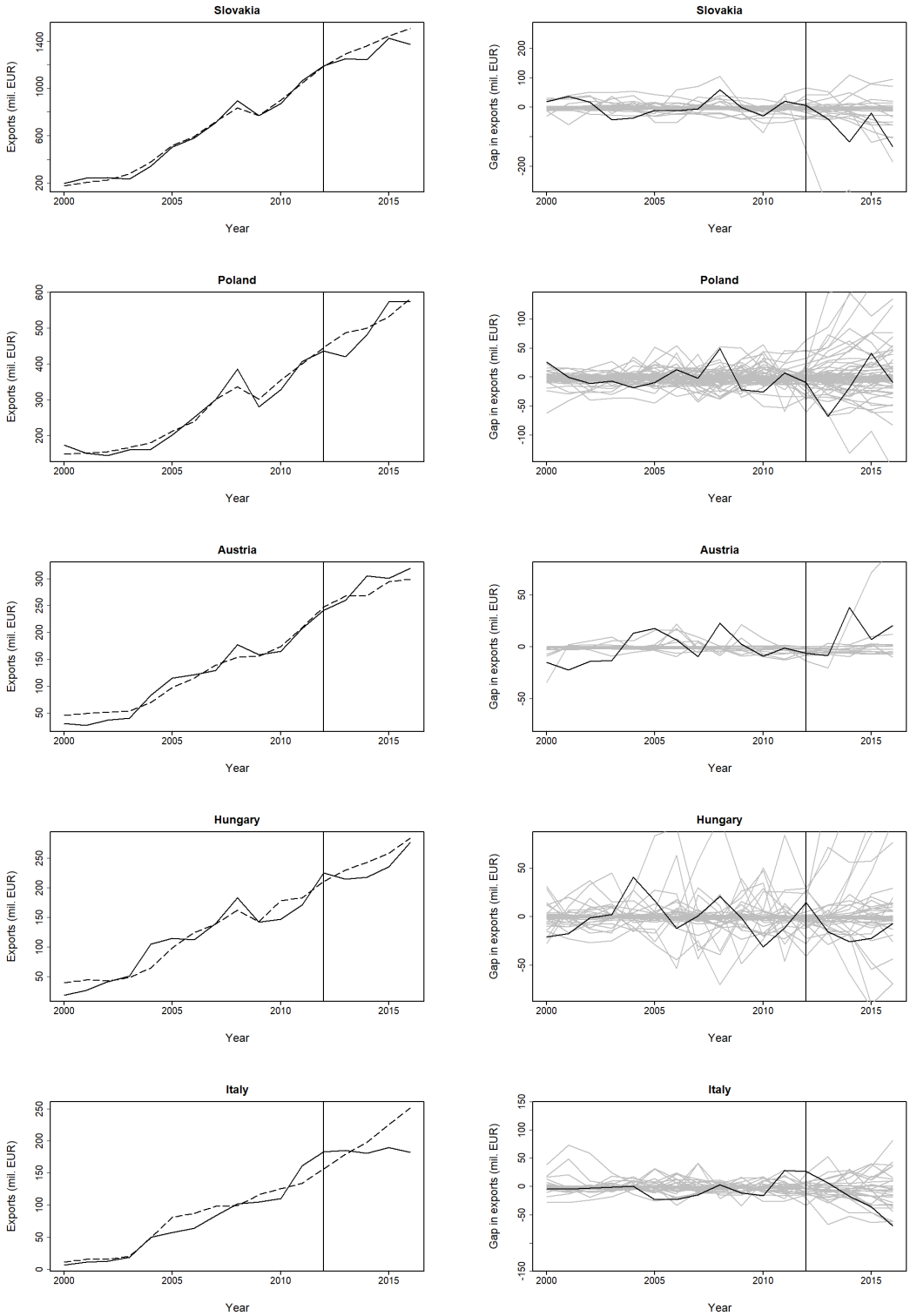
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.4: Category 0 – Bilateral exports (Base specification)



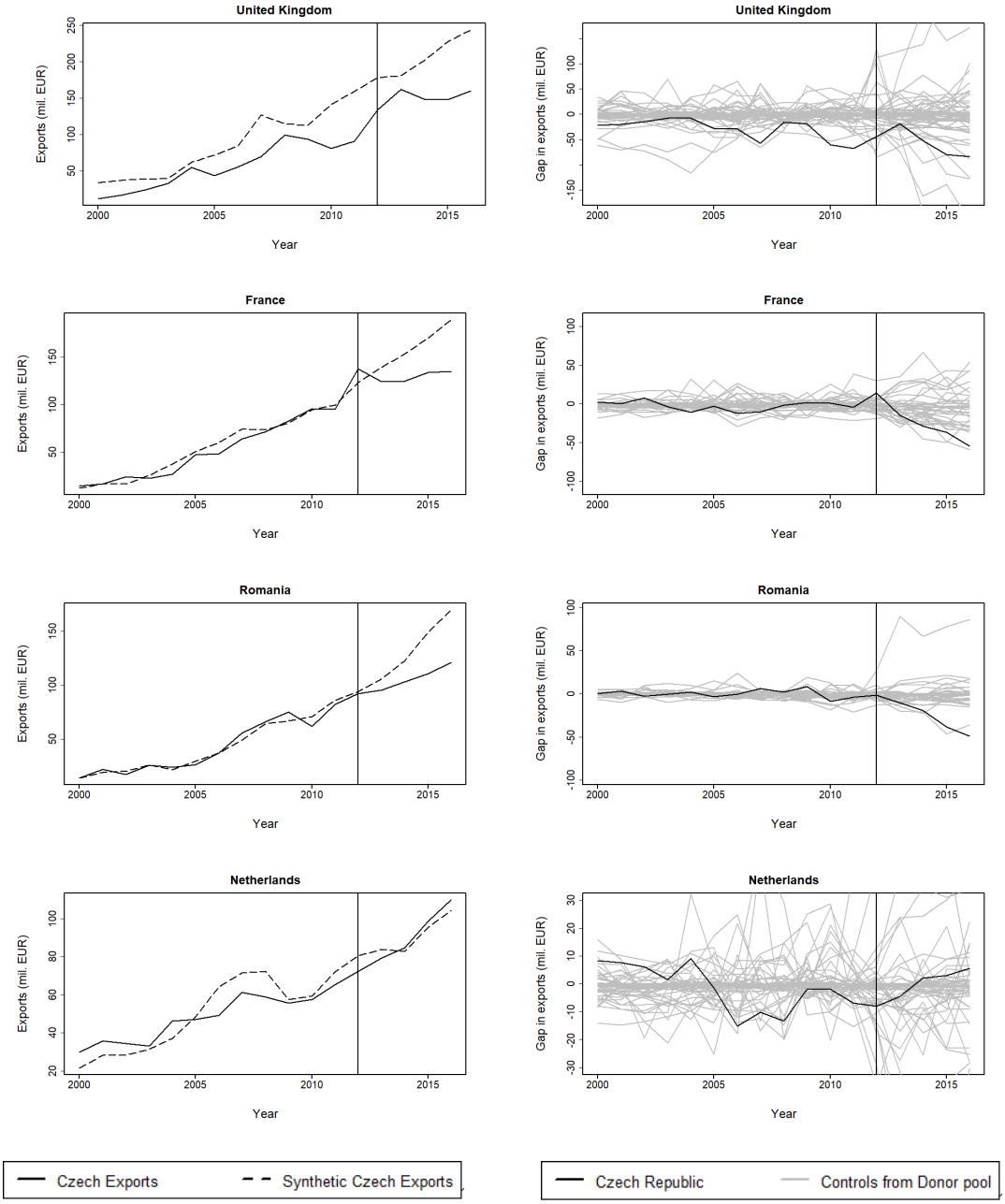
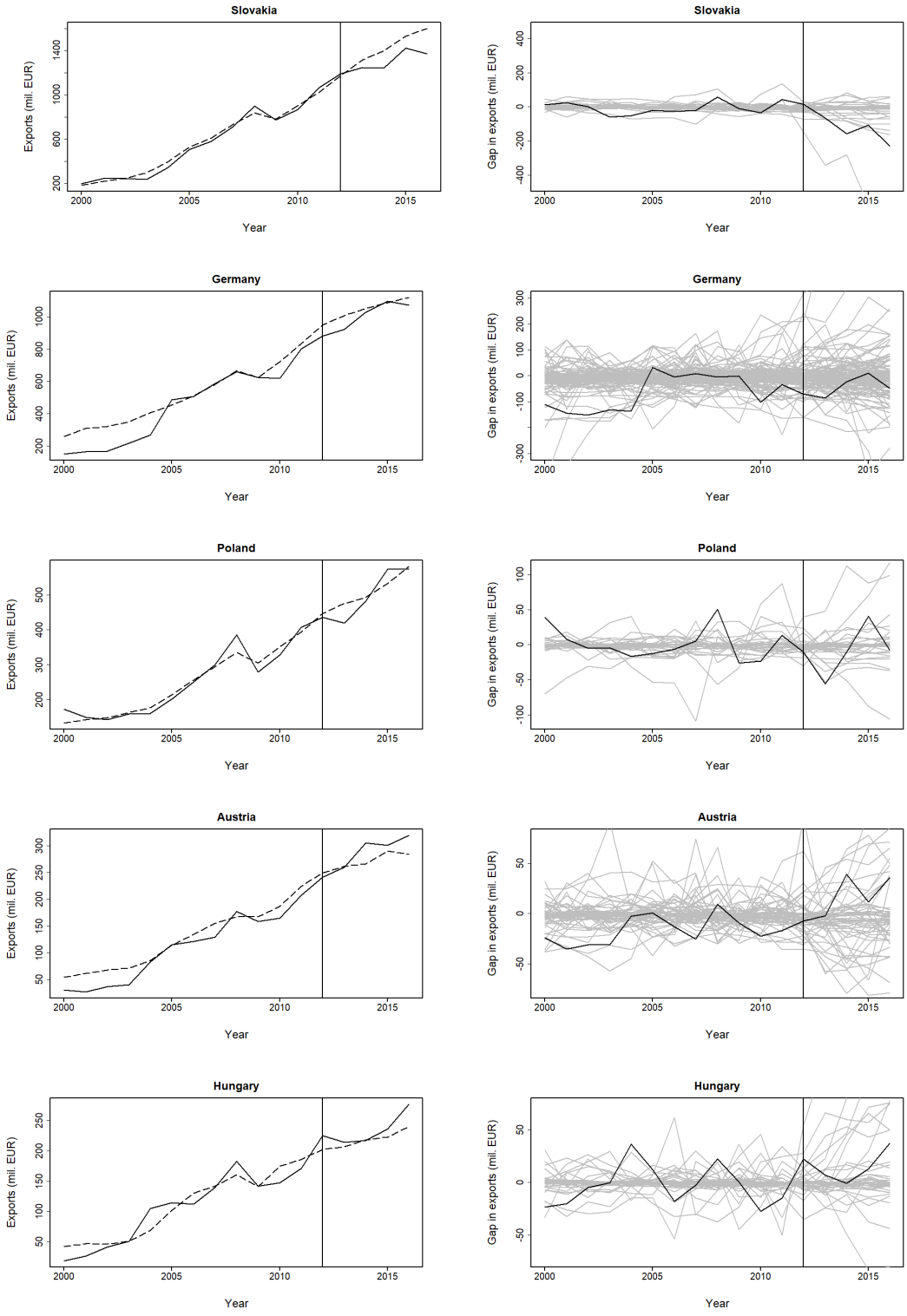
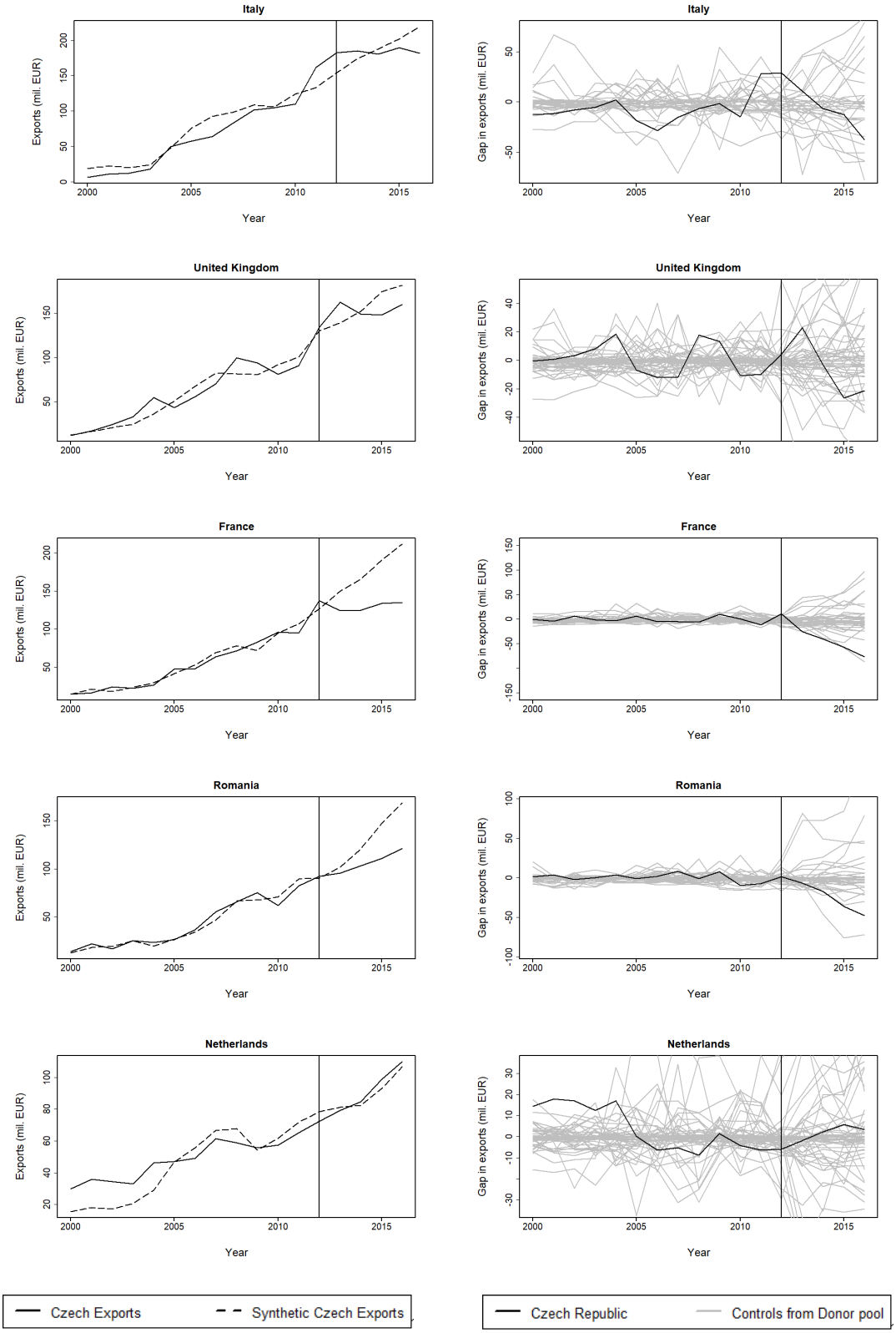

United Kingdom
Exports (mil. EUR)
Year
United Kingdom
Gap in exports (mil. EUR)
Year
France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
Romania
Exports (mil. EUR)
Year
Romania
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

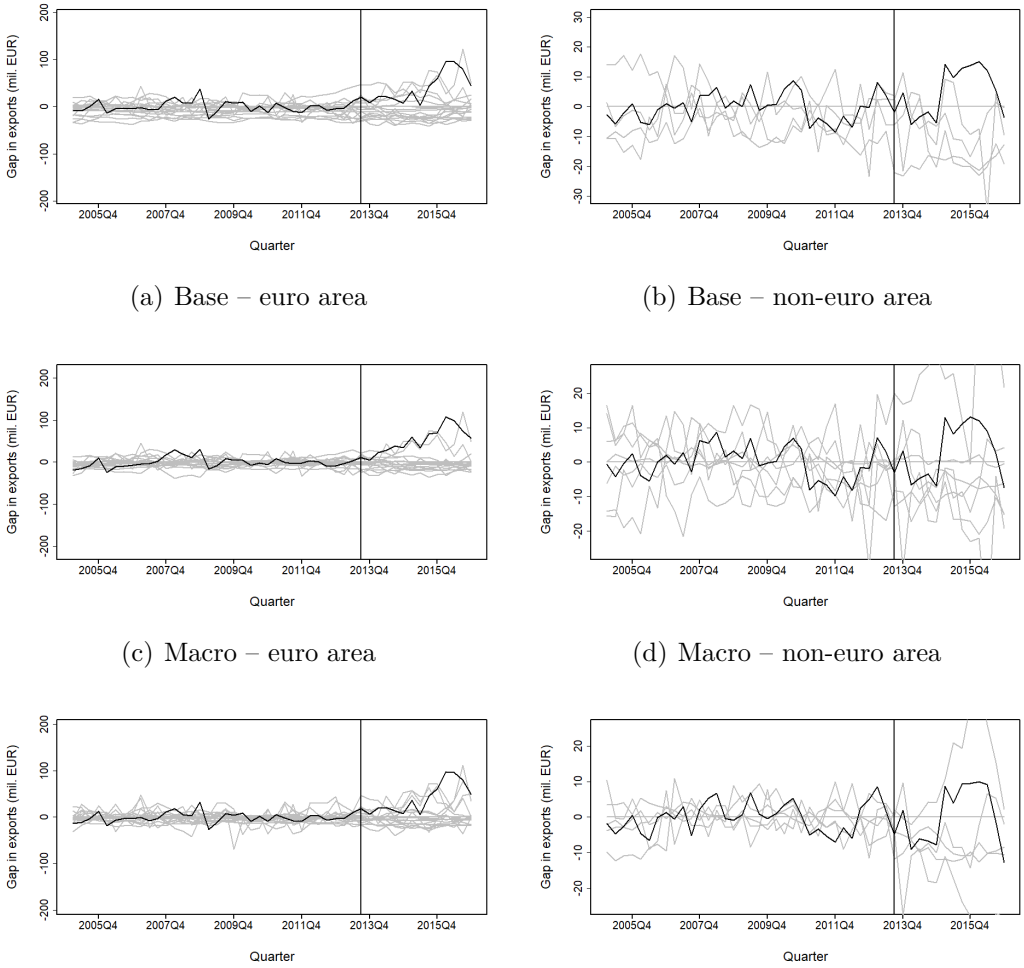
Figure A.5: Category 0 – Bilateral exports (Institutions specification)




Italy
Exports (mil. EUR)
Year
Italy
Gap in exports (mil. EUR)
Year
United Kingdom
Exports (mil. EUR)
Year
United Kingdom
Gap in exports (mil. EUR)
Year
France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
Romania
Exports (mil. EUR)
Year
Romania
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

A.2 SITC category 1

Figure A.6: Category 1 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

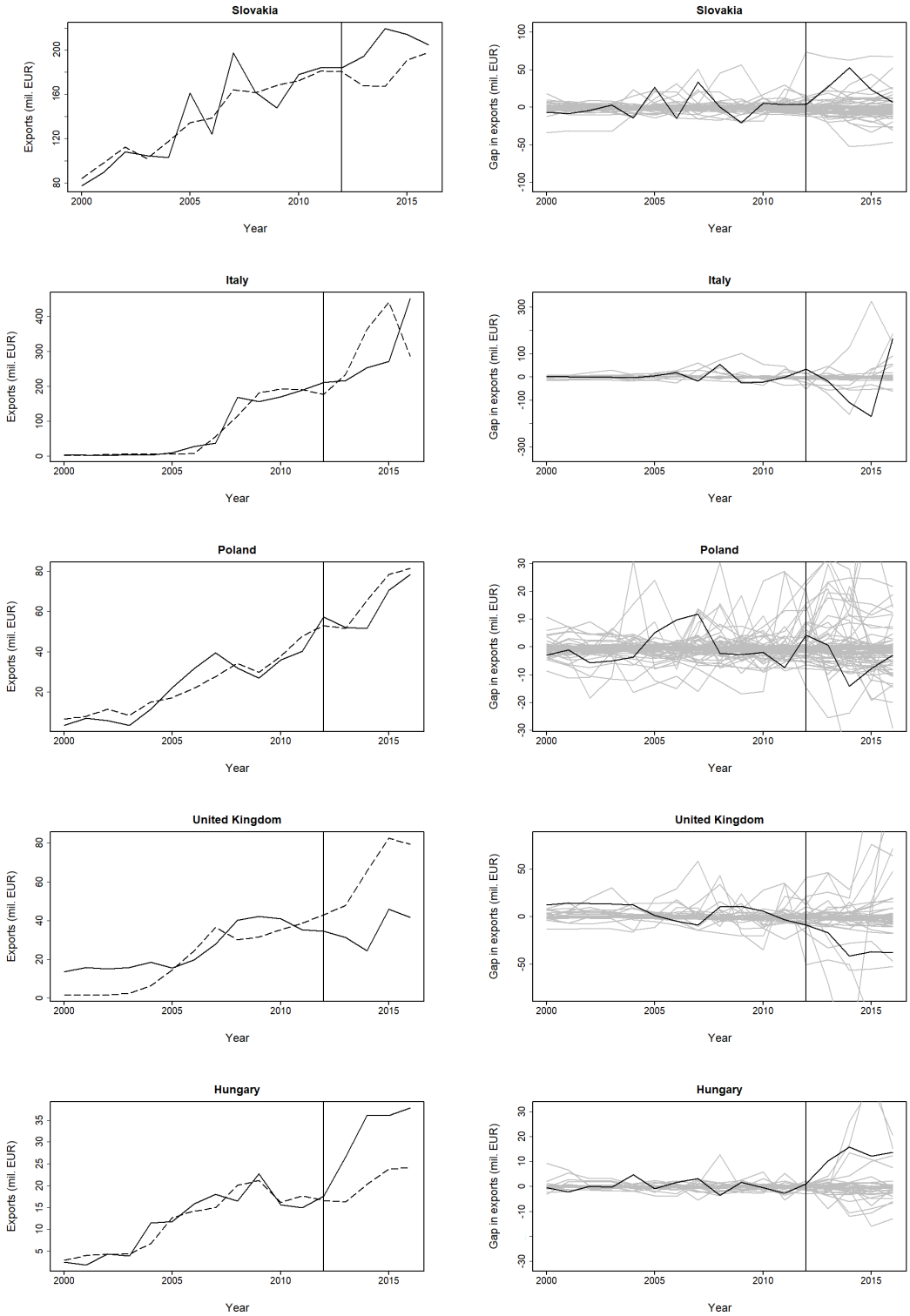
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.7: Category 1 – Bilateral exports (Base specification)



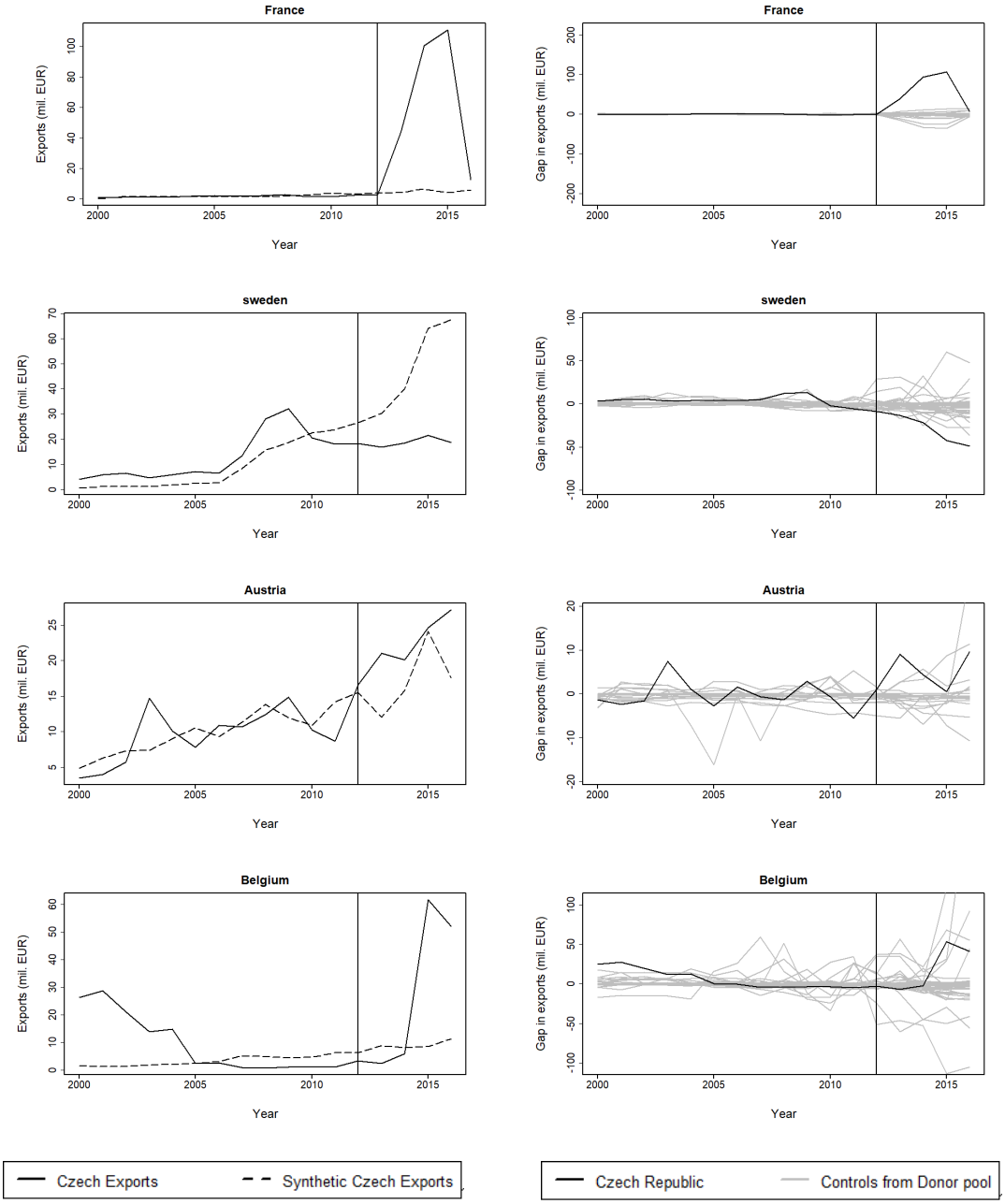
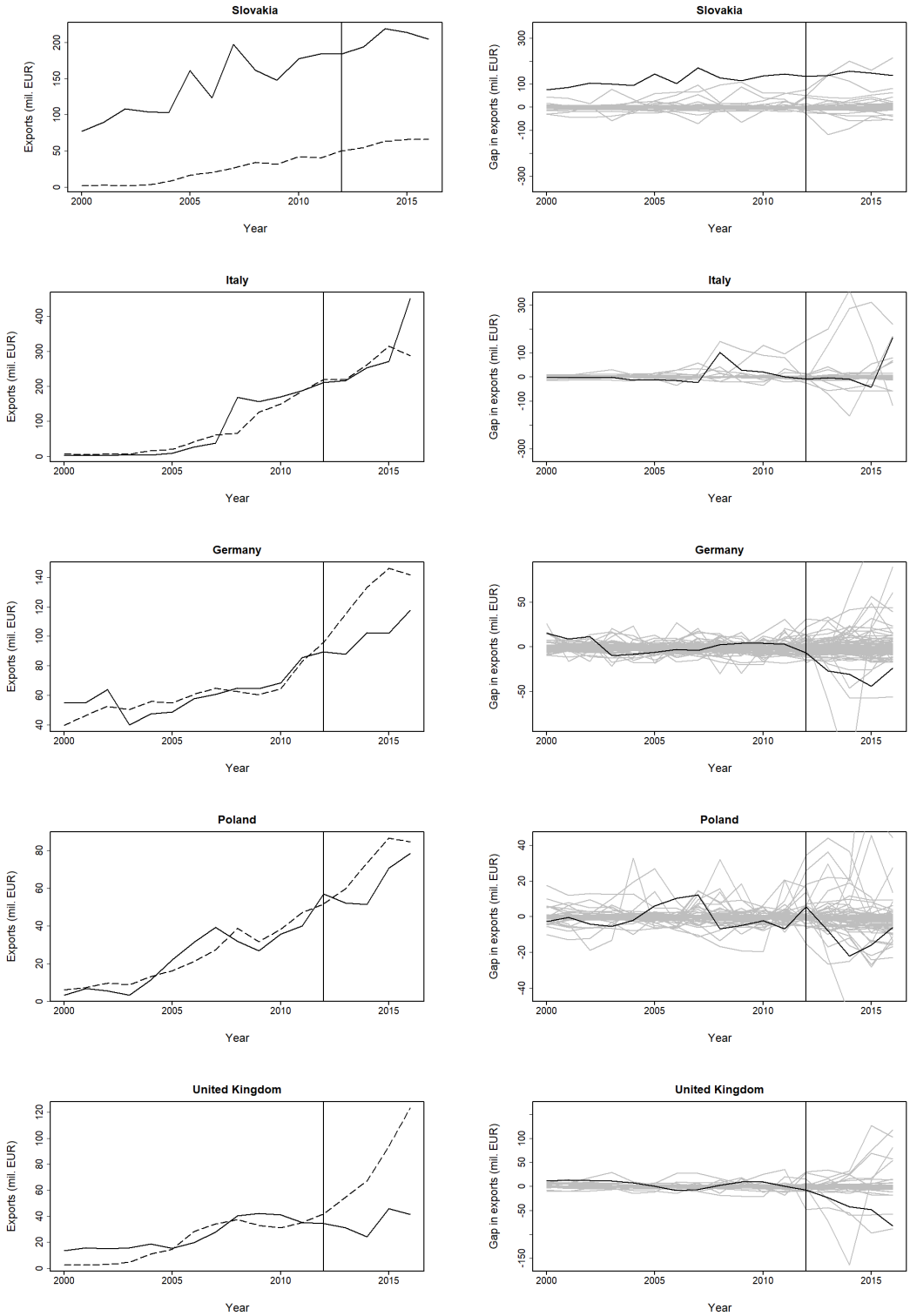
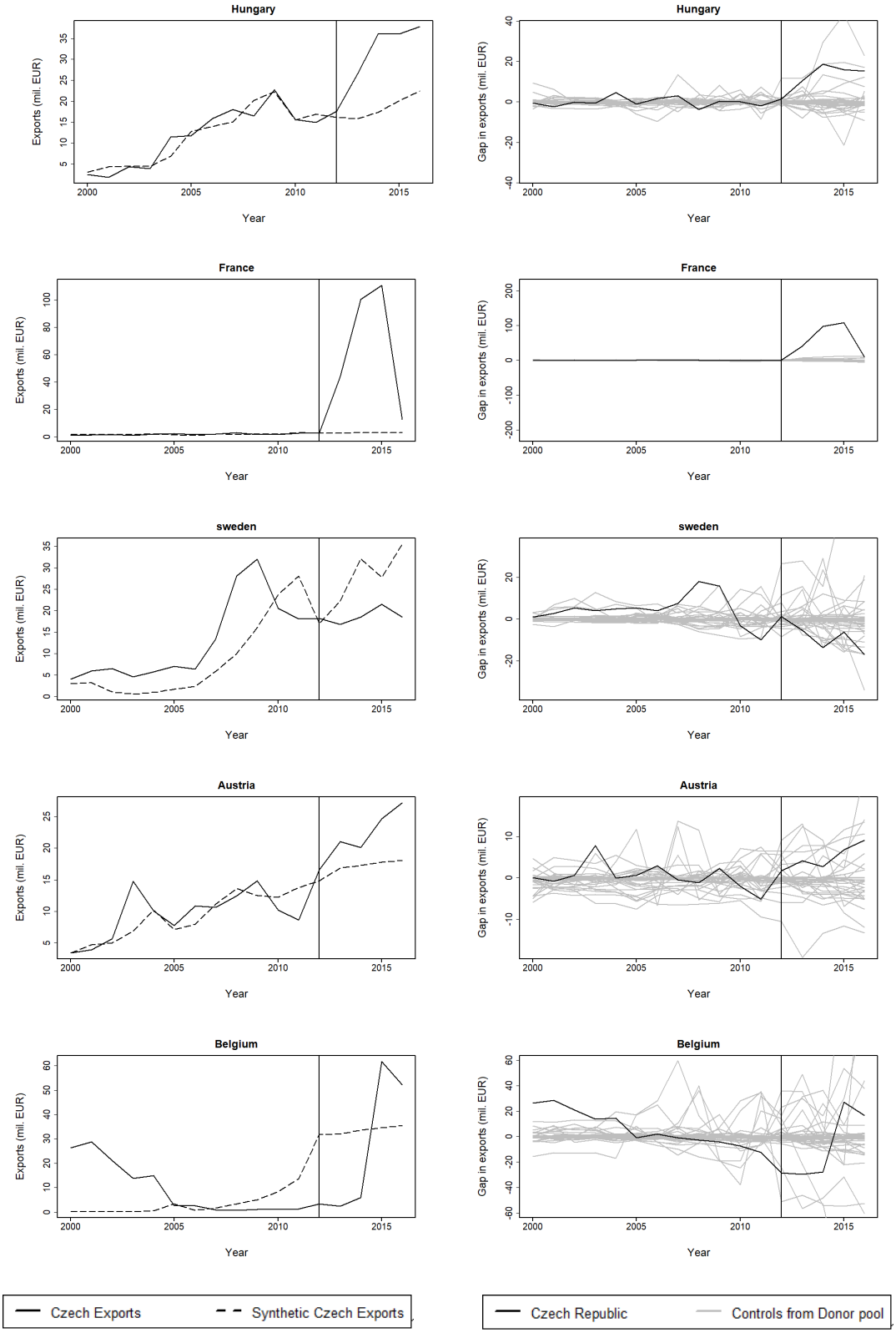

France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
sweden
Exports (mil. EUR)
Year
sweden
Gap in exports (mil. EUR)
Year
Austria
Exports (mil. EUR)
Year
Austria
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

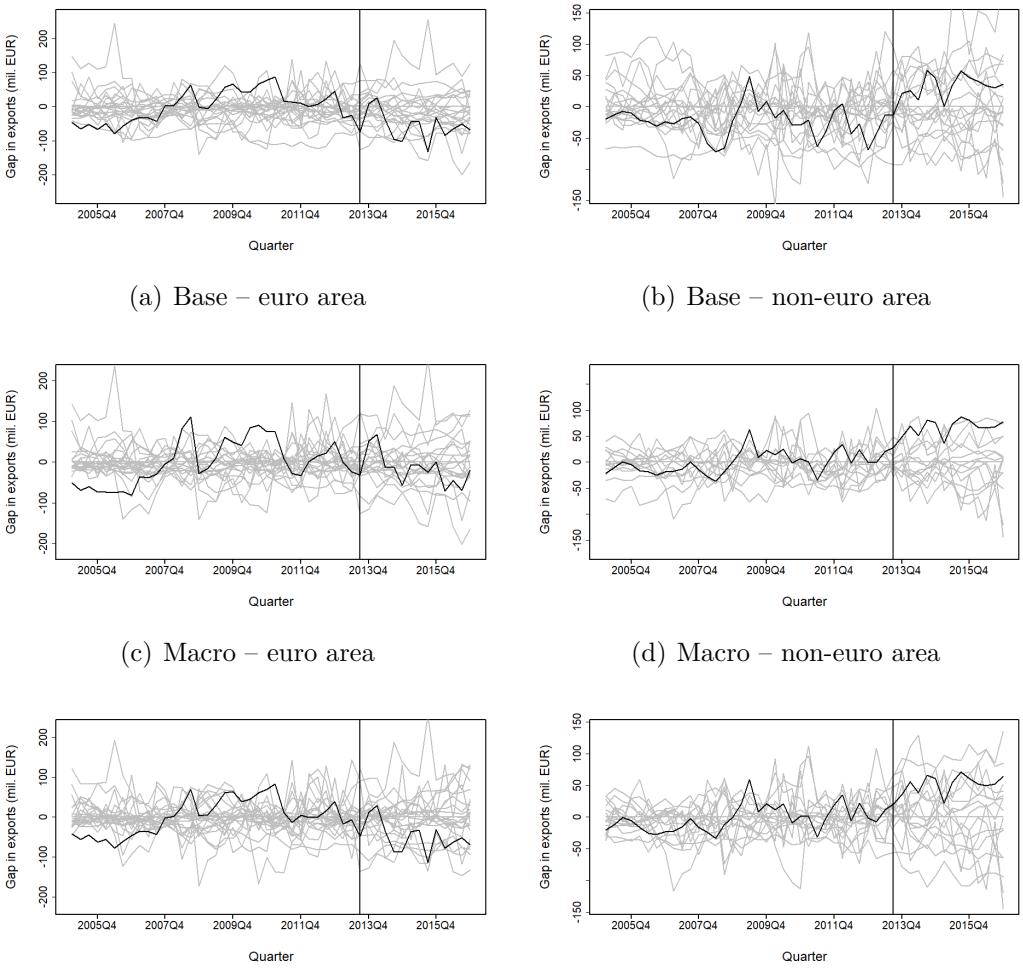
Figure A.8: Category 1 – Bilateral exports (Institutions specification)




Hungary
Exports (mil. EUR)
Year
Hungary
Gap in exports (mil. EUR)
Year
France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
sweden
Exports (mil. EUR)
Year
sweden
Gap in exports (mil. EUR)
Year
Austria
Exports (mil. EUR)
Year
Austria
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

A.3 SITC category 2

Figure A.9: Category 2 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

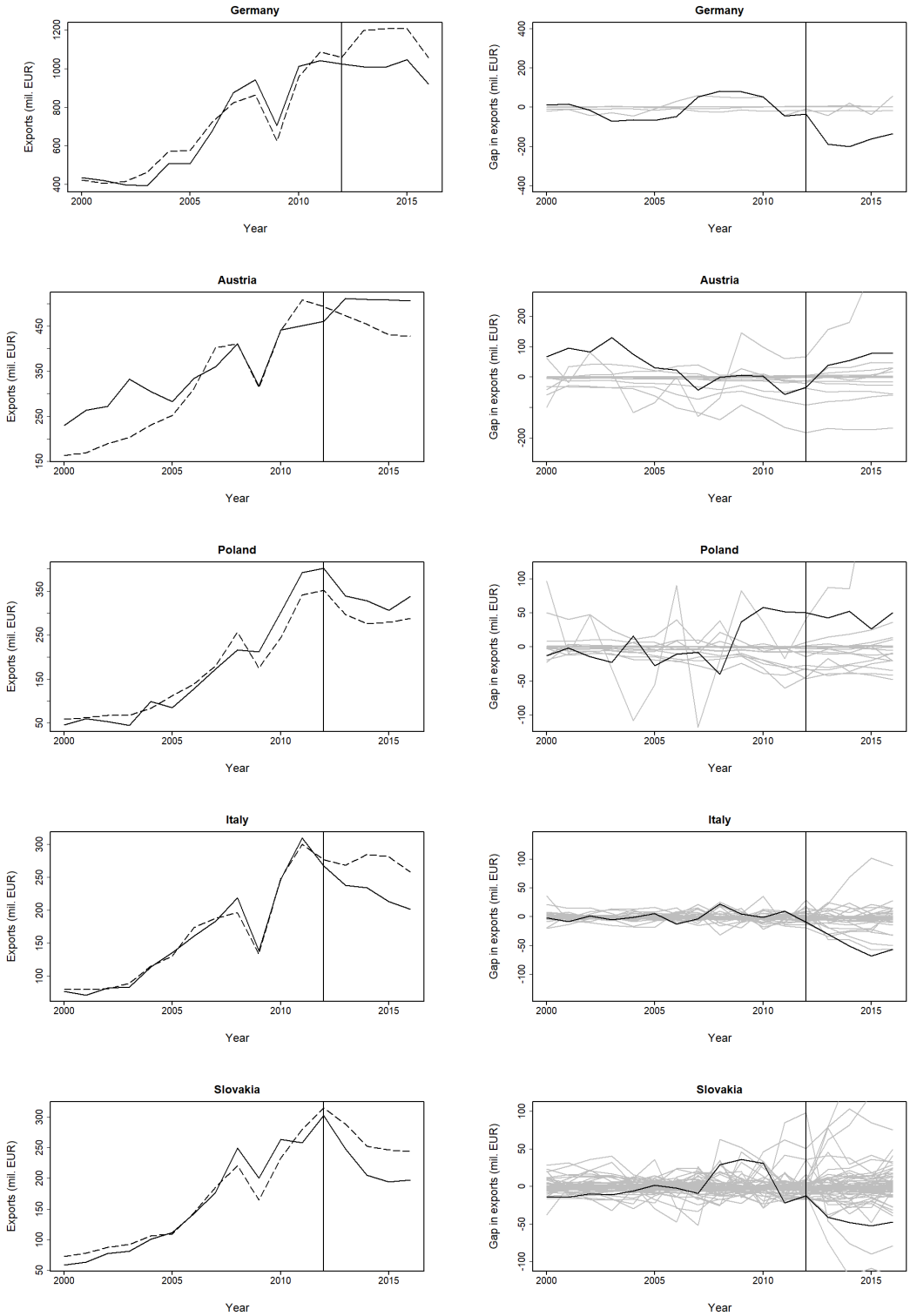
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.10: Category 2 – Bilateral exports (Base specification)



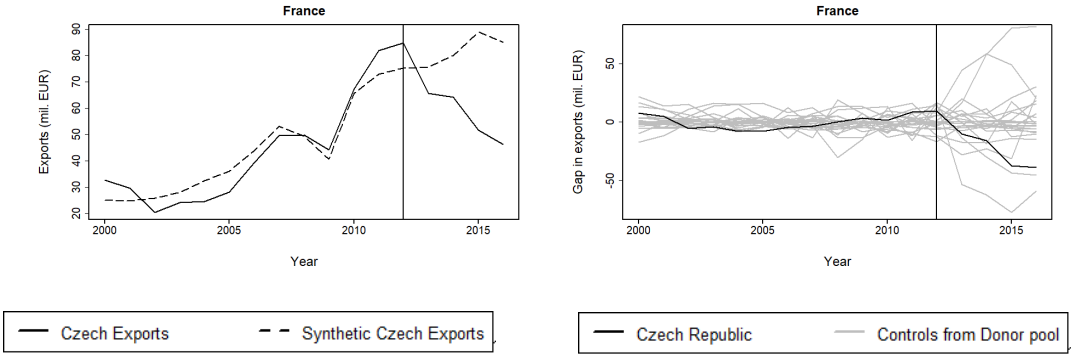


Figure A.11: Category 2 – Bilateral exports (Institutions specification)

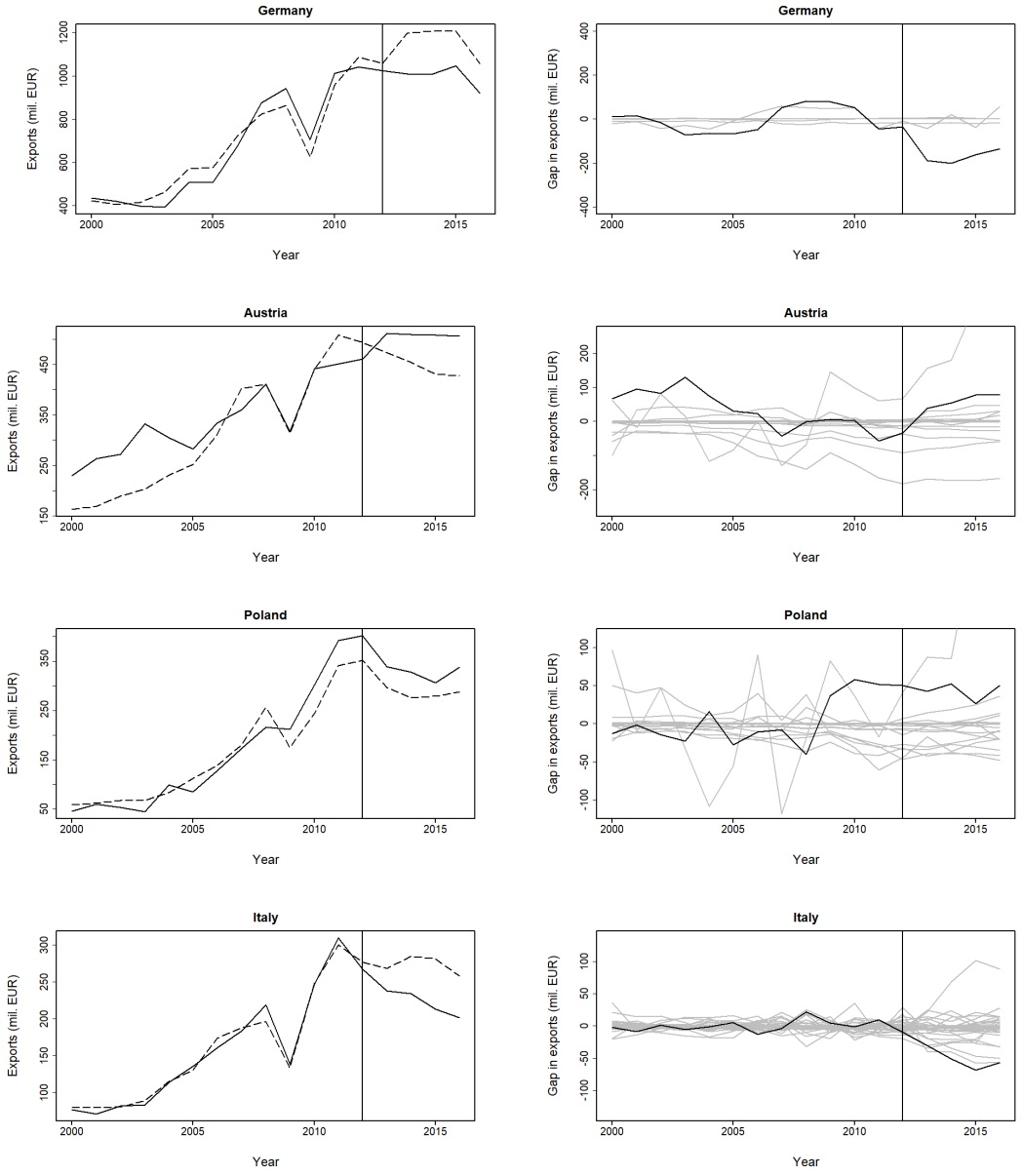
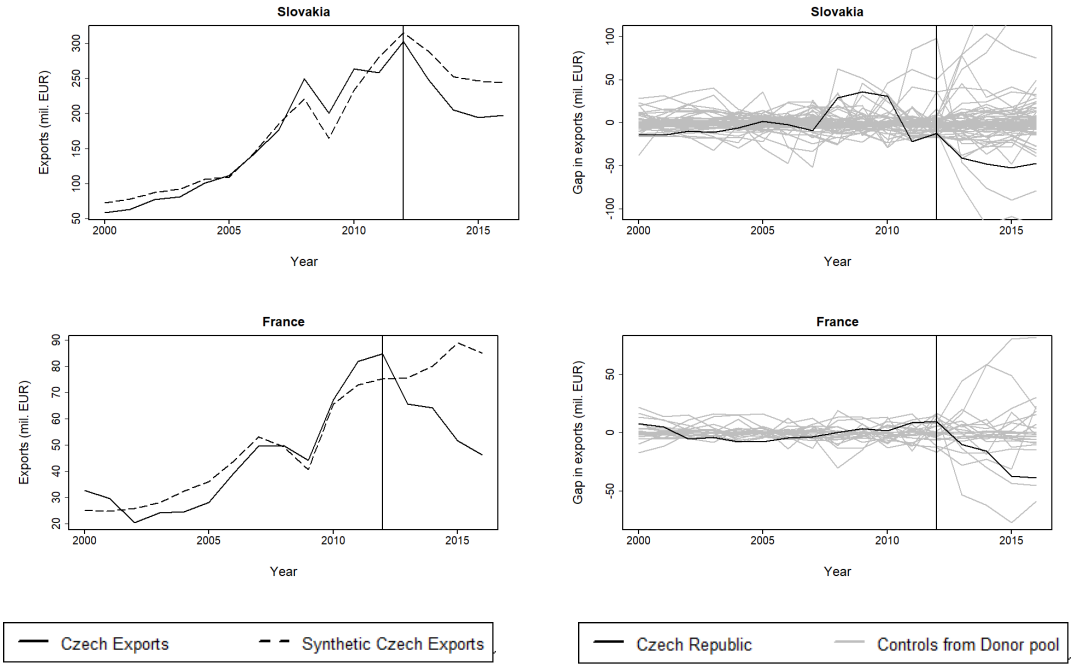
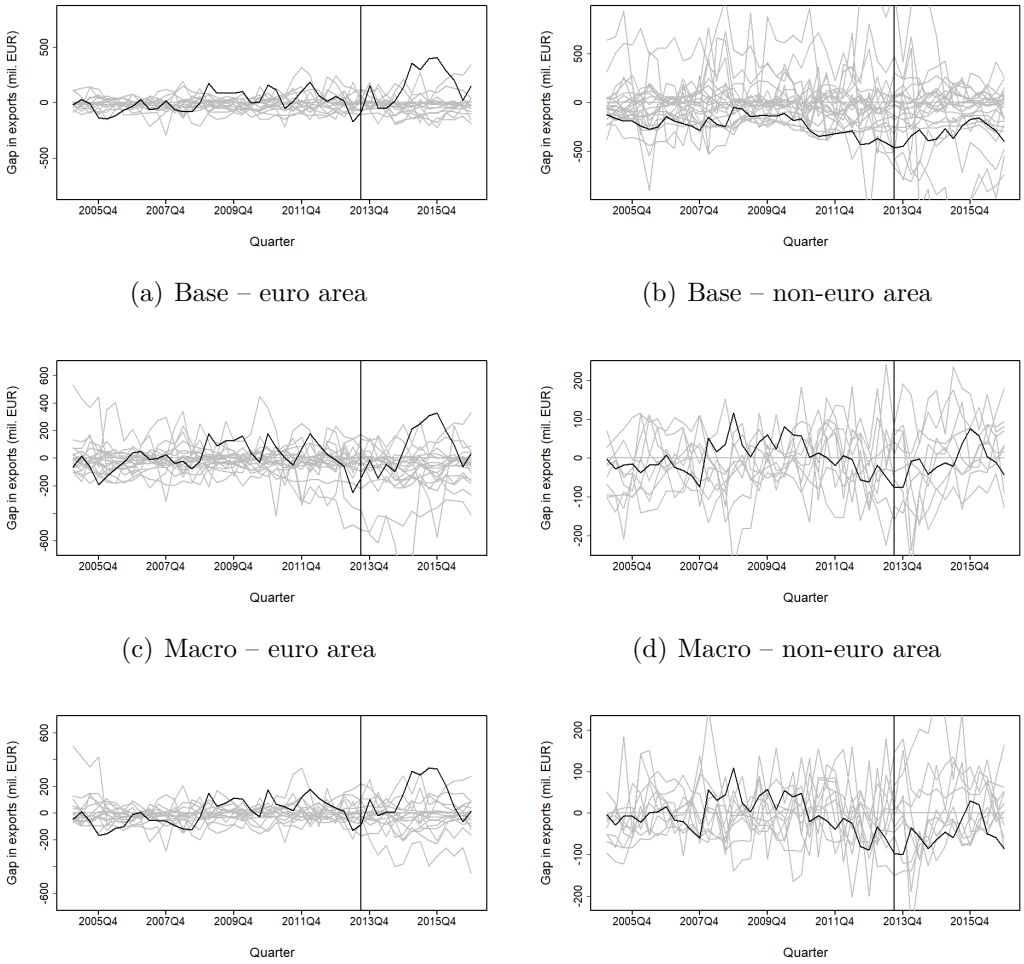


Figure A.11: Category 2 – Bilateral exports (Institutions specification)



A.4 SITC category 3

Figure A.12: Category 3 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.13: Category 3 – Bilateral exports (Base specification)

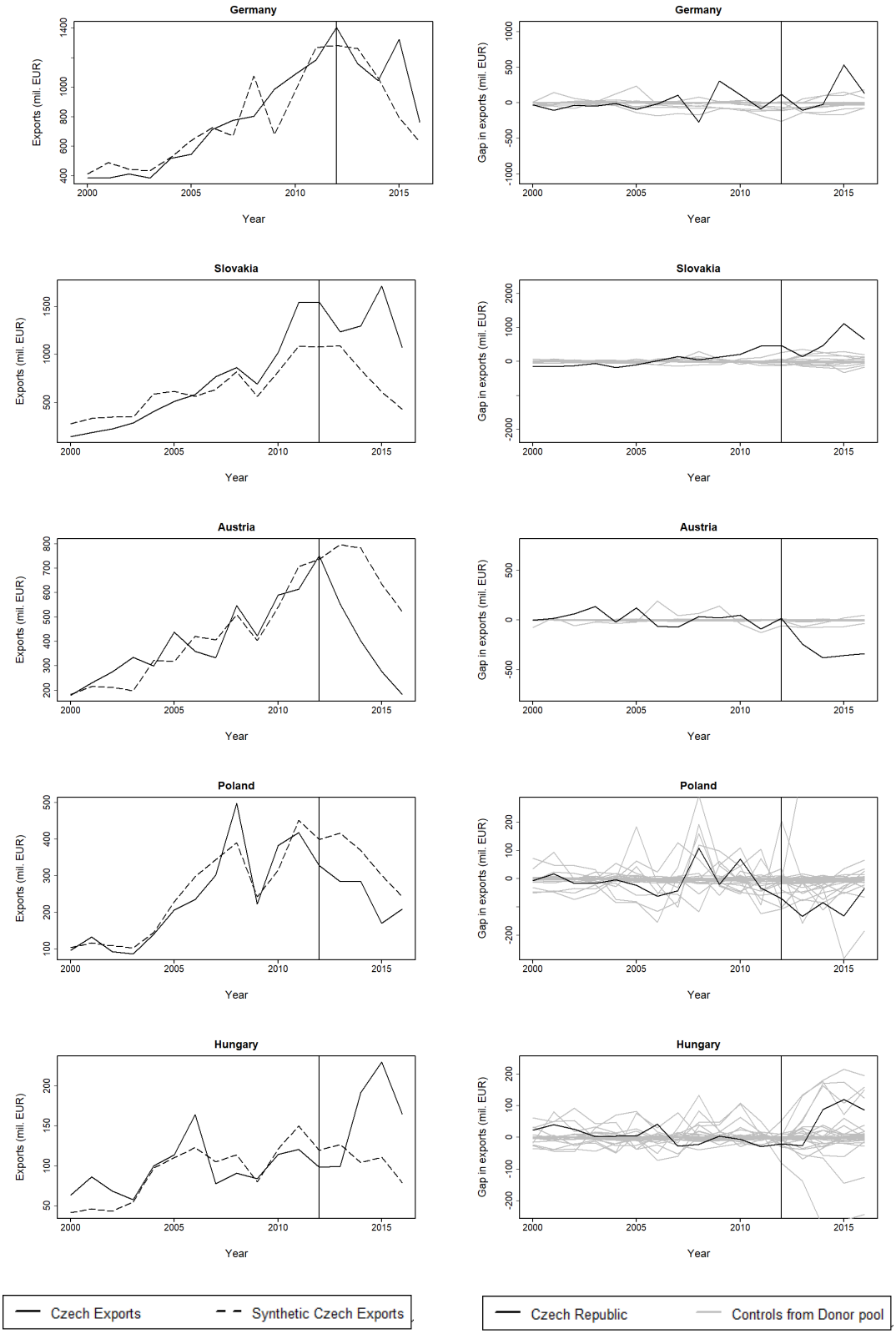
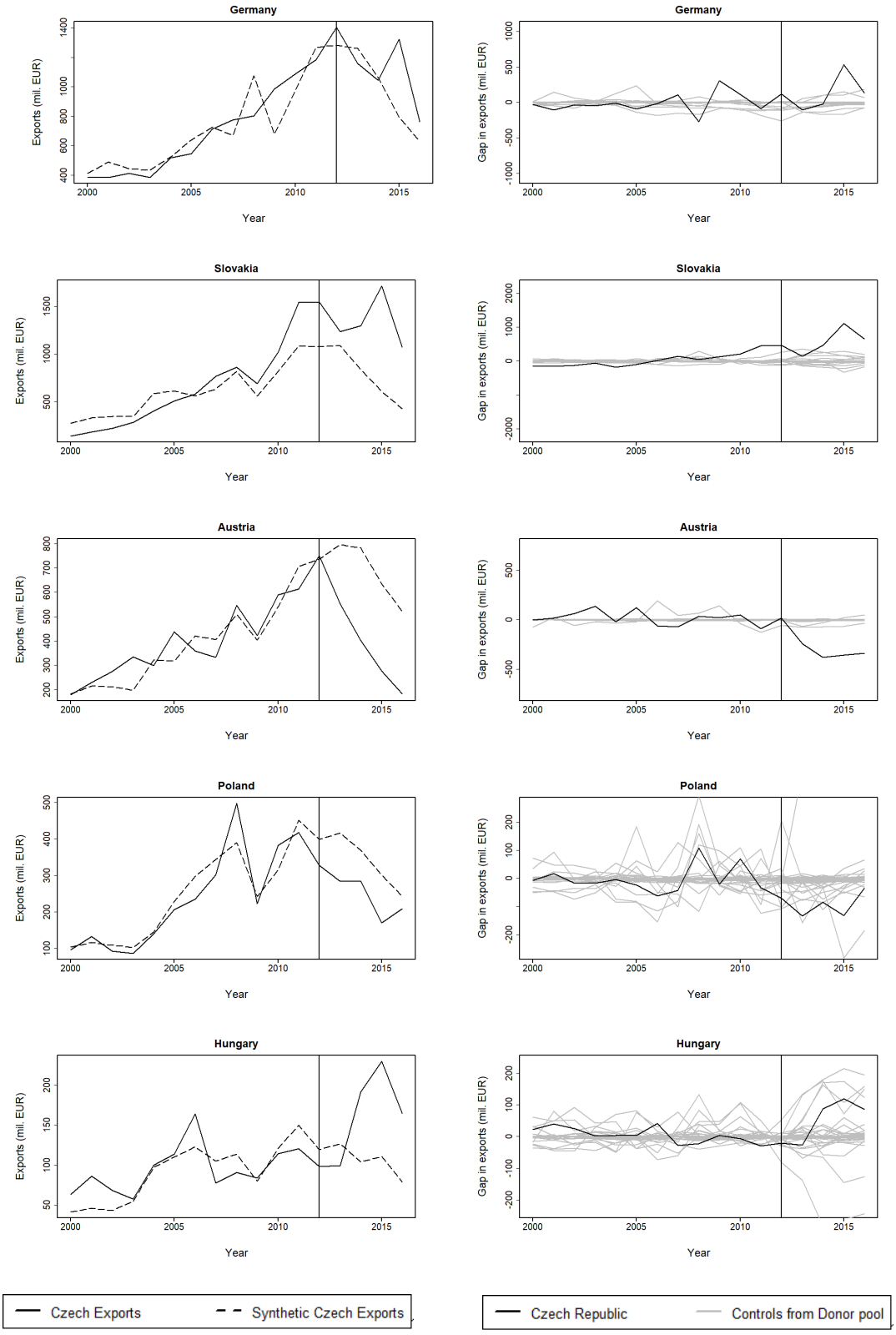
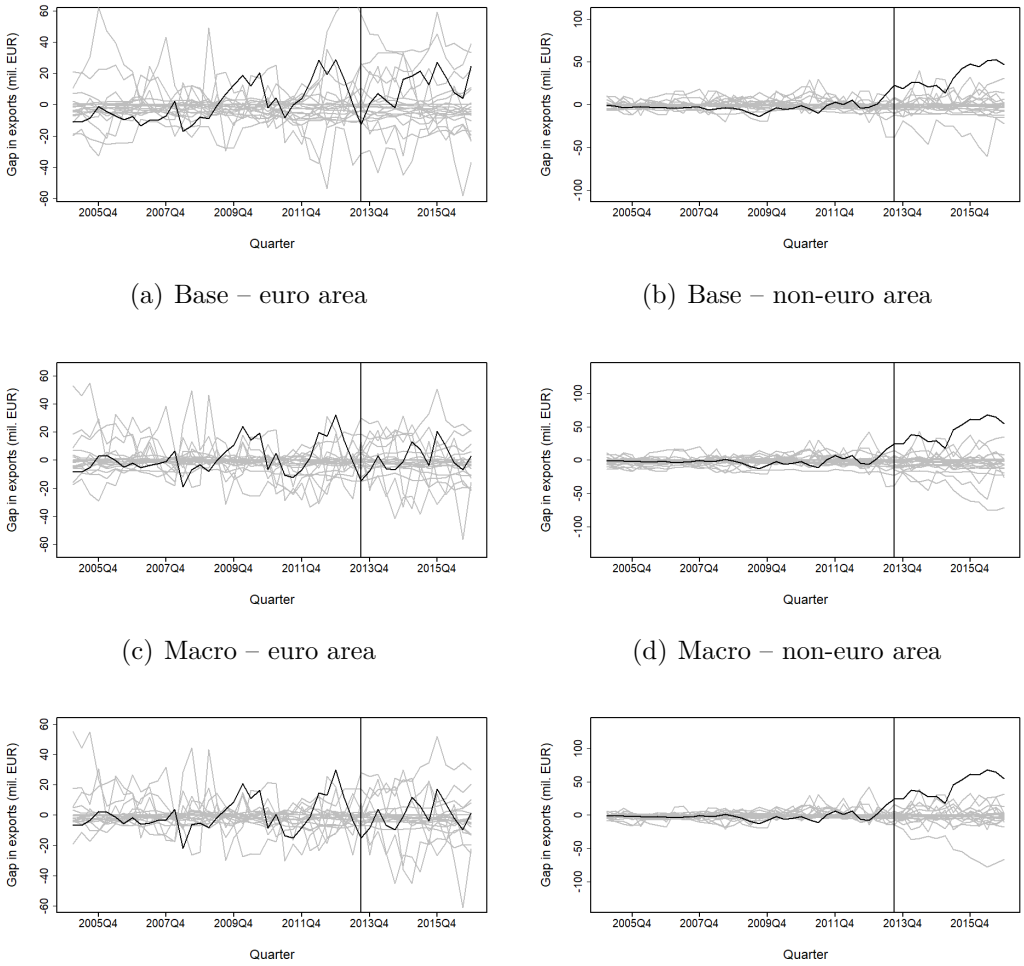


Figure A.14: Category 3 – Bilateral exports (Institutions specification)



A.5 SITC category 4

Figure A.15: Category 4 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

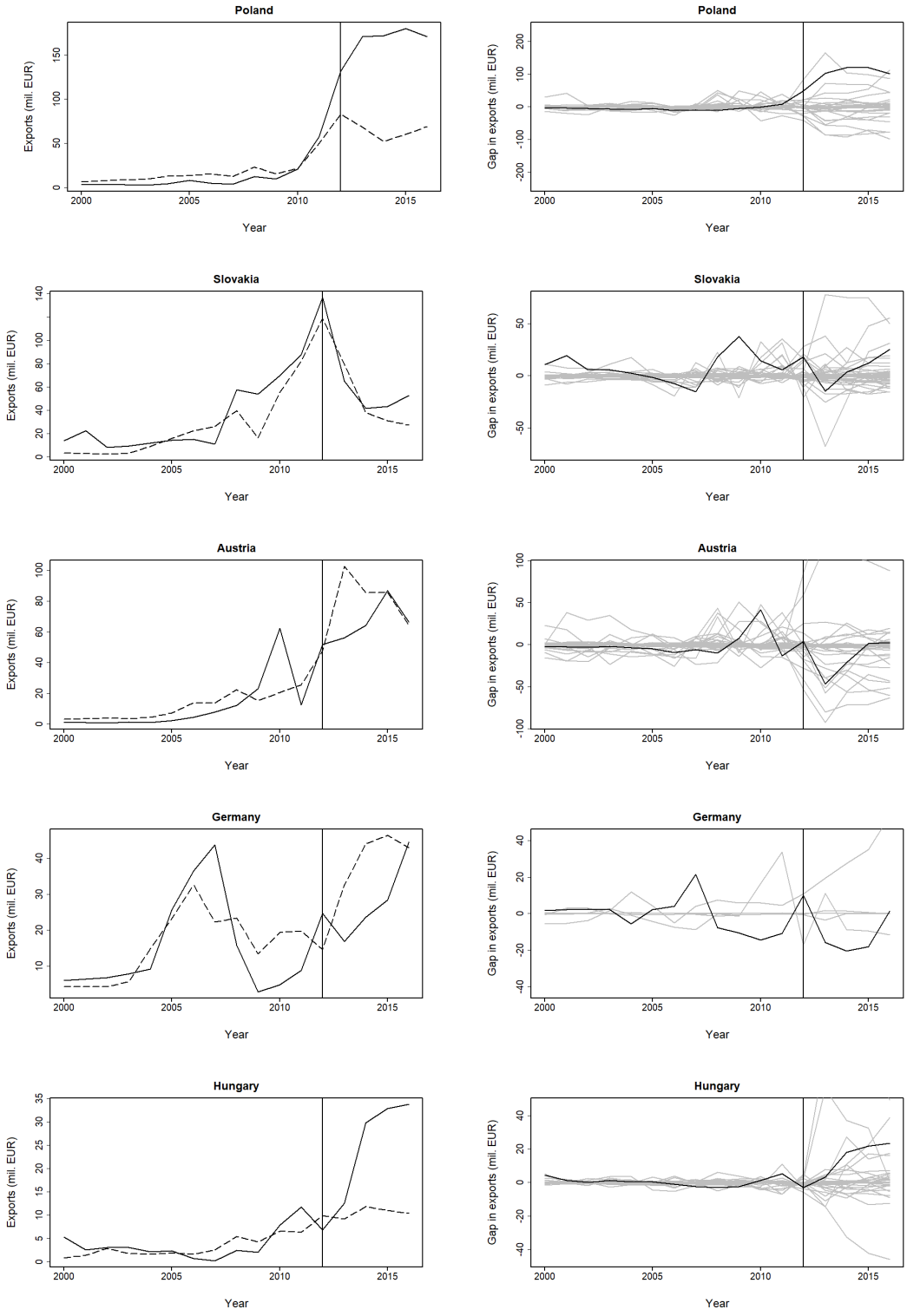
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.16: Category 4 – Bilateral exports (Base specification)



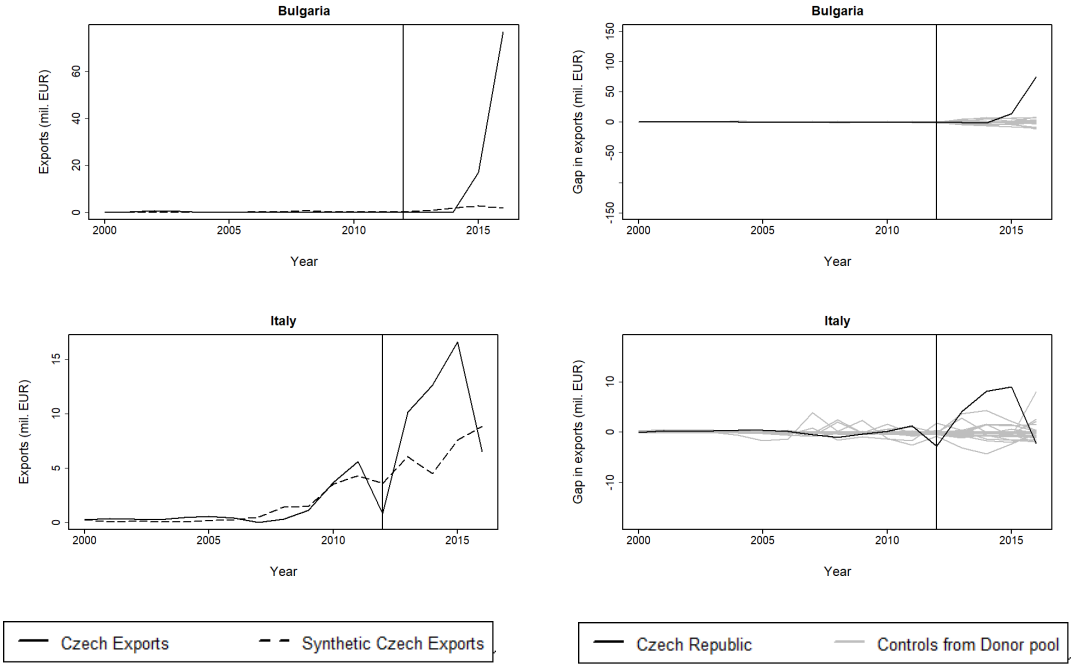
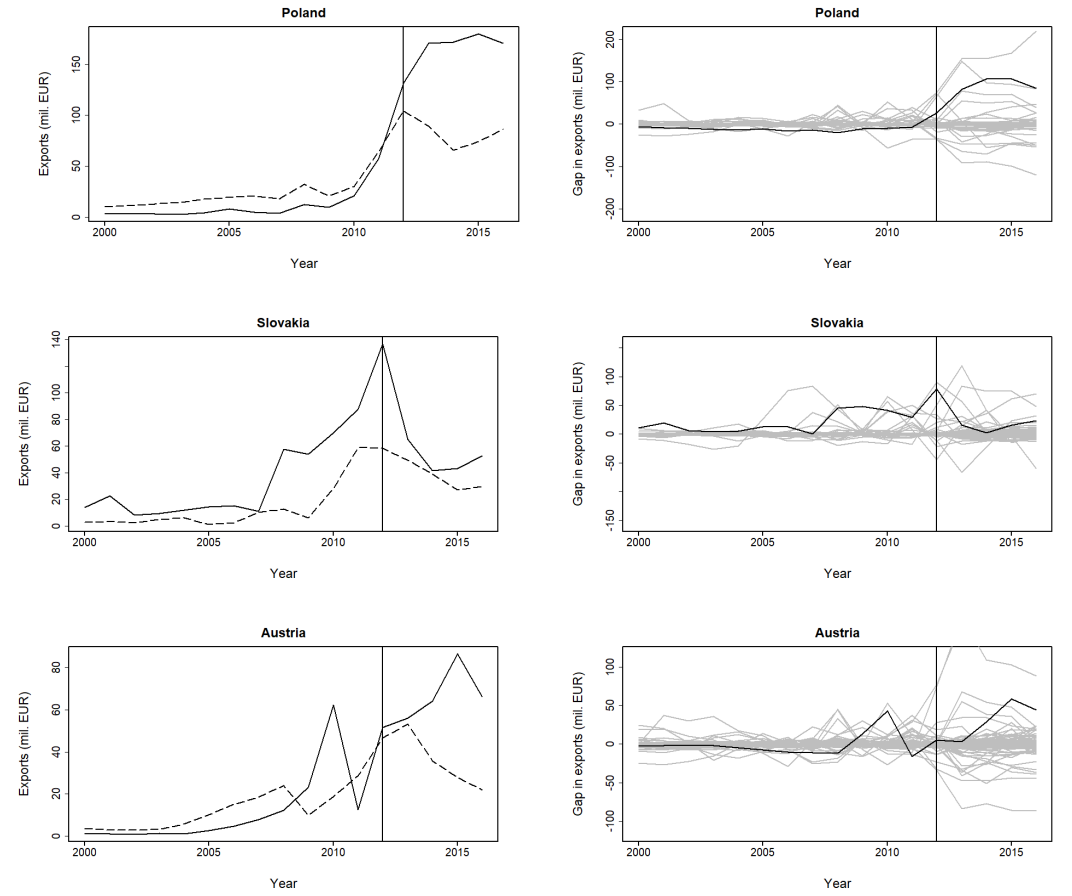
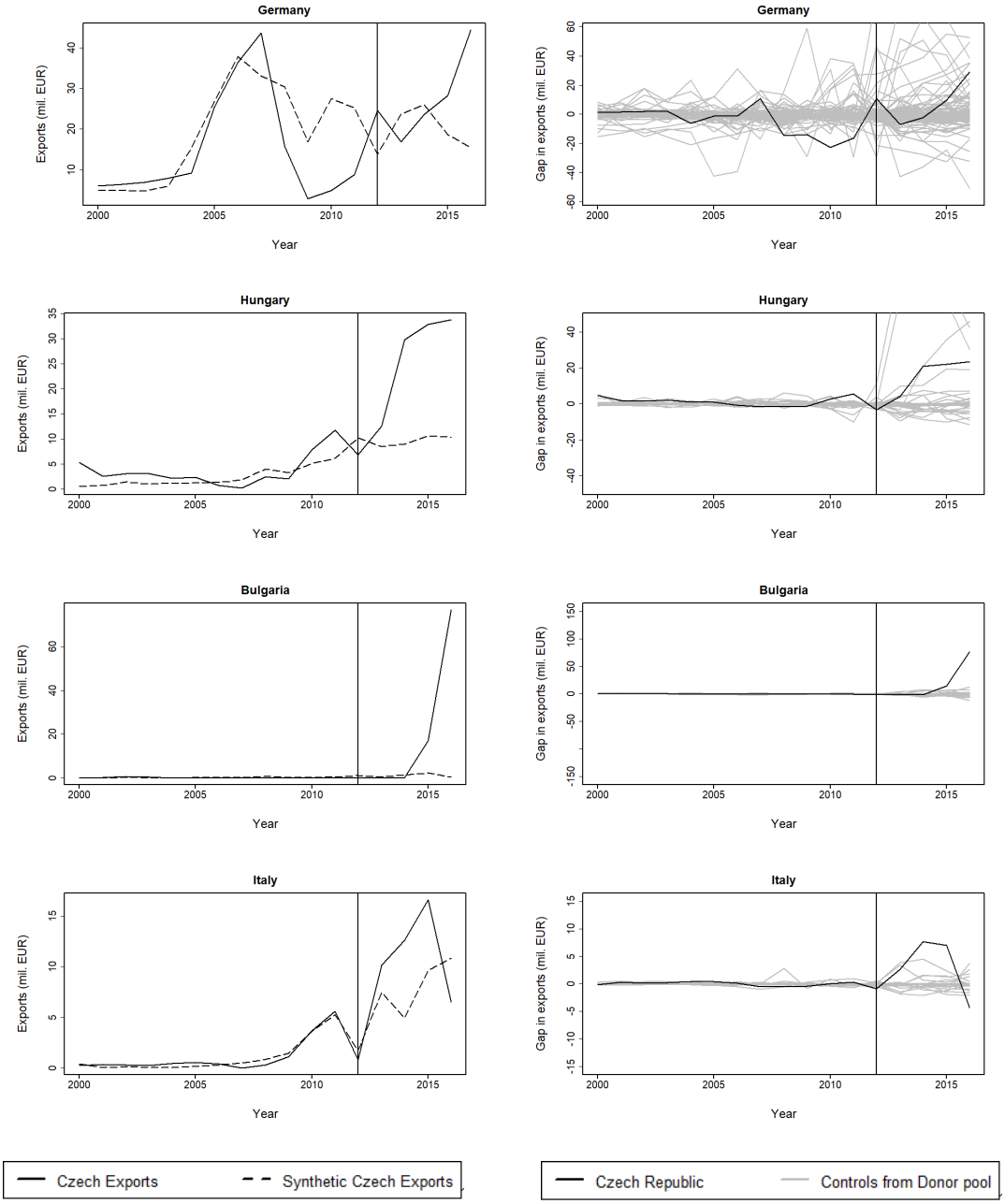


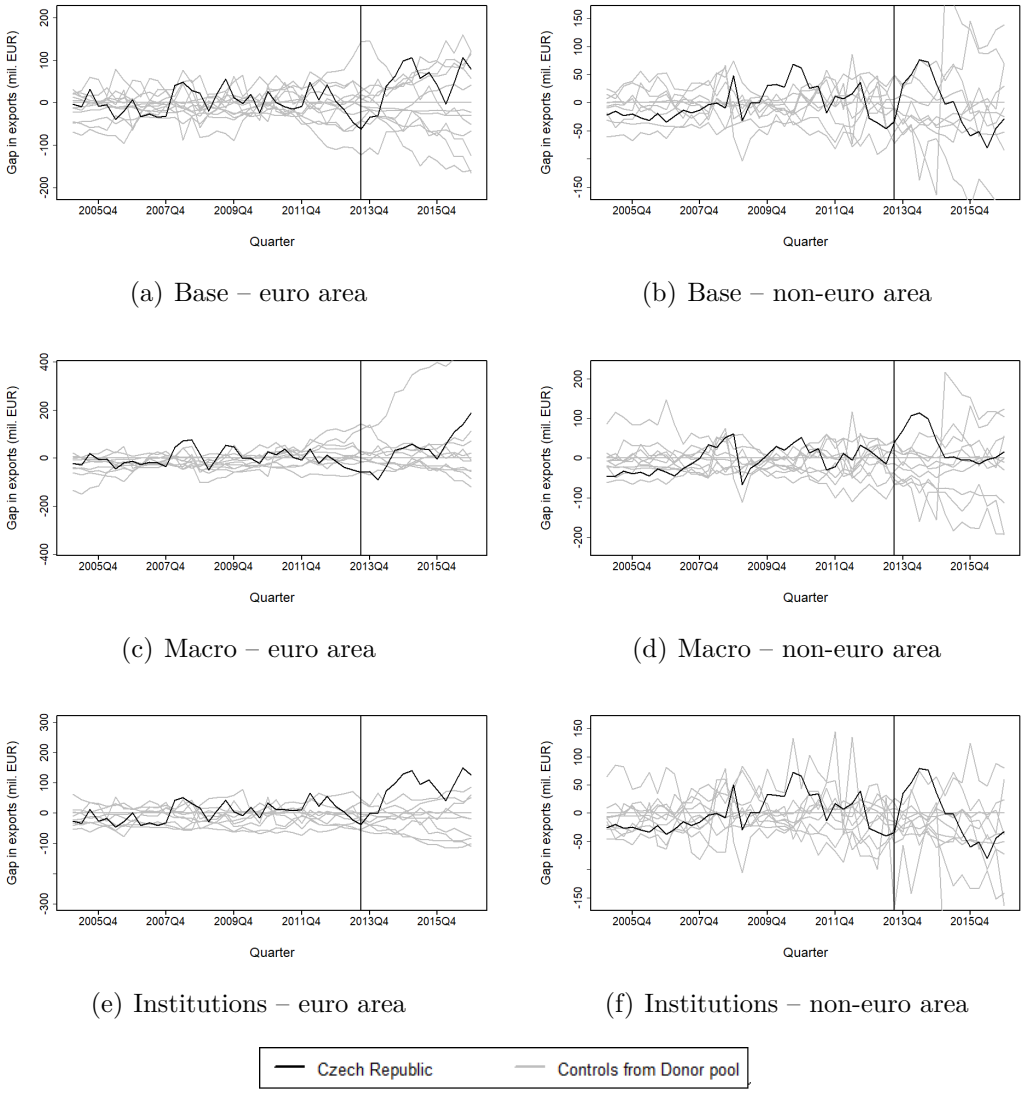
Figure A.17: Category 4 – Bilateral exports (Institutions specification)




Germany
Exports (mil. EUR)
Year
Germany
Gap in exports (mil. EUR)
Year
Hungary
Exports (mil. EUR)
Year
Hungary
Gap in exports (mil. EUR)
Year
Bulgaria
Exports (mil. EUR)
Year
Bulgaria
Gap in exports (mil. EUR)
Year
Italy
Exports (mil. EUR)
Year
Italy
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

A.6 SITC category 5

Figure A.18: Category 5 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

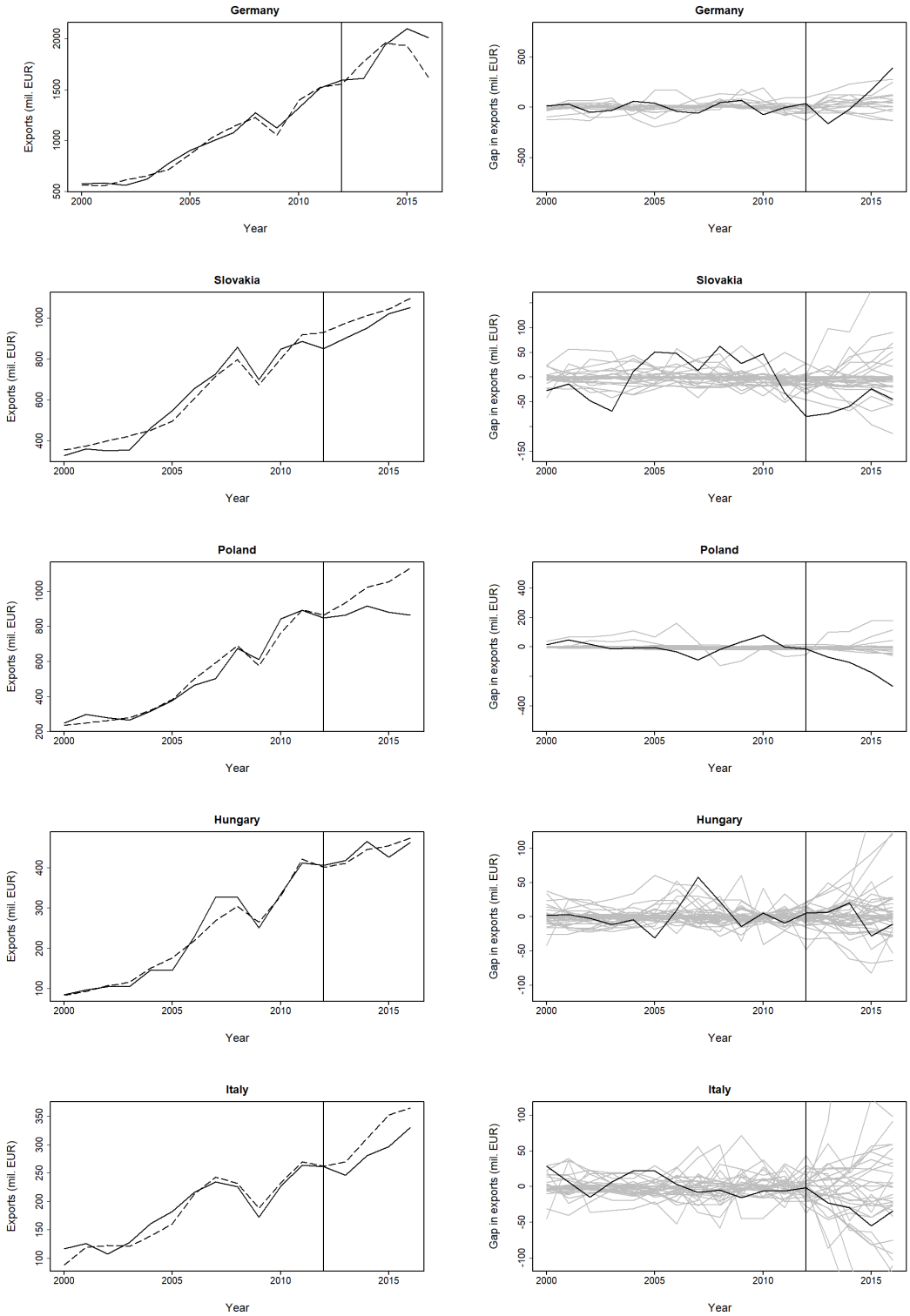
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.19: Category 5 – Bilateral exports (Base specification)



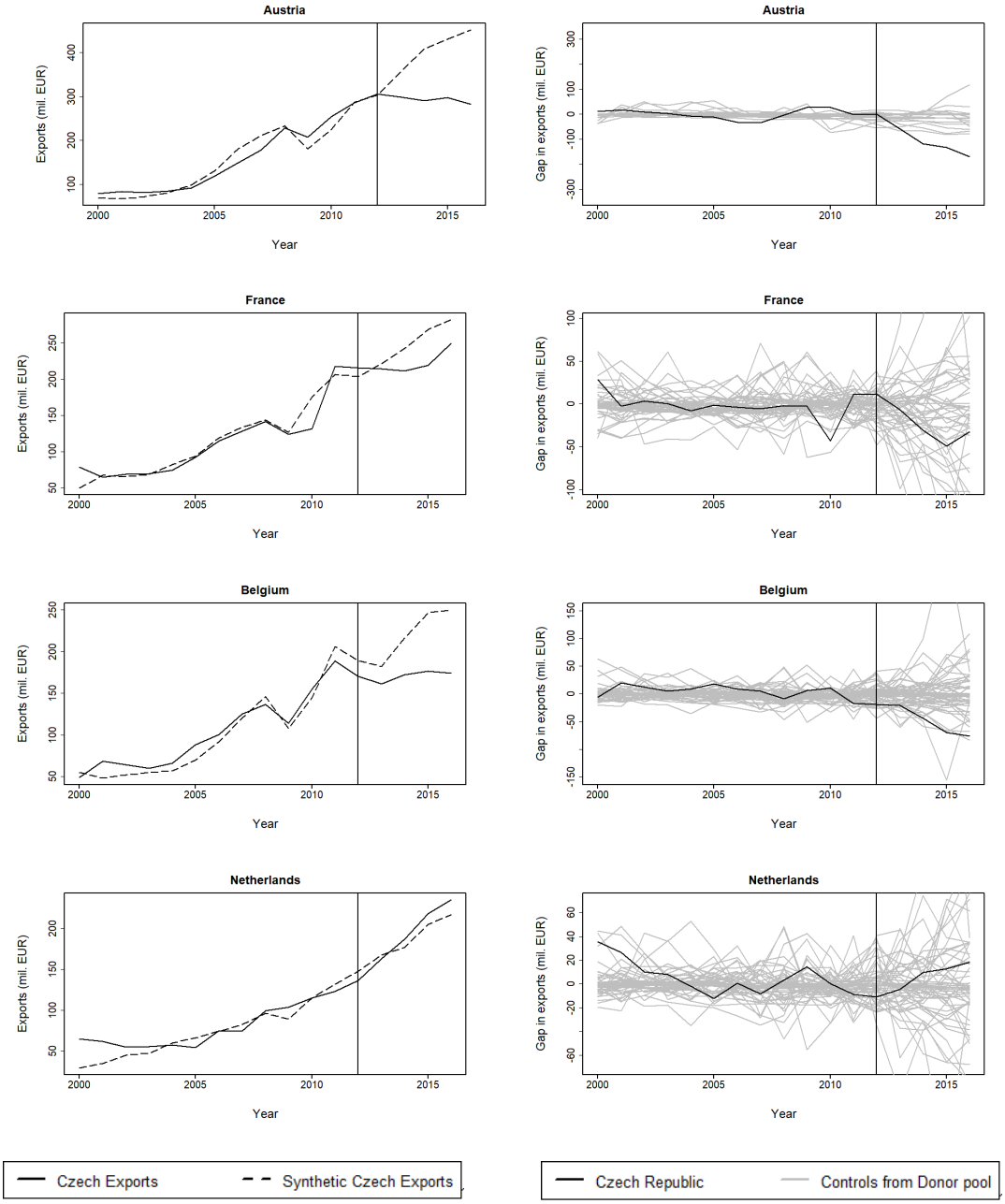
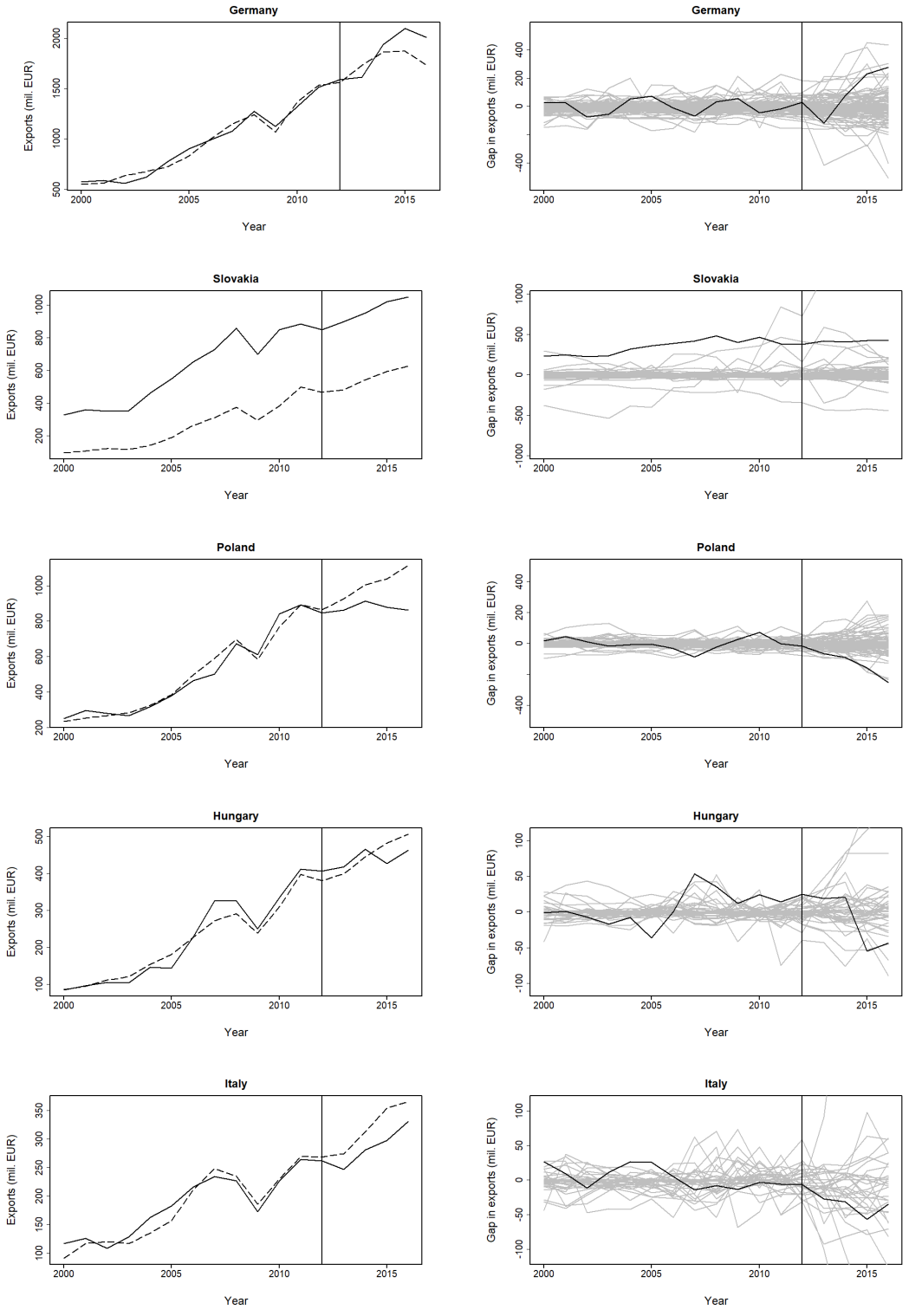
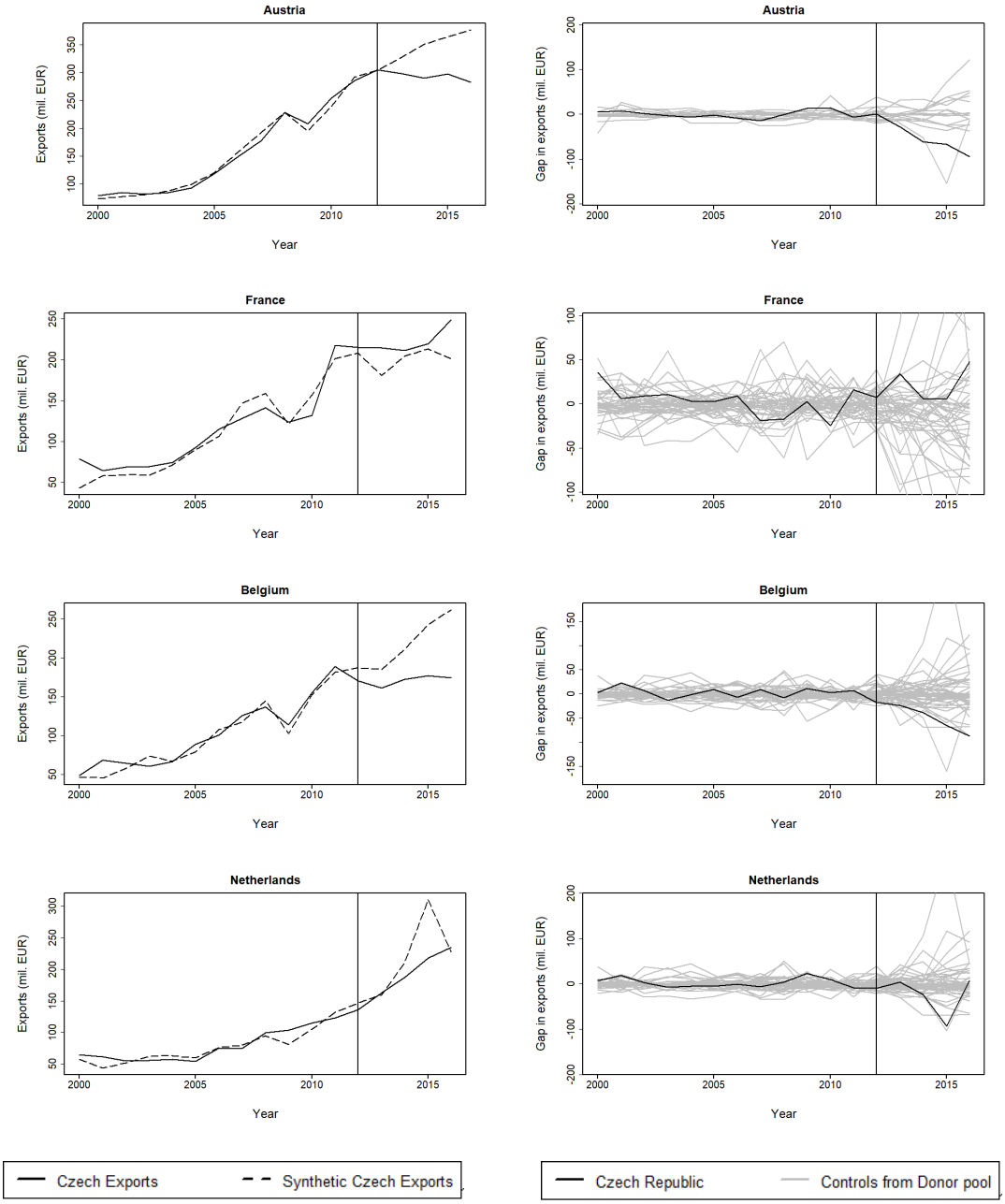

Austria
Exports (mil. EUR)
Year
Austria
Gap in exports (mil. EUR)
Year
France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

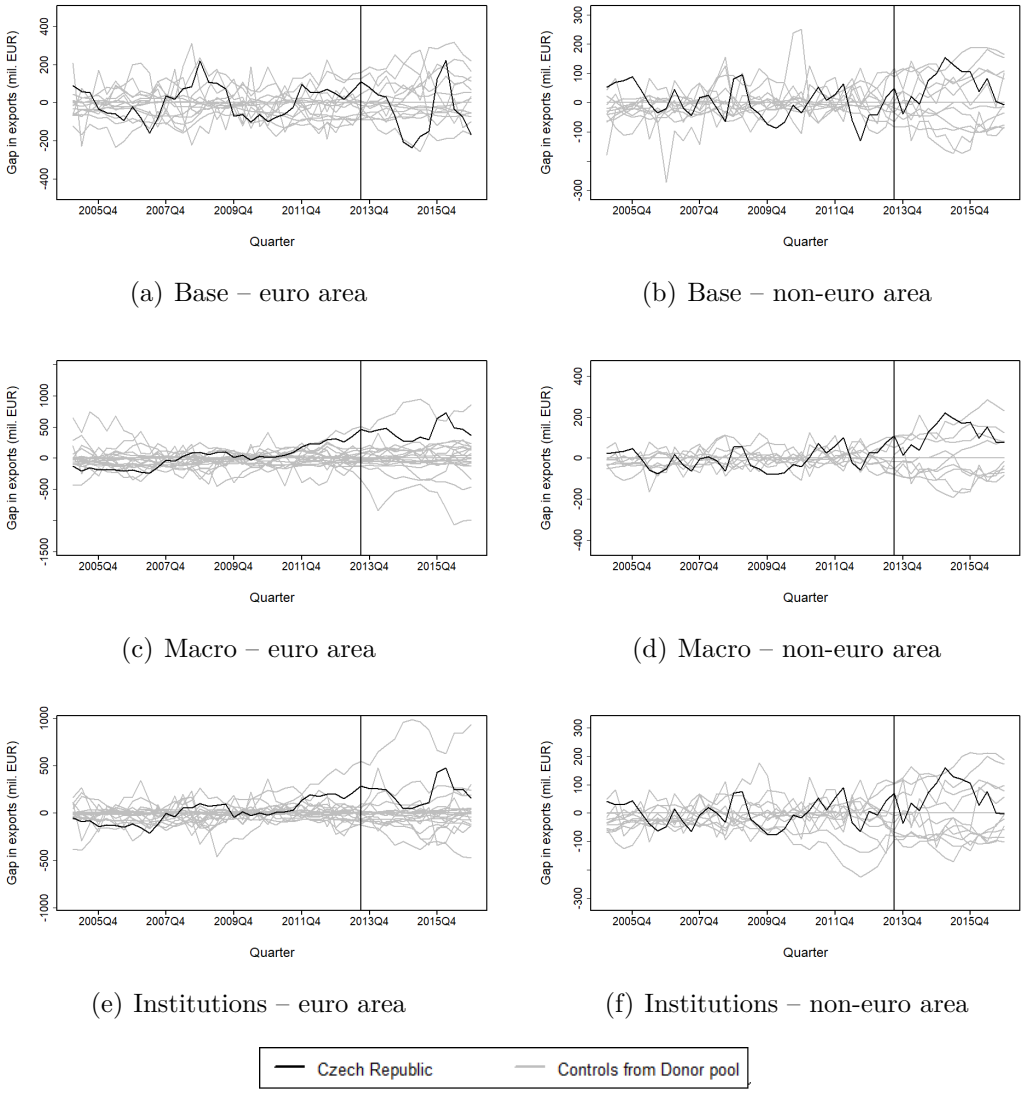
Figure A.20: Category 5 – Bilateral exports (Institutions specification)




Austria
Exports (mil. EUR)
Year
Austria
Gap in exports (mil. EUR)
Year
France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

A.7 SITC category 6

Figure A.21: Category 6 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

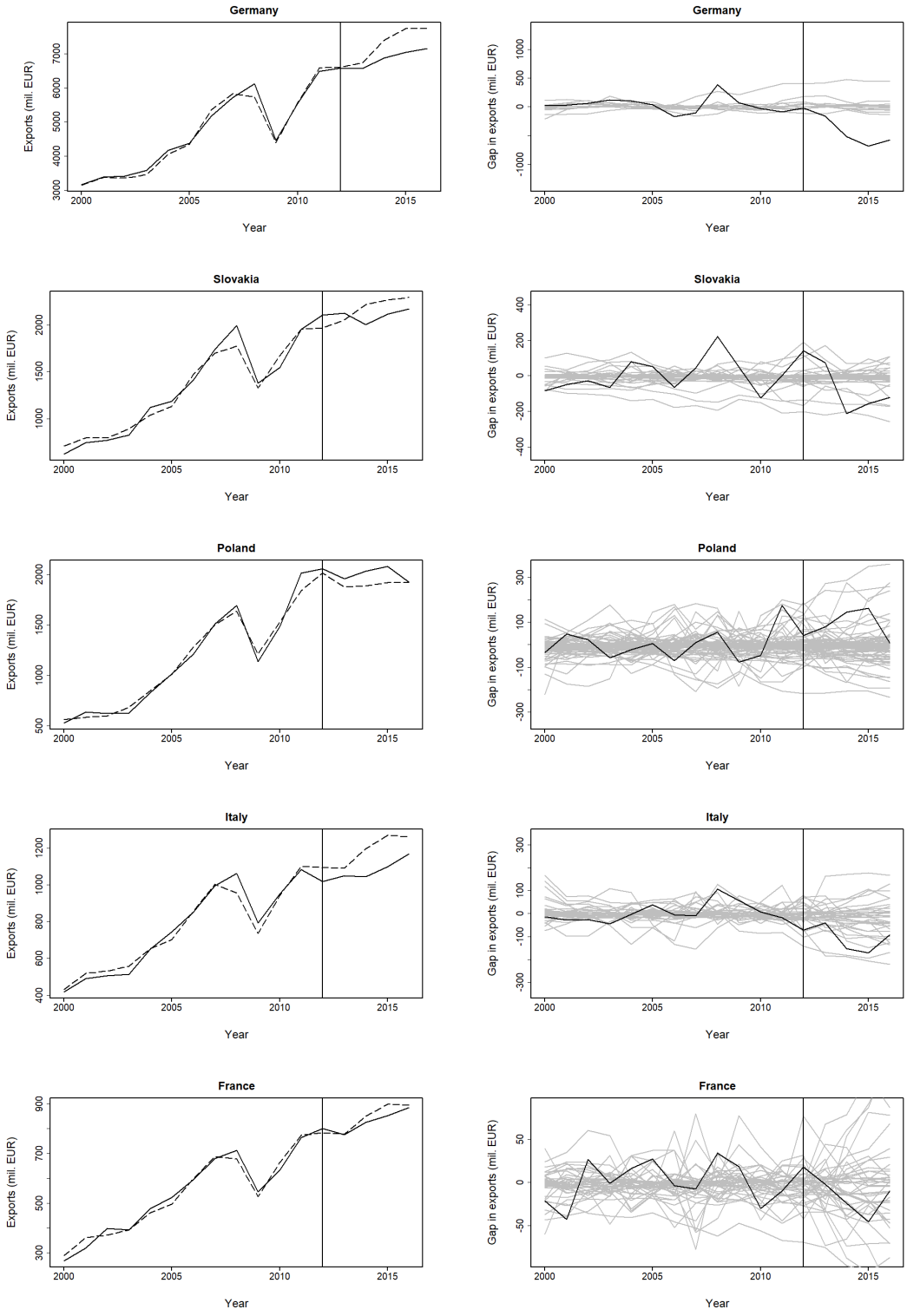
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.22: Category 6 – Bilateral exports (Base specification)



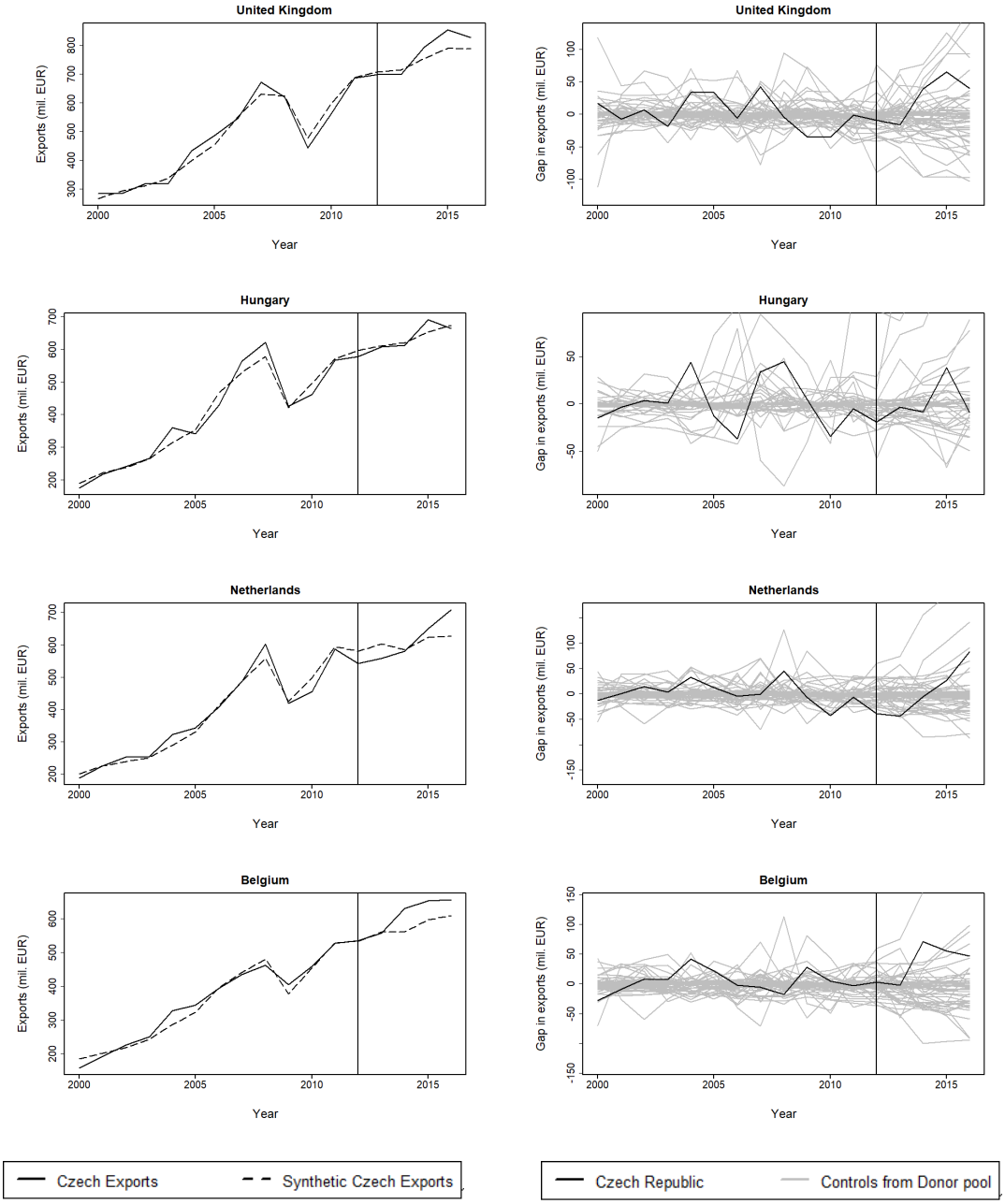
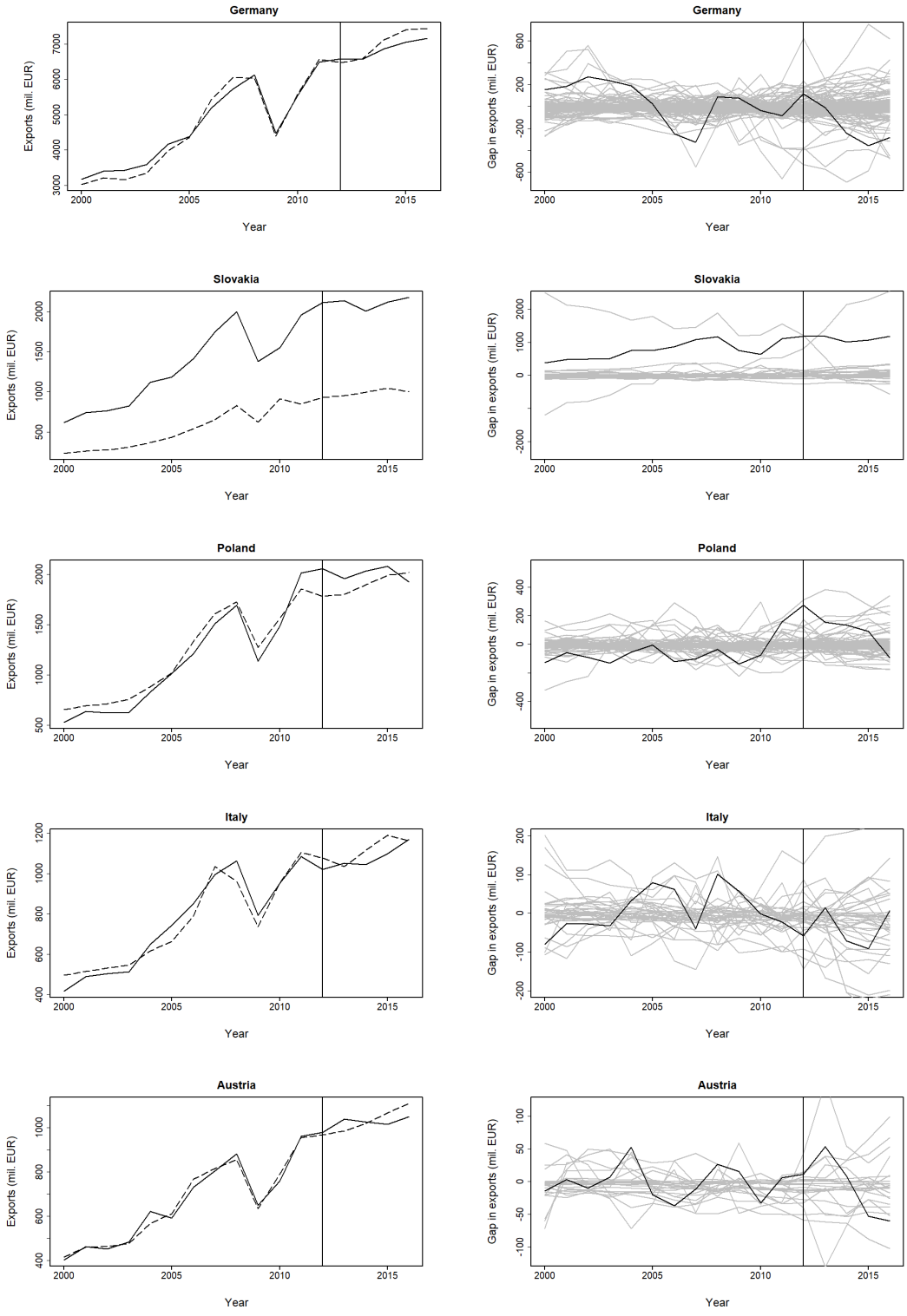
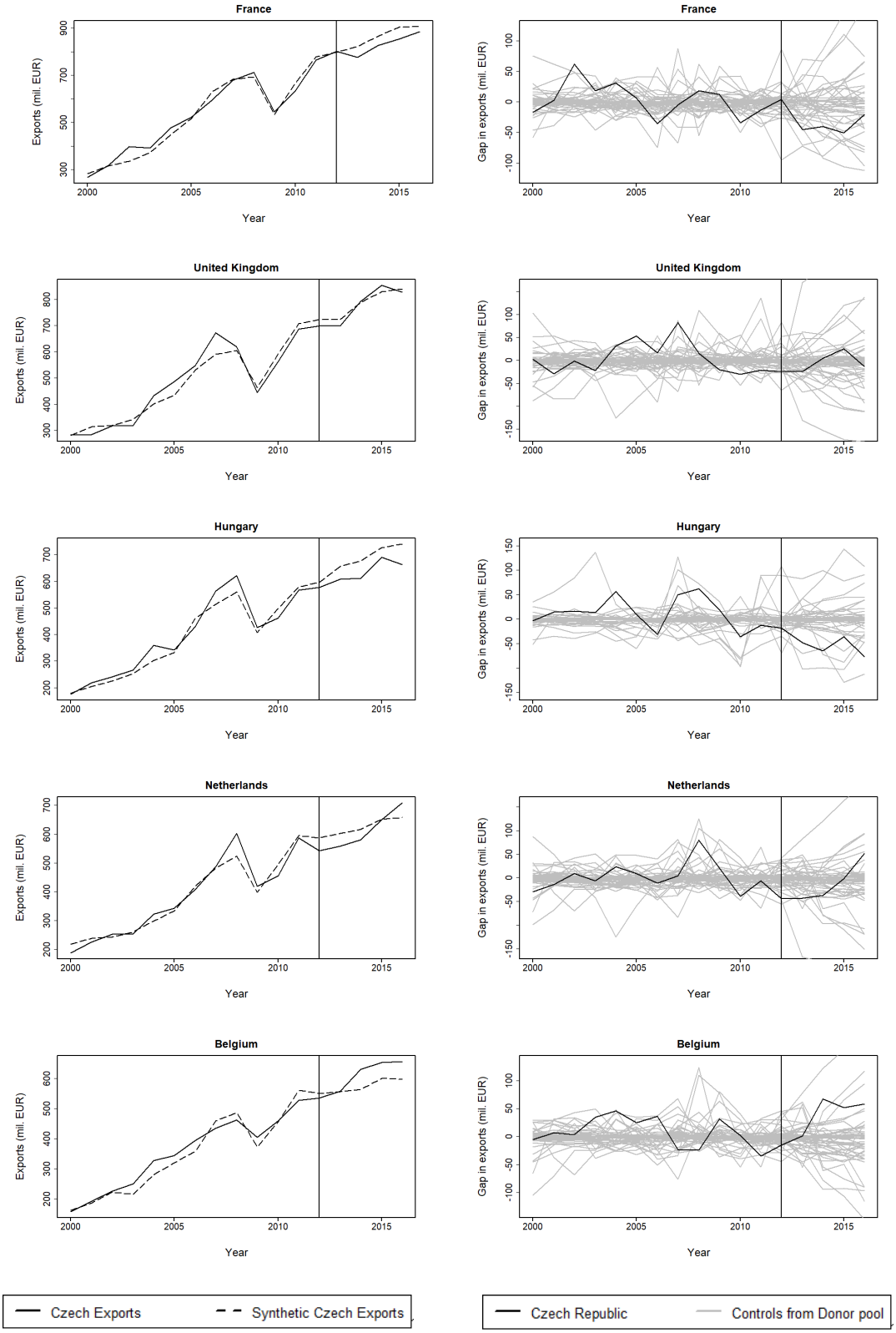

United Kingdom
Exports (mil. EUR)
Year
United Kingdom
Gap in exports (mil. EUR)
Year
Hungary
Exports (mil. EUR)
Year
Hungary
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

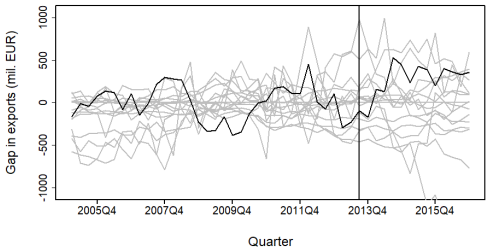
Figure A.23: Category 6 – Bilateral exports (Institutions specification)



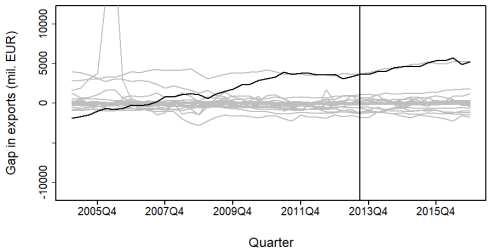

France
Exports (mil. EUR)
Year
France
Gap in exports (mil. EUR)
Year
United Kingdom
Exports (mil. EUR)
Year
United Kingdom
Gap in exports (mil. EUR)
Year
Hungary
Exports (mil. EUR)
Year
Hungary
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

A.8 SITC category 7

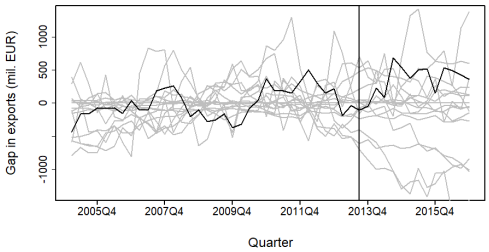
Figure A.24: Category 7 – Placebo study for exports to euro area and outside euro area



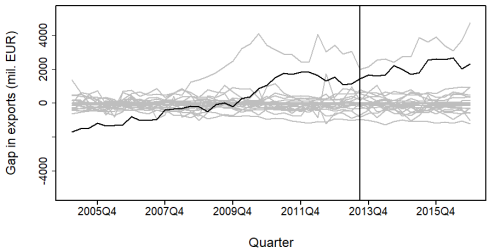
(a) Base – non-euro area



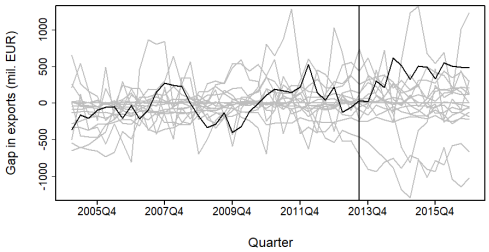
(b) Macro – euro area



(c) Macro – non-euro area

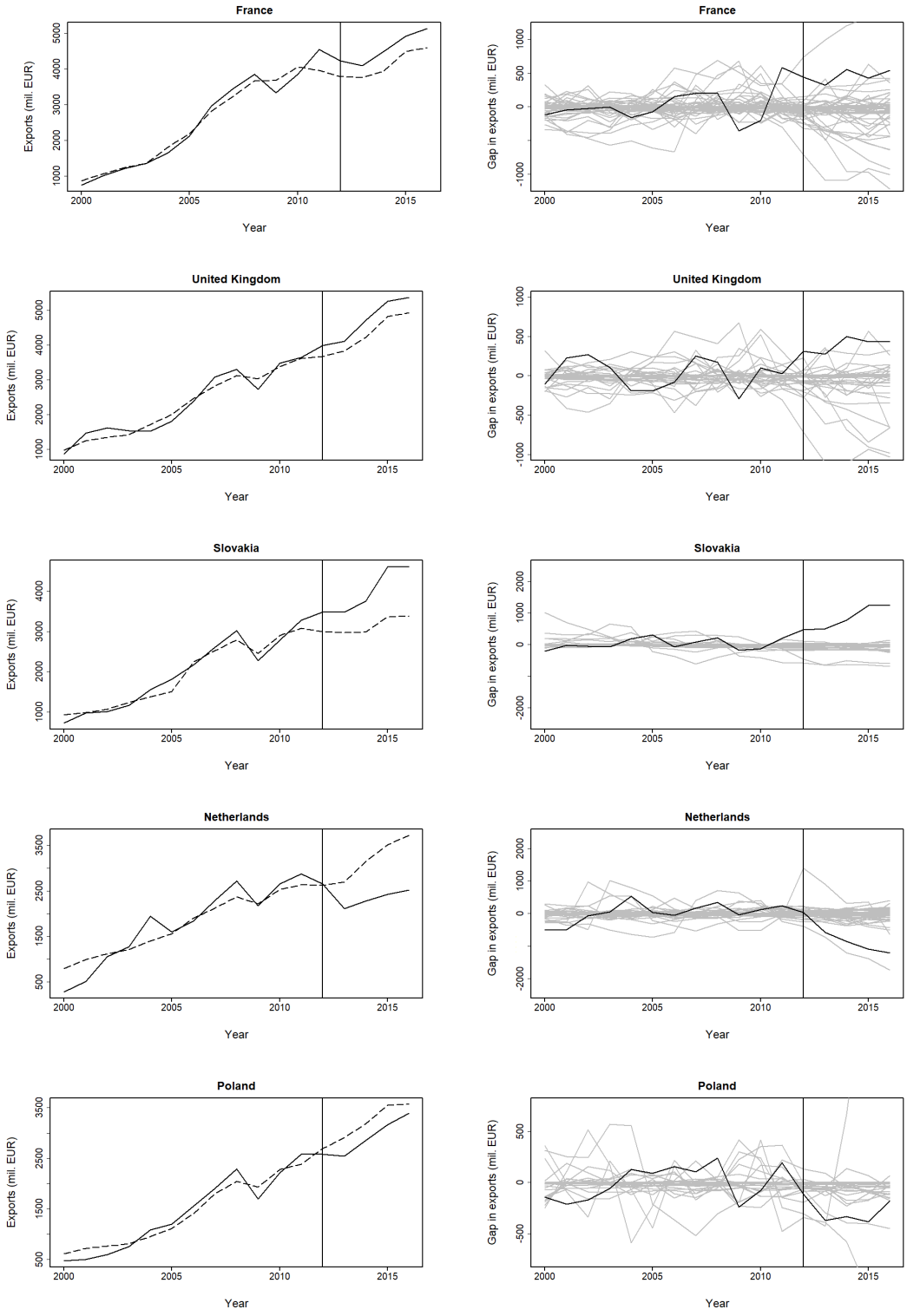


(d) Institutions – euro area



(e) Institutions – non-euro area

Figure A.25: Category 7 – Bilateral exports (Base specification)



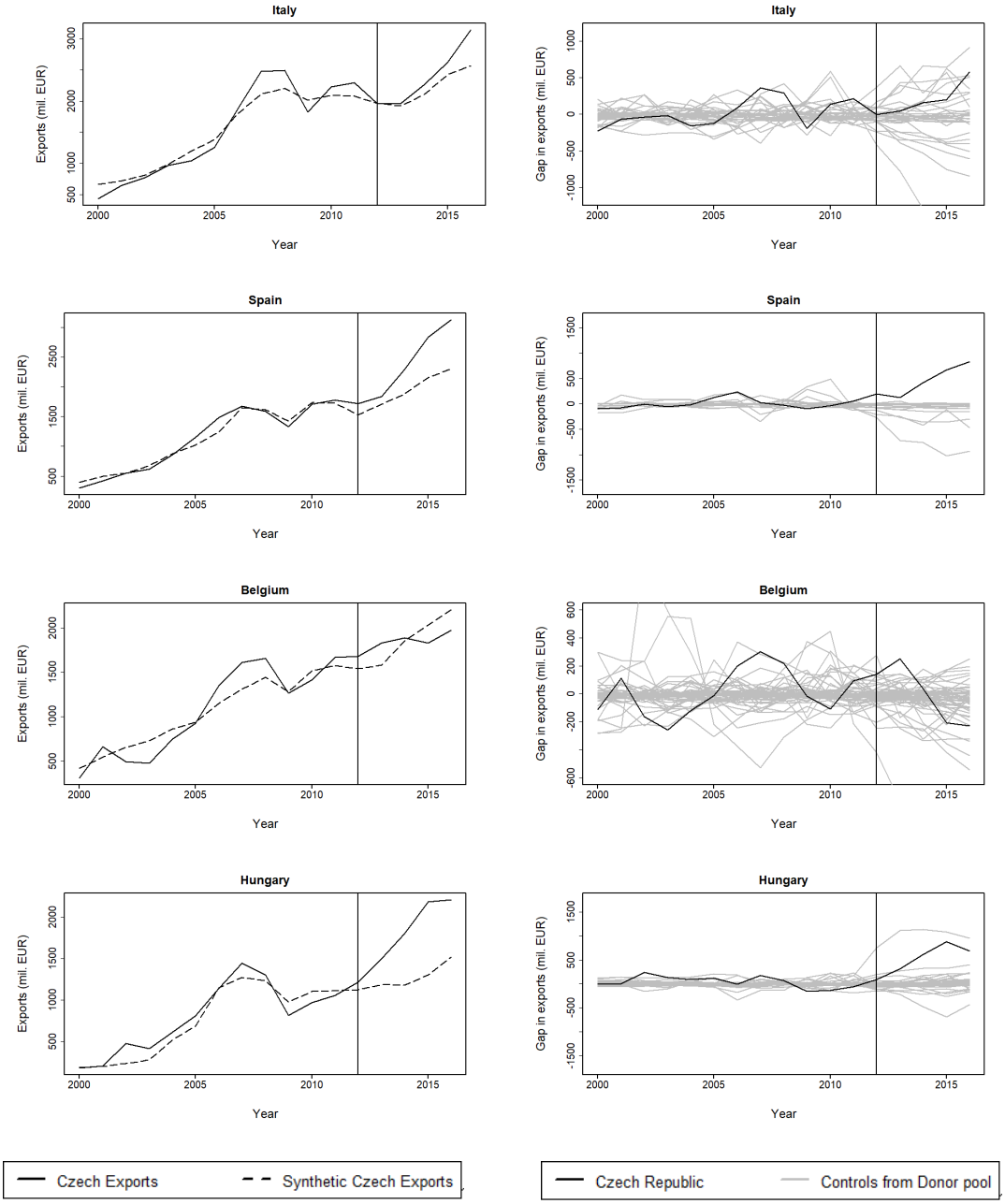
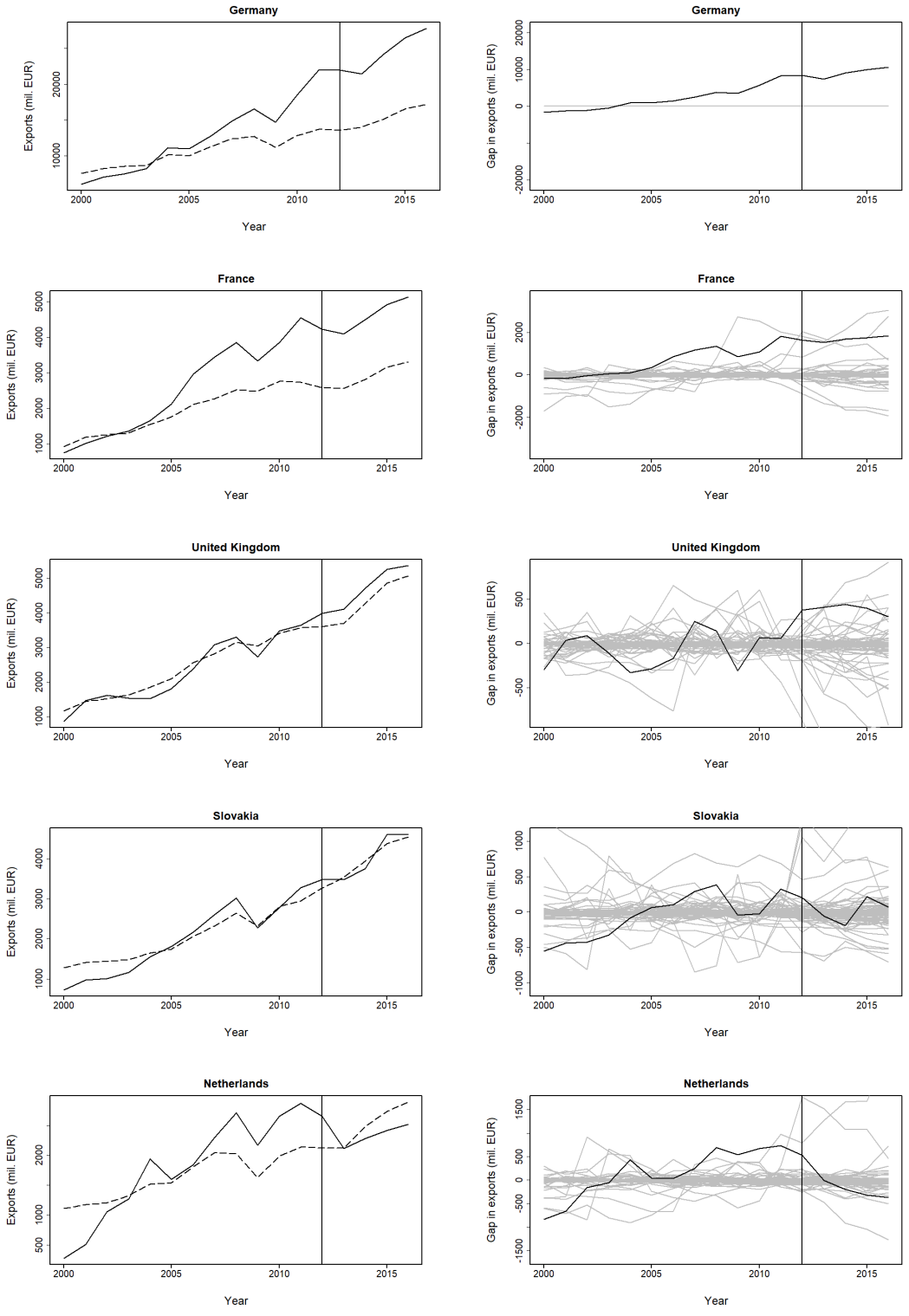
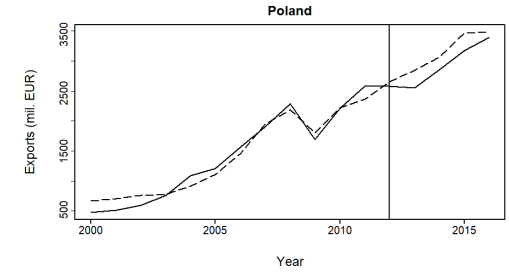
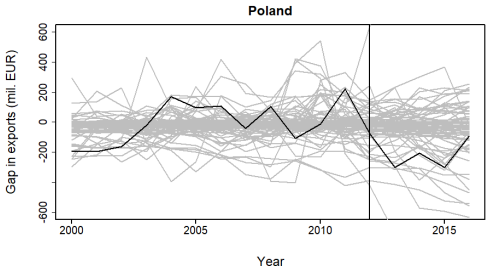
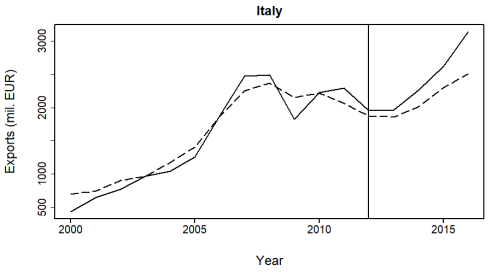

Italy
Exports (mil. EUR)
Year
Italy
Gap in exports (mil. EUR)
Year
Spain
Exports (mil. EUR)
Year
Spain
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Hungary
Exports (mil. EUR)
Year
Hungary
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

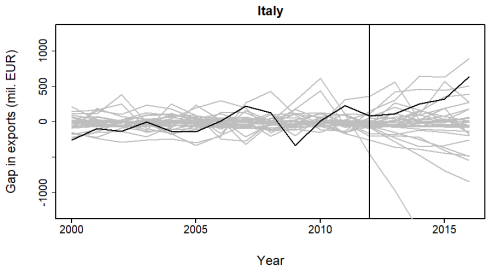
Figure A.26: Category 7 – Bilateral exports (Institutions specification)

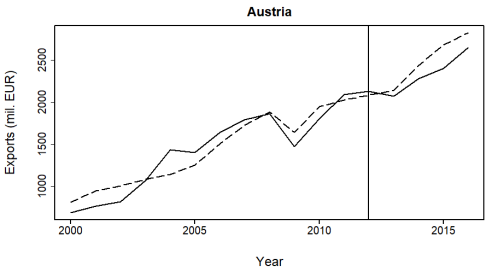


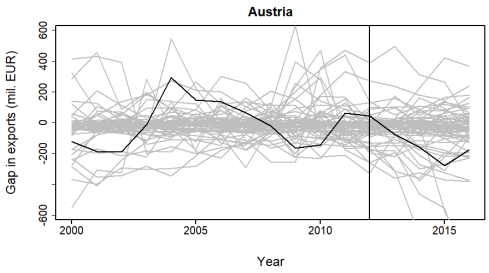

Poland
Exports (mil. EUR)
500
1500
2500
3500
2000
2005
2010
2015
Year

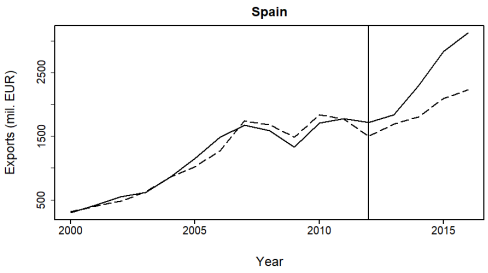

Poland
Gap in exports (mil. EUR)
-600
-200
200
400
600
2000
2005
2010
2015
Year

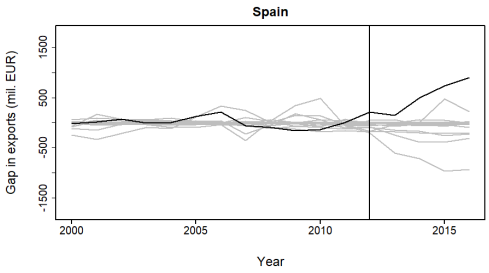

Italy
Exports (mil. EUR)
500
1000
2000
3000
2000
2005
2010
2015
Year

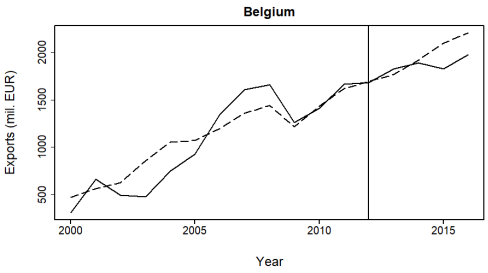

Italy
Gap in exports (mil. EUR)
-1000
0
500
1000
2000
2005
2010
2015
Year


Austria
Exports (mil. EUR)
1000
1500
2000
2500
2000
2005
2010
2015
Year


Austria
Gap in exports (mil. EUR)
-600
-200
200
400
600
2000
2005
2010
2015
Year


Spain
Exports (mil. EUR)
500
1500
2500
2000
2005
2010
2015
Year


Spain
Gap in exports (mil. EUR)
-1500
-500
500
1500
2000
2005
2010
2015
Year


Belgium
Exports (mil. EUR)
500
1000
1500
2000
2000
2005
2010
2015
Year

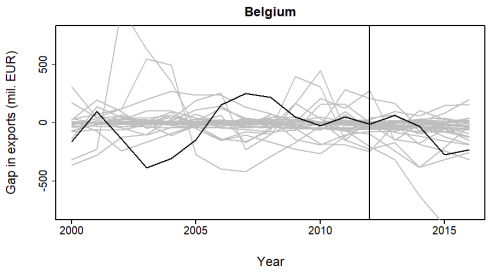
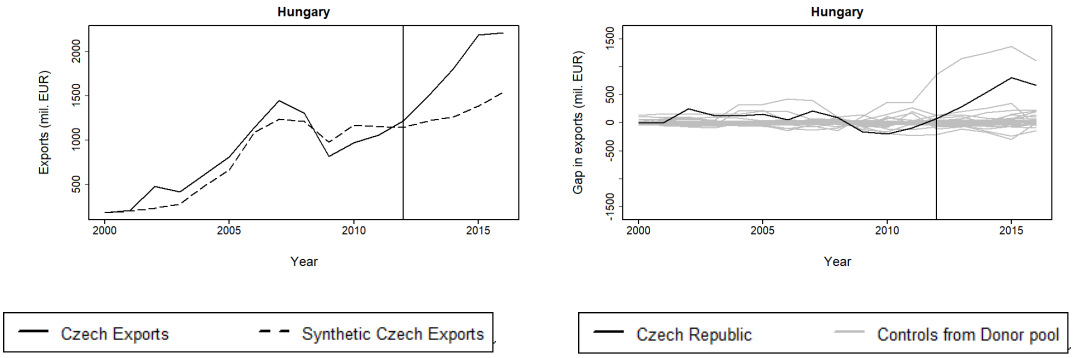
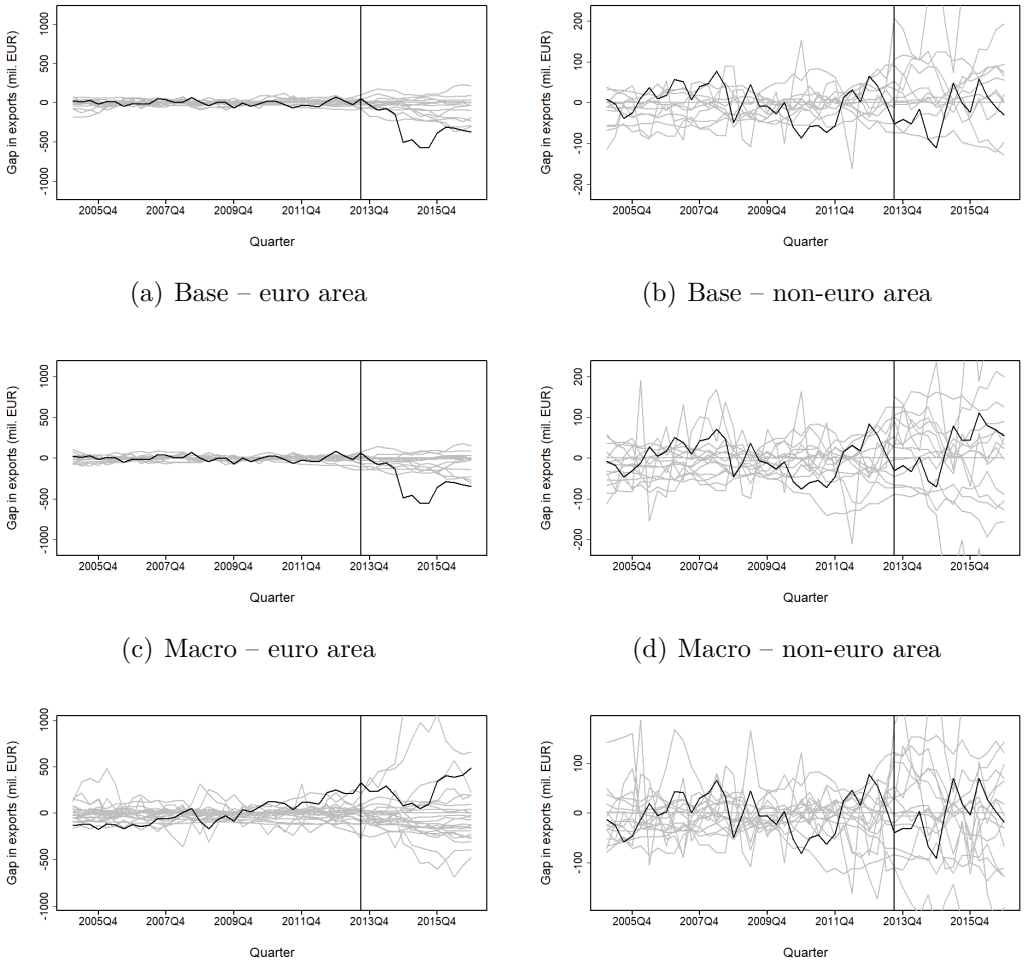

Belgium
Gap in exports (mil. EUR)
-500
0
500
2000
2005
2010
2015
Year

Figure A.26: Category 7 – Bilateral exports (Institutions specification)



A.9 SITC category 8

Figure A.27: Category 8 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

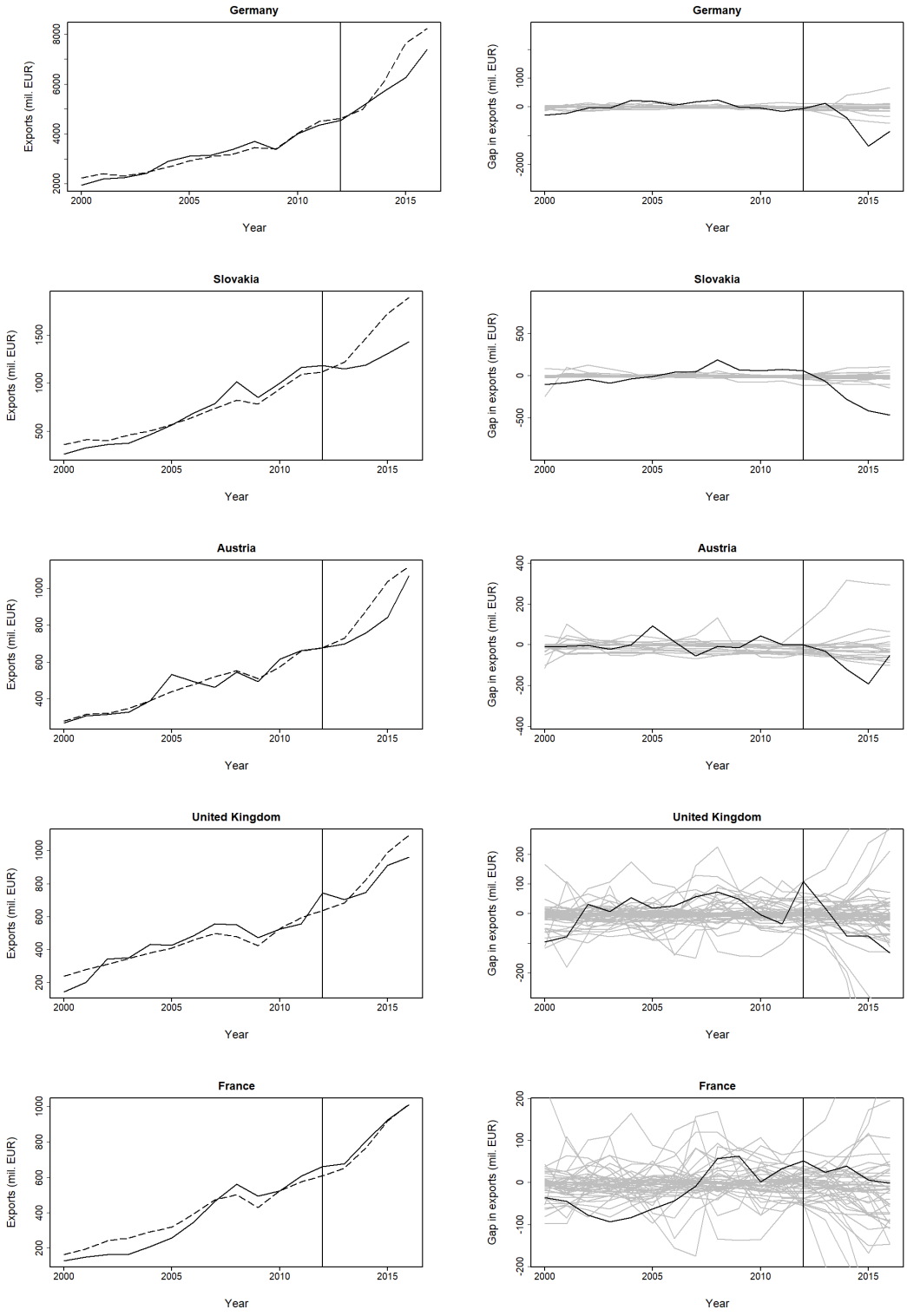
(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.28: Category 8 – Bilateral exports (Base specification)



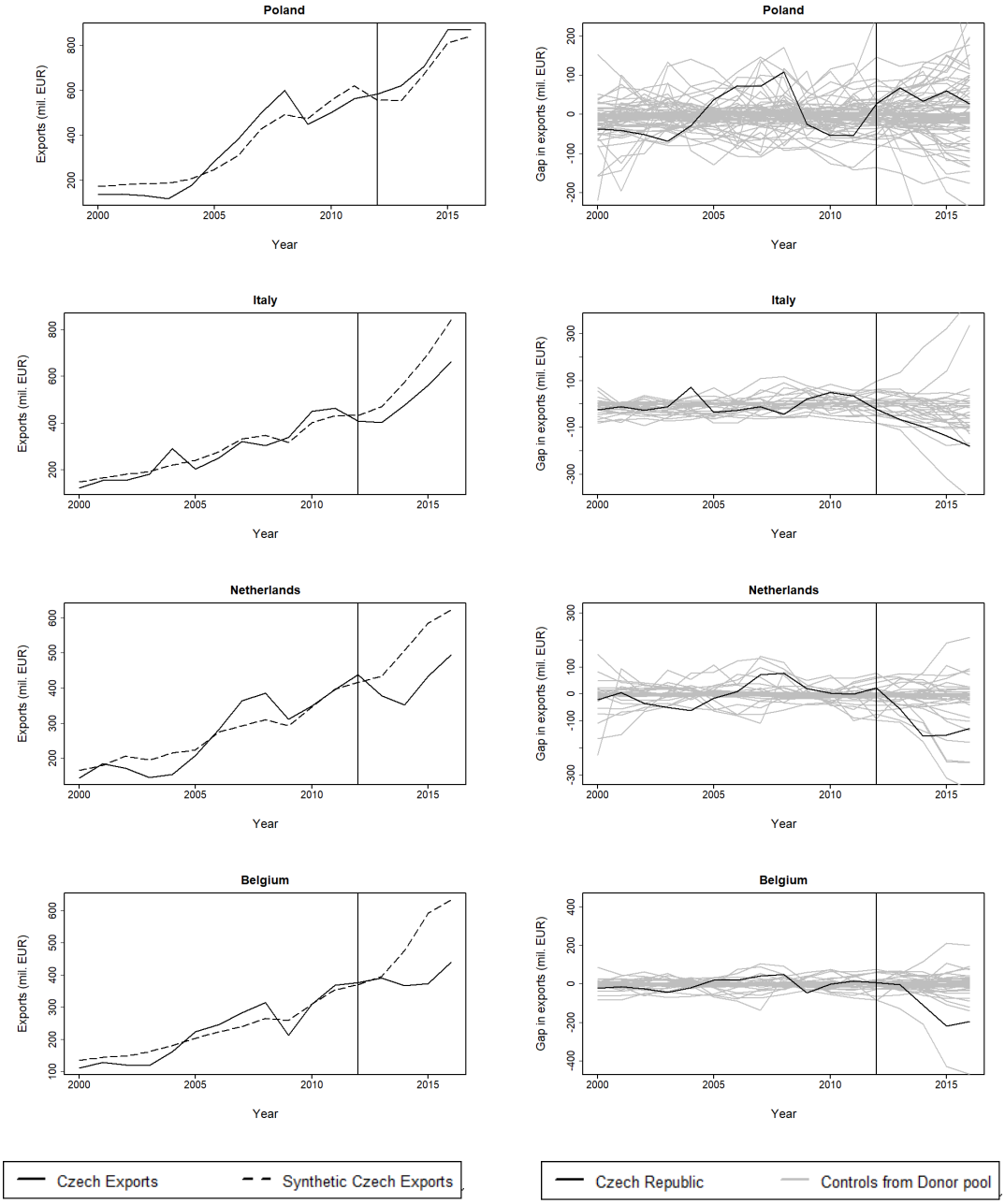
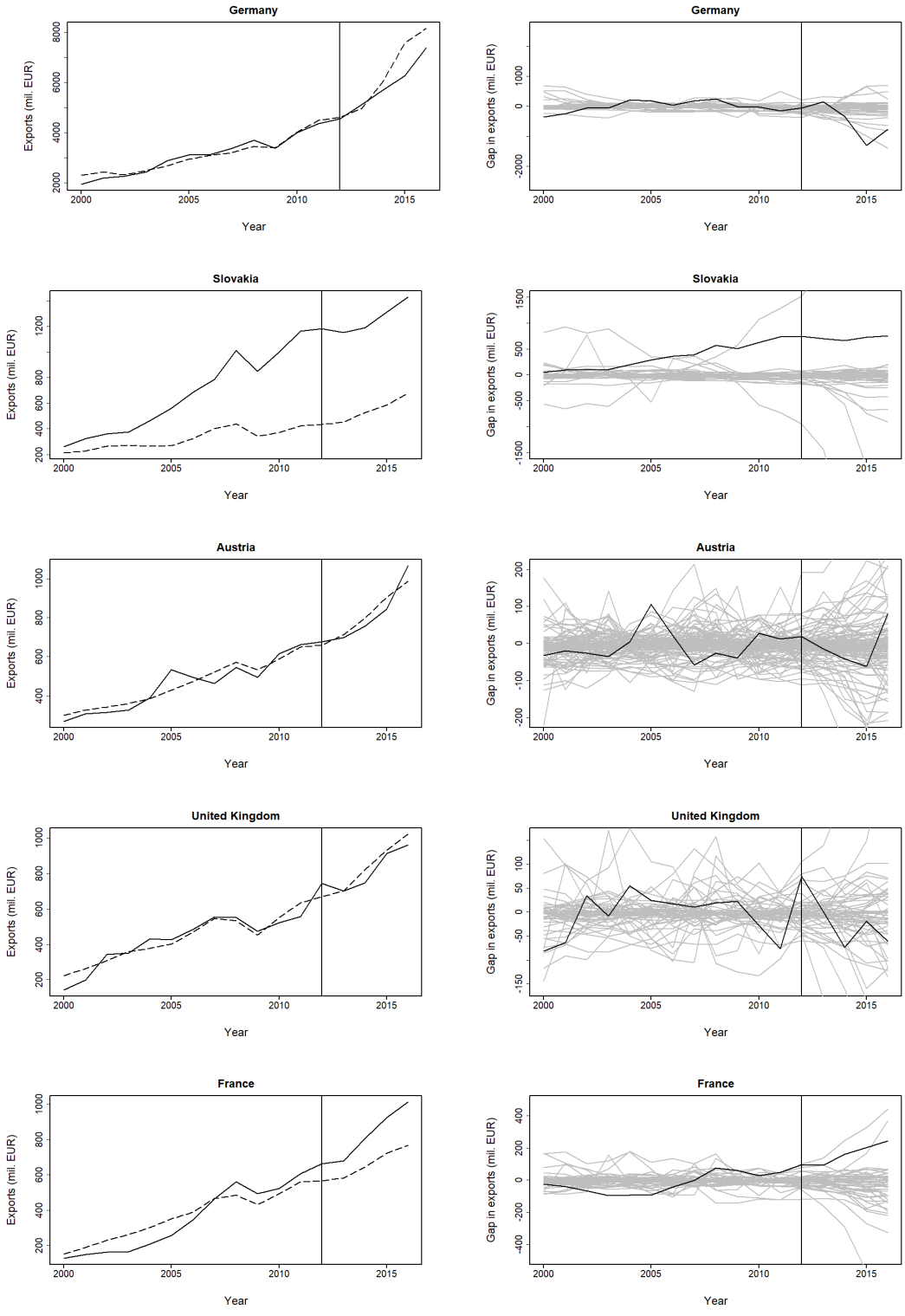
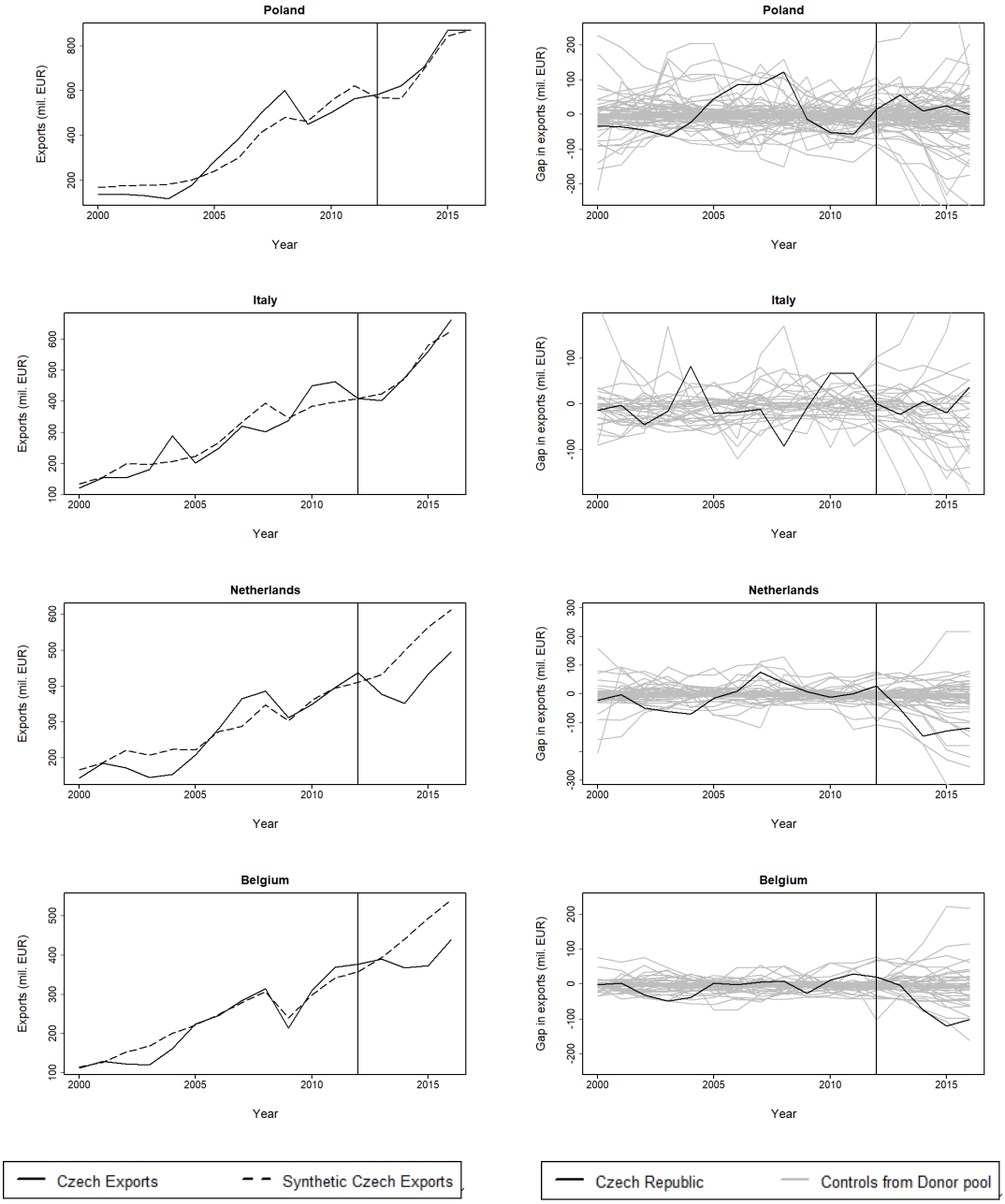

Poland
Exports (mil. EUR)
Year
Poland
Gap in exports (mil. EUR)
Year
Italy
Exports (mil. EUR)
Year
Italy
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

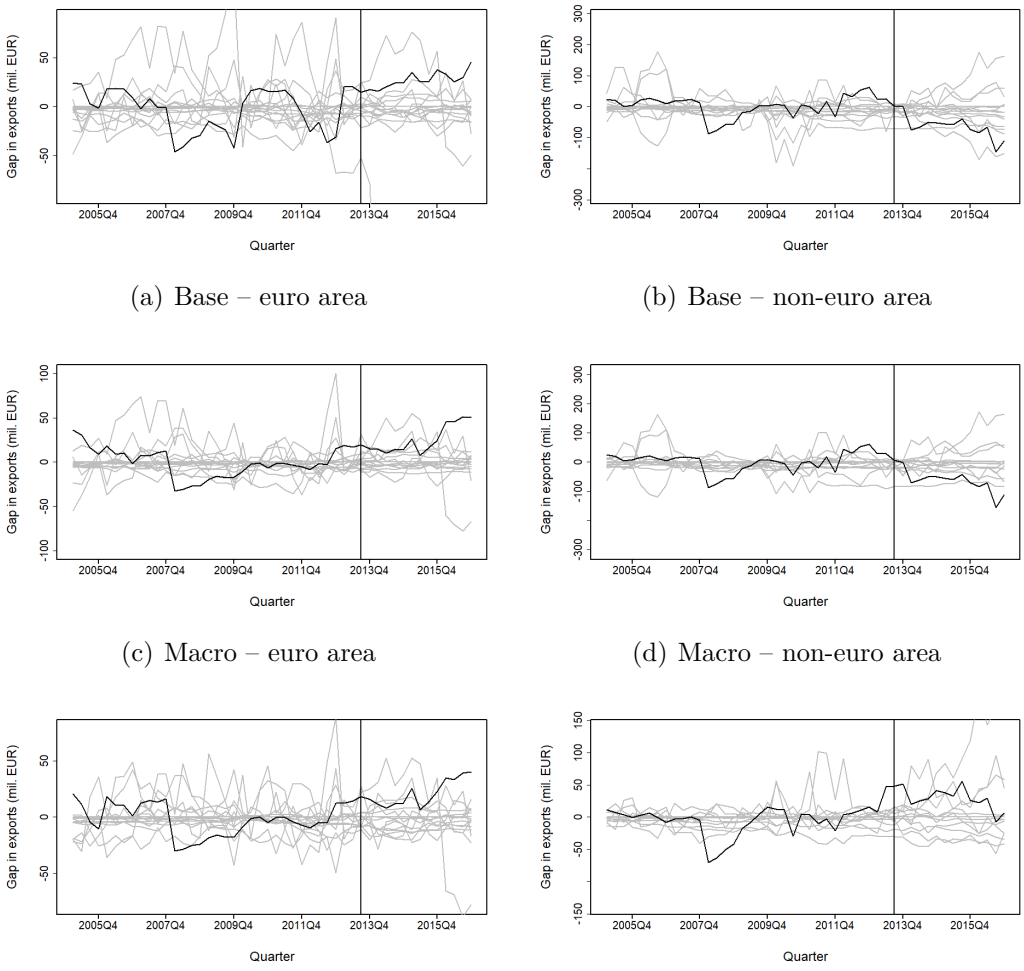
Figure A.29: Category 8 – Bilateral exports (Institutions specification)




Poland
Exports (mil. EUR)
Year
Poland
Gap in exports (mil. EUR)
Year
Italy
Exports (mil. EUR)
Year
Italy
Gap in exports (mil. EUR)
Year
Netherlands
Exports (mil. EUR)
Year
Netherlands
Gap in exports (mil. EUR)
Year
Belgium
Exports (mil. EUR)
Year
Belgium
Gap in exports (mil. EUR)
Year
Czech Exports
Synthetic Czech Exports
Czech Republic
Controls from Donor pool

A.10 SITC category 9

Figure A.30: Category 9 – Placebo study for exports to euro area and outside euro area



(a) Base – euro area

(b) Base – non-euro area

(c) Macro – euro area

(d) Macro – non-euro area

(e) Institutions – euro area

(f) Institutions – non-euro area

Figure A.31: Category 9 – Bilateral exports (Base specification)

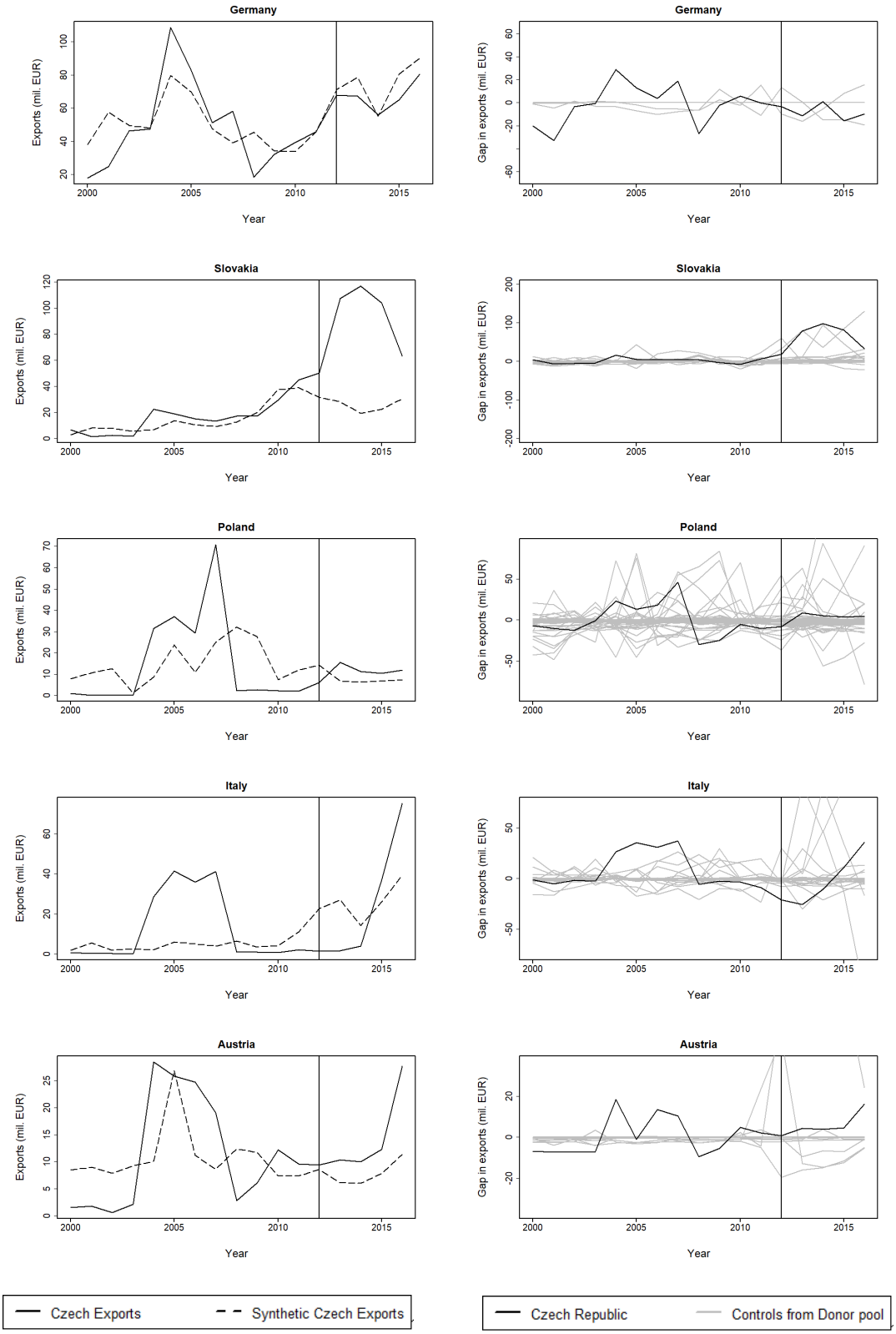
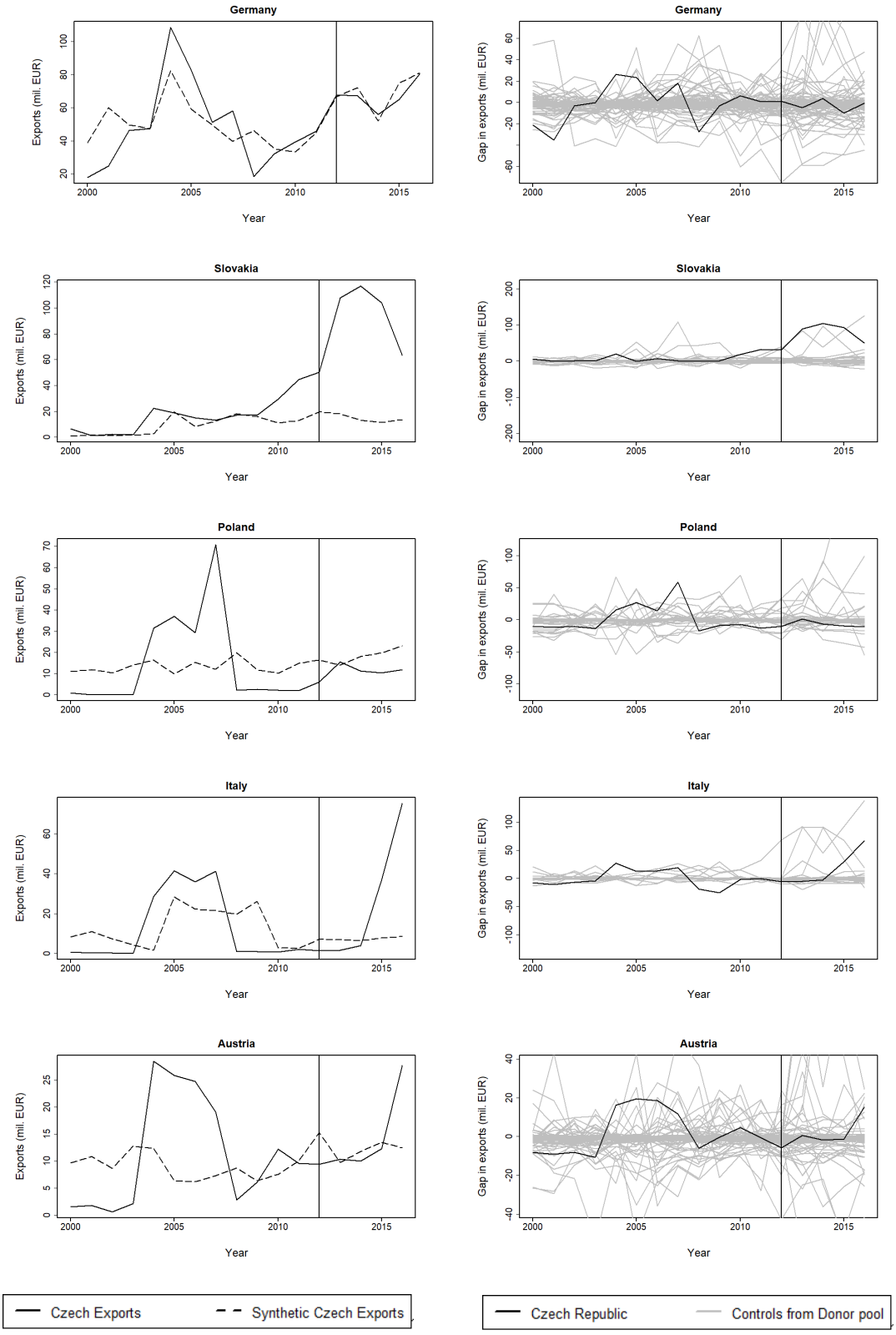


Figure A.32: Category 9 – Bilateral exports (Institutions specification)



Appendix B

Electronic sources

Here are the hyperlinks to websites from which you can obtain data and results presented in this thesis:

`https://github.com/Teichji/DP_Teichman_electronic_sources`

`https://drive.google.com/open?id=1GT50c8_vODDnC4LlwQZ2UOT3B3lf2oub`