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Mighty Midas' magic touch: Does the euro turn GDP into gold?

Estimating the effect of the introduction of the euro on GDP per capita of Eurozone countries, a bias-corrected synthetic control approach

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Abstract

The euro was introduced in 1999 as a means of furthering economic integration on the European continent. However, the underlying economics are heavily debated by economists and its practical implications are debated by politicians. This research analyses the effects of the introduction of the euro on GDP per capita levels for 17 Eurozone countries. This is done by estimating a bias-corrected synthetic control group for each country. The synthetic controls are constructed using data on 24 donor pool countries from 1970 until 2019. However, the main results are insignificant, as the estimates are indistinguishable from the placebo test estimates. It is nevertheless argued that the introduction of the euro had heterogeneous effects on the GDP per capita levels of Eurozone countries, as it is follows from the theoretical literature and is found by other authors. Hence, policymakers should keep these heterogeneous effects in mind when designing, and improving on, a currency area. Finally, the external validity of these results might be limited due to the unique historical, political, and cultural context in which the euro is situated.

Keywords

Common currency area, Optimum currency area, The euro, Eurozone, GDP, GDP per capita, Bias corrected synthetic control method

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*“So Midas, king of Lydia, swelled at first with pride when he found he could transform everything he touched to gold; but when he beheld his food grow rigid and his drink harden into golden ice then he understood that this gift was a bane and in his loathing for gold, cursed his prayer.”**

* Claudianus (ca. 396 C.E./1922)

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Marcus van Schie

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1 Introduction

Ancient Greek mythology tells us the story of Midas, king of Lydia, a country in modern-day Western Turkey. The king was a lover of all the best that life had to offer. He partied and drank large quantities of wine. His lifestyle made him a devoted follower of the Greek God Dionysus, the God of winemaking, festivity, and theatre, among others. One day some peasants found the satyr Silenus, foster father to Dionysus, sleeping in a bush. They brought the satyr to king Midas. The king welcomed Silenus into his home and cared for him for ten days. The king then took the satyr back to Dionysus, who granted the king a wish as a reward for his hospitality. King Midas declared that he wished everything that he touched turned into gold, since his lust for gold was never satisfied. Dionysus granted the king his wish.

King Midas soon came to regret his newly gained power, as even his food, drink, and, according to some versions of the story, his own daughter turned to gold. The king cursed his gift and begged to be relieved of his power. Dionysus consented to his request and told Midas to wash his hands in a nearby river in order to get rid of his golden touch.

The story of king Midas stands as a tale for how a wealth generating power can eventually turn out to be a curse, rather than a blessing. This tale is not merely an anecdote, but can also serve as an analogy to modern situations. The euro, the common currency of 19 European countries, was positioned as a wealth generating instrument that would make Europe a major player in the global economy, as follows from an op-ed written by Martin Feldstein (2000), former chairman of President Reagan's Council of Economic Advisers. It was part of a part of a long process of European integration that followed after the Second World War. Yet, the world is divided over the success of the euro more than 20 years after the its creation. This can be seen by looking at statements from nationalist European politicians, e.g. Dutch politician Thierry Baudet (2019), who claimed that a return to the Dutch Guilder would increase purchasing power by 8.4%. Although it should be noted that it is not only politicians who remain divided over the effects of the euro, as the economic literature shows, this will be discussed in section 2.1 and 2.2. This research seeks to contribute to our understanding of the effects of the euro on GDP in Eurozone countries. The central question is therefore the following:

What is the effect of the introduction of the euro on GDP per capita of Eurozone countries?

This research seeks to answer this question by applying macroeconomic perspective. This is done by applying a bias-corrected synthetic control method and quarterly and annually nationally aggregated data from 1970 until 2019. This makes it possible to obtain treatment effects for 17 Eurozone countries.[1] The bias-corrected synthetic control method is an extension of the classic synthetic control method and accounts for differences between the predictor values of the treatment and synthetic control

[1] This research looks at all Eurozone countries, except Cyprus and Malta, as these countries lack sufficient data.

group. The synthetic control method relies on a large number of observations on several donor pool countries, as well as on predictor variables in order to construct a suitable counterfactual for the treatment group. This research uses quarterly and annual data on 24 donor pool countries from 1970 until 2019. The predictor variables, used for creating the synthetic control, show a country's macroeconomic and population characteristics. The data has been collected from the Organisation for Economic Cooperation and Development (OECD), World Bank, and Penn World Table.

Several robustness analyses are performed in order to test the validity of the estimates that are obtained through the bias-corrected synthetic control method. First, the donor pool is restricted by removing countries that might bias the results due to having access to the European internal market, having an exchange rate that is pegged to the euro, or which might have experienced asymmetric macroeconomic shocks. This test will make it possible to assess whether a single donor pool unit is driving the results. Second, an in-time placebo test is performed. The intervention is backdated to 1992 for the initial 11 Eurozone countries. This is done as this research considers 1995 to be the intervention period, but the possibility exists that the effect occurs directly after the signing of the Treaty of Maastricht. Third, an in-space placebo test is performed. This test is specifically designed for the synthetic control method and synthetically assigns treatment to donor pool countries in order to assess robustness.

The results presented in section 4 indicate heterogeneous treatment effects on member states, with substantial differences between the pre- and post-2008 periods. However, these estimates are proven to be insignificant by the in-space placebo tests.[2] It is nevertheless argued that the euro had heterogeneous effects on Eurozone countries. This is done based on the theoretical and empirical literature discussed in section 2.

The central question and its answer have high degree of societal and academic relevance. First, the answer to this question can provide for arguments on the effects of the euro in the political debate within the Eurozone. Policymakers can also use these finding to identify where improvements on the common currency can potentially be made. Another, yet not insignificant, point of relevance lies within the possibility for policymakers outside the Eurozone to form expectations about joining the Eurozone or create their own currency area. This allows them to enact policies such their country could benefit optimally from a common currency. Although it should be noted that the external validity of this research is certainly not absolute. The euro is situated in a unique political, legal, cultural, and historical context. This entails that the results do not provide a guarantee to other countries that similar results will be obtained.

The academic relevance lies in the fact that this research goes further than the currently existing academic literature on this topic. First, this research implements a novel econometric approach that has, to the best of my knowledge, not previously been implemented in the empirical literature. The currently

[2] The other rigidity tests cast doubt on the rigidity of some of the individual estimates. However, the in-space placebo test performed in section 5.3 shows that all estimates are insignificant.

existing literature on the effects of the euro on GDP used the traditional synthetic control, whereas this research uses a bias-corrected synthetic control in order to account for differences between the predictor values of the treatment and synthetic control estimate. Second, the currently existing literature does not consider Eurozone countries that joined after Greece's ascension to the Eurozone. This research does include these countries, as it is believed that enough time has passed for some treatment effects to occur. Third, this research considers a longer time-path, compared to the other literature. This research will analyse the effects of the euro until 2019, whereas other studies only studied the effects until 2015, at its most recent. Finally, this research uses quarterly data in the construction of the synthetic control. The currently existing literature, which applies a synthetic control method in order to measure the impact of the euro on GDP, use yearly measured data, even though the synthetic control method relies on large quantities of data in order to create a suitable counterfactual. The use of quarterly measured data therefore constitutes a novel and useful addition to the currently existing literature.

This research proceeds as follows. Section 2 analyses the theoretical and empirical literature on optimum currency areas. Section 3 discusses the methodology and data used in this research. Section 4 presents the main results, after which the results of several rigidity tests are presented in section 5. Section 6 discusses several policy implications. Section 7 discusses the results, potential problems with this research, and options for future research. Section 8 concludes.

2 Literature review

2.1 Optimum currency area: The theoretical framework

This research is situated in a well-developed field of macroeconomic literature. A comprehensive understanding of the theory of common currency areas and its empirical outcomes is therefore essential in order to place this research among its peers. The foundations for the theory of optimum currency areas were laid in the 1940s and 1950s, but the theory matured in the 1960s (Cesarano, 2006; Kunroo, 2015). This research therefore considers the 1960s as the literary starting point and explores the theoretical framework from this point onwards. Special attention is directed towards the characteristics and effects of currency areas, since these findings can be used in analysing the main results of this research.

First, it is essential to highlight the distinction between two core concepts: a *common currency area* and an *optimum currency area*. For the purposes of this research a common currency area is defined as an area that shares the same currency or has a fixed exchange rate system, without fluctuation margins around parities, with guaranteed convertibility of currencies across the entire region, and free capital movement throughout the union (Werner Report, 1970). This infers that a country gives up its ability to conduct independent monetary policy, as is discussed later. An optimum currency area is a common currency area that fulfils a number of criteria which create an environment that generates additional benefits to member states. This means that an optimum currency area is a common currency area per definition, although the opposite does not necessarily hold true.

Another important distinction that has to be made is between symmetric and asymmetric economic shocks. Symmetric shocks are unexpected economic disturbances that hits all observed countries similarly in magnitude and direction, i.e. positive or negative. Contrary, asymmetric shocks will not hit countries or regions uniformly.

The literature has identified several characteristics and criteria for the identification and optimality assessment of a currency area, as well as the suitability of potential member states. A greater understanding of these characteristics is useful when analysing the results of this research. It should be noted that the debate over this set of criteria, as well as the relative importance of each individual criterion, is not yet settled. The presented overview should therefore be considered a general overview and not an absolute and limitative presentation of criteria.[3] Additionally, several authors argue that the presence of some of these characteristics can make up for the absence of other characteristics or unfavourable economic conditions within the union (Fleming, 1971; Vrňáková, & Bartušková, 2013).

(i) *Factor mobility*. This first criterion concerns the mobility of production factors, i.e. labour and capital. The importance of factor mobility, especially labour, has been emphasised since the creation of the literary field on optimum currency areas by Mundell (1961) and McKinnon (1963). McKinnon (1963) states that factor mobility should not only be understood as mobility between different geographical areas, but also among industries. High levels of labour mobility could serve as a substitute for exchange rate mechanisms in times of asymmetric shocks (Mundell, 1961). Kenen (1969) added that a high degree of labour mobility implies occupational mobility, which can only be achieved when labour is homogenous. It should be noted that labour market institutions are also important in order to generate sufficient levels of labour mobility (De Grauwe, 2003).

(ii) *Price and wage flexibility*. Mundell (1961) also stated that price and wage flexibility constitute mechanisms to cope with asymmetric economic shocks in the presence of fixed exchange rates. The flexibility infers that those adjustments to the asymmetric shock are less likely to be characterized by heterogeneous inflationary and unemployment effects. This idea can be traced back to Friedman (1953), who argued that the such flexibilities negate the need for adjustments via flexible exchange rates. Corden (1972) and Fleming (1971) reason that price and wage flexibility are important criteria, as these factors respond quicker to economic shocks, compared to other stabilisation mechanisms.

(iii) *Homogenic production structure*. This is the third criterion that follows from Mundell (1961). It is argued that countries that have similar production structures are less susceptible to asymmetric shocks to their terms-of-trade, this is also shown by Kenen (1969).

[3] See also Ishiyama (1975), Tavlas (1993), Broz (2005), Vrňáková and Bartušková (2013), and Kunroo (2015), as they provide comprehensive discussions of the literature and the assessment criteria/characteristics of optimum currency areas.

Experiencing more symmetric shocks to the external balance means that there is a lower need for exchange rate mechanisms to compensate for such shocks (Tavlas, 1993).

(iv) *Product diversification*. Kenen (1969) argues that the degree of product diversification should be considered in determining a country's exchange rate regime. It in concluded that a higher degree of product diversification reduces potential effects of negative demand shocks, as a shock to a singular sector will have less of an impact on total exports. This insulation reduces the reliance on exchange rate mechanisms for changes to a country's or area's terms-of-trade, allowing for fixed exchange rates.

(v) *Openness and size of the economy*. McKinnon (1963) states that open economies are more likely to prefer a fixed exchange rate, as a flexible regime would generate a larger degree of price instability and reduce the currency's liquidity. Additionally, he argues that open economies benefit less from exchange rate mechanism adjustments. Combined, these factors negate the need for flexible exchange rates in open economies, making them more likely to benefit from a currency area. McKinnon also argues that an inverse correlation exists between the size and openness of the economy, meaning that smaller economies are more likely to be open and experience larger benefits from a currency union.[4]

(vi) *Convergence of economies*. Melitz (1999), Kunroo (2015), and Vrňáková and Bartušková (2013) consider synchronization and convergence an important characteristic in assessing the optimality of a currency area. Monetary policy and cooperation will be more successful if the member countries are more similar to each other in nominal and real terms (Vrňáková, & Bartušková, 2013). The same holds for the convergence of inflation rates, as more diverging inflation rates can be costly in forming and maintaining a common currency area (Haberler, 1970; Fleming, 1971; Corden, 1972; Vrňáková, & Bartušková, 2013). Furthermore, the costs of joining a currency area will be lower if the business cycles are synchronized, as this means that the monetary interests of the union are similar to that of member states (Alesina et al., 2002; Kunroo, 2015).

(vii) *Fiscal integration*. This criterion was proposed by Kenen (1969), as fiscal policies and transfers would be necessary to balance differences between regions in response to asymmetric shocks and the absence of national exchange rate mechanisms. Some authors, like Kempf (2019), consider fiscal integration through a fiscal transfer mechanism, including debt transfers, a necessary component of an optimum currency union.

(viii) *Political will*. The aforementioned characteristics are all economic in nature. However, the political will to integrate economies is also often mentioned. Mintz (1970), Goodhart (1995) and Machlup (1997) even argue that the political will might perhaps be the only necessary condition for the implementation of a currency area. This view is corroborated by Cohen

[4] Vrňáková and Bartušková (2013) indeed find that smaller economies within the Eurozone indeed show a larger degree of economic openness.

(1993). He concludes that economic criteria are superseded by political characteristics in a successful currency union, based on empirical research into six currency unions.

It should be noted that not all characteristics are exogenous to a union, as follows from work by Frankel and Rose (1997, 1998). For example, the authors find a strong positive relationship between international trade patterns and business cycles. Furthermore, Frankel and Rose (1997, 1998) conclude that it could be possible for a potential member state not to meet the optimality criteria prior to joining, but that these criteria can be met after joining, as the integration process will lead to further convergence.

The optimal size of a currency area and the suitability of potential member states can be assessed in accordance with the aforementioned criteria. No one-size-fits-all equation exists in order to obtain the maximum number of member states for a currency union. However, Mundell (1961) provides special attention to the upper limit of currency areas in the penultimate section of his work. Special attention is given to his work as Mundell highlights two extreme cases for the size of an optimum currency area. First, he argues that factor mobility is a dynamic concept that changes of time and in response to economic and political conditions. If internal stability were the main objective of economic policy, then internal stability would be more successfully achieved when currency areas are small, according to Mundell. Yet, this does not provide an argument for increasing the size of common currency areas, as even the smallest degree of factor immobility would warrant creating a new currency area. This argument for many small currency areas is rejected by Mundell, as it ignores the fact that an increasing number of currencies comes with increasing transaction costs. Other economists, like John Stuart Mill (1848), therefore argue for the complete abolition of national currencies and the creation of a single world currency. The upper limit of the number of currency areas lies somewhere in-between being equal to the number of regions in the world and one, according to Mundell (1961). Mundell argues that a large amount of currency areas would thin foreign exchange markets, raise information and transaction costs, and mean that money becomes less efficient. These arguments can be interpreted to support large currency areas (Kunroo, 2015). However, Mundell (1961) does not present a minimum number of currency areas, whereas the maximum number of currency areas is capped by the necessary degree of money illusion.

The characteristics and size of an optimum currency area leave questions on the potential effects of currency areas unanswered. The final part of this section is therefore devoted to the benefits of a currency area to its member states. The costs of joining a union are discussed in section 2.2.

Tower and Willet (1976) conclude that a currency area improves the usefulness of money as a medium of exchange. An often-cited benefit of a common currency is therefore the decrease in trading costs, as there is no need for currency conversion (Artis, 1991; Obstfeld, & Rogoff, 1996; Frankel, 1997; Stevens, 1999; Krugman, 2013). Reduced costs imply increased trade among member states, resulting in higher GDP levels (Alesina, & Barro, 2002; Frankel, & Romer, 1999; Alcalá, & Ciccone, 2004). Another benefit to intra-union trade is generated by a higher degree of relative price predictability and the elimination of currency risk (Obstfeld, & Rogoff, 1996; Stevens, 1999; Krugman, 2013). Although

it should be noted that the effect of exchange rate volatility on trade is highly debated (Schiavo, 2007). Price predictability also has an effect on investments, this is because exchange rate uncertainty has a negative effect on international investments (Calcagnini, & Saltari, 2000; Schiavo, 2007). Removing such uncertainties by fixing exchange rates might therefore boost investment, which in turn boosts GDP. Another benefit is described by Ishiyama (1975). The author states that a currency area could eliminate speculative capital flows between member states. Yet another benefit stems from protection against speculative financial bubbles and monetary shocks that would otherwise cause fluctuations in the real exchange rate, given sticky domestic prices (Obstfeld, & Rogoff, 1996). A common currency might also increase competition within the union due to increased transparency and price comparability (Stevens, 1999; Krugman, 2013). Finally, there are also non-economic and political benefits to joining a currency area, as membership could lead to increased policy credibility and decreased political pressure for protectionist trade measures (Alesina et al., 2002; Obstfeld, & Rogoff, 1996). Beetsma and Giuliodori (2010) go further and state that any net economic benefit of a joining a currency union can only be derived from political and institutional factors that are less binding in a union, compared to a situation with full national monetary autonomy. Policy credibility might be increased, as monetary integration allows for greater central bank independence. This increases the bank's credibility in turn reduces inflation expectations. The magnitude of all these effects is dependent on the economic, political, and institutional characteristics of the (prospective) member state, as also follows from the described criteria, Cooper and Kempf (2000), Beetsma and Giuliodori (2010), and Jablonski (2017).

2.2 Optimum currency area: An opponent's view

Section 2.1 presented the characteristics and benefits an optimum currency area. However, not all economists agree with the presented analysis and point to associated costs and missing underlying characteristics. This section therefore discusses the macroeconomic costs and critiques on the theory of optimum currency areas

An often-cited cost of joining a currency union relates to the fact that a country surrenders its ability to conduct independent national monetary policy in response to (asymmetric) economic shocks (Corden, 1972; Ishiyama, 1975; Tavlas, 1993; Obstfeld, & Rogoff, 1996; Frankel, & Rose, 1997; Eudey, 1998; Alesina, & Barro, 2002; Beetsma, & Giuliodori, 2010; Kunroo, 2015; Aizenman, 2016). This can be inferred from the impossible trinity of economics (Aizenman, 2016). A costly consequence of this is that a unionwide monetary policy stance might harm the national economies of individual member states, as the policy might not be attuned a country's specific needs (Ishiyama, 1975). An additional cost comes from the fact that a lack of stabilisation through independent monetary policy also implies larger cyclical fluctuations in economic output (Alesina et al., 2002). The eventual magnitude of the incurred costs depends on the degree of business cycle synchronisation of member states, the implicit or explicit contract between member states on the union's monetary policy, and the effectiveness of monetary

policy in general (Alesina et al., 2002; Calvo, & Reinhart, 2002, Broz, 2005).[5] Beetsma and Giuliodori (2010) add that responsiveness of import prices to the exchange rate is also indicative of the size of the associated costs, in a New Keynesian framework, this also follows from Corsetti and Pesenti (2002) and Devereux and Engel (2003). Many authors only consider these costs in relation to asymmetric shocks. However, Melitz (1991) shows that this is also the case when a symmetric shock hits the union, as differing initial positions might still give rise to different monetary policy needs. Another consequence of losing monetary autonomy is that this infers an inability to reduce the real pressure of public debt (Obstfeld, & Rogoff, 1996). A final, yet unexpected, consequence is a decreased likelihood to implement structural reforms (Duval, & Elmeskov, 2006). Beetsma and Giuliodori (2010) also studied the effects on structural reforms and came to similar conclusions, they argue that entry into a union reduced structural reform incentives due to free-riding problems within the union.

Many variants of the aforementioned impossible trinity exist (Issing, 2006). Beck and Prinz (2012) state that the union itself is also constraint by a trilemma. This trilemma exists between fiscal sovereignty, independent monetary policy, and the presence of a no-bailout clause. Any choice between these factors entails different additional economic or political costs and constraints for the union. These consist of either requiring sovereign bailouts, forcing monetary policy to accommodate fiscal policy, or the loss of fiscal autonomy.

It is also argued that joining a currency union causes a country to lose control over its sovereign debt, as the currency union alters the "nature" of the debt (De Grauwe, 2011, abstract). This is because of the fact that the member state loses control over the currency in which their debt is denominated. De Grauwe (2011) argues that financial markets can then push these countries into default, essentially downgrading member states "to the status of emerging economies" (p. 7) and creating a fragile union.

Ishiyama (1975) states that joining a currency union might result in the "deterioration of regional economies" (p. 368), thereby increasing regional inequalities and being harmful to economies. A priori differences in regional economic performance might lead to capital flows being redirected towards growing regions within the union. This will accelerate growth within these regions, but have adverse consequences on disadvantaged regions, whose performance will further deteriorate relative to the well-performing regions. This argument is supported by Kaldor (1970), Johnson (1971), and Hirsch (1972). It should be noted that the argument also holds on a national level, as Ishiyama (1975) argues that Southern Italy and Scotland could potentially benefit from having their own currency. Creating their own currency would allow them to depreciate its value in order to boost economic performance.

Obstfeld and Rogoff (1996) identified two other costs. First, they argue that there are costs associated with the transition from several national currencies to one common currency, as speculative attacks can be an important issue during this phase. Another problem relates to distributional issues of seigniorage revenue, i.e. how should seigniorage generated by the union's central be distributed among

[5] Alesina et al. (2002) conclude that the loss of monetary autonomy might yield a benefit in the case of developing countries.

member states? This gives rise to political frictions during the creation of a union, but might also have lasting costs for countries who rely on seigniorage revenues to close their budget. Artis (1991) argues that the costs of losing seigniorage revenues could be large for countries with an underdeveloped tax system. This is because an underdeveloped fiscal system has higher costs on increasing government revenue through increasing taxes, compared to using seigniorage to increase government revenue (De Grauwe, 1992).

Furthermore, the described main characteristics of a currency union might not be attainable in practice, thereby forming major problems for the theory of optimum currency areas. Various authors discussed the potential practical issues of these characteristics for an international currency union and how they hinder a union's ability to generate (sufficient) benefits. Examples are Ishiyama (1975) and Corden (1973) on the absence of labour mobility between regions. Another prime example relates to fully flexible prices and wages, which are unattainable in practice. This is one of the reasons why Milton Friedman was a proponent of flexible exchange rates, as they could serve as a well-function adjustment mechanism to asymmetric shocks (Artis, 1991; Vrňáková, & Bartušková, 2013; Jablonski, 2017). Other arguments proposed by Friedman in favour of flexible exchange rates were that it promoted international trade and insulated a country from monetary policy mistakes made by other countries, among others (Friedman, 1953; Jablonski, 2017).

Another critique arises from the fact that even if a currency union ex-ante fulfils all aforementioned criteria, it is still possible that the union and its member states fail these criteria ex-post, meaning that the union cannot generate the (full) potential benefits described in section 2.1 (Kunroo, 2015). The ex-post failure of a currency union can be caused by increasing regional economic specialisation within the union, resulting in the union being susceptible to asymmetric economic shocks (Krugman, 1995; McKinnon, 2004).

These problems and costs might cause the implementation of a common currency to yield a negative effect. Although it should be noted that the quantification of the individual costs and benefits of a currency union is difficult (Krugman, 2013). Yet, these findings can possibly provide possible explanations for results of this research.

2.3 Common currency area in practice: Empirical analysis of the euro

The previous sections presented a theoretical analysis of the characteristics and theoretical costs and benefits of currency unions. This section presents the empirical literature that assess the impact of the euro on member states' GDP, with an exception to the literature that applies the synthetic control method, as this is discussed in section 2.4. Assessing the empirical literature shows the real-world implications of a currency area and allows for comparisons between the existing literature and this research.

First, the question should be answered whether the Eurozone constitutes an optimum currency area or an imperfect representation of the theoretical framework. Eichengreen (1991) sought to answer this question prior to the introduction of the euro. He concluded that the, then future, Eurozone would not constitute an optimum currency area. Eichengreen (1991) identified regionally asymmetric shocks and differences in price flexibilities as the main reasons for this conclusion. Vrňáková and Bartušková (2013) also concluded that the Eurozone does not meet the majority of the criteria set out for an optimum currency area, however they did so ex-post.[6] The first reason is the low degree of labour mobility between member states. The authors consider this a structural obstacle and ascribe this to a wide range of issues, e.g. historical differences, rigid labour markets, differences in education systems, and lingual differences between countries. A second reason follows from the differences in price and wage flexibility, also identified by Eichengreen (1991). These differences reflect different macroeconomic conditions, according Vrňáková and Bartušková (2013). Furthermore, the heterogeneous characteristics of the European economies, in terms of development, size, business cycle, and composition, means that the required convergence of economies is unattainable. Finally, the Eurozone lacks a fiscal transfer mechanism, fiscal cooperation, and a unionwide fiscal policy. This means that asymmetric shocks to one part of the union cannot be compensated for by other parts of the union. Taken together, the authors conclude that the Eurozone is not an optimum currency area, even though political will and capital mobility are present.

However, the Eurozone did create real economic effects, even though it cannot be considered an optimum currency area. An example of this is presented by Barrell et al. (2008). The authors concluded that the euro had a direct positive effect on output in Belgium, France, Germany, Italy, and the Netherlands. A quantification of the effects led to the conclusion that the euro raised output by approximately 2% during the first 5 years after the introduction of the euro. The authors state that this effect is relatively small, but that this will grow over time, as they draw similarities with the introduction of the single internal market from the 80s and 90s. This conclusion appears to be validated by Conti (2014). Conti (2014) estimated the effect of the introduction of the euro on GDP per capita for seventeen European countries, using a difference-in-difference model with country specific time fixed effects. It is concluded that the euro raised GDP per capita levels by approximately 3 to 4 per cent, a substantially larger effect compared to the effects found by Barrell et al. (2008). The results presented by Conti (2014) also provide evidence to support the claim that the effect was smaller in countries with a high debt-to-GDP ratio. Finally, Özdeşer (2020) estimated the effects on GDP per capita in Germany, France, and Italy by comparing the fourteen years prior and after the introduction of the euro. GDP per capita levels were all positively affected. Although it should be noted that these results are obtained using a naïve

[6] Many other authors also discussed this question and came to similar conclusions. These aforementioned works are highlighted as they highlight ex-ante and ex-post views on the Eurozone. See also: Eichengreen (1996), Frankel and Rose (1997, 1998, 2000), Bayoumi et al. (1997), Bayoumi and Eichengreen (1997), Eichengreen and Frieden (1993), Eichengreen and Wyplosz (1998), Kenen (1998), and Tobin (2001).

comparison between years prior and after the introduction of the euro. Hence, these results might be biased.

These results might give the impression that the euro has unquestionably generated benefits to a country's GDP per capita. However, this would be a false impression, as no real consensus exists in the academic literature on the effects of the euro on GDP per capita. Drake and Mills (2010) apply a stochastic trend specification in order to estimate the effect of the euro on trend growth in Eurozone countries. It is concluded that the common currency resulted in lower trend growths across Eurozone countries during the Maastricht convergence phase, from 1992 until 1999, as well as between 2001 and 2006, relative to the baseline period between 1983 and 1992. The decrease was estimated to be approximately 1.6 per centage points in the post-2001 period compared to baseline period. Similar results were obtained by Da Silva (2018). Da Silva (2018) implemented a fixed effects growth model and found that the introduction of the euro led to lower levels of economic growth in all founding states of the European Union.

The European Commission (2004) argues that these negative effects are the result of external shocks and weak internal demand growth, although there might also be country specific factors that caused lower growth rates in specific regions (Barrell et al., 2008). However, it should be noted that Giannone and Reichlin (2006) show that country specific shocks only have a small, yet persistent, effect on output fluctuations in Eurozone member states, whereas common shocks account for the majority of the effect on output fluctuations. Wyplosz (2006) argues that slow growth performance is not driven by the introduction of the common currency, but by the one-size-fits-all Maastricht convergence criteria and strong economic performance of the United States and United Kingdom at the same time. Giannone and Reichlin (2006) find that GDP per capita levels and growth rates in Eurozone countries have neither converged or diverged over between 1970 and 2005, irrespective of the conclusion whether or not the euro increased or decreased growth.

2.4 Common currency area in practice: Synthetically recreating the euro

This section presents an overview of the economic literature that attempted to estimate the impact of the introduction of the euro on GDP by applying the synthetic control method.[7] Special attention needs to be directed towards this string of literature, as it applies a similar methodology to this research. Doing so makes it possible to shed light on similarities and any clear distinctions between the existing literature and this research. See Appendix I for a schematic overview of this literature.

Puzzelo and Gomis-Porqueras (2018) were, to the best of my knowledge, the first to publish their analysis on the effects of the introduction of the euro on GDP per capita using a synthetic control

[7] Other studies that use a synthetic control to assess the effects of European integration include: Hope (2016), Addessi et al. (2018), Campos et al. (2019), Lehtimäki and Sondermann (2020), and Gunnella et al. (2021). However, these studies are not discussed in this research, as they either discuss a different intervention or have a different variable of interest.

method, as they published their working paper in 2015. Their analysis looks at six Eurozone countries and uses annual country-level data spanning from the early 70s until 2007. The authors use 1995 as the intervention period, due to the fact that many countries undertook policy measures to meet the Maastricht requirements prior to actually implementing the euro as their national currency. They look at real GDP per capita (measured in 2005 international US dollars at purchasing power parity). It is concluded that there are large differences in treatment effects between countries. Belgium, France, Germany, and Italy would have had higher real GDP per capita if they had kept their national currency, according to the authors. The authors find no real treatment effect on the Netherlands and only observe a large positive effect on Ireland. Finally, the authors look at factors which might explain why some countries benefit from the euro and others do not. It is found that a higher degree of intra-union trade and migration openness, as well as a higher degree of capital market integration, and a higher degree of business-cycle synchronization relative to that of the union, are factors that might increase the experienced benefits of a common currency.

Fernández and García Perea (2015) look at the same dependent variable as Puzzelo and Gomis-Porqueras (2018). However, the authors' main focus lies on the Eurozone's aggregate GDP. This analysis considers the initial 11 member states, excluding Luxembourg, and adds Greece. Their data set contains annual country-level data from 1970 until 2013, using 1999 as the intervention period. Fernández and García Perea (2015) conclude that the euro did not have a persistent positive effect on GDP per capita, only showing small positive effects in the early 2000s. The authors make similar conclusions to Puzzelo and Gomis-Porqueras (2018) with respect to the treatment effects on individual member countries. They identify winners, many losers, and unaffected countries. Although it should be noted that they identify different winners, losers, and unaffected countries compared to Puzzelo and Gomis-Porqueras (2018), see Appendix I.

A similar analysis was performed by Verstegen et al. (2017). The authors also use annually observed country-level data, but use more predictor variables and apply a different selection methodology with respect to selecting donor pool countries. Fernández and García Perea (2015) and Puzzelo and Gomis-Porqueras (2018) select their donor pool countries not merely based on the availability of data, but also on theoretical arguments relating to differences between the treatment and donor pool countries. This restricts their donor pool greatly. Verstegen et al. (2017) do not consider these theoretical grounds and let the composition of their data set be wholly dependent on the available data. They then follow a two-step strategy in order to limit their donor pool to countries who are empirically similar to the treatment countries. This had led to a different composition of the synthetic control. However, the outcomes are similar, as the study identifies multiple winners and losers. Although it should be noted that these countries are different from the countries mentioned by the other authors. Furthermore, the authors conclude that all countries benefited from the euro prior to 2008, except for Italy. Finally, the authors find that labour market rigidity and competitiveness are driving factors to who

benefits and loses, in addition to the drivers that were identified by Puzzelo and Gomis-Porqueras (2018).

Lin and Chen (2017) start by dividing the initial 12 Eurozone member states into two groups, core and peripheral countries, and use 24 non-Eurozone countries as donor pool countries.[8] The authors find that core countries are generally worse of compared to the counterfactual, except for Austria and Belgium, who did not experience major gains or losses. The peripheral countries show heterogeneous treatment effects. Greece, Portugal, and Spain show major losses as a result of the introduction of the euro, whereas Luxembourg and Ireland benefited greatly. It should be noted that placebo tests indicate that these results are statistically insignificant. This would mean that no country gained or lost as a result of the Euro.

Gasparotti and Kullas (2019) only looked at eight Eurozone countries and found substantial positive effects on GDP per capita in Germany and the Netherlands. However, the authors estimate that the combined GDP of these eight countries dropped by 6.3 trillion euro by 2017. These results are primarily driven by France and Italy.

The last study is by Gabriel and Pessoa (2020). Their data consists of annual country-level data from 1970 until 2007. They look at real GDP in the initial 11 Eurozone countries as well as Greece. The authors first estimate their results based on their full data set and then test for robustness by excluding certain donor pool countries that might bias the results, e.g. due to the fact that they pegged their currency to the euro or by being part of the European Union's internal market. It is concluded that there are several minor losers and only one country clearly benefited from the euro: Ireland. Finally, the drivers of these results are found to be heterogeneous. The introduction of the euro led to increased government spending, but also led to a decrease in private consumption and investments in most countries. An increase in trade was also observed in most countries, but only two experienced net trade benefits.

These papers show many similarities, as they all apply the traditional synthetic control method, use annual country-level data, only look at early adopters of the euro, and show that not all countries benefited from the euro.[9] Nevertheless, the results of the papers contradict each other and are not in line with the theory on optimum currency areas, which would predict an improvement for all countries in the optimum currency union, as follows from section 2.1. The former might be due to differences in donor pool countries and predictor variables. The latter problem could possibly be explained by the fact that the Eurozone does not constitute an optimum currency area, as discussed in section 2.3, which led to different countries being in a better position to profit from the common currency.

It is possible to observe some notable differences between the string of literature that applies the synthetic control method and the string that applies different methodological frameworks. The string of literature which applied a synthetic control method consistently finds winners, losers, and countries who

[8] The following countries are considered core countries: Austria, Belgium, France, Germany, Italy, and the Netherlands. The peripheral countries are: Finland, Greece, Ireland, Luxembourg, Portugal, and Spain.
[9] Interestingly, the literature appears to be inconclusive on what countries benefited or lost. See Appendix I.

did not benefit or lose as a result of the Eurozone. The literature discussed in section 2.3 generally seem to find more homogenic results, i.e. countries either all win or all lose. Second, the literature presented in section 2.3 finds static treatment effects, whereas the synthetic control method allows for changing treatment effects over time.

3 Methodology & Data

This section presents the methodology used in order to estimate the main results of this research. The applicability of this methodology, its framework, and data are discussed in this section. The methodological approaches of the rigidity tests, i.e. restricting the donor pool, the in-time placebo tests, and the in-space placebo tests, will be discussed in section 5.1, 5.2, and 5.3 respectively.

3.1 Applicability of the synthetic control framework

This research implements a bias-corrected synthetic control method, thereby implementing a more sophisticated version of the synthetic control method. The traditional synthetic control method has been proposed and developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015). This method is akin to the difference-in-difference methodology, although it accepts that a single control group will not provide a reliable counterfactual to the treatment group (Abadie et al., 2010). Hence, a synthetic control group is created by taking a weighted average of a set of comparison units, based on a number of observable characteristics. The bias-corrected synthetic control group is similar to this, but also accounts for differences in the predictor variables of the treatment and synthetic control group (Abadie, & L'Hour, 2021; Ben-Michael et al., 2021). An additional benefit of the synthetic control method over other causal inference models is that it allows for changing treatment effects over time.

Abadie (2021) highlights six contextual requirements for situations in which the synthetic control method is an appropriate method for policy evaluation. These are discussed, as they show the relevance of this methodology for this research. The first aspect regards the effect size and volatility of the outcome variable. The effects of small interventions are difficult to estimate, especially if the outcome variable is volatile. However, even a large treatment effect is hard to estimate if the outcome variable is volatile. A substantial intervention and an outcome variable with a low degree of volatility are therefore preferable. It is believed that this research fits this criterion, as the introduction of the euro can be considered a substantial policy implementation and that GDP per capita is relatively involatile. Second, a group of untreated donor pool units should be available for the construction of a counterfactual, which should be similar in observed characteristics to the treatment group. Units that implemented similar policies to the treatment group should be removed from the donor pool, as they would bias the results. Units that suffered large idiosyncratic shocks to their outcome variable (i.e. GDP per capita) should also be removed. The specifics of the data are discussed in section 3.3, but it is believed that this assumption holds, as the data set contains data on 24, mainly OECD, donor pool countries, similarly to the method applied by Abadie et al. (2015). The main results are based on the full

sample of donor countries, but additional analyses assess the presence of potential biases due to idiosyncratic shocks or similar treatments implemented in donor countries. Third, there should be no anticipation of the policy, as the synthetic control method exploits time variation in the outcome variable. Abadie (2021) advises to backdate the intervention period to a time without any anticipation of the treatment. This research therefore considers 1995 as the intervention period for the initial eleven Eurozone countries, as it is likely that there are anticipation effects of the introduction of the euro. Four years prior to the actual implementation is assumed to be sufficiently far back in order to capture these potential effects. The intervention periods for the other six countries studied in this research are also backdated four years prior to the actual intervention. Although it is possible to argue that the anticipation effects go start in 1992, with the signing of the Treaty of Maastricht. Hence, additional analyses will be performed in order to assess further anticipation effects for the initial Eurozone countries. A fourth requirement concerns spillover effects. Tensions exists between the absence of any spillover effects and countries that are similar, therefore often close to, the treatment country. Some of the donor pool countries might be affected by spillover effects, but it is expected to be minor, as the common currency mainly has benefits to countries within the union, not to outside world.[10] Fifth, sufficient levels of post-intervention data must be available, as treatment effects may emerge over time. This holds true for this research, as more than 20 years has passed for most Eurozone countries since the introduction of the common currency. The final requirement concerns the convex hull condition. This implies that the observed characteristics should not be extremely high or low, compared to other countries, as they cannot be reliably approximated by the donor pool countries. It appears that this holds as well, expect for Luxembourg, as will be presented in section 4.

The analysis of these criteria shows that the synthetic control method is a suitable method to estimate the impact of the euro on GDP per capita levels in Eurozone countries, especially given the additional analyses that are performed in order to remove potential biases.

3.2 Bias-corrected synthetic control framework

This section presents the general framework that is used in order to obtain the results presented in section 4. The treatment effect, that follows from the bias-corrected synthetic control method implemented in this research, is estimated through a two-step process. First, a synthetic control group is estimated. Then a bias-correction is applied in order to obtain a bias-corrected treatment effect. The synthetic control is calculated in accordance with the existing methodological framework presented by Abadie et al. (2010), among others. It should therefore be noted that this section heavily relies on notation and previous works by Abadie et al. (2010), Abadie (2021), and Wiltshire (2022a, 2022b).

[10] This assumption can be argued over, as increased exchange rate predictability or other factors might benefit non-euro countries. However, Barrell et al. (2008) found no statistically significant effect of the introduction of the euro on the output of outsider economies.

We observe outcome variable (Y_t), i.e. GDP per capita at time t, for $I + J$ countries, where all countries $i = 1, \dots, I$ are treated, i.e. Eurzone countries, and all countries $j = I + 1, \dots, I + J$ are untreated. These countries are observed for pre-intervention periods $t = 1, \dots, T_0$ and post-intervention periods $t = T_0 + 1, \dots, T$.

Let $Y_{j,t}^N$ denote the potential outcome of country j at time t in the absence of treatment. Furthermore, $Y_{j,t}^I$ can be defined as country j's potential outcome at time t when treated. The treatment effect for Eurozone country i at post-intervention time t is therefore:

$$\tau_{i,t} = Y_{i,t}^I - Y_{i,t}^N \tag{1}$$

We only observe $Y_{i,t}^I = Y_{i,t}$ for all $t > T_0$. Hence, we need to estimate the treated country's counterfactual, i.e. $Y_{i,t}^N$. This is done by constructing a synthetic control group, based observations on a weighted combination of untreated donor pool countries:

$$\hat{Y}_{i,t}^N = \sum_{j=I+1}^{I+J} w_j^* Y_{j,t} \quad \forall \ t \tag{2}$$

This methodology is based on the tenet that the synthetic control mimics the pre-intervention outcomes of $Y_{i,t}$ and that it then presents a plausible estimate of its counterfactual during $t > T_0$. Each donor pool country j is assigned weight (w) during the construction of the synthetic control group. Let w_j^* denote the optimal weight for country j, $w_j^* = [0,1] \, \forall \, j$, and $\sum_{j=I+1}^{I+J} w_j^* = 1$. Let $W^* = (w_{I+1}^*, \dots, w_{I+J}^*)'$ denote a vector of all donor pool country weights. W^* is constant over time and is obtained by minimising

$$\left(\sum_{k=1}^{K} v_k \left(X_{i,k} - \sum_{j=I+1}^{I+J} w_j X_{j,k} \right)^2 \right)^{\frac{1}{2}} \tag{3}$$

over the pre-intervention period. It follows from this equation that the optimal weights depend on predictor variables (X_k) and their relative weight (v_k). The predictor variable shows specific observable characteristics (X_k) of countries i and j. X_k is a $T_0 \times 1$ matrix containing the observations on the predictor value for country i or j for all time $t \leq T_0$. It should be noted that $v_k = [0,1] \, \forall \, k$ and $\sum_{k=1}^{K} v_k = 1$. Let $V_j = (v_1, \dots, v_k)$ be a vector of predictor value weights for country j. It should be noted that V_j is constant over time.

A given selection of V creates synthetic control $W^*(V) = (w_{I+1}^*(V), \dots, w_{I+J}^*(V))'$ (Abadie, 2021). However, this leaves unanswered how V is obtained. There are multiple options for estimating V, as shown by Abadie (2021). This research takes a quantitative approach and does so similarly to Abadie and Gardeazabal (2003) and Abadie et al. (2010). V is chosen "such that the synthetic control $W(V)$ minimizes the mean squared prediction error" over the entire pre-intervention period (Abadie, 2021, p. 396). This means minimising equation (4) over the pre-intervention period. It should be noted

that equation (3) and (4) depend on each other and thereby for a nested, i.e. bilevel, optimisation problem. [11]

$$\sum_{t=1}^{T_o} \left(Y_{i,t} - \sum_{j=I+1}^{I+J} w_j^*(V) Y_{j,t} \right)^2 \tag{4}$$

It is now possible to approximate equation (1), as we know $\hat{Y}_{i,t}^N$. The estimated treatment effect ($\hat{\tau}$) at time $t > T_0$ is as follows:

$$\begin{aligned} \hat{\tau}_{i,t} &= Y_{i,t}^I - \hat{Y}_{i,t}^N \\ &= Y_{i,t} - \sum_{j=I+1}^{I+J} w_j^* Y_{j,t} \end{aligned} \tag{5}$$

However, this leaves the potential differences in predictor values between the treatment country and its synthetic control unaccounted for (Abadie, 2021). Omitting any control for these differences might generate biases. Hence, Abadie and L'Hour (2021) and Ben-Michael et al. (2021) propose to implement regression-based corrections.[12] This involves including a ridge regression ($\hat{\mu}_{0,t}$), as proposed by Ben-Michael et al. (2021).[13] This regression is estimated by "regressing the untreated outcomes, $Y_{I+1,t}, \dots, Y_{I+J,t}$, on the values of the predictors for the untreated units, i.e. $V_{I+1}, \dots, V_{I+J}$" (Abadie, 2021, p. 419). This results in the following bias correction:

$$\varphi_t = \left(\hat{\mu}_{0,t}(V_i) - \sum_{j=I+1}^{I+J} w_j^* \hat{\mu}_{0,t}(V_j) \right) \tag{6}$$

Combining equation (5) and (6) results in a bias-corrected treatment effect ($\tilde{\hat{\tau}}$) for treated country i all $t > T_0$. The result is presented in equation (7):[14]

$$\begin{aligned} \tilde{\hat{\tau}}_{i,t} &= \hat{\tau}_{i,t} - \varphi_t \\ &= \left(Y_{i,t} - \sum_{j=I+1}^{I+J} w_j^* Y_{j,t} \right) - \left(\hat{\mu}_{0,t}(V_i) - \sum_{j=I+1}^{I+J} w_j^* \hat{\mu}_{0,t}(V_j) \right) \\ &= \left(Y_{i,t} - \hat{\mu}_{0,t}(V_i) \right) - \sum_{j=I+1}^{I+J} w_j^* \left(Y_{j,t} - \hat{\mu}_{0,t}(V_j) \right) \end{aligned} \tag{7}$$

The bias-corrected treatment effect thus consists of the synthetic control treatment effect, as well as the bias-correction.

[11] See Dube and Zipperer (2015), Firpo and Possebom (2016), Malo et al. (2020), Ferman (2021), and Ferman and Pinto (2021) for a more comprehensive overview of the nested optimisation procedure applied by this research.

[12] This method is based on earlier work on bias-correction by Rubin (1973), Quade (1982), and Abadie and Imbens (2011), according to Abadie (2021).

[13] Other parametric or nonparametric regression functions can be used (Abadie, 2021). However, this research applies a ridge regression in order to account for potential biases.

[14] It should be noted that the second line of equation (6) uses a slightly different, yet equivalent, notation compared to Abadie (2021) and Wiltshire (2022a; 2022b). Their notation is as follows: $\tilde{\hat{\tau}}_{i,t} = \left(Y_{i,t} - \sum_{j=I+1}^{I+J} w_j^* Y_{j,t} \right) - \sum_{j=I+1}^{I+J} w_j^* \left(\hat{\mu}_{0,t}(V_i) - \hat{\mu}_{0,t}(V_j) \right)$. Equivalence holds, as $\hat{\mu}_{0,t}(V_i)$ does not involve $j = \{I+1, \dots, I+J\}$ (J. C. Wiltshire, personal communication, April 7, 2022).

3.3 Data

The construction of a synthetic control requires large quantities of data on the treatment and donor pool units. Abadie (2021) highlights three distinct data requirements for the credible application of the synthetic control method. This section shortly discusses these requirements, followed by an overview of the data used in this research.

The first requirement concerns the availability of data on the outcome variable and predictor variables for the treatment group and donor pool units. Second, data must be available on treatment group and donor pool units for sufficient pre-intervention periods, as the synthetic control's ability to replicate the treatment unit depends on the amount of pre-intervention information. The third criterion relates to sufficient levels of data on post-intervention periods. This point is related to the fifth contextual requirement discussed in section 3.1 and is important, as treatment effects might only be visible after some time has passed. Abadie (2021) states that "extensive post-intervention information allows [for] a more complete picture of the effects of the intervention, in time and across the various outcomes of interest" (p. 414).

Table 1 Overview of predictor variables used in constructing the synthetic control

No.	Variable	Unit	Frequency	Source
(1)	Consumer price index	% change	Quarterly	OECD
(2)	Share of private consumption	% of GDP at PPP	Annual	Penn World Table
(3)	Share of government consumption	% of GDP at PPP	Annual	Penn World Table
(4)	Share of capital formation	% of GDP at PPP	Annual	Penn World Table
(5)	Average depreciation rate of capital	%	Annual	Penn World Table
(6)	Real internal rate of return	%	Annual	Penn World Table
(7)	FDI net inflows	% of GDP	Annual	World Bank
(8)	Urbanisation rate	% of population	Annual	World Bank
(9)	Human capital index	Index	Annual	Penn World Table
(10)	Working population	% of total population	Annual	World Bank
(11)	Dependency ratio	Ratio of total population	Annual	World Bank
(12)	Life expectancy at birth	Years	Annual	World Bank

Note: Table 1 presents all predictor variables used in the construction of the synthetic control. Column 1 presents a number for every variable. Column 2 presents the variables name and Column 3 its unit of measurement. Column 4 shows the measurement frequency of the original data set. All annually measured variables are linearly interpolated in order to obtain quarterly observations. Column 5 presents the source. References and hyperlinks to the original data sets are presented at the end of this research.

It is believed that all these requirements are met by the data used in this research. The first requirement is satisfied by the availability of macroeconomic data on all our treatment and donor pool countries. The second and third are met if we look at other research and compare their timespans to that applied in this research, e.g. Abadie et al. (2015). Abadie et al. (2015) assess the impact of Germany's

reunification on GDP by using 30 pre-intervention and 13 post-intervention periods. This research has access to quarterly data for most countries in the data set from 1970 until 2019. Hence, far exceeding the general requirements.

The main variable of interest (*Y*) is GDP per capita. Data has been collected from the OECD's statistical database on quarterly GDP of 17 Eurozone countries, i.e. all Eurozone member states, except for Malta and Cyprus, and 24 donor pool countries (OECD, n.d.-a).[15] The majority of countries show data from 1970 onwards.[16] However, certain countries only show data from the early- and mid-1990s.[17] The precise cause of the lack of data is uncertain, however it is likely that geopolitical and national security reasons form the basis for a possible explanation. A country's GDP is calculated via the expenditure approach and all values are shown in US dollars, current prices, at purchasing power parity, and are seasonally adjusted.

Total population levels are then needed in order to rescale a country's GDP to its GDP per capita. Data on population levels have been retrieved from the World Bank (n.d.-a). Population data is only measured on a yearly basis, whereas GDP is measured quarterly. Yearly population levels are therefore linearly interpolated in order to obtain quarterly population levels. Subsequently dividing total GDP by the total population yields the main variable of interest.

The construction of a synthetic control requires several predictor values. This research uses a number of macroeconomic and demographic variables in order to recreate treatment countries. These variables are presented in Table 1 and have been selected on the basis of the availability of sufficient levels of data for the period between 1970 and 2019, a variable's representativeness of (macroeconomic) characteristics and performance, as well as a variable's ability to allow for the suitable construction of a synthetic control. Comparisons with the existing literature, discussed in section 2.4 and shown in Appendix I, show similarities with the nature of predictor variables used in this research.

All predictor variables are scaled to GDP, population, growth rates, or indexed in order to facilitate intercountry comparisons. Table 1 presents an overview of all predictor variables, unit of measurement, measurement frequency in the original data set, and source.

[15] The donor pool countries are: Australia, Brazil, Bulgaria, Canada, Chile, Czechia, Denmark, Hungary, Iceland, Israel, Japan, Mexico, New Zealand, Norway, Poland, Romania, Russia, South Africa, South Korea, Sweden, Switzerland, Turkey, United Kingdom, and United States. The data set did not contain data on Malta and Cyprus. This is the main reason for omitting these countries from this study.

[16] This research uses data until the fourth quarter of 2019, as the COVID-19 pandemic might diminish the reliability of the estimates. The omission of 2020 is also driven by the fact that many of the control variables do not show sufficient levels of data for 2020, 2021, and the first quarter of 2022.

[17] The following countries do not show data from 1970 onwards: Brazil, Bulgaria, Chile, Czechia, Estonia, Hungary, Israel, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia. All these countries show data from 1996 onwards. Therefore, 1996 will be the starting for the analyses of the Eurozone countries that belong to this group. The aforementioned non-Eurozone countries are not used in the construction of the synthetic control for Eurozone countries that show data from 1970 onwards. However, they are used in the construction of the synthetic control for Estonia, Latvia, Lithuania, Slovakia, and Slovenia.

4 Results

The previous section presented the methodology. This section implements this methodology and presents the results of the analysis. The treatment effects are presented graphically for each country, although the precise results are also presented in Appendix V. The treatment effects are presented, as this is the main focus of this research and equally indicative of the goodness of fit of the synthetic control in pre-intervention periods compared to presenting the GDP per capita trend over time. The weights assigned to each donor pool country can be found in Appendix II. The weights assigned to each control variable are presented in Appendix III. These form the core characteristics of the synthetic control. The means for the predictor values of each treatment country and its synthetic control are presented in Appendix IV. This allows for an overview and comparison between the characteristics of the treated country and its synthetic control. The estimated treatment effects obtained by the classic and bias-corrected synthetic control methods are presented in Appendix V, these estimates form the basis for the graphical presentation of the estimates presented below.

The Panels presented below show the estimated treatment effects using the classic and bias-corrected synthetic control methods. First, the treatment effects for each country are shown separately. Subsequently, Panel R, S, and T combine the treated countries into one Panel in order to present general findings. These treatment effects are calculated in accordance with equation (5) and (7). It should be noted that the classic and bias-correct synthetic control outcomes are graphically indistinguishable from each other. However, Appendix V shows the different outcomes from both methods. The treatment effect, expressed in terms of GDP per capita at time t and measured in US dollars, is presented on the Y-axis. The X-axis shows time.

Two vertical lines are added in order to ease readability. The black vertical line indicates treatment, whereas the grey vertical line indicates the start of the 2007 – 2008 global financial crisis during the fourth quarter of 2007. This date is chosen in accordance with the Federal Reserve's classification of the start of the recession (Board of Governors of the Federal Reserve System, n.d.). The indication is useful, as there is evidence to suggest that there are differences in treatment effects in the pre- and post-financial crisis periods (Verstegen et al., 2017).

The title of the graph indicates the treated country. Additionally, the treatment period and pre-intervention root mean square prediction error are reported below the title. The treatment period is chosen in order to remove any anticipation effects, in accordance with the suggestions made by Abadie (2021), and following the precedent set by Puzzelo and Gomis-Porqueras (2018). The root mean square prediction error is an indication of the quality of the synthetic control's fit (Abadie, 2021). The lower this metric, the better.[18] Finally, it should be noted that the Y-axes of all graphs are scaled $[-7500, 10000]$, except for Ireland, Luxembourg, and the averages presented in Panel R and S. These countries are therefore provided with an asterisk (*) in their title in order to emphasise the distorted

[18] The pre-intervention root mean squared prediction error's equation is presented in equation (8). See section 5.3.

scaling of the Y-axis. A positive effect infers that the country experienced higher GDP per capita levels than it would have had if it kept its national currency. A negative result infers that GDP per capita levels would have been higher if the country kept is national currency.

The existing literature shows three classifications of results: winners, no effect, and losers. This research replaces the "no effect" category with a category representing countries that show unreliable estimates.[19] This is done in order to improve the credibility of the assigned classifications to the unbiased estimates and the fact that no country truly shows no treatment effect. The distinction is important as the presence of heterogeneous treatment effects is discussed in the literature and is also clearly shown in Panel R, S, and T. Panel S and T only show the countries with a well-fitting synthetic control in pre-intervention periods. To reiterate, it is important for the synthetic control group to reproduce the treatment group in pre-intervention periods, i.e. on the left side of the black vertical line. This means that the gap between the treatment and synthetic control group should ideally be zero.

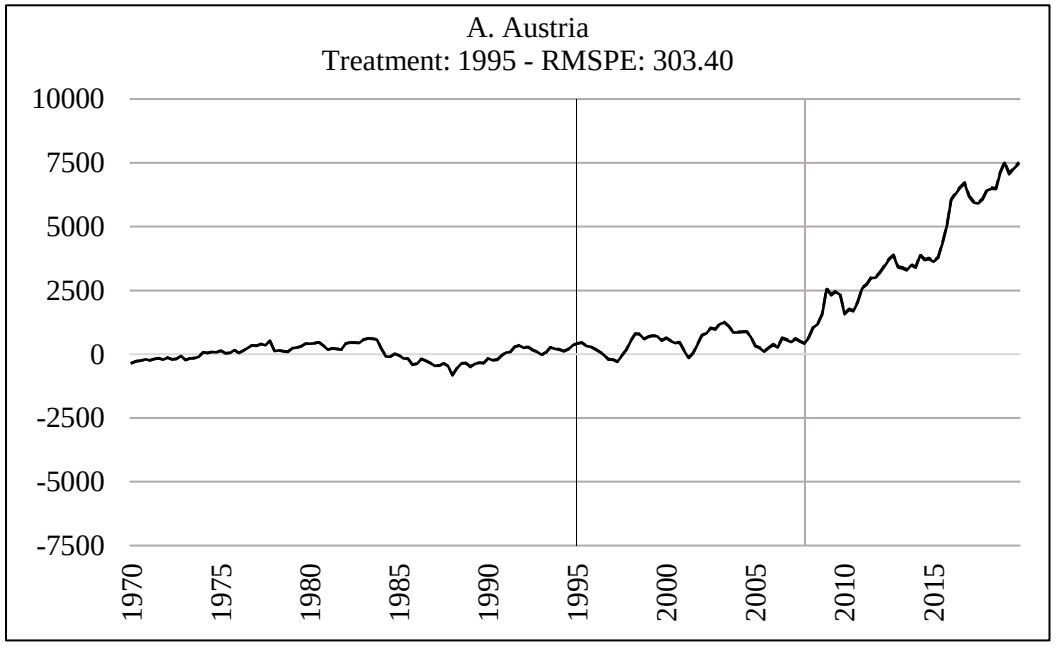
The results are discussed in two stages, a pre-2008 and post-2008 period. It should be noted that Lithuania and Latvia will not be discussed in section 4.1, as these countries receive treatment after 2008. The distinction between the pre- and post-2008 period is made because there is evidence to support the fact that the treatment effects change after the global financial crisis, e.g. Verstegen et al. (2017). Finally, it should be noted that the results will be taken on face value, as their rigidity is tested and discussed in section 5.

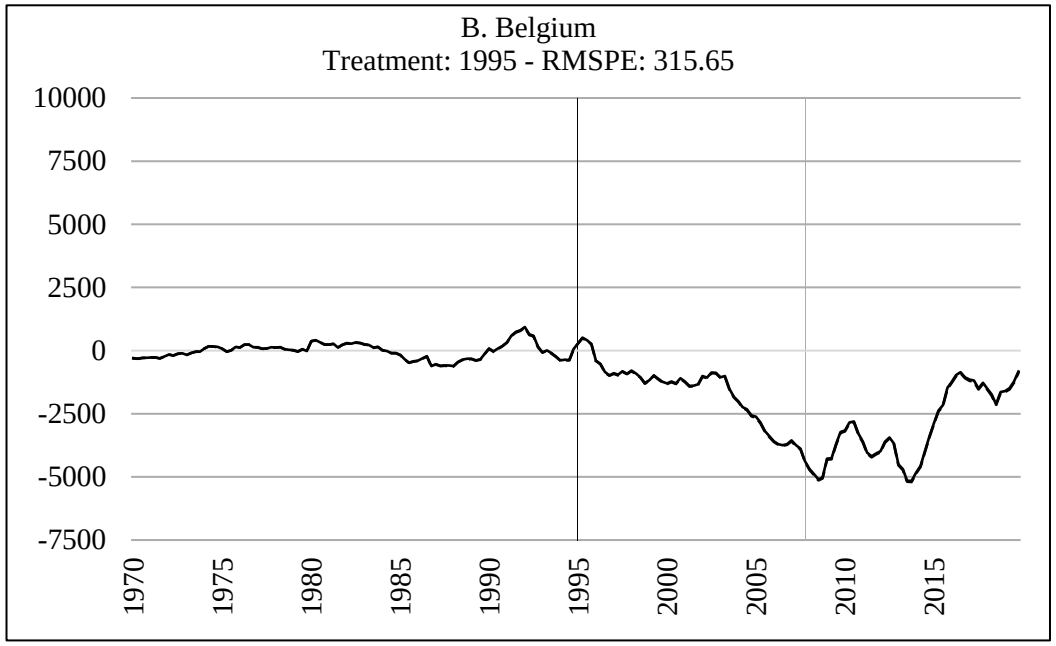
4.1 Pre-2008

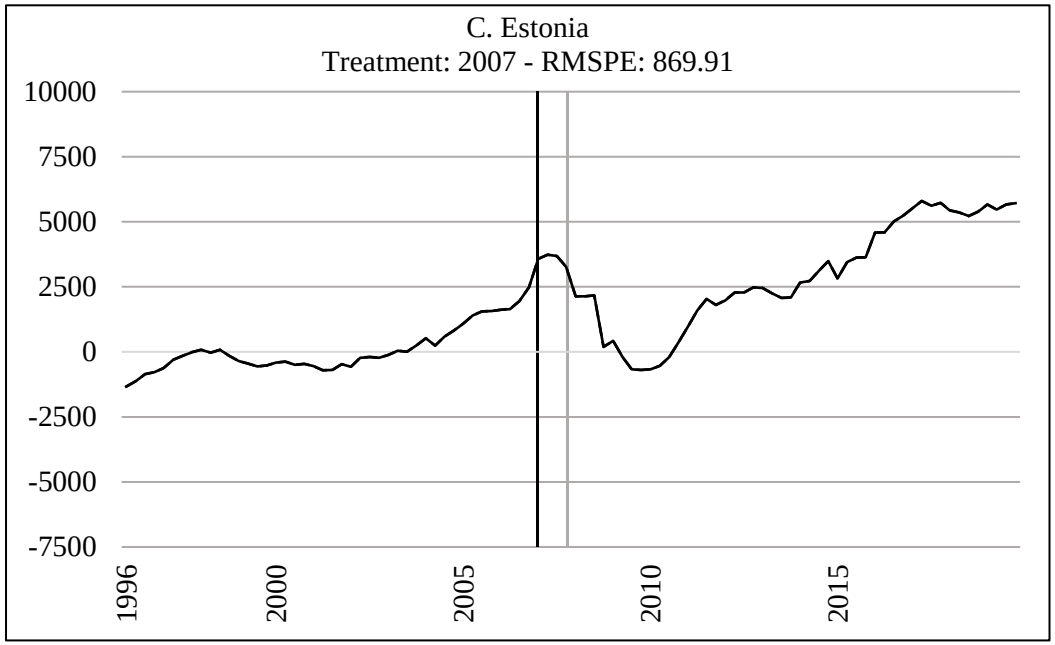
It is estimated that most of the treated countries benefitted from the euro in the pre-2008 period, as follows from the presented graphs. The countries that are considered to have benefited in the pre-2008 are: Austria, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. This also follows from Table 2, which presents the cumulative treatment effects. However, the countries are very dissimilar in the magnitude of the estimated effect. Austria, France, Italy, Portugal, and Slovenia all show a relatively small positive treatment effects over the pre-2008 period. Whereas Finland, Greece, Ireland, the Netherlands, Slovakia, and Spain saw substantial benefits as a result of the euro.

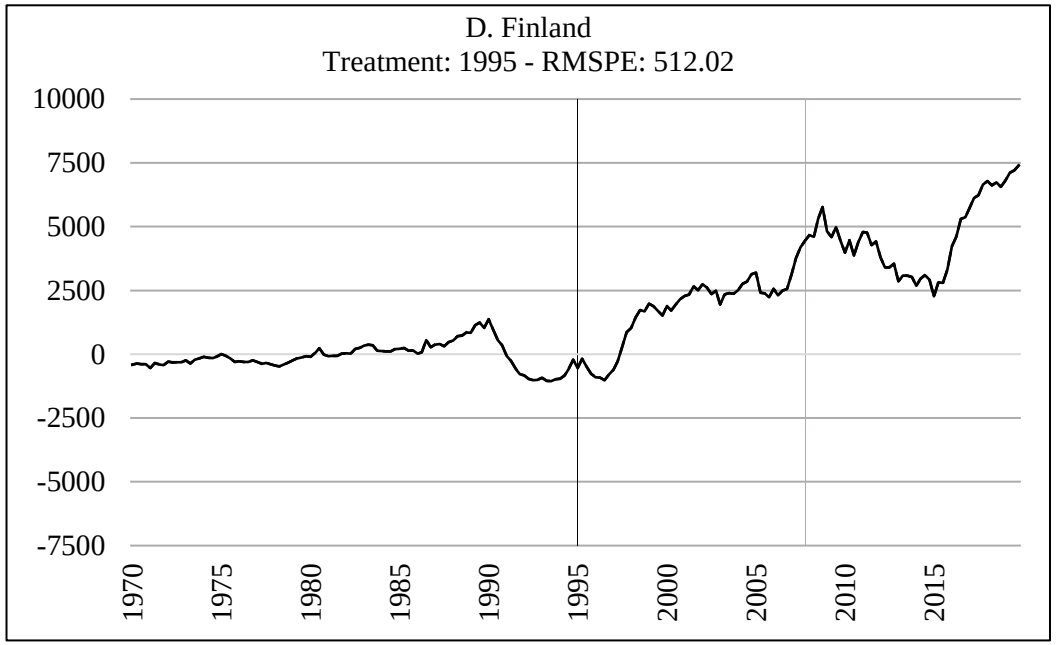
No single intuitive one size fits all explanation appears to exist for these results, as some countries are dissimilar in geographic, political, and economic characteristics, but do show similar treatment effects. Alternatively, a priori similar countries show different treatment effects. For example, Italy, Portugal and Spain are often grouped together, with other Southern European countries, when discussing their economies. Yet, Spain saw a large positive treatment effect, whereas Portugal experienced a small positive effect in the pre-2008 period, but this returned to approximately

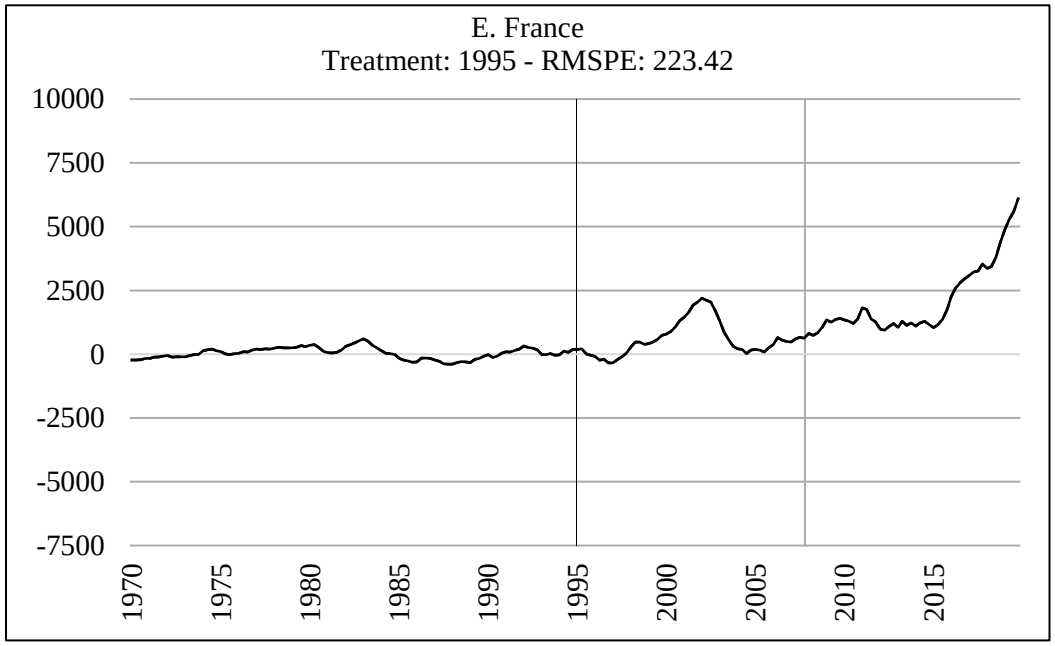
[19] Although it should be noted that these results do not show any country that neither benefited or lost as a result of the introduction of the euro.

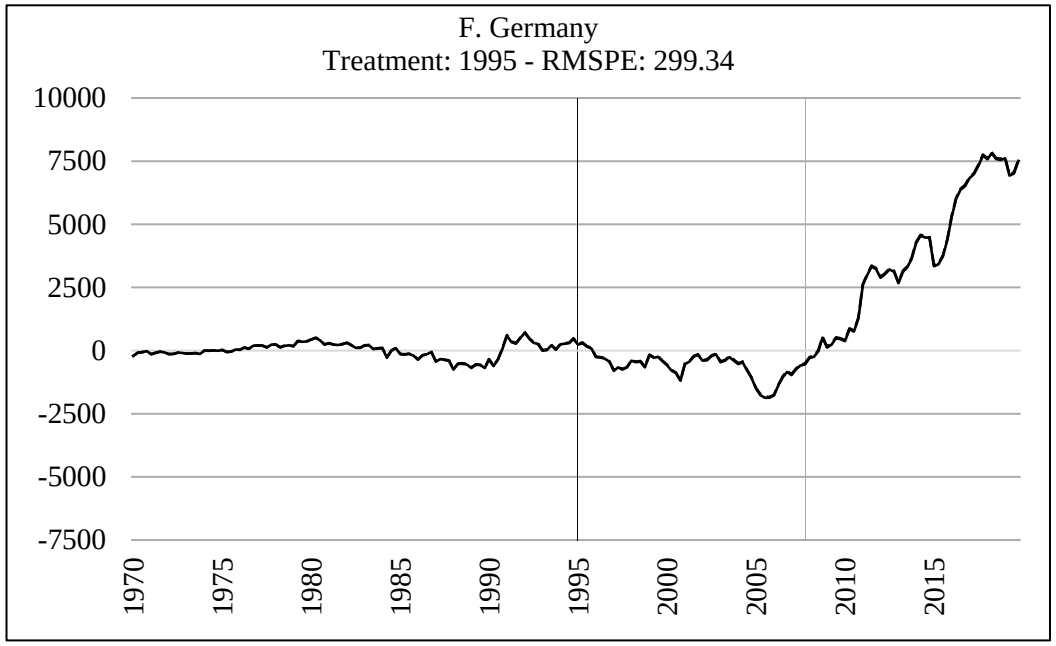

A. Austria
Treatment: 1995 - RMSPE: 303.40
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

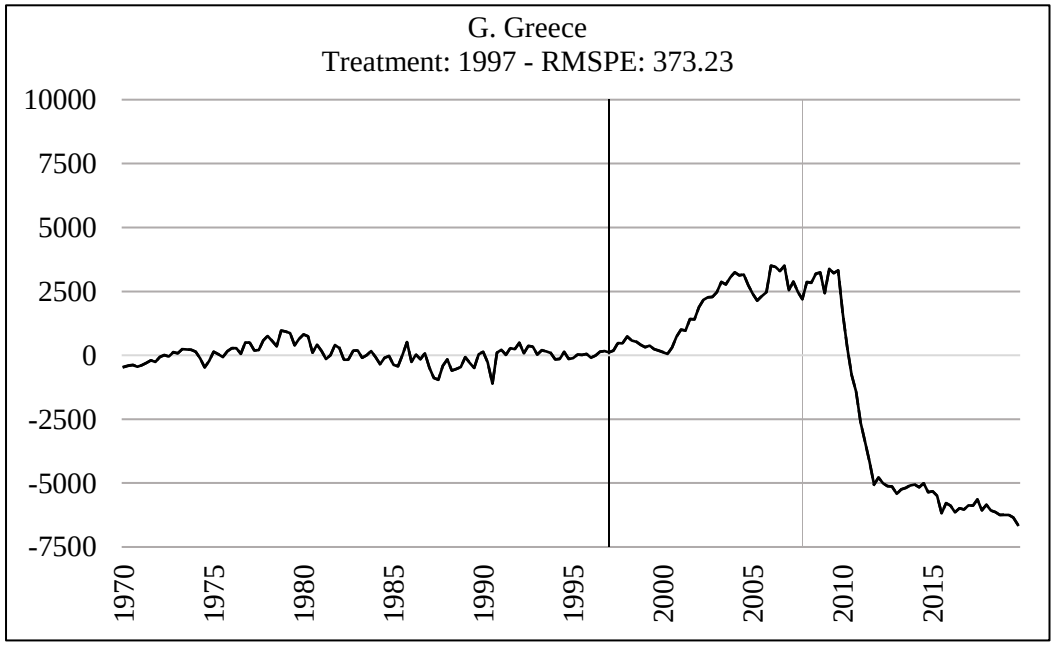

B. Belgium
Treatment: 1995 - RMSPE: 315.65
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

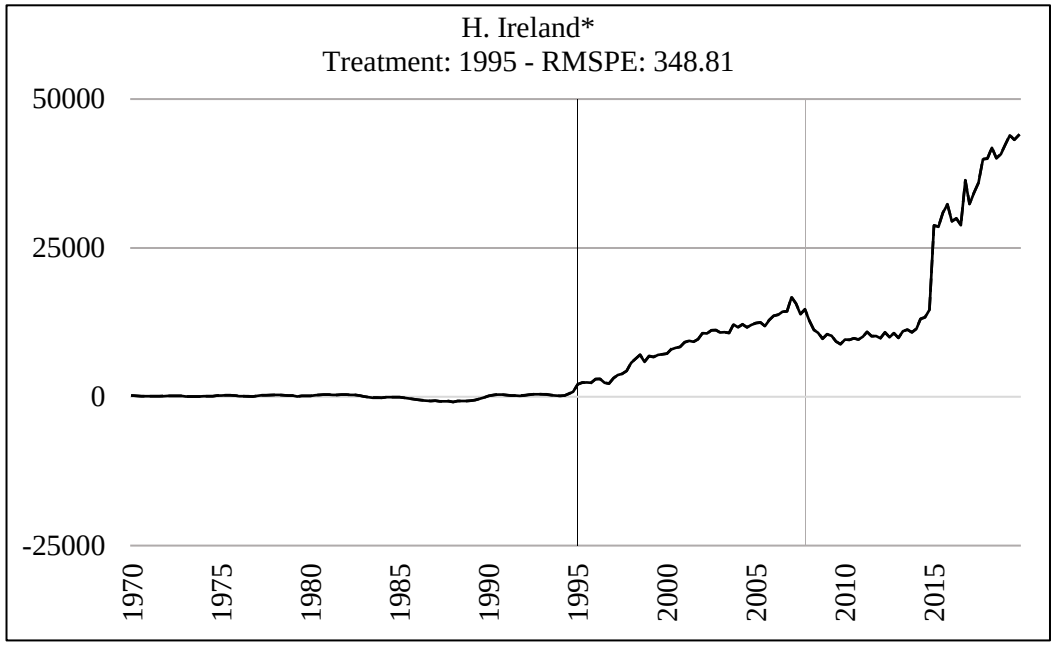

C. Estonia
Treatment: 2007 - RMSPE: 869.91
10000
7500
5000
2500
0
-2500
-5000
-7500
1996
2000
2005
2010
2015

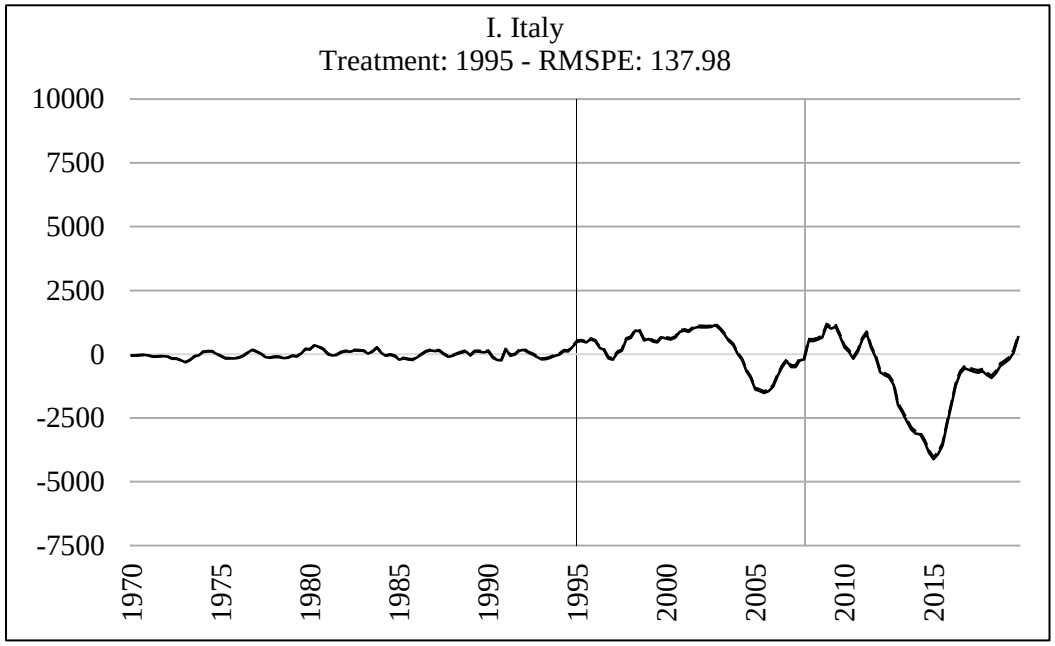

D. Finland
Treatment: 1995 - RMSPE: 512.02
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

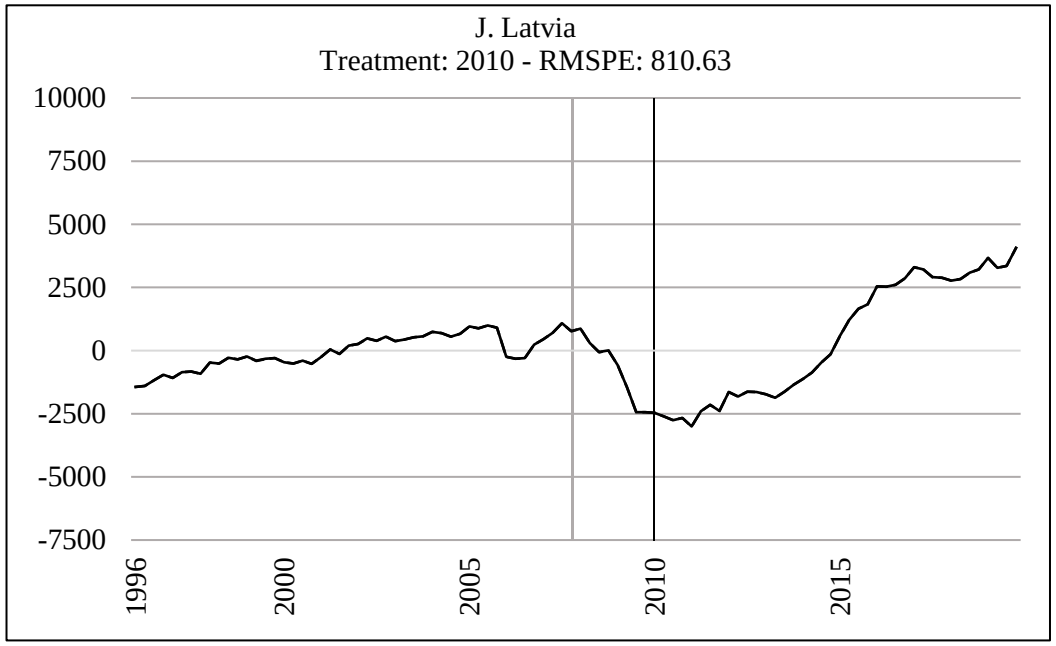

E. France
Treatment: 1995 - RMSPE: 223.42
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

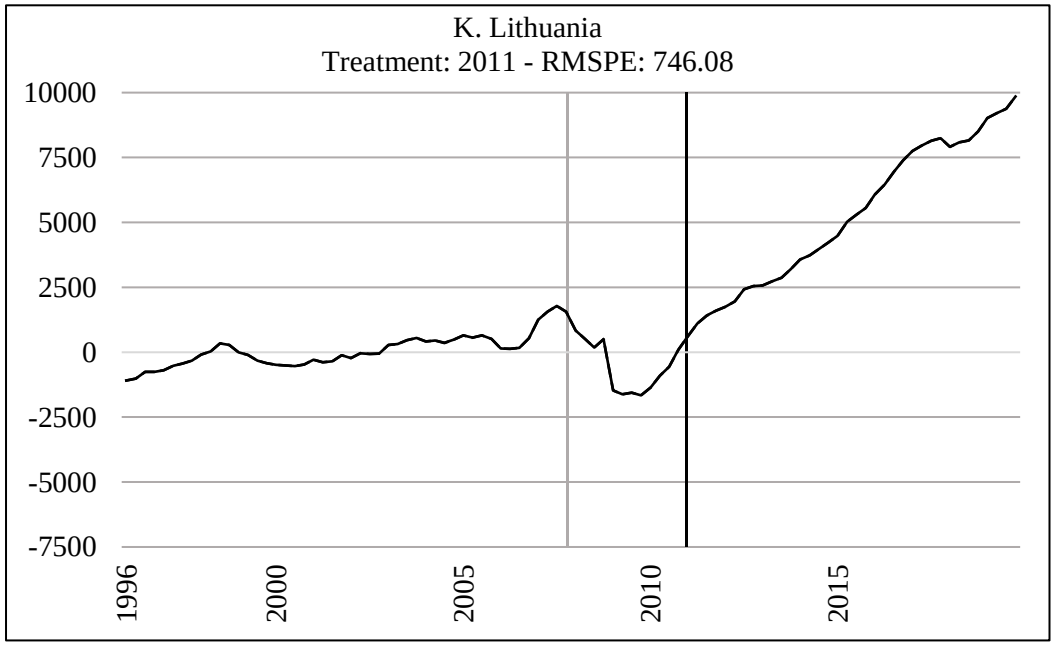

F. Germany
Treatment: 1995 - RMSPE: 299.34
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

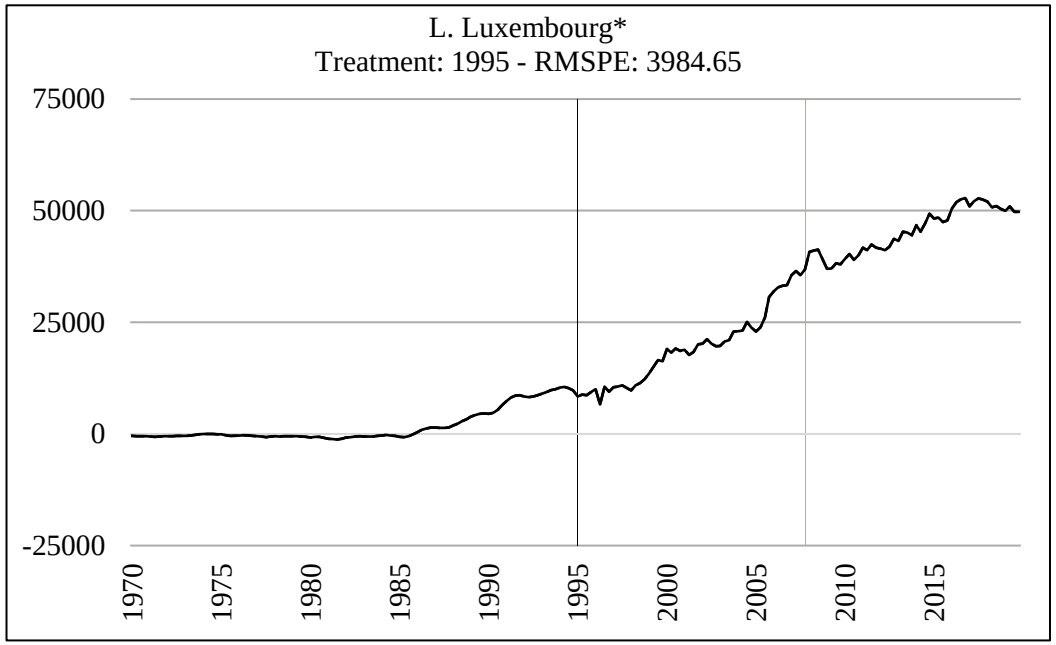

G. Greece
Treatment: 1997 - RMSPE: 373.23
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

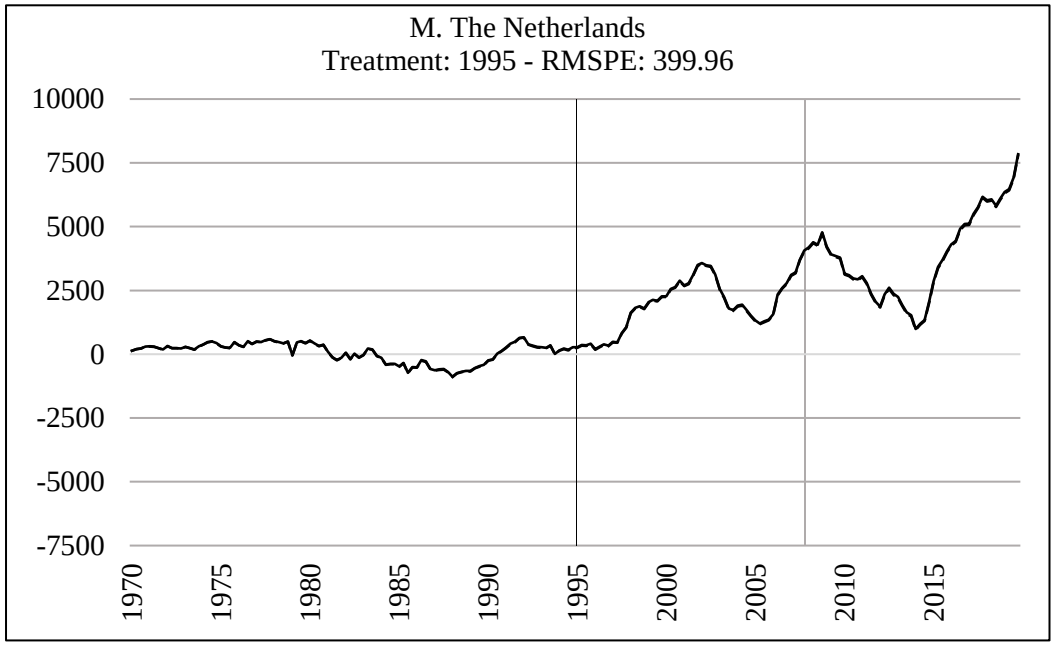

H. Ireland*
Treatment: 1995 - RMSPE: 348.81
50000
25000
0
-25000
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

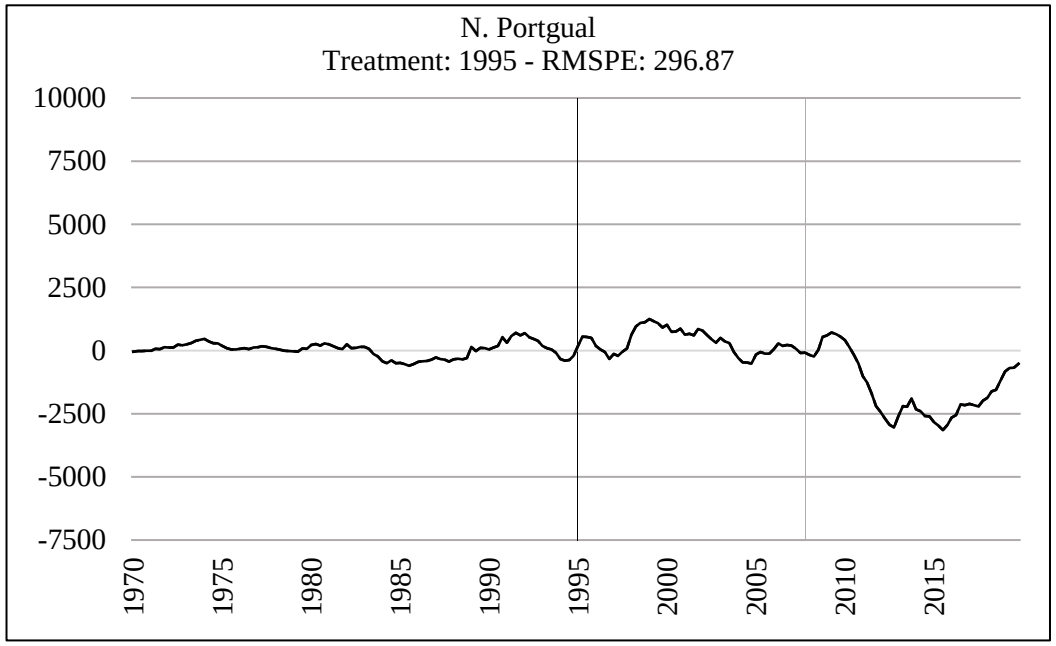

I. Italy
Treatment: 1995 - RMSPE: 137.98
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

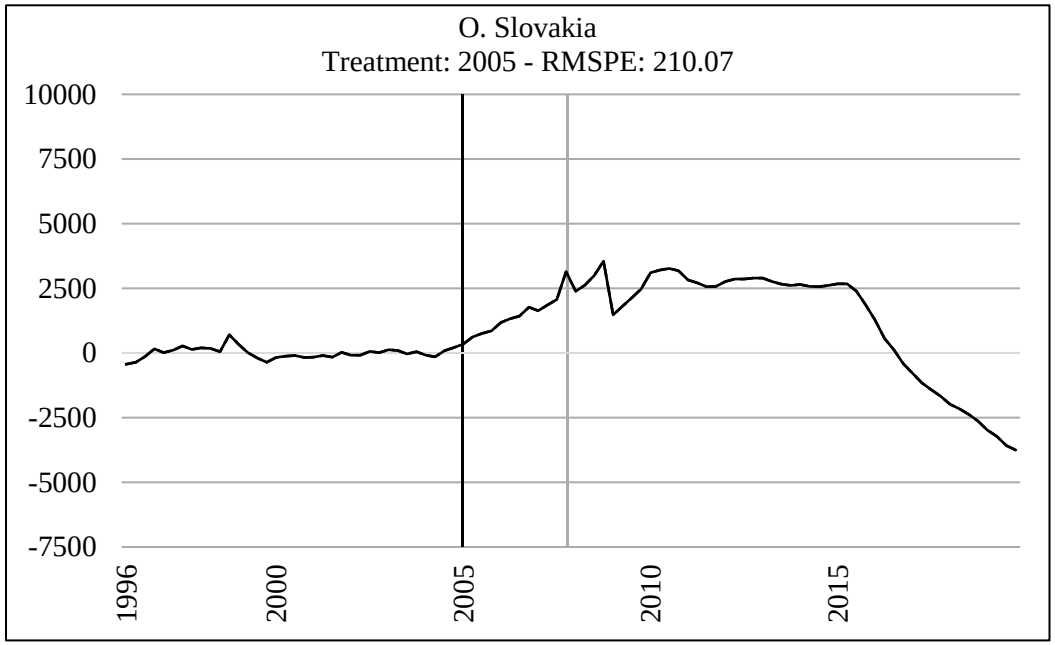

J. Latvia
Treatment: 2010 - RMSPE: 810.63
10000
7500
5000
2500
0
-2500
-5000
-7500
1996
2000
2005
2010
2015

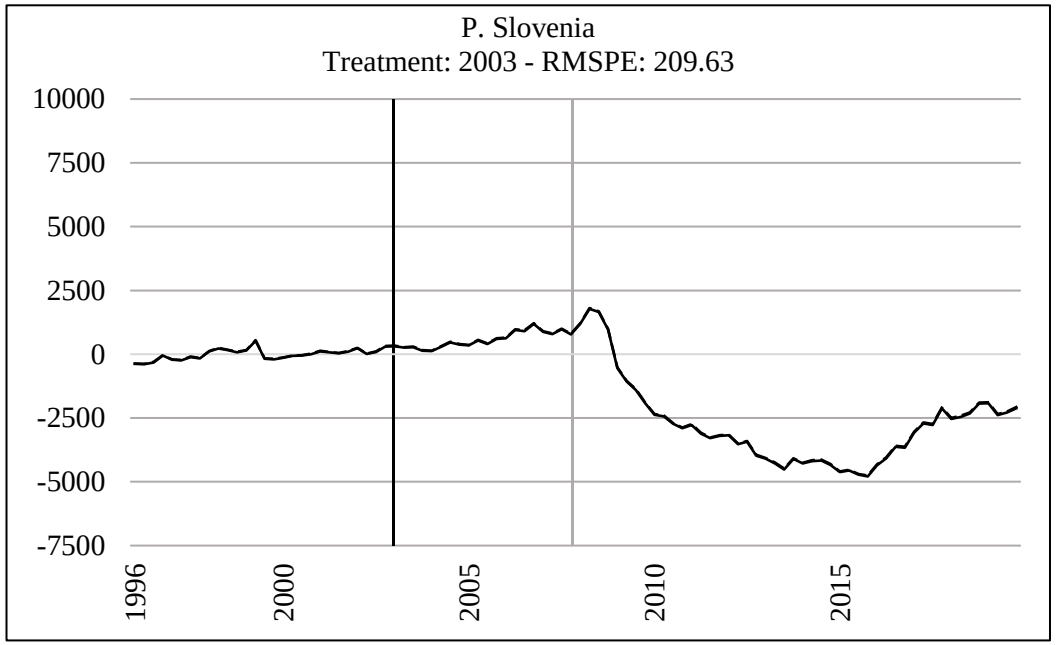

K. Lithuania
Treatment: 2011 - RMSPE: 746.08
10000
7500
5000
2500
0
-2500
-5000
-7500
1996
2000
2005
2010
2015

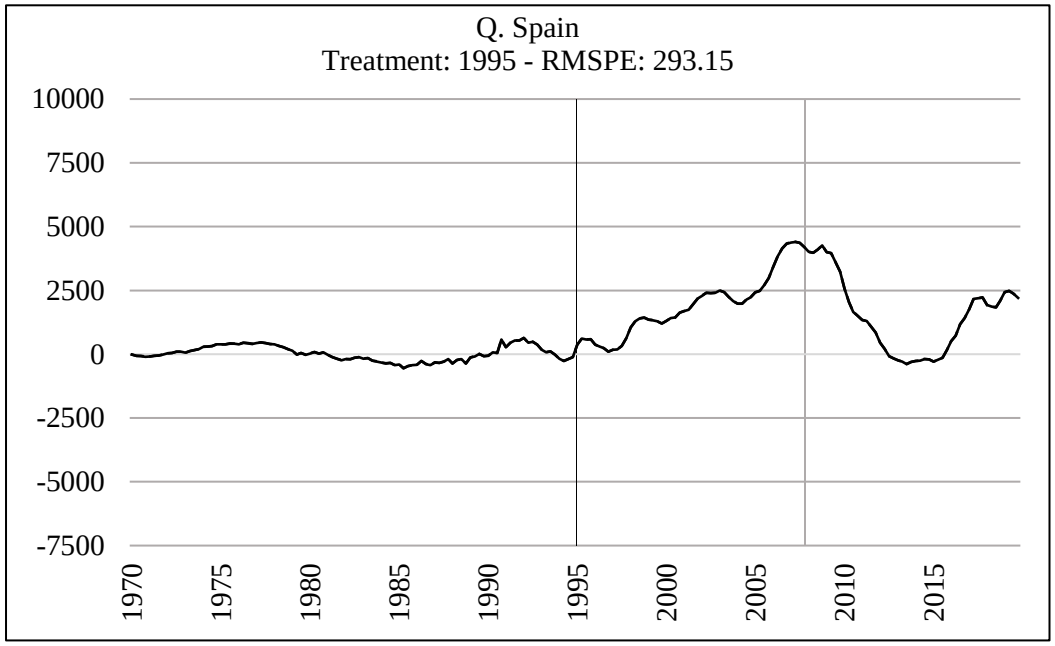

L. Luxembourg*
Treatment: 1995 - RMSPE: 3984.65
75000
50000
25000
0
-25000
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

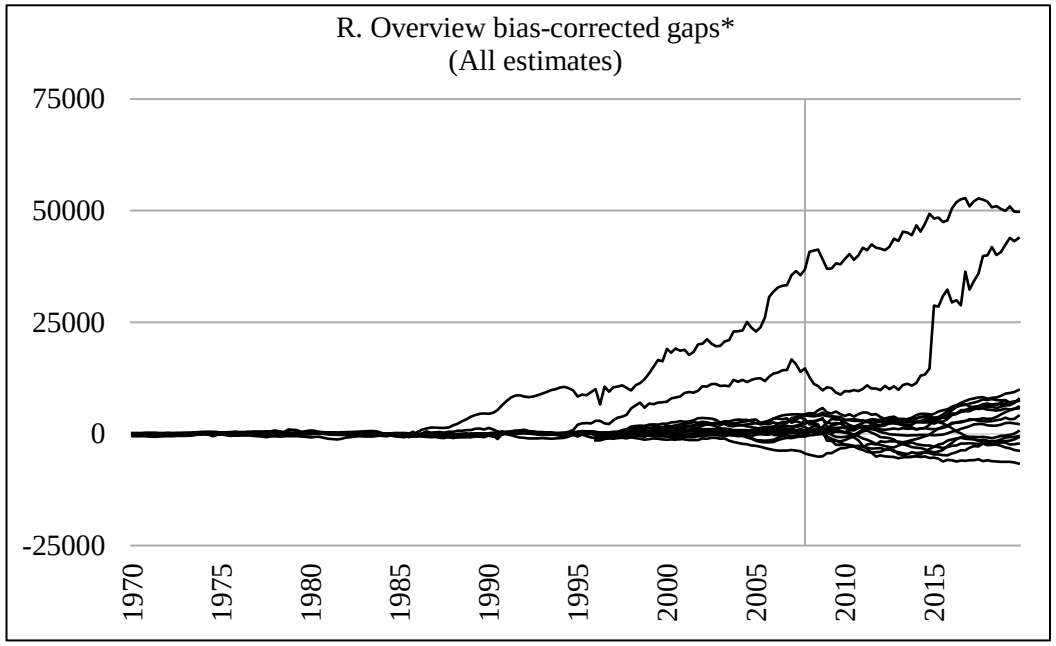

M. The Netherlands
Treatment: 1995 - RMSPE: 399.96
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

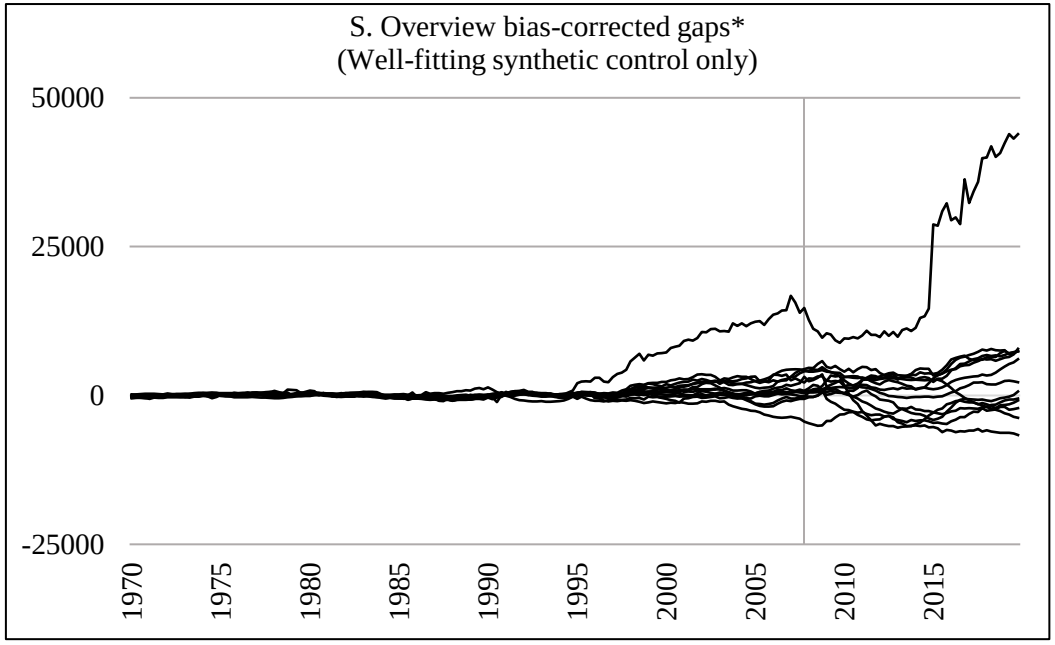

N. Portgual
Treatment: 1995 - RMSPE: 296.87
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

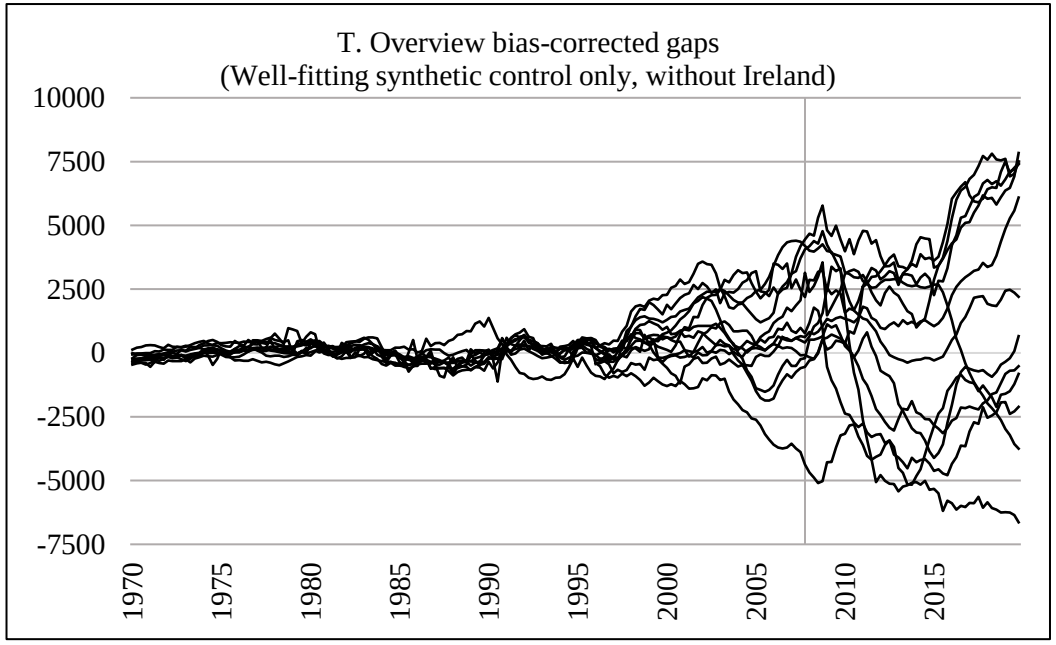

O. Slovakia
Treatment: 2005 - RMSPE: 210.07
10000
7500
5000
2500
0
-2500
-5000
-7500
1996
2000
2005
2010
2015

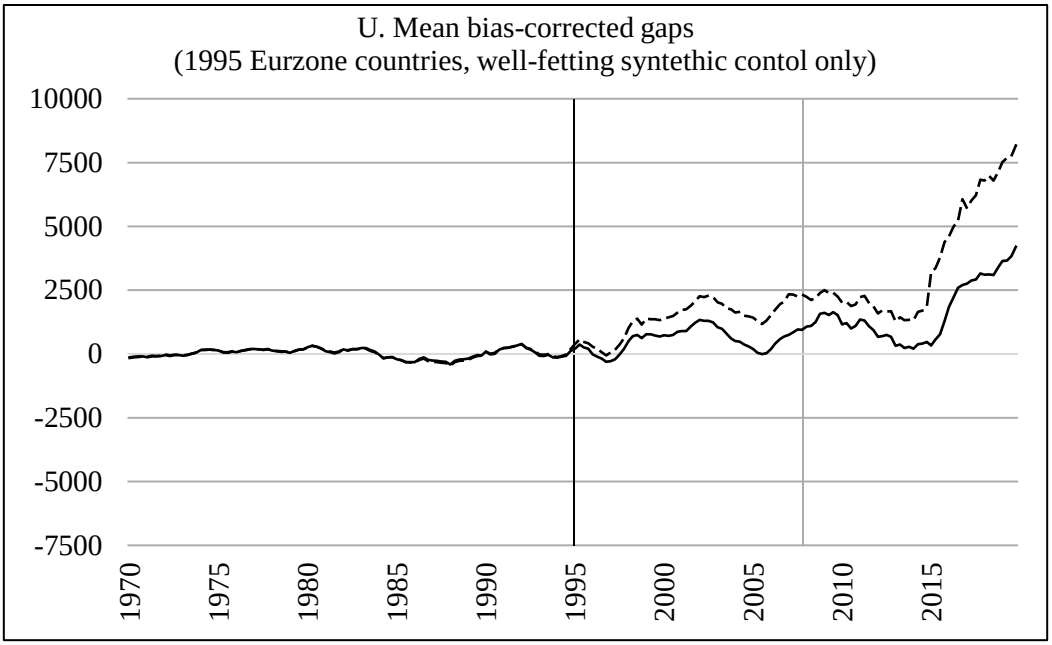

P. Slovenia
Treatment: 2003 - RMSPE: 209.63
10000
7500
5000
2500
0
-2500
-5000
-7500
1996
2000
2005
2010
2015


Q. Spain
Treatment: 1995 - RMSPE: 293.15
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


R. Overview bias-corrected gaps*
(All estimates)
75000
50000
25000
0
-25000
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


S. Overview bias-corrected gaps*
(Well-fitting synthetic control only)
50000
25000
0
-25000
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


T. Overview bias-corrected gaps
(Well-fitting synthetic control only, without Ireland)
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015



zero in 2007. The estimated cumulative effect for Italy is even lower. It must therefore be concluded that the results are highly country-specific and that any explanation must follow from a thorough country- specific analysis. However, this falls outside the scope of this study.

Belgium and Germany appear to have experienced negative treatment effects prior to 2008. Belgium shows increasingly large losses as a result of the euro. Germany on the other hand shows relatively small, yet consistent, negative treatment effects until 2005, afterwards the losses become larger until 2007.

Finally, the main results of Estonia and Luxembourg are considered to be unreliable and hence do not allow for a general conclusion on the effects of the euro. This is the result of a poor fit of the synthetic control during pre-intervention periods. This follows from the relatively high root mean square prediction errors and can also be inferred from the graphical representation of the poor fit in pre-treatment periods. Confounding factors might therefore influence the results. This means that no reliable causal estimate can be derived from this. Special attention needs to be directed towards Luxembourg, as its synthetic control is solely based on Switzerland and the United States, as follows from Appendix II. This is because no other countries in the donor pool are able to replicate the high levels of GDP per capita in Luxembourg. This problem was also encountered by other authors, e.g. Lin and Chen (2017), Verstegen et al. (2017), and Puzzelo and Gomis-Porqueras (2018).[20]

[20] Interestingly, Lin and Chen (2017) estimated Luxembourg's synthetic control based solely on Norway. This could possibly be driven by the fact that the United States was not present in their data set.

Table 2 Cumulative treatment effects (US dollar)

	Pre-2008	Post-2008	Total
Austria	24,581.61	196,924.20	221,505.80
Belgium	-84,333.10	-144,405.00	-228,738.00
Estonia	14,258.78	140,247.60	154,506.40
Finland	91,234.29	222,618.40	313,852.70
France	30,656.66	99,754.30	130,411.00
Germany	-31,749.20	186,735.00	154,985.80
Greece	75,766.78	-172,673.00	-96,906.50
Ireland	458,449.30	1,022,799.00	1,481,249.00
Italy	10,204.38	-43,470.60	-33,266.20
Latvia	-	18,081.76	18,081.76
Lithuania	-	189,799.70	189,799.70
Luxembourg	1,009,885.00	2,185,662.00	3,195,547.00
The Netherlands	101,115.80	184,902.10	286,017.90
Portugal	17,571.73	-72,338.60	-54,766.80
Slovakia	16,981.96	59,009.96	75,991.92
Slovenia	11,208.85	-133,370.00	-122,161.00
Spain	98,899.40	70,633.36	169,532.80

Note: Table 2 presents the cumulative treatment effects. Eurozone, i.e. treated, countries are presented on the left side of the table and are ordered alphabetically. The columns indicate the cumulative treatment effect over the pre-2008, post-2008, and all periods (i.e. "Total") respectively. All values are expressed in US dollars, as discussed in section 3.3. All values are rounded to two decimal places.

4.2 Post-2008

The scope of the analysis will now shift towards the post-2008 period, which was marked by structural economic changes and crises. Europe was especially hit hard, as it also suffered a sovereign debt crisis that started in 2010. The results change dramatically compared to the pre-2008 period. This follows from a substantial change in the list of the countries that benefitted or lost due to the euro.

Austria, Finland, France, Ireland, the Netherlands, Slovakia, and Spain experienced benefits during the pre-2008 period and also did so afterwards. Although the magnitude and growth rate of the benefits are still widely different across countries. For example, Austria only experienced small benefits prior to 2008, but saw a substantial increase after 2008. A similar observation can be made with respect to Germany, although it showed a negative treatment effect during the pre-2008 period. Other countries, i.e. Ireland, the Netherlands, and Spain lost some of the benefits they accumulated during the pre-2008 periods, but treatment effects remained positive and they eventually recouped these losses.

An observation should be made with respect to Ireland. It shows a steep jump in the treatment effect around 2015. The large positive treatment effects are similar to those found by Fernández and García Perea (2015), Verstegen et al. (2017), Lin & Chen (2017), Puzzelo and Gomis-Porqueras (2018), and Gabriel and Pessoa (2020). However, it might be that the results during the post-2015 period are biased as a result of misleading GDP figures for the country. This is the result of the large presence of

multinational corporations, as also acknowledged by Honohan (2021), former governor of the Central Bank of Ireland. An example is provided by the IMF's World Economic Outlook from April 2018, where it concluded that Apple's intellectual property accounted for one-fourth of Ireland's economic growth (IMF, 2018). This means that the post-2015 results should be looked at with a high degree of caution.

Germany saw its negative treatment effect change to a substantial positive effect after 2008. However, Belgium experienced negative effects pre-2008 and did so after 2008 as well. Furthermore, many more countries saw their accumulated benefits evaporate and turn to losses. Greece, Italy, and Portugal all experienced substantial losses during the post-2008 period. These three countries do have a common characteristic which is likely to have caused this outcome: high debt-to-GDP ratios. Slovenia is the last country to suffer substantial negative treatment effects post-2008. Although the country did recoup some of its losses after 2015.

The conclusions for Estonia and Luxembourg do not change. Latvia and Lithuania both received treatment after 2008, but their synthetic controls show a poor fit. Hence, their results cannot be interpreted either.

It can be concluded that country specific characteristics that ensured several member states were better able to react and cope with the crises in the post-2008 period. The fact that not all countries managed to cope with this shock might be indicative of transmission and factor mobility issues of the common currency area, as the union is not able to dissipate the shock across member states.

Finally, Panel U shows the simple mean of the estimated bias-corrected treatment effects at time t for the unbiased estimates of countries that have 1995 as their intervention period, i.e. Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain. Only these countries are taken into account, as using all countries would not yield a representative graph for the periods during which not all countries received treatment. The black dashed line includes Ireland, whereas the solid black line omits it, as it is an outlier relative to the other countries. It follows from Panel U that the initial Eurozone countries, on average, experienced gains from the euro, only showing minor negative effects around 1997 if we omit Ireland from the calculation. These gains increased substantially after 2015.[21]

5 Rigidity tests

5.1 Rigidity tests: Restricting the donor pool

The main results presented in section 4 are taken on face value and are based on the full set of donor pool countries. However, some countries in the donor pool have experienced asymmetric economic shocks during the studied period, e.g. Russia, Japan, and the United Kingdom, whereas other countries

[21] The results remain similar when we add Greece, who received treatment in 1997, albeit with slightly lower benefits in the post-2010 era. Only showing brief and small negative effects between 2012 and 2015. However, this is not surprising, as Panel T shows near zero effects during this period.

were unable to conduct independent monetary policy, as their national currencies were tied to the euro, e.g. Denmark. Additionally, the United Kingdom, Denmark, and Sweden opted out of treatment by choosing to keep their national currency during the euro's introduction in 1999. Including these countries might therefore bias the results. Additionally, including countries that deliberately opted out of treatment, i.e. Denmark, Sweden, and the United Kingdom, might lead to a reverse causality problem (Gabriel, & Pessoa, 2020). These countries will be iteratively excluded from the donor pool in order to assess potential biases and conclude the results presented in section 4 are driven by one of these countries, as is also done by Gabriel and Pessoa (2020). It should be noted that only those synthetic control estimates will be recalculated in which the donor pool country under consideration is assigned a non-zero weight.

Puzzelo and Gomis-Porqueras (2018) argue that Canada experienced "profound structural shocks" (p. 4). They conclude that the inclusion of Canada does not affect their results. Yet, this research nevertheless tests whether this drives the results presented in section 4. Canada is assigned a weight in the construction of the synthetic control groups for Austria, France, Italy, and the Netherlands. It follows from the graphs presented in Panel VI.A., VI.B., VI.C., and VI.D. in Appendix VI that the results do not change much, meaning that including Canada in the donor pool does not drive the results and that the results are robust to removing it from the donor pool.

Denmark joined the European Exchange Rate Mechanism (ERM) II in January 1999. The ERM II was meant to reduce exchange rate volatility and thereby promote monetary stability. However, this meant that Denmark was unable to exercise full monetary autonomy, as it was bound by the ERM II requirements (Puzzelo, & Gomis-Porqueras, 2018). This might mean that including Denmark biases the results. The country was assigned a weight in three synthetic controls: Austria, Germany, and Greece. Omitting Denmark from these synthetic control groups yields no substantial change to the treatment effects for Austria and Germany. The estimated treatment effect for Greece shows larger negative estimates, however is generally still the same as presented in section 4. The results of this analysis are presented in Panel VI.E. to VI.G. of Appendix VI.

Southern Japan was hit by earthquake with a magnitude of a 7.3 on the Richter scale in 1995. This constituted a large asymmetric shock to Japan's economy, as it is estimated that it resulted in a 12% lower in GDP per capita level in 2008 (DuPont, & Noy, 2015). The earthquake had a persistent negative effect on GDP and must therefore be accounted for. Another cause for concern arises from the asset price bubble that Japan experienced at the end of the 20th century. This bubble burst in 1991 and led to the lost decades, which were characterised by low growth rates (Yoshino, & Taghizadeh-Hesary, 2015, 2016). Including Japan would therefore overestimate any treatment effect, as the synthetic control group would experience disproportionately lower levels of GDP per capita. Japan is assigned a weight in the construction of six synthetic control groups: Austria, Finland, France, Germany, Italy, and the Netherlands. It is concluded that Japan is the main driver of the results presented in section 4. All estimated benefits dissipate and losses have become more severe. Only Finland and the Netherlands

have benefited from the euro when using this restricted donor pool, as follows from Panel VI.H. to VI.M. of Appendix VI. It should be noted that this is an intuitive outcome, as including Japan has lowered the counterfactual's GDP per capita levels as a result of the asymmetric shocks. The true effect of these countries is therefore more likely to reflect the results presented in Panel VI.H. to VI.M. of Appendix VI.

Russia invaded Ukraine in 2014, which resulted in a continuing war in Eastern Ukraine and sanctions against Russia's economy. Kholodilin and Netšunajev (2019) found weak evidence that this shock had an effect on Russia's GDP. However, Russia is assigned a substantial weight in the construction of the synthetic controls for Estonia, Latvia, and Lithuania. It should therefore be accounted for, even though that this might only potentially have a small effect on the post-2014 period. The results are presented in Panel VI.N., VI.O., and VI.P. of Appendix VI. First, it should be noted that these results were already characterised by a poor fit of the synthetic control. This does not change by omitting Russia from the donor pool, but it can also be concluded that the results presented in section 4 are partially driven by Russia.

The United Kingdom voted to leave the European Union in June 2016. It eventually did so in February 2020. This constitutes an asymmetric shock to the economy that might bias the results in the post-2016 period. Additionally, the United Kingdom chose not to adopt the euro in 1999, similarly to Denmark and Sweden. This might mean that there is some exogenous characteristic that drove this choice that might bias the results. The United Kingdom is assigned a weight in the synthetic control groups for Belgium, Ireland, Portugal, and Spain. The estimates for Belgium and Ireland remain mostly unchanged. Although the former does show a substantial divergence in the post-Brexit referendum period. The results for Portugal and Spain are driven by the inclusion of the United Kingdom in the donor pool, as its omission means that both countries lost substantially as a result of the euro. This is in stark contrast with the results presented in section 4, where Spain appeared to have benefitted from the euro. The results are presented in Panel VI.Q. to VI.T. in Appendix VI.

Finally, Puzzelo and Gomis-Porqueras (2018) argue that Sweden experienced "profound structural shocks" (p. 4). They conclude that the inclusion of Sweden does not affect their results, similarly to the inclusion of Canada, but this research nevertheless tests whether this drives the results presented in section 4. Furthermore, the country opted out of adopting the euro, as stated before, which presents another cause for concern. Sweden is assigned a weight in the synthetic control groups for Finland, France, and Greece. It is concluded that omitting Sweden from the donor pool does not change the estimated effects on France and Greece. It appears the estimated effect on Finland is somewhat overestimated in section 4, but this does not change the general conclusion. The results are presented in Panel VI.U. to VI.W. in Appendix VI

5.2 Rigidity tests: In-time placebo test

Section 3.1 discusses the need for backdating the intervention to a period without anticipatory effects. This research considers the four years prior to the actual implementation of the euro to also be part of the treatment period, as economic policies are implemented in order to prepare an economy for the common currency. This means that 1995 is considered to be the intervention period for the initial 11 Eurozone countries, which is in line with research performed by Puzzelo and Gomis-Porqueras (2018). However, it is possible to argue that economic policies and accompanying anticipatory effects arise directly after the signing of the Treaty of Maastricht in 1992. Hence, treatment is backdated to the first quarter of 1992 for the initial 11 Eurozone countries.

The results of this analysis are presented in Appendix VII. The estimates for Finland, Germany, Ireland, Italy, and Luxembourg remain nearly identical to the results presented in section 4 and are therefore robust to backdating the intervention to 1992. Austria, France, and Portugal show slightly different results in terms of magnitude, but remain the similar to the direction of the results presented in section 4. These results can therefore be considered to be robust. Belgium, the Netherlands, and Spain show vastly different results, compared to those presented in section 4. Belgium shows increasingly positive treatment effects in Panel VII.B. of Appendix VII, whereas it showed negative treatment effects in section 4. This is likely due to a substantially different composition of the synthetic control group. The Netherlands show much larger positive treatment effects over the entire post-intervention period and Spain shows substantially lower treatment effects, compared to those presented in section 4, even showing negative treatment effects post-2010. The results for these countries are therefore not robust and might.

5.3 Rigidity tests: In-space placebo test

Section 5.1 presented an informal test in order to assess the rigidity of the results presented in section 4 and to see whether a single country is driving the results. Section 5.2 assessed whether the results for the 11 initial countries are robust to backdating the intervention. Abadie et al. (2010, 2015) propose an in-space placebo test, in order to try to falsify the results. This test involves the assigning treatment to donor pool units and obtaining a "treatment effect" for untreated units (Wiltshire, 2022b). The treatment effect on the treated unit can then be compared to the placebo test results on the basis of p-values. Wiltshire (2022b) states that this test "remains the most widely adopted inferential approach" (p. 6) in the synthetic control literature. Hence, this test will be applied to this research.

The placebo tests need to be performed prior to calculating p-values. As stated, the in-space placebo means that, for each treated unit i, we iteratively assign treatment to all donor pool countries j. i and the remaining j are then used for the calculation of j's synthetic control. This follows the same process as described in section 3.2.

It should be noted that this research will apply the same process as Abadie et al. (2010). We therefore need four pieces of information in order to obtain p-values. First, the pre-intervention root mean squared prediction error, denoted by ξ_a. This can be obtained by using equation (8).

$$\xi_a = \left(\frac{1}{T_0} \sum_{t=1}^{T_0} \left(Y_{i,t}^I - Y_{i,t} - \sum_{j=I+1}^{I+J} w_j^* Y_{j,t} \right)^2 \right)^{\frac{1}{2}} \tag{8}$$

This must be done for the post-intervention root mean squared prediction error as well. This is denoted by ξ_p and can be obtained in a similar manner to equation (8), as presented in equation (9).

$$\xi_p = \left(\frac{1}{(T - T_0)} \sum_{T_0+1}^{T} \left(Y_{i,t}^I - Y_{i,t} - \sum_{j=I+1}^{I+J} w_j^* Y_{j,t} \right)^2 \right)^{\frac{1}{2}} \tag{9}$$

The ratio of the post- and pre-intervention root mean squared prediction error is then taken in order to compare the magnitude of the treatment effect, relative to the synthetic's control fit. This is denoted by ξ_r and calculated in accordance with equation (10).

$$\xi_r = \frac{\xi_p}{\xi_a} \tag{10}$$

We then obtain $S = 1, \dots, s$ number of ratios. Robust results are indicated by the fact that this ratio is substantially larger for the treated country, relative to its donor pool countries. It should be noted that the ratio of treated country $i \in S$. Abadie et al. (2010) then present a method for obtaining the probability the a post-/pre-intervention ratio is as large as that of the treated country. This is done by ranking the ratios for all countries in order of magnitude. The treated country's rank is then divided by the total number of countries in order to obtain the p-value for country i's estimate. This is formalised by Wilshire (2022b):

$$p_i = \frac{\sum_{s=1}^{S} \mathbb{1}\left[\xi_{r,s} \geq \xi_i\right]}{S} \tag{11}$$

The results graphical results of this analysis are presented in Appendix VIII. Table 3 presents the p-values. It follows from these results that none of the estimates presented in section 4 are significant at a 1%, 5%, or 10% level. This means that there are large probabilities of obtaining as large, or even larger, post-/pre-intervention ratios as that of the treated country. The results are thus, in essence, falsified by this placebo analysis.

This conclusion also follows from the Panels presented in Appendix VIII. The estimated treatment effects for the treated units are indistinguishable from the placebo tests. The presentation of these graphs also follows the methodology described by Abadie et al. (2010). Frist, a full version is presented with all in-space placebo tests, under the first part, i.e. "I", of each panel. Subsequently, in-space placebo estimates are omitted from donor pools that show a pre-intervention mean squared prediction error that is at least two times higher than that of the treatment country, these are presented under the second part, i.e. "II", of each panel.

Table 3 Overview of the p-values obtained from the in-space placebo test

Country	p-value	Country	p-value
Austria	0.500	Latvia	0.880
Belgium	0.375	Lithuania	0.240
Estonia	0.640	Luxembourg	0.813
Finland	0.500	The Netherlands	0.563
France	0.688	Portugal	0.625
Germany	0.375	Slovakia	0.120
Greece	0.438	Slovenia	0.480
Ireland	0.125	Spain	0.563
Italy	0.438		

Note: Table 3 presents the p-values that follow from the in-space placebo test. Column 1 and 3 present the country. Column 2 and 4 show the estimated p-value of its estimated treatment effect. All values are obtained in accordance with the process set out in section 5.3 and rounded to three decimal places.

5.4 Revaluation of the results

The results presented in section 5.1 showed that many of the results were robust to the omission of donor pool countries that experienced asymmetric shocks or might have otherwise biased the results. Similarly, the majority of the results of the initial Eurozone countries are robust to backdating the intervention to 1992. However, the in-space placebo tests presented in section 5.3 were much less lenient and forgiving towards the results presented in section 4. It must therefore be concluded that the results presented in section 4 are insignificant, as they do not differ significantly from their placebos.

This begs the question whether we can learn anything from this research? It is clear that nothing can be inferred from the individual estimates presented in section 4. Yet, I nevertheless believe that the true effect of the euro on GDP per capita levels of member states is heterogeneous in nature. This is due to the fact the Eurozone countries have widely differing economic characteristics, which result in differing effects of the common currency on an economy. This believe is in line with the theoretical and empirical economic literature discussed in section 2.1. It should also be noted that the existing literature provides evidence to support the believe that the euro had a heterogeneous effect on the economies of Eurozone countries. The following sections will therefore disregard the individual estimates and elaborate on the heterogeneous effects of the euro and its consequences.

6 Policy implications

Section 4 and 5 provide the results, rigidity tests, and revaluated results of this research. The results presented in section 4 are disregarded due to their insignificant nature. It is nevertheless believed that the effects of the euro are heterogeneous. However, the previous sections do not provide any information on the policy implications that follow from this. This section seeks to hypothesise and extrapolate from the findings presented above and the literature discussed in section 2.

The existing literature shows heterogeneous treatment effects on Eurozone countries. A possible explanation for this lies within the fact that business cycles are imperfectly synchronised across

European countries (Guerini et al., 2019). The authors found that synchronisation reached its highest degree during the global financial crisis, but that it decreased to a level similar to the start of the 21st century in the aftermath of the crisis. The authors add that a North-South axis exists between the European Union's member states. The asynchronization of business cycles might be an explanation for the different treatment effects. Especially given the fact that the European Central Bank is only able to set a single interest rate for the entire Eurozone, thereby only being able to attend to the needs of a specific group of member states. Attempts to increase business cycle synchronisation might therefore be warranted.

The imperfect mobility of production factors between member states might also be an important factor in explaining why some countries benefited and others lost, especially in the post-2008 period. Capital is highly mobile between Eurozone countries, but labour mobility, a factor whose importance is stressed since the birth of the literary field, is still lacking (Vrňáková, & Bartušková, 2013). This means that the Eurozone can only imperfectly response to (asymmetric) economic shocks. Improving response capabilities by increasing labour mobility is therefore desirable.

A more radical response would be to split the Eurozone into multiple, more synchronised and even more interconnected, smaller currency areas. This might create several currency areas that show a higher degree of optimality, relative to the euro, and might enable central banks to enact policy that is beneficial to all member states. However, this would most likely come with tremendous costs and collateral damage. Such a policy would potentially decrease trade between currency areas withing the European Union, create political factions, and undo years of commitment towards to common currency, assuming that the European Union continues to exist in such a scenario. This might, in a worst-case scenario, undermine trust in the European Union and the newly created currencies. If the European would dissolve in response to the creation of several smaller currency areas, it might have significantly negative effects on European economies, as European Union membership leads to higher GDP levels (Campos et al., 2019).

Section 5.4 argues that the effects of the euro are highly country specific. This means that it a lot uncertainty exists on the effects prior to a joining the currency area. Thorough analyses by prospective member states could potentially reduce these uncertainties, although it should be noted that countries who appear to share similar characteristics can still experience widely different effects. Any reductions might therefore be incremental, but might still prove worthwhile.

The fact that the effects are different across member states might not only interest European policymakers, even if the results are limited in their external validity, as it also sends signals on the general uncertainty on the effects of currency areas. This signalling can be considered to have broader implications, as the euro is the primary example of economic integration and implementation of a common currency. This uncertainty might make it harder for future currency areas to be created, as

policymakers want to avoid potential negative effects on their economies.[22] Risk sharing mechanisms could provide a solution to this, but come with costs of their own, as they might be politically unpopular, come with monitoring costs, and are potentially practically infeasible.

These are some of the potential lessons that can be learned from the results presented in this research. Yet, it should be noted that there are many more policy implications that can be drawn from this research. Finally, there are still some a number of interesting question unanswered, as well as some potential problems facing this research, these are discussed in section 7.

7 Discussion & Shortcomings

This research seeks to estimate the effect of the introduction of the euro on GDP per capita of Eurozone countries. The results for this are presented in section 4, tested for rigidity in section 5.1, 5.2 and 5.3, and revaluated in section 5.4. These results provide interesting insights, yet they are not perfect, as becomes abundantly clear from the in-space placebo analysis. Several questions, opportunities, and problems arise as a result of this research. This section addresses these factors. First, several unanswered questions and research opportunities are discussed in section 7.1. Section 7.2 will discuss potential problems facing this research and provides some potential solutions.

7.1 Discussion

The main results of this paper seek to shed a light on the effects of the euro on GDP per capita in Eurozone countries. However, several related questions fall outside of the scope of this study and will therefore be shortly discussed here.

The previous sections concluded that the estimated effects are highly country-specific. This research stops short of analysing the underlying causes for the direction and magnitude of the effects. However, this is an important question in order to fully understand the effects of a common currency on member states. A country-specific analysis, using a quantitative, as well as qualitative research approach into what drives the results might therefore be desirable. Doing so would also make it possible to pinpoint areas of improvement to the Eurozone. Additionally, extra research into the hypotheses and policy implications presented in section 6 is desirable.

Campos et al. (2019) analyse the benefits of EU membership and enlargement using a synthetic control method. Lehtimäki and Sondermann (2020) assess the effects the European internal market on growth using a synthetic control. These works shows that different stages of European integration all had an effect on GDP. Combining these integration rounds and isolating these effects might provide useful insights into the effects of the euro, but also on the European integration experiment in general.

[22] This holds for a benevolent policymaker, as well as for those who maximize their own utility. Benevolent policymakers want the best for their country. Whereas a utility maximizing will maximize their own influence, income, or probability of remaining in power. All of which will be increased by growing economies and positive effects of a common currency.

This study provides a general, per capita, effect of the euro.[23] However, it is likely that the introduction of the common currency had an effect on the wealth and income distribution in member states. Increased capital mobility might have benefited the population groups with large amounts of wealth most. Whereas decreased trade costs meant that outsourcing within the union and imports from relatively low-wage member states became cheaper. Such effects could potentially be reflected in distributional patterns, but could also change inequalities between member states due to differences in wage levels. Such questions could potentially be answered by analysing Gini coefficients or microeconomic data. An assessment of these distributional consequences would be a valuable addition to the literature on common currency areas.

The distributional effects could possibly be studied using microeconomic data. This might prove especially useful given the fact that Krugman (1995) argues that the literature on optimum currency areas lacks microeconomic evidence on the costs and benefits, as described by Broz (2005). An assessment of the effects of the euro at the individual level therefore provides a useful addition to existing the literature.

A final option for future research is to analyse the effects of the euro on the Eurozone as a single entity. Doing so might provide insights into the aggregate effects on the union and allow for information on the optimality of the union. This research has refrained from performing such an analysis due to the potential problems that arise from aggregating predictor values from a national level to a representative unionwide value. Instead, this research has provided a simple mean of the treatment effect in Panel U in section 4.

These extensions might provide further insights into the practical implications of common currency areas. Although it should be noted that the analysis presented in this paper is not to be taken as gospel. Section 7.2 will highlight this and will show how future research can improve on the methodology and framework implemented in this research.

7.2 Shortcomings

There are several (potential) shortcomings that face this research, as stated before. These problems are the result of economic shocks, the selection of donor pool countries, selection of predictor variables, and methodology in general. A first potential problem relates to macroeconomic shocks that caused structural changes in a number of economies, i.e. the global financial crisis of 2007 – 2008 and the subsequent European sovereign debt crisis. These shocks caused structural changes, which the synthetic control might not be able to perfectly account for. This means that the results of the post-2008 period should be interpreted with a high degree of caution. This holds especially true for countries who were heavily affected by these crises, e.g. Italy, Greece, Spain, and Portugal. The need for caution is increased by the fact that the predictive power of the synthetic counterfactual decreases after a certain point, as

[23] Additionally: an analysis on the effects of the euro on GDP growth rate might also be interesting.

the probability increases that the synthetic control group is not representative of the treatment group at that time.

This does not mean that caution is only advised in certain cases, e.g. Southern European economies or the post-2008 period, as it is possible that the true effect of the euro on GDP cannot be estimated in the first place. This relates to the Lucas critique, as this research seeks to estimate the macroeconomic effects of a policy intervention, using historical data.[24] Frankel and Rose (1997, 1998) acknowledged this as they formulated their findings on the endogenous nature of optimum currency area characteristics. The introduction of the euro, as well as subsequent related policies, fundamentally changed the Eurozone countries in such a way that an unbiased estimate of the effects might be unattainable.

However, discussing this critique transcends the scope of this research. Let us assume that estimating we are able to estimate an effect. This research uses data on 24 donor pool countries in order to do so, the majority of which are European. This selection, which is guided by the availability of data on the variable of interest, might unknowingly have introduced a degree of bias into the results. The donor pool countries might inhibit unobservable characteristics that bias the results or they might not be diverse enough, which might lead to a failure to construct a suitable synthetic control. The inclusion of more and more diverse donor pool countries might therefore be desirable.

The estimates might also benefit from the inclusion of more and more diverse predictor variables. This research uses macroeconomic and demographic variables for the construction of the synthetic control groups, as discussed in section 3.3. Yet, other relevant variables could facilitate the construction of the synthetic control, such as data on government and regulatory quality, crime, innovation, environmental characteristics and policy, and (digital) infrastructure. These variables might facilitate a better comparison, be relevant for GDP, and ensure that the synthetic control group is akin to the treatment group in more aspects than just economics. However, there are also some additional macroeconomic indicators that could be added in order to improve the synthetic control. These variables relate to public debt, unemployment, and income and wealth inequality.

Another possibility is to use annual data, similarly to the existing synthetic control literature. This research argues that the use of quarterly data is an improvement, as the synthetic control relies on large quantities of data. However, it is possible to doubt the reliability of quarterly data, as not all countries are able to reliably measure these figures quarterly. This might therefore mean that these

[24] Lucas (1976) summarised his critique: "given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models" (p. 41.). Lucas (1976) adds that "for issues involving policy evaluation, in contrast, it is fundamental; for it implies that comparisons of the effects of alterative policy rules using current macro-econometric models are invalid regardless of the performance of these models over the sample period or in ex ante short-term forecasting" (p. 41).

figures are annual data linearly interpolated. Were this to be the case for the GDP figures used in this research, it might be beneficial to use annual data, even if this means having fewer observations.

This research calculates the optimal donor pool and variable weights by minimising the formulas presented in section 3.2 over the entire pre-intervention period, thereby creating a unique vector of weights. However, it could be argued that the weights are differ between periods. A potential solution for this can be found in work by Cerulli (2020). Cerulli (2020) proposes a nonparametric synthetic control in order to obtain "a vector of weights for each of the periods" (p. 847) which can then be averaged in order to obtain a unique vector of weights, instead of a single vector of weights for the entire period. However, it should be noted that this method has not yet been combined with the bias-correction applied in this research. Yet, such an approach could possibly lead to better synthetic counterfactuals. Additionally, different types of bias-correction can be applied, e.g. using a lasso or elastic net regression.

The results presented in section 4 do not show confidence intervals. Future research could improve on this by including such intervals to assess whether the estimates are statistically significantly different from zero. This could be done using the framework described by Cattaneo et al. (2021).

Two final remarks can be made with respect to limitations to the comparability and external validity of the results. First, Europe and the euro underwent substantial changes after 1999, e.g. changes to the European Central Bank's inflation target, the European Central Bank's policy instruments, and regulatory legislation throughout Europe. It could therefore be argued that the euro that was introduced in the Netherlands in 1999 is not comparable to the euro that was introduced in Lithuania in 2015, for example. This means that treatment is not equal across countries. Although it should be noted that this does not affect the analysis for an individual country or the comparisons between countries that adopted the euro at the same time. Second, the external validity of these findings is uncertain. The euro has been introduced within an environment of advanced legal, political, and economic integration, notwithstanding the cultural and historical context of its creation that might influence its effects. This means that the results of this research are most likely not applicable to other regions or currency areas, as they lack this specific environment. However, this does not negate the fact that the overview of the literature presented in section 2 and main results are not informative of currency areas. These can be used as one of many potential outcomes for future currency areas.

8 Conclusion

The euro marked a major change in Europe and presented a real-world implementation of the theory on common currency areas. Mundell (1961) described that the creation of a common currency appeared to be outside the realm of "political feasibility" (p. 657) at first, yet political hurdles were overcome and the euro was introduced in 1999 and the number of member states grew in the following decades. This research seeks to estimate the effect of the introduction of the euro on GDP per capita levels in Eurozone countries using a bias-corrected synthetic control method.

Several studies looked at the effects on GDP for early adopters of the euro using a classic synthetic control method. These studies found widely differing effects in magnitude of the effect and on the countries that benefited or lost as a result of the euro. This research seeks to improve on the existing literature by not only studying early adopters, by implementing an extended version of the classic synthetic control that accounts for differences between predictor values of the treatment and synthetic control group, and by using quarterly data, instead of annual.

Section 4 presented the main results and showed heterogeneous treatment effects and large differences between the pre- and post-2008 periods. The results are tested for potential biases introduced by countries that experienced heterogeneous shocks or countries that might otherwise bias the results. The majority of the results are unaffected by this analysis, except for those synthetic control estimates that are influenced by Japan, as well as the estimates for Portugal and Spain.[25] The in-time placebo tests did not yield any substantial changes for the majority of the initial 11 Eurozone countries, i.e. the majority of the results were robust to this test. The results for Belgium, the Netherlands, and Spain were found not to be robust. However, the in-space placebo tests indicate that all of the main results presented in section 4 are indistinguishable from placebo test outcomes. This means that all of the estimates on individual countries are, in the end, insignificant.

It is nevertheless argued that the euro had heterogeneous effects, as follows from the literature discussed in section 2.4. It is hypnotised that the heterogeneous effects are the result of imperfectly synchronised business cycles and labour immobility. Policies aimed at increase business cycle synchronisation and labour mobility might thus prove beneficial. The creation of several smaller currency areas is discussed, as this might yield several currency areas with a higher degree of optimality, but it is concluded that this has detrimental costs in the case of Europe. Finally, it is argued that risk sharing mechanisms might reduce uncertainty on the potential effects and might lower barriers for new entrants that arise as a result of this uncertainty.

There are several points on which future research could improve. The inclusion of more and more diverse donor pool countries could improve the credibility of the synthetic control. The same holds for the inclusion of predictor variables that reflect governance, crime, inequality, innovation, infrastructure, and ecological characteristics. The implementation of a non-parametric synthetic control, as proposed by Cerulli (2020), might be beneficial, possibly combined with the bias-correction applied in this research. More fundamental concerns arise from asymmetric economic shocks to treated countries that make the estimation of a treatment effect and subsequent inference difficult. This is because the synthetic control is unable to account for such shocks. Furthermore, caution should be exercised in comparing or extrapolating from these results. It could be argued that the euro changed significantly throughout the two decades after its introduction, meaning that the implementation of the euro in 1999 is different from the introduction of the euro in the 2007, for example. The external validity

[25] The estimates of Estonia, Latvia, and Lithuania also appear to be (partially) driven by a single country, Russia. However, these results are already unreliable due to the poor fit of the synthetic control.

of this research is also uncertain, as the euro is situated in a historical, political, and cultural context that does not exist anywhere else.

The results of this study can shed a light on the effects of common currencies and can inform policymakers, inside and outside the European Union, on the real-world implications of common currencies, albeit in a highly specific context. Furthermore, these results might provide European politicians and policymakers with insights into the euro and provide a starting point for analysis into areas of improvement. Finally, it can provide economist with insights in how to implement this novel econometric approach in practice.

King Midas was overjoyed with his new power at first, but soon realised that his golden touch was, in fact, a curse. The effects of the euro do not show such unambiguous results. The euro appears to be a blessing to some, whereas others suffered the consequences. Whether those who suffered, and potentially even those who have appeared to have gained, wish to wash their powers away is up to politicians and other policymakers. However, it might also be possible to improve the euro in such a way that it moves closer to an optimum currency area and potentially provide benefits to all who join. As it stands, it appears that is a priori uncertain whether the euro has a golden touch.

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Appendix

Appendix I – Literature overview: Estimating the impact of the euro on GDP using a synthetic control method

Table I.A Schematic overview existing literature on the effects of the introduction of the euro on GDP using a synthetic control method

Study	Period	Treatment period	Positive effect on GDP	No effect on GDP	Negative effect on GDP	Donor pool countries	Control variables
Fernández & García Perea (2015)	1970 – 2013	1999	Ireland; Finland; Greece; Spain	Euro area; Austria; France; Germany; The Netherlands	Belgium; Italy; Portugal	Australia; Canada; Iceland; Japan; Korea; Mexico; Norway; New Zealand; Switzerland; Turkey; United States	Private consumption share of GDP; Public consumption share of GDP; Investment share of GDP; Export share of GDP; Import share of GDP; Average years of education; Dependency ratio
Gabriel & Pessoa (2020)	1970 – 2007	1999 (Greece: 2001)	Ireland; Luxembourg	Austria; Belgium; Finland; Greece; The Netherlands; Spain	France; Germany; Italy; Portugal	Australia; Canada; Chile; Denmark; Iceland; Israel; Mexico; New Zealand; Norway; South Korea; Sweden; Switzerland; United Kingdom; United States	Labour productivity growth; Employment share (ratio); Private consumption expenditure (as % of GDP); General government final consumption expenditure (as % of GDP); Gross fixed capital formation (as % of GDP); Exports of goods and services (as % of GDP); Imports of goods and services (as % of GDP)

Gasparotti & Kullas (2019)	1980 – 2017	1999 (Greece: 2001)	Germany; The Netherlands	Belgium; Greece	France; Italy; Portugal; Spain	Australia; Bahrain; Barbados; Denmark; Israel; Japan; New Zealand; Singapore; Switzerland; Turkey; United Kingdom	Inflation rate; Output industrial and consumption sector (as % of GDP); Fixed capital formation (as % of GDP); Total exports and imports from goods and services (as a % of GDP)
Lin & Chen (2017)	1991 – 2013	1999 (Greece: 2001)	Finland; Ireland; Luxembourg	Austria; Belgium	France; Germany; Greece; Italy; The Netherlands; Portugal; Spain	Azerbaijan; Belarus; Bulgaria; Czechia; Denmark; Georgia; Iceland; Kazakhstan; Lithuania; Norway; Poland; Romania; Russia; Sweden; Switzerland; Turkey; United Kingdom	Secondary school enrolment (% of total) (logs); Sum imports and exports of goods and services (% of GDP) (logs); Gross fixed capital accumulation (% of GDP) (logs); Annual population growth (%) (logs)
Puzzelo & Gomis-Porqueras (2018)	Early 70s – 2007	1995	Ireland	The Netherlands	Belgium; France; Germany; Italy	Australia; Bahrain; Barbados; Gabon;	Inflation rate; GDP deflator; Industry share of value added; Investment to GDP;

						New Zealand; Norway; Singapore; Switzerland; Trinidad and Tobago; United Kingdom; United States	Secondary education; Trade openness
Verstegen et al. (2017)	1960 – 2015	1997	Austria; Finland; Germany; Ireland; The Netherlands	Belgium; France; Greece; Portugal; Spain	Italy	Argentina; Australia; Bahamas; Chile; Costa Rica; Denmark; Fiji; Iceland; Israel; Japan; Morocco; Nigeria; Norway; Panama; Sweden; Switzerland; Trinidad and Tobago; Tunisia; United Kingdom; United States	Growth rate of real GDP; Total population (logs); Birth rate; Death rate; Net exports (as % of GDP); Sum of exports and imports (as % of GDP); Gross fixed capital formation (as % GDP); GDP deflator; Labour force participation (as % of working-age population); Female labour force participation (as % of female working-age population); Life expectancy; Patent applications (per capita); Primary school enrolment (%); Secondary school enrolment (%); Tertiary school enrolment (%); Unemployment (as % of the labour force); Youth unemployment (as % of total youth labour force); Urban population (as % of total population);

							Public debt (as % of GDP); Net migration (as % of the population); International migrant stock (as % of the population); Liquid liabilities (as % of GDP); Private credit (as % of GDP); Deposit money banks' assets (as % of GDP); Credit to government (as % of GDP); Voice and accountability; Political stability; Government effectiveness; Regulatory quality; Rule of law; Control of corruption

Note: Table I.A provides a schematic overview of the economic literature that estimates the effect of the introduction of the euro on GDP (per capita) using a synthetic control method. Column 1 shows the authors of the study and the year in which the (working) paper was published, ordered alphabetically. Column 2 shows the period over which data has been collected. Column 3 shows the intervention period, with diverging treatment periods shown in parentheses. Column 3 to 6 show the countries that benefited, neither gained or lost, or lost due to the introduction of the euro, respectively. It should be noted that these indications constitute a broad classification of the results and ignore major changes in treatment effects over time. Furthermore, they do not indicate the magnitude of the gains or losses. Column 7 shows all countries in the donor pool that were assigned a non-zero weight in the construction of the synthetic control groups. Column 8 shows all control variables used in the construction of the synthetic control groups.

Appendix II – Donor pool weights in the bias-corrected synthetic control

Table II.A Synthetic control weights assigned to the countries in the synthetic control group

	1970 – 2019														1996 – 2019								
	Australia	Canada	Denmark	Iceland	Japan	Mexico	New Zealand	Norway	South Africa	South Korea	Sweden	Switzerland	Turkey	United Kingdom	United States	Brazil	Bulgaria	Chile	Czechia	Hungary	Israel	Poland	Romania	Russia
Austria	0	0.05	0.14	0	0.34	0	0	0.09	0.11	0	0	0.06	0	0	0.22	-	-	-	-	-	-	-	-	-
Belgium	0.44	0	0	0	0	0	0	0.17	0	0	0	0.04	0	0.36	0	-	-	-	-	-	-	-	-	-
Finland	0	0	0	0.01	0.32	0	0	0.07	0.22	0	0.39	0	0	0	0	-	-	-	-	-	-	-	-	-
France	0.17	0.12	0	0	0.32	0.04	0	0	0.16	0	0.07	0	0	0	0.12	-	-	-	-	-	-	-	-	-
Germany	0	0	0.12	0	0.45	0	0	0	0.12	0	0	0.05	0	0	0.26	-	-	-	-	-	-	-	-	-
Ireland	0	0	0	0	0	0.14	0	0.09	0	0.36	0	0	0	0.41	0	-	-	-	-	-	-	-	-	-
Italy	0	0.19	0	0	0.44	0.18	0	0	0	0	0	0	0	0	0.19	-	-	-	-	-	-	-	-	-
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0.41	0	0	0.59	-	-	-	-	-	-	-	-	-
Netherlands	0.33	0.29	0	0	0.23	0	0	0.14	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
Portugal	0	0	0	0	0	0.24	0	0	0.06	0.32	0	0	0.06	0.31	0	-	-	-	-	-	-	-	-	-
Spain	0	0	0	0	0	0.13	0	0	0.18	0.23	0	0.07	0	0.39	0	-	-	-	-	-	-	-	-	-
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.57	0	0	0	0.43
Greece	0.20	0	0.01	0.06	0	0.15	0	0	0.32	0	0.24	0	0.02	0	0	-	-	-	-	-	-	-	-	-
Latvia	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0.41	0	0.05	0	0	0	0.51
Lithuania	0	0	0	0	0	0	0	0	0.15	0	0	0	0	0	0	0	0	0	0	0.31	0	0	0	0.54
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.21	0.30	0	0.34	0.14	0
Slovenia	0.31	0	0	0	0	0	0	0	0	0.28	0	0	0	0	0	0	0	0	0	0	0	0.41	0	0

Note: Table II.A shows the donor pool weights assigned to each synthetic control group. Eurozone, i.e. treated, countries are presented on the left side of the table. All countries that adopted the euro in 1999 are ordered alphabetically above the dashed black line. All countries that adopted the euro post-1999 are order alphabetically below the dashed line. The Columns indicate the weight of each donor pool country in the respective synthetic control. These donor pool countries are also sorted alphabetically and divided into two groups. First, the group that contains Australia,…, United States. These countries show data from 1970 until 2019. These countries are taken into account for the construction of every synthetic control groups. The second group, containing Brazil,…, Russia, only contains data from 1996 until 2019. These countries are only taken into account for the construction of the synthetic control groups for Estonia, Latvia, Lithuania, Slovakia, and Slovenia, as these treated countries also only show data from 1996 until 2019 as well. Using Brazil,…, Russia for the construction of the other synthetic control groups would yield less predictive value due to the unavailability of data in the pre-1996 period. All values are obtained in accordance with equation (3) and rounded to two decimal places. Rounding might cause the weights not to sum to one. The main results presented in section 4 are obtained using more precise donor pool weights than presented above.

Appendix III – Variable weights in the synthetic control group

Table III.A Weights assigned to predictor variables in the synthetic control group

	Average depreciation rate of capital	Consumer price index	Dependency ratio	FDI net inflows	Human capital index	Life expectancy at birth	Urbanisation rate	Real internal rate of return	Share of capital formation	Share of government consumption	Share of private consumption	Working population
Austria	0.0184	0.6079	0.0049	0.0026	0.0141	0.0189	0.0094	0.1225	0.0003	0.0368	0.0002	0.1639
Belgium	0.0526	0.0678	0.0539	0.0477	0.0009	0.0994	0.1023	0.1323	0.1567	0.0468	0.0376	0.2019
Estonia	0.0467	0.0326	0.0047	0.0005	0.0695	0.0370	0.0887	0.0248	0.0001	0.5960	0.0846	0.0148
Finland	0.1692	0.0616	0.0001	0.0009	0.7343	0.0133	0.0036	0.0138	0	0.0021	0.0011	0
France	0.0033	0.0014	0.0150	0.0218	0.0024	0.0068	0.7096	0	0.0055	0	0.1340	0.1001
Germany	0	0.0533	0.0026	0.1218	0	0.2189	0.0967	0.2326	0.1834	0.0064	0	0.0841
Greece	0	0.0479	0	0.9026	0	0	0.0002	0	0	0.0002	0.0491	0
Ireland	0.1534	0.1162	0.0070	0.0170	0.1598	0.1798	0.0597	0.1958	0.0782	0	0.0014	0.0318
Italy	0.0745	0.0419	0.0610	0.0326	0.0547	0.4799	0.0543	0.0139	0.0480	0.0042	0.0703	0.0648
Latvia	0.0020	0.0018	0.0004	0.0091	0.0021	0.9817	0.0008	0	0.0010	0.0002	0.0002	0.0007
Lithuania	0.1064	0.0430	0.0273	0.0427	0.0613	0.0001	0.2143	0.0065	0.1360	0.2106	0.0682	0.0835
Luxembourg	0	0.2589	0.1680	-	0.0079	0.1126	0.0042	0.0067	0.1487	0	0.0747	0.2182
The Netherlands	0	0	0	0	0	0	0	0	0	0	1.0000	0
Portugal	0.0588	0.0264	0.0713	0.1181	0.1040	0.1561	0.1280	0.0001	0.0645	0.0192	0.1950	0.0585
Slovakia	0.0565	0.2328	0.0425	0.0072	0.0824	0.0718	0.1853	0.1300	0.1108	0.0401	0.0280	0.0126
Slovenia	0.1238	0.0221	0.1457	0.0462	0.0774	0.0029	0.0330	0.0507	0.1032	0.0092	0.2158	0.1712
Spain	0	0.1515	0.0636	0.0068	0.1496	0.0068	0	0	0.3216	0.0831	0.1905	0.0265

Note: Table III.A. show the weights assigned to predictor values in the construction of each synthetic control group. Eurozone, i.e. treated, countries are presented on the left side of the table and are ordered alphabetically. The Columns indicate predictor variables as described in section 3.3. A dash indicates that the variable has been omitted due to the unavailability of data. All values are obtained in accordance with equation (4) and rounded to four decimal places. Rounding might cause the weights not to sum to one. The main results presented in section 4 are obtained using more precise weights than presented above.

Appendix IV – Overview predictor means

Table IV.A Predictor variable means for the treatment country (Austria, Belgium, Estonia, and Finland) and its synthetic control

	Austria		Belgium		Estonia		Finland	
	Real	Synthetic	Real	Synthetic	Real	Synthetic	Real	Synthetic
Average depreciation rate of capital	3.69	3.78	3.99	3.35	3.55	3.48	3.72	3.72
Consumer price index	4.66	6.43	5.38	8.02	4.26	17.10	7.66	8.07
Dependency ratio	54.03	53.82	52.66	55.03	48.64	45.67	48.49	58.01
FDI net inflows	0.41	0.39	2.05	1.42	8.69	5.58	0.24	0.30
Human capital index	2.82	2.97	2.59	3.13	3.27	3.05	2.74	2.74
Life expectancy at birth	73.07	73.41	73.76	74.72	70.63	69.08	73.32	72.53
Real internal rate of return	6.94	7.13	6.36	6.74	4.67	4.48	5.03	7.03
Share of capital formation	27.77	30.57	28.75	28.33	23.77	19.08	36.74	30.74
Share of government consumption	15.54	14.83	18.66	16.40	29.88	27.81	17.66	18.07
Share of private consumption	61.06	54.53	58.02	59.40	55.18	53.93	47.65	51.88
Urbanisation rate	64.43	73.00	95.39	79.79	69.35	68.78	72.83	72.72
Working population	65.04	65.20	65.55	64.63	67.28	68.67	67.35	63.67

Note: Table IV.A Shows the means for all predictor variables for the treatment country presented in the Column and its synthetic control. Values are rounded to two decimal places and reported in accordance with the measurement unit reported in section 3.3.

Table IV.B Predictor variable means for the treatment country (France, Germany, Greece, and Ireland) and its synthetic control

	France		Germany		Greece		Ireland	
	Real	Synthetic	Real	Synthetic	Real	Synthetic	Real	Synthetic
Average depreciation rate of capital	2.82	3.47	3.37	3.67	2.32	3.46	3.81	3.80
Consumer price index	7.00	8.49	3.87	6.27	15.43	15.44	8.39	13.53
Dependency ratio	55.80	56.77	50.63	53.18	53.61	68.44	67.94	62.30
FDI net inflows	0.63	0.64	0.17	0.28	0.81	0.81	1.23	1.03
Human capital index	2.60	2.87	3.21	2.97	2.36	2.47	2.60	2.66
Life expectancy at birth	74.49	72.49	73.17	73.28	74.46	68.86	73.06	70.68
Real internal rate of return	6.16	7.02	5.07	7.42	9.63	8.57	13.93	12.60
Share of capital formation	27.83	29.05	30.32	30.77	34.29	25.49	26.27	27.72
Share of government consumption	17.30	14.25	15.89	14.11	15.19	15.10	19.04	15.51
Share of private consumption	56.22	56.24	58.88	54.80	59.56	59.56	64.63	61.46
Urbanisation rate	73.25	73.30	72.83	73.06	69.27	70.14	55.17	68.82
Working population	64.22	64.24	66.49	65.49	65.14	59.82	59.59	61.98

Note: Table IV.B Shows the means for all predictor variables for the treatment country presented in the Column and its synthetic control. Values are rounded to two decimal places and reported in accordance with the measurement unit reported in section 3.3.

Table IV.C Predictor variable means for the treatment country (Italy, Latvia, Lithuania, and Luxembourg) and its synthetic control

	Italy		Latvia		Lithuania		Luxembourg	
	Real	Synthetic	Real	Synthetic	Real	Synthetic	Real	Synthetic
Average depreciation rate of capital	3.19	3.52	2.44	3.10	3.22	3.51	2.99	3.82
Consumer price index	10.48	11.26	6.56	14.12	4.76	15.61	5.13	5.10
Dependency ratio	51.60	56.18	48.39	47.48	49.86	46.46	47.74	52.35
FDI net inflows	0.31	0.57	4.56	4.51	3.94	5.28	-	-
Human capital index	2.34	2.90	2.88	2.99	2.98	2.99	2.56	3.33
Life expectancy at birth	74.60	73.90	70.60	70.60	71.53	66.70	72.70	74.56
Real internal rate of return	9.92	8.98	4.60	6.73	7.98	4.64	8.09	5.72
Share of capital formation	26.87	29.23	23.04	20.28	17.21	18.28	31.28	30.70
Share of government consumption	14.97	13.06	30.10	21.03	31.01	25.54	14.25	9.76
Share of private consumption	59.17	57.38	58.05	54.64	62.40	54.33	67.05	60.59
Urbanisation rate	66.23	73.84	68.10	77.92	66.89	68.91	79.22	74.29
Working population	66.03	64.50	67.40	67.90	66.74	68.40	67.72	65.68

Note: Table IV.C Shows the means for all predictor variables for the treatment country presented in the Column and its synthetic control. FDI net inflows are omitted from Luxembourg's synthetic control, as no data is available for the treated group. Values are rounded to two decimal places and reported in accordance with the measurement unit reported in section 3.3.

Table IV.D Predictor variable means for the treatment country (The Netherlands, Portugal, Slovakia, and Slovenia) and its synthetic control

	The Netherlands		Portugal		Slovakia		Slovenia	
	Real	Synthetic	Real	Synthetic	Real	Synthetic	Real	Synthetic
Average depreciation rate of capital	3.40	3.41	2.65	3.75	4.08	4.18	3.39	3.75
Consumer price index	4.53	6.62	15.95	18.91	7.54	14.14	8.15	6.01
Dependency ratio	50.66	51.40	57.38	68.14	45.39	46.22	42.95	46.05
FDI net inflows	1.44	1.06	0.99	0.94	4.05	4.91	1.73	2.48
Human capital index	2.86	3.12	1.70	2.43	3.29	3.10	3.24	3.19
Life expectancy at birth	75.67	75.51	71.31	68.34	73.09	72.67	75.06	75.48
Real internal rate of return	4.43	5.48	7.01	14.60	5.29	7.58	4.41	8.94
Share of capital formation	25.59	30.54	24.91	26.05	21.10	19.89	27.94	26.13
Share of government consumption	16.88	15.09	17.49	13.78	29.99	25.80	17.93	17.34
Share of private consumption	54.32	54.37	65.82	63.36	54.91	57.16	58.95	56.02
Urbanisation rate	65.71	78.27	43.90	65.64	56.20	64.13	50.72	73.58
Working population	66.47	66.21	63.59	60.05	68.81	68.41	69.95	68.45

Note: Table IV.D Shows the means for all predictor variables for the treatment country presented in the Column and its synthetic control. Values are rounded to two decimal places and reported in accordance with the measurement unit reported in section 3.3.

Table IV.E Predictor variable means for the treatment country (Spain) and its synthetic control

	Spain	
	Real	Synthetic
Average depreciation rate of capital	3.27	3.81
Consumer price index	10.97	13.40
Dependency ratio	56.07	65.32
FDI net inflows	1.10	0.97
Human capital index	2.26	2.57
Life expectancy at birth	75.15	68.98
Real internal rate of return	8.26	11.30
Share of capital formation	26.09	26.14
Share of government consumption	12.83	14.52
Share of private consumption	64.72	63.01
Urbanisation rate	72.26	66.84
Working population	64.13	60.99

Note: Table IV.E Shows the means for all predictor variables for the treatment country presented in the Column and its synthetic control. Values are rounded to two decimal places and reported in accordance with the measurement unit reported in section 3.3.

Appendix V – Classic and bias-corrected synthetic control gaps

This Appendix presents the estimated outcomes using the classic (C) and bias corrected (BC) synthetic control method during the pre- and post-intervention periods. The results are presented in US dollars. The results are obtained using the Stata *allsynth* command, beta version 0.0.9., released 2 May 2022, developed by Wiltshire (2022b).

Table V.A Classic and bias-corrected pre- and post-intervention gaps for Austria, Belgium, Estonia, and Finland

	Austria		Belgium		Estonia		Finland	
	C	BC	C	BC	C	BC	C	BC
1970	-336,25	-338,85	-304,69	-301,78			-408,40	-410,53
	-270,36	-273,02	-323,33	-320,35			-368,78	-370,95
	-253,45	-256,13	-293,60	-290,56			-386,26	-388,50
	-203,16	-205,88	-286,00	-282,91			-393,57	-395,84
1971	-235,04	-237,83	-270,48	-267,28			-542,90	-545,20
	-193,13	-196,00	-269,50	-266,23			-346,00	-348,32
	-155,71	-158,66	-306,93	-303,59			-395,14	-397,45
	-206,98	-209,97	-239,57	-236,18			-421,82	-424,15
1972	-131,22	-134,28	-161,82	-158,33			-288,77	-291,11
	-200,49	-203,66	-196,54	-192,98			-320,09	-322,39
	-183,48	-186,69	-125,87	-122,23			-312,29	-314,64
	-60,68	-64,01	-108,70	-104,94			-315,44	-317,80
1973	-229,62	-233,11	-170,34	-166,46			-241,08	-243,40
	-159,36	-162,93	-99,01	-95,04			-368,33	-370,65
	-154,32	-157,98	-47,05	-42,98			-214,08	-216,42
	-93,37	-97,19	-41,60	-37,37			-166,79	-169,13
1974	79,55	75,65	77,83	82,13			-104,67	-107,02
	46,73	42,70	173,04	177,47			-133,87	-136,22
	95,37	91,20	155,55	160,11			-145,88	-148,23
	80,65	76,39	137,31	141,97			-82,63	-84,98
1975	137,00	132,66	70,73	75,46			6,65	4,30
	36,73	32,30	-49,36	-44,52			-59,95	-62,32
	59,07	54,52	11,75	16,71			-160,85	-163,22
	161,02	156,34	142,84	147,93			-297,93	-300,30
1976	48,36	43,53	120,01	125,23			-277,95	-280,30
	145,06	140,15	230,20	235,53			-304,83	-307,22
	253,29	248,26	229,03	234,49			-299,48	-301,91
	353,31	348,16	130,41	136,01			-236,10	-238,55
1977	333,30	328,04	123,26	128,98			-300,12	-302,60
	403,69	398,31	68,72	74,60			-369,81	-372,30
	359,95	354,43	80,80	86,83			-338,19	-340,70
	530,82	525,12	125,01	131,20			-384,83	-387,33
1978	131,59	125,75	116,03	122,37			-439,46	-441,95
	150,17	144,09	129,80	136,38			-477,19	-479,66
	122,31	116,05	55,63	62,38			-405,91	-408,37
	97,98	91,51	23,34	30,32			-324,21	-326,67
1979	243,86	237,21	6,84	13,99			-242,71	-245,17

	266,84	259,93	-43,74	-36,36	-157,97	-160,41
	305,69	298,58	50,90	58,49	-128,71	-131,14
	415,15	407,75	-21,76	-13,83	-78,72	-81,19
1980	425,04	417,44	370,21	378,31	-105,00	-107,46
	436,60	428,89	404,80	413,03	56,33	53,87
	473,53	465,58	320,13	328,62	239,29	236,82
	341,79	333,53	234,76	243,57	-12,39	-14,85
1981	180,96	172,37	230,10	239,25	-79,84	-82,29
	231,59	222,73	263,04	272,44	-66,88	-69,34
	211,55	202,45	117,92	127,57	-67,68	-70,13
	191,62	182,36	222,09	231,90	22,67	20,24
1982	429,28	419,91	288,82	298,74	34,93	32,49
	457,03	447,51	264,93	275,01	28,49	26,05
	463,46	453,83	313,16	323,34	206,50	204,05
	449,04	439,35	294,62	304,87	248,85	246,36
1983	569,17	559,40	236,22	246,56	335,27	332,75
	620,59	610,65	217,69	228,17	379,43	376,90
	616,69	606,52	114,29	125,00	351,77	349,24
	586,98	576,59	141,92	152,85	132,90	130,38
1984	227,55	216,82	11,65	22,91	124,48	121,97
	-80,65	-91,53	-33,50	-22,05	109,08	106,52
	-84,83	-95,92	-100,63	-88,97	109,62	107,07
	25,11	13,85	-109,39	-97,57	207,41	204,87
1985	-46,24	-57,74	-185,60	-173,54	210,86	208,31
	-153,21	-164,88	-364,26	-352,03	243,79	241,23
	-168,00	-179,86	-486,74	-474,31	133,83	131,25
	-403,93	-415,95	-441,78	-429,18	145,31	142,71
1986	-367,26	-379,34	-412,03	-399,34	22,07	19,43
	-174,65	-186,88	-327,55	-314,73	73,79	71,17
	-258,16	-270,55	-235,42	-222,43	556,60	553,97
	-334,32	-346,80	-629,46	-616,35	274,70	272,04
1987	-447,05	-459,68	-554,43	-541,19	383,41	380,76
	-440,54	-453,50	-611,64	-598,06	398,75	396,10
	-354,12	-367,30	-605,85	-592,04	313,00	310,35
	-466,08	-479,50	-607,76	-593,70	475,18	472,51
1988	-814,96	-828,61	-629,36	-615,07	534,29	531,59
	-535,06	-548,85	-467,77	-453,35	708,63	705,94
	-355,06	-369,05	-372,98	-358,35	732,28	729,59
	-337,32	-351,57	-341,91	-327,03	857,90	855,20
1989	-483,13	-497,65	-339,75	-324,59	844,51	841,81
	-367,03	-381,76	-398,46	-383,10	1145,18	1142,47
	-325,59	-340,44	-365,92	-350,41	1239,68	1236,94
	-337,87	-352,91	-130,70	-114,97	1033,32	1030,55
1990	-145,13	-160,42	67,47	83,45	1372,98	1370,21
	-230,06	-245,62	-49,67	-33,40	969,86	967,06
	-206,04	-221,72	60,79	77,21	570,16	567,34
	-54,14	-69,98	165,93	182,51	348,64	345,82
1991	75,08	59,23	311,86	328,48	-56,60	-59,45
	101,59	85,63	576,20	592,96	-265,42	-268,28

	297,15	281,07	720,32	737,19			-559,71	-562,58
	352,70	336,54	782,40	799,35			-778,04	-780,91
1992	269,21	252,90	915,85	932,95			-824,37	-827,25
	286,63	270,23	620,12	637,30			-970,74	-973,61
	169,68	153,20	570,12	587,39			-1019,16	-1022,04
	101,14	84,53	138,35	155,75			-996,26	-999,15
1993	-15,92	-32,64	-84,06	-66,54			-921,13	-924,06
	85,74	68,84	-5,79	11,92			-1037,24	-1040,18
	274,12	257,01	-118,15	-100,27			-1053,58	-1056,50
	224,60	207,25	-249,52	-231,44			-974,99	-977,87
1994	197,44	179,85	-401,13	-382,84			-960,94	-963,78
	124,16	106,30	-380,48	-361,94			-835,26	-838,08
	206,51	188,45	-388,68	-369,93			-570,98	-573,82
	365,94	347,65	34,68	53,71			-218,36	-221,25
1995	426,07	407,72	269,66	288,78			-541,61	-544,58
	462,46	444,03	491,90	511,14			-172,44	-175,46
	342,50	323,93	388,58	407,96			-493,68	-496,69
	301,69	282,98	243,63	263,13			-762,03	-765,01
1996	208,57	189,49	-413,18	-393,31	-1331,65	-1332,84	-898,56	-901,54
	104,35	85,02	-539,52	-519,41	-1120,33	-1121,51	-912,95	-915,93
	-3,28	-22,85	-861,87	-841,53	-853,37	-854,53	-1014,34	-1017,34
	-193,69	-213,60	-995,81	-975,09	-777,44	-778,60	-793,19	-796,22
1997	-200,26	-220,48	-919,25	-898,20	-625,78	-626,95	-601,40	-604,44
	-279,95	-300,48	-979,28	-957,94	-303,51	-304,67	-277,08	-280,11
	-45,88	-66,54	-835,93	-814,49	-158,79	-159,96	290,47	287,48
	184,69	163,88	-934,06	-912,48	-12,37	-13,57	860,55	857,61
1998	533,06	512,32	-813,21	-791,76	82,14	80,91	1026,01	1023,15
	809,72	788,78	-928,81	-907,16	-30,82	-32,10	1438,39	1435,56
	795,24	774,14	-1075,56	-1053,76	84,14	82,86	1730,80	1727,99
	614,89	593,53	-1308,58	-1286,51	-154,98	-156,26	1687,34	1684,54
1999	695,59	674,06	-1187,83	-1165,62	-347,45	-348,72	1985,96	1983,17
	732,43	710,70	-999,84	-977,43	-454,44	-455,70	1884,55	1881,73
	718,46	696,35	-1135,56	-1112,77	-557,27	-558,50	1698,02	1695,19
	553,39	530,68	-1256,93	-1233,54	-519,58	-520,82	1519,68	1516,83
2000	649,62	626,43	-1327,75	-1303,89	-415,77	-416,98	1890,09	1887,22
	536,07	512,50	-1244,13	-1219,89	-370,00	-371,22	1712,91	1710,04
	458,51	434,60	-1320,20	-1295,62	-502,67	-503,91	1944,91	1942,04
	475,12	451,01	-1118,17	-1093,40	-463,18	-464,40	2155,39	2152,50
2001	148,35	124,17	-1244,48	-1219,64	-544,27	-545,50	2286,14	2283,26
	-122,57	-147,09	-1422,12	-1396,94	-706,64	-707,87	2339,60	2336,73
	63,32	38,80	-1413,59	-1388,42	-689,62	-690,86	2665,81	2662,94
	417,04	392,26	-1357,14	-1331,71	-475,25	-476,52	2509,01	2506,16
2002	751,96	727,09	-1028,64	-1003,12	-572,66	-573,90	2745,55	2742,67
	843,78	818,50	-1099,68	-1073,75	-229,18	-230,43	2606,12	2603,23
	1035,91	1010,44	-896,96	-870,86	-197,25	-198,49	2358,86	2355,97
	988,55	962,89	-911,49	-885,20	-231,44	-232,67	2498,43	2495,55
2003	1201,22	1175,47	-1080,77	-1054,40	-118,84	-120,07	1949,69	1946,83
	1265,77	1240,09	-1038,41	-1012,13	44,25	43,03	2347,19	2344,33
	1119,32	1093,26	-1540,92	-1514,26	3,37	2,16	2398,63	2395,77

	872,06	845,50	-1855,48	-1828,31	256,26	255,05	2371,40	2368,53
2004	878,62	851,45	-2038,99	-2011,20	522,01	520,79	2511,21	2508,33
	894,73	867,15	-2263,94	-2235,75	242,26	241,05	2756,22	2753,35
	901,15	873,19	-2357,89	-2329,31	589,63	588,42	2850,97	2848,09
	705,93	677,66	-2597,42	-2568,52	824,78	823,59	3134,21	3131,33
2005	342,87	314,50	-2649,51	-2620,51	1083,26	1082,12	3203,30	3200,39
	259,83	230,88	-2876,72	-2847,12	1392,95	1391,80	2414,19	2411,27
	130,88	101,39	-3210,99	-3180,85	1553,93	1552,81	2385,44	2382,51
	261,69	231,58	-3422,45	-3391,69	1571,39	1570,27	2233,73	2230,79
2006	394,91	364,08	-3620,88	-3589,41	1618,77	1617,66	2564,71	2561,77
	296,67	265,11	-3733,10	-3700,90	1648,09	1646,97	2313,95	2311,00
	647,41	615,44	-3771,42	-3738,79	1948,94	1947,83	2498,30	2495,33
	587,33	555,04	-3734,41	-3701,44	2481,80	2480,68	2558,05	2555,06
2007	513,63	480,94	-3592,49	-3559,11	3571,48	3570,37	3121,04	3118,03
	621,04	587,86	-3779,03	-3745,14	3736,34	3735,22	3768,52	3765,50
	531,28	497,71	-3913,66	-3879,39	3682,77	3681,67	4191,64	4188,61
	442,33	408,05	-4407,45	-4372,45	3272,60	3271,52	4446,28	4443,23
2008	675,34	640,74	-4714,30	-4679,00	2139,72	2138,69	4672,18	4669,10
	1073,01	1037,93	-4918,16	-4882,37	2138,23	2137,21	4600,69	4597,62
	1208,00	1172,77	-5139,40	-5103,49	2168,81	2167,82	5300,25	5297,18
	1594,01	1559,29	-5061,24	-5025,83	185,59	184,55	5774,88	5771,86
2009	2589,20	2555,66	-4312,26	-4278,06	428,92	427,89	4819,38	4816,37
	2339,46	2305,93	-4303,32	-4269,11	-190,39	-191,41	4589,97	4586,93
	2483,00	2449,22	-3741,57	-3707,09	-674,84	-675,86	4985,19	4982,14
	2364,78	2330,75	-3264,90	-3230,16	-696,28	-697,29	4452,49	4449,42
2010	1605,51	1571,20	-3197,17	-3162,19	-670,36	-671,32	3981,29	3978,24
	1774,63	1739,83	-2876,99	-2841,50	-538,45	-539,43	4468,66	4465,58
	1715,57	1680,49	-2837,77	-2801,99	-204,45	-205,43	3869,32	3866,24
	2071,94	2036,27	-3320,18	-3283,80	368,16	367,16	4410,10	4406,98
2011	2623,03	2587,03	-3637,23	-3600,54	977,68	976,69	4791,55	4788,47
	2755,25	2718,73	-4075,69	-4038,49	1598,45	1597,45	4769,49	4766,41
	3021,12	2984,19	-4227,34	-4189,69	2041,47	2040,46	4281,40	4278,28
	3037,69	3000,62	-4113,68	-4075,88	1798,68	1797,68	4422,13	4419,00
2012	3236,98	3199,65	-4025,39	-3987,32	1980,39	1979,43	3796,83	3793,69
	3480,05	3442,62	-3639,51	-3601,33	2285,93	2284,95	3399,86	3396,71
	3745,68	3708,01	-3472,16	-3433,77	2282,99	2282,00	3404,61	3401,47
	3900,55	3862,52	-3719,39	-3680,63	2480,69	2479,71	3546,69	3543,55
2013	3434,43	3395,75	-4545,40	-4506,00	2459,37	2458,40	2863,47	2860,34
	3404,55	3365,49	-4734,34	-4694,55	2250,26	2249,29	3088,53	3085,39
	3319,21	3279,62	-5190,39	-5150,09	2077,26	2076,30	3078,28	3075,15
	3528,45	3488,47	-5202,88	-5162,19	2091,88	2090,90	3030,83	3027,70
2014	3423,88	3383,83	-4869,31	-4828,57	2666,69	2665,73	2688,72	2685,61
	3912,33	3872,10	-4605,60	-4564,69	2720,68	2719,71	2958,72	2955,65
	3728,00	3687,47	-4014,31	-3973,07	3117,78	3116,78	3104,85	3101,75
	3769,74	3729,18	-3431,04	-3389,75	3484,00	3482,98	2923,36	2920,24
2015	3665,90	3625,43	-2907,72	-2866,49	2821,22	2820,18	2266,64	2263,49
	3816,14	3775,23	-2417,29	-2375,57	3455,97	3454,89	2829,86	2826,69
	4387,30	4346,10	-2200,53	-2158,52	3622,60	3621,52	2801,46	2798,27
	5094,60	5053,28	-1523,38	-1481,25	3638,60	3637,48	3326,30	3323,13

2016	6081,53	6040,03	-1287,78	-1245,51	4582,82	4581,72	4230,26	4227,13
	6330,94	6288,69	-1015,68	-972,65	4598,03	4596,90	4613,80	4610,69
	6562,98	6520,39	-896,01	-852,67	5017,32	5016,16	5303,41	5300,34
	6733,33	6690,04	-1101,58	-1057,53	5231,18	5230,03	5366,52	5363,45
2017	6216,29	6172,73	-1191,34	-1147,05	5514,13	5513,03	5726,96	5723,88
	5989,17	5945,19	-1232,68	-1187,96	5799,94	5798,81	6124,27	6121,19
	5949,38	5905,05	-1540,56	-1495,49	5611,45	5610,35	6233,83	6230,74
	6104,82	6059,93	-1317,63	-1272,00	5726,14	5725,04	6647,44	6644,34
2018	6461,39	6416,02	-1557,71	-1511,58	5438,11	5437,03	6783,34	6780,21
	6532,32	6486,33	-1781,97	-1735,21	5352,61	5351,55	6618,02	6614,90
	6512,85	6466,73	-2162,95	-2116,09	5224,13	5223,10	6739,78	6736,66
	7139,66	7093,45	-1688,24	-1641,31	5388,43	5387,38	6559,95	6556,87
2019	7549,84	7503,64	-1645,01	-1598,08	5663,30	5662,24	6805,78	6802,75
	7100,82	7054,32	-1541,68	-1494,46	5464,02	5462,98	7112,34	7109,32
	7305,26	7258,58	-1275,52	-1228,14	5663,03	5661,99	7206,74	7203,73
	7484,84	7437,71	-873,80	-825,97	5715,25	5714,20	7396,58	7393,57

Note: Table V.A shows the differences between the treatment group and classic synthetic control group under C. Additionally, the differences between the treatment group and bias-corrected synthetic control group are presented under BC. The black horizontal line indicates treatment. All values are rounded to two decimal places.

Table V.B Classic and bias-corrected pre- and post-intervention gaps for France, Germany, Greece, and Ireland

	France		Germany		Greece		Ireland	
	C	BC	C	BC	C	BC	C	BC
1970	-226,67	-226,88	-202,74	-207,53	-453,48	-456,82	189,69	187,45
	-223,28	-223,51	-81,92	-86,81	-404,83	-408,25	135,25	132,95
	-211,06	-211,30	-58,53	-63,48	-377,62	-381,13	114,45	112,12
	-159,67	-159,94	-16,82	-21,86	-449,64	-453,20	92,10	89,72
1971	-170,47	-170,71	-145,97	-151,08	-386,04	-389,60	115,51	113,08
	-119,14	-119,37	-86,75	-91,93	-295,81	-299,41	103,70	101,20
	-108,36	-108,62	-40,46	-45,74	-192,11	-195,73	102,19	99,59
	-77,71	-77,96	-59,11	-64,44	-260,72	-264,34	121,39	118,75
1972	-57,50	-57,74	-134,28	-139,69	-65,70	-69,36	149,69	146,99
	-114,43	-114,70	-132,89	-138,39	11,84	8,20	124,85	122,03
	-100,68	-100,95	-76,03	-81,60	-45,81	-49,49	145,58	142,72
	-99,38	-99,65	-85,44	-91,12	122,87	119,18	124,12	121,14
1973	-103,37	-103,66	-119,60	-125,43	81,66	77,98	38,95	35,81
	-57,40	-57,70	-111,86	-117,79	242,02	238,31	47,56	44,34
	-16,83	-17,12	-97,53	-103,57	233,57	229,84	47,99	44,67
	1,50	1,21	-131,21	-137,39	213,46	209,73	49,16	45,70
1974	138,84	138,59	6,94	0,70	141,08	137,37	103,38	99,84
	175,03	174,77	-5,04	-11,43	-118,10	-121,80	86,65	82,97
	201,88	201,59	11,76	5,22	-468,13	-471,85	105,35	101,51
	137,65	137,32	0,96	-5,70	-223,92	-227,67	191,25	187,32
1975	103,67	103,33	26,93	20,18	145,92	142,15	230,11	226,08
	9,39	9,05	-52,49	-59,35	39,43	35,66	276,75	272,62
	-17,67	-18,02	-32,09	-39,07	-66,15	-69,92	279,70	275,45
	24,54	24,17	50,07	42,96	158,71	154,93	212,94	208,56
1976	35,44	35,06	37,92	30,67	279,98	276,19	120,77	116,25
	94,81	94,42	127,19	119,82	280,69	276,85	83,69	79,07
	83,29	82,92	72,72	65,23	60,28	56,41	65,83	61,10
	166,76	166,41	200,22	192,59	504,23	500,33	64,83	59,98
1977	201,37	201,04	206,62	198,89	495,68	491,76	148,33	143,39
	185,37	185,03	200,98	193,12	195,14	191,20	235,38	230,31
	209,31	208,98	128,10	120,11	207,83	203,88	276,80	271,60
	203,50	203,18	249,58	241,43	576,41	572,47	285,12	279,75
1978	236,83	236,50	245,36	237,08	760,48	756,57	311,15	305,61
	275,95	275,60	134,46	125,94	559,63	555,73	304,95	299,19
	249,18	248,84	192,52	183,83	351,67	347,79	265,11	259,15
	252,97	252,64	218,45	209,55	971,96	968,08	212,40	206,22
1979	244,25	243,89	175,41	166,33	927,30	923,39	204,53	198,20
	279,34	278,99	386,90	377,57	868,24	864,37	56,56	49,94
	333,00	332,65	363,01	353,49	390,32	386,46	146,41	139,60
	300,51	300,22	377,96	368,16	640,12	636,26	129,79	122,69
1980	351,09	350,77	444,24	434,24	814,62	810,80	153,43	146,09
	374,58	374,29	508,32	498,20	738,57	734,74	285,03	277,61
	257,69	257,38	410,15	399,79	103,82	99,96	317,96	310,29
	114,81	114,51	246,70	236,04	417,14	413,29	386,63	378,66

1981	63,30	62,99	293,15	282,17	171,86	168,02	369,80	361,51
	42,81	42,52	242,75	231,51	-138,70	-142,52	336,26	327,69
	69,61	69,31	237,92	226,43	4,39	0,54	319,51	310,71
	161,65	161,33	256,80	245,16	403,76	399,90	346,30	337,35
1982	311,41	311,07	317,36	305,61	285,90	282,03	379,20	370,13
	371,51	371,16	221,49	209,57	-167,18	-171,07	333,44	324,19
	440,81	440,45	119,04	107,00	-166,95	-170,84	290,68	281,31
	525,28	524,92	126,19	114,07	178,61	174,70	204,92	195,48
1983	602,45	602,13	214,58	202,39	194,42	190,52	22,44	12,90
	515,44	515,10	224,24	211,87	-99,70	-103,62	-54,46	-64,18
	348,92	348,58	75,88	63,27	5,56	1,62	-149,26	-159,20
	255,55	255,20	99,36	86,53	165,52	161,57	-148,59	-158,75
1984	137,78	137,40	113,77	100,58	-71,01	-74,96	-173,85	-184,36
	41,60	41,25	-268,45	-281,78	-349,97	-353,93	-77,74	-88,40
	21,69	21,36	2,82	-10,72	-96,33	-100,28	-62,78	-73,65
	-8,06	-8,40	106,23	92,52	-26,40	-30,36	-51,32	-62,36
1985	-161,00	-161,34	-127,99	-141,93	-368,93	-372,90	-69,25	-80,53
	-228,31	-228,65	-145,97	-160,09	-428,91	-432,91	-181,04	-192,48
	-270,41	-270,74	-120,61	-134,92	19,23	15,26	-281,56	-293,22
	-309,28	-309,60	-176,73	-191,21	515,61	511,63	-393,52	-405,35
1986	-300,34	-300,65	-344,16	-358,70	-254,48	-258,49	-488,11	-500,00
	-149,58	-149,93	-177,78	-192,48	28,45	24,41	-571,23	-583,25
	-146,66	-147,02	-128,75	-143,63	-153,22	-157,27	-650,13	-662,34
	-165,52	-165,85	-38,87	-53,82	87,17	83,12	-712,15	-724,45
1987	-222,09	-222,43	-420,07	-435,16	-483,63	-487,71	-662,42	-674,84
	-281,91	-282,27	-320,77	-336,20	-887,22	-891,31	-750,09	-762,86
	-377,05	-377,41	-359,20	-374,85	-955,86	-959,97	-749,13	-762,11
	-386,79	-387,14	-380,19	-396,08	-406,74	-410,86	-737,89	-751,10
1988	-389,87	-390,21	-742,63	-758,76	-162,37	-166,53	-876,56	-890,01
	-332,87	-333,21	-509,91	-526,18	-594,96	-599,12	-692,39	-705,96
	-295,71	-296,05	-504,47	-520,95	-532,88	-537,06	-713,39	-727,16
	-307,51	-307,86	-529,24	-545,99	-458,94	-463,14	-725,16	-739,18
1989	-332,93	-333,27	-668,80	-685,81	-73,81	-78,01	-649,93	-664,23
	-204,54	-204,87	-541,04	-558,26	-291,81	-295,99	-544,46	-558,98
	-160,79	-161,08	-558,95	-576,28	-489,60	-493,81	-347,23	-361,84
	-71,19	-71,49	-674,11	-691,66	47,85	43,61	-114,72	-129,53
1990	-9,70	-9,98	-330,33	-348,12	134,24	129,99	139,63	124,58
	-121,58	-121,85	-594,17	-612,23	-271,51	-275,78	288,54	273,22
	-76,53	-76,79	-347,90	-366,08	-1114,43	-1118,69	395,61	380,17
	40,87	40,62	91,02	72,68	102,10	97,86	363,83	348,19
1991	92,50	92,25	613,17	594,81	219,92	215,66	293,61	277,97
	82,74	82,50	359,84	341,37	17,82	13,55	220,39	204,62
	152,39	152,15	297,60	279,01	286,58	282,31	214,87	198,99
	195,81	195,59	519,05	500,39	242,69	238,42	186,20	170,24
1992	321,89	321,68	725,67	706,86	490,87	486,61	232,65	216,53
	260,78	260,58	484,77	465,88	83,24	78,99	342,13	325,93
	232,09	231,88	335,12	316,14	369,29	365,03	428,17	411,89
	177,39	177,19	282,20	263,08	344,02	339,73	445,38	428,97
1993	-15,99	-16,19	17,53	-1,70	31,43	27,09	439,62	423,11

	-14,64	-14,83	44,82	25,40	198,32	193,97	393,94	377,24
	28,65	28,44	224,47	204,84	154,44	150,13	292,13	275,19
	-33,60	-33,83	48,75	28,88	89,73	85,44	217,88	200,70
1994	-29,96	-30,22	265,53	245,42	-157,97	-162,26	136,62	119,20
	129,47	129,19	288,20	267,83	-139,53	-143,79	206,04	188,35
	73,82	73,56	322,89	302,32	137,46	133,18	505,21	487,32
	186,15	185,90	486,84	466,01	-141,20	-145,50	870,65	852,52
1995	185,98	185,75	257,76	236,84	-100,48	-104,83	2101,26	2083,05
	206,01	205,77	325,12	304,10	29,54	25,13	2377,30	2359,00
	11,86	11,61	176,50	155,33	16,47	12,06	2429,40	2410,97
	-33,40	-33,67	104,29	82,98	50,66	46,28	2359,71	2341,12
1996	-84,13	-84,39	-233,46	-255,12	-91,79	-96,14	2986,97	2968,00
	-233,75	-234,00	-254,81	-276,73	-4,91	-9,28	2988,52	2969,32
	-196,07	-196,30	-302,05	-324,20	138,99	134,65	2349,34	2329,86
	-339,42	-339,62	-419,39	-441,88	163,52	159,18	2226,61	2206,78
1997	-343,39	-343,60	-779,61	-802,40	119,80	115,45	3130,47	3110,34
	-209,55	-209,76	-638,86	-661,95	187,23	182,88	3641,57	3621,13
	-96,91	-97,14	-723,80	-747,02	484,59	480,26	3871,50	3850,94
	38,62	38,37	-647,31	-670,68	466,96	462,67	4335,38	4314,67
1998	279,92	279,64	-374,18	-397,46	735,31	731,04	5725,98	5705,37
	475,16	474,85	-436,52	-459,98	582,20	577,95	6388,18	6367,38
	481,18	480,86	-406,45	-430,09	535,15	530,89	7056,26	7035,30
	390,15	389,80	-635,11	-659,01	411,96	407,67	5891,35	5870,13
1999	418,14	417,78	-161,14	-185,21	317,46	313,17	6859,86	6838,48
	478,71	478,37	-257,37	-281,64	377,10	372,82	6695,17	6673,58
	570,43	570,12	-215,87	-240,53	245,32	241,10	7071,39	7049,36
	738,64	738,34	-398,88	-424,12	187,63	183,43	7133,43	7110,79
2000	793,41	793,14	-551,28	-577,01	123,46	119,31	7248,81	7225,65
	889,59	889,32	-764,14	-790,26	52,91	48,77	7990,57	7967,01
	1070,09	1069,83	-869,36	-895,81	302,17	298,06	8218,96	8195,03
	1317,46	1317,21	-1165,46	-1192,09	726,46	722,37	8383,20	8359,07
2001	1447,71	1447,45	-506,75	-533,46	1010,09	1005,96	9165,60	9141,41
	1640,05	1639,79	-414,39	-441,44	968,48	964,35	9402,51	9377,99
	1934,19	1933,91	-210,41	-237,48	1419,65	1415,49	9249,94	9225,43
	2039,20	2038,89	-147,95	-175,27	1404,53	1400,33	9678,81	9654,07
2002	2191,47	2191,17	-368,37	-395,81	1880,74	1876,52	10705,89	10681,04
	2123,52	2123,22	-352,14	-379,98	2174,30	2170,09	10656,65	10631,38
	2040,02	2039,72	-193,72	-221,75	2269,82	2265,60	11192,99	11167,55
	1700,63	1700,31	-119,74	-147,95	2280,04	2275,81	11208,09	11182,46
2003	1302,69	1302,37	-429,06	-457,37	2474,99	2470,78	10802,41	10776,67
	851,30	850,97	-369,83	-398,06	2875,53	2871,30	10864,11	10838,47
	568,57	568,25	-226,40	-255,02	2771,36	2767,14	10734,18	10708,14
	310,14	309,81	-363,76	-392,88	3053,40	3049,16	12165,57	12139,04
2004	214,21	213,88	-502,57	-532,31	3243,99	3239,77	11691,64	11664,46
	180,69	180,37	-435,08	-465,21	3129,96	3125,76	12171,29	12143,71
	19,69	19,37	-751,40	-781,91	3165,20	3161,00	11661,53	11633,57
	167,00	166,70	-1053,84	-1084,66	2749,48	2745,30	12126,58	12098,29
2005	192,38	192,10	-1469,17	-1500,09	2405,97	2401,80	12405,17	12376,78
	157,40	157,12	-1731,46	-1762,95	2137,40	2133,25	12508,78	12479,79

	91,64	91,39	-1832,19	-1864,23	2327,14	2323,02	11883,67	11854,12
	250,93	250,70	-1833,34	-1865,97	2475,53	2471,44	12872,42	12842,24
2006	373,02	372,81	-1751,85	-1785,20	3507,24	3503,21	13605,05	13574,12
	650,85	650,64	-1343,97	-1378,05	3456,96	3452,93	13803,57	13771,90
	555,41	555,20	-1036,47	-1070,98	3299,18	3295,14	14309,01	14276,93
	499,91	499,72	-802,33	-837,16	3504,93	3500,86	14365,08	14332,69
2007	474,35	474,17	-933,29	-968,54	2543,71	2539,60	16757,64	16724,85
	594,84	594,66	-708,87	-744,61	2882,98	2878,85	15665,22	15631,95
	662,59	662,42	-555,92	-592,04	2486,22	2482,10	13906,57	13872,91
	627,42	627,27	-508,05	-544,89	2196,46	2192,38	14719,42	14685,02
2008	815,88	815,75	-257,39	-294,54	2866,10	2862,06	12765,92	12731,16
	739,15	739,04	-203,81	-241,42	2840,33	2836,32	11234,88	11199,64
	839,62	839,52	15,93	-21,84	3190,46	3186,47	10782,82	10747,42
	1054,86	1054,70	557,54	520,28	3240,68	3236,65	9756,35	9721,50
2009	1340,56	1340,37	162,77	126,65	2431,32	2427,19	10498,91	10465,28
	1253,43	1253,26	270,33	234,22	3383,16	3379,01	10278,24	10244,62
	1364,33	1364,17	525,89	489,54	3215,87	3211,72	9309,72	9275,85
	1407,66	1407,51	485,29	448,67	3325,27	3321,10	8849,55	8815,44
2010	1338,58	1338,45	413,20	376,34	1672,01	1667,94	9616,60	9582,17
	1286,20	1286,06	880,03	842,66	337,20	333,08	9566,36	9531,45
	1204,64	1204,50	791,72	754,07	-764,16	-768,27	9846,49	9811,30
	1380,32	1380,20	1308,40	1270,15	-1426,07	-1430,20	9623,41	9587,61
2011	1814,27	1814,18	2642,35	2603,80	-2623,62	-2627,65	10113,03	10076,88
	1749,08	1748,99	3014,14	2975,08	-3386,22	-3390,26	10921,09	10884,43
	1372,22	1372,13	3367,99	3328,47	-4165,00	-4169,09	10203,93	10166,83
	1269,25	1269,18	3269,71	3230,06	-5055,40	-5059,49	10214,90	10177,67
2012	988,03	988,01	2920,34	2880,46	-4776,39	-4780,39	9856,53	9819,01
	934,52	934,49	3062,48	3022,49	-5001,31	-5005,34	10821,78	10784,17
	1093,95	1093,92	3248,11	3207,89	-5118,03	-5122,08	10040,66	10002,84
	1197,21	1197,16	3167,14	3126,55	-5129,28	-5133,35	10707,11	10668,93
2013	1050,65	1050,59	2707,32	2666,08	-5417,19	-5421,27	9903,91	9865,07
	1291,16	1291,10	3158,44	3116,80	-5238,96	-5243,07	11029,72	10990,51
	1131,34	1131,28	3326,00	3283,85	-5185,35	-5189,42	11291,20	11251,46
	1228,37	1228,29	3661,38	3618,82	-5086,92	-5091,04	10842,05	10801,92
2014	1107,59	1107,53	4296,39	4253,79	-5051,43	-5055,52	11428,79	11388,59
	1233,55	1233,49	4581,84	4539,07	-5161,51	-5165,57	13086,83	13046,46
	1284,86	1284,78	4526,98	4483,88	-5007,92	-5012,06	13345,75	13305,11
	1161,45	1161,37	4509,36	4466,23	-5353,26	-5357,45	14656,67	14616,02
2015	1045,31	1045,23	3383,87	3340,83	-5321,52	-5325,77	28775,60	28735,07
	1160,21	1160,13	3459,97	3416,47	-5490,55	-5494,87	28567,84	28526,89
	1371,17	1371,08	3773,93	3730,13	-6182,16	-6186,52	30966,51	30925,28
	1738,91	1738,79	4430,15	4386,22	-5782,78	-5787,20	32344,66	32303,33
2016	2260,25	2260,12	5316,10	5272,01	-5879,06	-5883,47	29484,85	29443,36
	2596,78	2596,62	6043,80	5998,94	-6139,86	-6144,28	29975,65	29933,41
	2802,19	2802,00	6409,13	6363,95	-5979,45	-5983,85	28830,34	28787,77
	2963,63	2963,45	6553,35	6507,48	-6034,25	-6038,64	36366,61	36323,33
2017	3083,05	3082,87	6865,36	6819,21	-5871,54	-5875,88	32387,22	32343,63
	3216,48	3216,29	7033,42	6986,84	-5885,39	-5889,74	34297,07	34253,05
	3263,92	3263,74	7370,62	7323,69	-5638,60	-5642,95	35939,18	35894,80

	3536,30	3536,13	7767,52	7720,04	-6064,89	-6069,22	39913,37	39868,43
2018	3364,83	3364,69	7614,55	7566,59	-5841,49	-5845,81	40025,21	39979,78
	3441,95	3441,81	7860,44	7811,86	-6068,33	-6072,63	41879,47	41833,42
	3812,57	3812,44	7628,44	7579,74	-6131,83	-6136,10	40096,16	40049,96
	4360,98	4360,80	7599,65	7550,85	-6248,95	-6253,24	40783,43	40737,16
2019	4866,12	4865,90	7658,33	7609,53	-6239,53	-6243,85	42415,53	42369,29
	5276,94	5276,71	6969,17	6920,05	-6248,17	-6252,53	43953,66	43907,14
	5575,63	5575,38	7066,00	7016,71	-6346,42	-6350,80	43183,13	43136,45
	6090,35	6090,10	7555,56	7505,81	-6631,58	-6635,96	43935,55	43888,41

Note: Table V.B shows the differences between the treatment group and classic synthetic control group under C. Additionally, the differences between the treatment group and bias-corrected synthetic control group are presented under BC. The black horizontal line indicates treatment. All values are rounded to two decimal places.

Table V.C Classic and bias-corrected pre- and post-intervention gaps for Italy, Latvia, Lithuania, and Luxembourg

	Italy		Latvia		Lithuania		Luxembourg	
	C	BC	C	BC	C	BC	C	BC
1970	-49,80	-55,89					-422,13	-421,36
	-44,50	-50,76					-482,81	-482,05
	-31,83	-38,23					-540,31	-539,56
	-14,21	-20,74					-498,37	-497,62
1971	-59,70	-66,38					-597,40	-596,63
	-90,78	-97,62					-613,44	-612,66
	-76,79	-83,82					-576,80	-576,05
	-69,64	-76,76					-502,78	-502,02
1972	-87,43	-94,73					-499,56	-498,80
	-170,93	-178,41					-470,36	-469,63
	-167,13	-174,75					-426,91	-426,18
	-236,77	-244,63					-450,29	-449,55
1973	-312,87	-321,01					-441,25	-440,57
	-223,72	-232,04					-342,34	-341,67
	-82,56	-91,09					-183,52	-182,83
	-33,69	-42,52					-108,61	-107,91
1974	93,25	84,27					-24,36	-23,61
	117,78	108,53					-16,29	-15,54
	118,01	108,46					15,86	16,57
	20,12	10,36					-41,79	-41,12
1975	-63,42	-73,37					-110,25	-109,60
	-151,61	-161,77					-291,32	-290,65
	-154,67	-165,08					-410,70	-410,04
	-156,04	-166,73					-397,30	-396,65
1976	-127,70	-138,67					-393,59	-392,97
	-49,64	-60,84					-307,08	-306,48
	73,72	62,27					-325,65	-325,01
	189,22	177,50					-422,22	-421,57
1977	112,03	100,07					-490,09	-489,42
	26,32	14,09					-605,65	-604,99
	-99,57	-112,09					-694,39	-693,73
	-122,43	-135,31					-606,03	-605,38
1978	-95,78	-108,96					-474,10	-473,44
	-94,80	-108,43					-572,39	-571,76
	-143,29	-157,28					-508,92	-508,28
	-122,81	-137,25					-538,17	-537,53
1979	-51,52	-66,28					-505,44	-504,82
	-72,59	-87,86					-525,45	-524,84
	36,80	21,13					-598,28	-597,65
	212,37	196,02					-678,51	-677,85
1980	202,17	185,46					-757,44	-756,77
	368,09	351,16					-620,89	-620,19
	298,77	281,34					-654,77	-654,10
	208,41	190,38					-891,54	-890,86

1981	18,27	-0,41	-1084,45	-1083,78
	-29,40	-48,63	-1115,96	-1115,25
	-6,84	-26,54	-1241,85	-1241,17
	96,20	76,18	-1070,60	-1069,96
1982	135,48	115,20	-810,93	-810,31
	114,68	94,06	-723,27	-722,69
	167,70	146,84	-572,80	-572,21
	161,03	140,01	-486,07	-485,48
1983	154,80	133,61	-561,09	-560,45
	44,28	22,76	-607,82	-607,18
	116,23	94,27	-564,69	-564,05
	274,97	252,55	-418,00	-417,38
1984	77,42	54,34	-339,34	-338,75
	-36,02	-59,43	-249,09	-248,44
	-6,99	-30,84	-334,16	-333,51
	-50,69	-74,87	-450,32	-449,69
1985	-193,55	-218,20	-651,46	-650,82
	-143,26	-168,25	-691,81	-691,19
	-179,10	-204,52	-516,14	-515,48
	-202,17	-227,94	-103,46	-102,79
1986	-102,80	-128,74	401,71	402,39
	7,11	-19,11	913,61	914,24
	127,74	101,15	1240,16	1240,78
	173,77	146,95	1410,16	1410,80
1987	156,29	129,21	1413,64	1414,24
	162,63	134,83	1327,78	1328,36
	20,39	-7,83	1332,83	1333,40
	-77,70	-106,41	1444,83	1445,41
1988	-38,74	-67,92	1896,30	1896,89
	35,74	6,32	2320,80	2321,39
	95,13	65,32	2872,21	2872,80
	146,48	116,16	3324,03	3324,62
1989	-20,21	-51,07	3887,99	3888,59
	137,06	105,80	4211,33	4211,96
	135,25	103,74	4488,10	4488,76
	101,63	69,69	4614,24	4614,91
1990	145,06	112,64	4512,98	4513,65
	-106,14	-139,14	4745,69	4746,38
	-197,92	-231,18	5394,50	5395,21
	-209,80	-243,43	6437,85	6438,59
1991	238,26	204,58	7409,73	7410,47
	-32,96	-66,89	8197,51	8198,25
	14,59	-19,57	8606,95	8607,69
	168,45	134,16	8676,98	8677,74
1992	205,49	170,89	8401,37	8402,16
	100,36	65,61	8269,00	8269,79
	21,43	-13,50	8379,63	8380,42
	-77,47	-112,67	8637,67	8638,46
1993	-170,40	-205,85	9054,36	9055,15

	-148,90	-184,72					9359,82	9360,62
	-102,02	-138,22					9802,23	9803,02
	-29,28	-65,94					10061,88	10062,65
1994	24,73	-12,35					10358,63	10359,34
	160,37	122,77					10506,53	10507,22
	146,55	108,52					10249,39	10250,12
	332,61	294,05					9713,69	9714,44
1995	543,21	504,44					8369,71	8370,52
	553,54	514,54					8842,97	8843,77
	495,90	456,65					8655,48	8656,28
	621,93	582,43					9412,43	9413,22
1996	549,63	509,37	-1441,87	-1440,95	-1087,36	-1087,12	10052,25	10053,05
	289,03	248,29	-1404,08	-1403,16	-1018,16	-1017,95	6609,10	6609,90
	213,85	172,61	-1168,27	-1167,33	-758,15	-757,95	10571,24	10572,08
	-118,44	-160,43	-957,07	-956,13	-752,90	-752,72	9485,77	9486,64
1997	-167,56	-210,20	-1083,23	-1082,31	-697,37	-697,21	10488,16	10489,01
	93,00	49,76	-854,13	-853,20	-523,45	-523,28	10625,23	10626,07
	180,87	137,44	-834,33	-833,41	-439,20	-439,01	10883,02	10883,85
	624,82	581,13	-914,71	-913,81	-327,58	-327,39	10331,99	10332,78
1998	682,96	639,53	-479,33	-478,45	-91,63	-91,47	9767,59	9768,34
	965,32	921,48	-507,01	-506,19	36,97	37,11	10864,04	10864,73
	941,61	897,46	-284,39	-283,56	340,80	340,95	11419,07	11419,74
	578,24	533,57	-344,82	-344,01	279,92	280,06	12242,39	12243,03
1999	648,33	603,37	-230,25	-229,43	-6,37	-6,21	13534,92	13535,55
	544,14	498,77	-404,86	-404,02	-96,27	-96,08	15049,29	15049,97
	505,35	459,18	-328,88	-328,02	-323,76	-323,54	16544,50	16545,23
	712,44	665,06	-291,66	-290,79	-419,97	-419,74	16240,76	16241,53
2000	663,10	614,73	-457,09	-456,19	-479,28	-479,03	19071,23	19072,06
	623,76	574,62	-512,42	-511,51	-505,66	-505,41	18171,36	18172,19
	694,17	644,32	-403,57	-402,67	-532,27	-532,01	19113,60	19114,45
	920,48	870,25	-528,89	-527,99	-472,14	-471,85	18599,47	18600,36
2001	976,53	926,17	-261,34	-260,44	-292,40	-292,09	18863,65	18864,51
	930,45	879,41	40,91	41,79	-390,99	-390,67	17730,17	17731,01
	1070,51	1019,48	-127,26	-126,38	-344,32	-343,99	18380,59	18381,41
	1114,29	1062,74	193,89	194,73	-113,24	-112,91	20101,61	20102,36
2002	1109,90	1058,18	256,60	257,47	-230,36	-230,01	20196,03	20196,81
	1107,42	1054,84	482,16	483,02	-42,33	-41,97	21184,69	21185,47
	1117,48	1064,56	391,13	392,00	-67,79	-67,41	20205,37	20206,15
	1196,94	1143,65	551,29	552,15	-48,10	-47,71	19614,67	19615,43
2003	1043,03	989,55	372,40	373,26	275,86	276,26	19731,17	19731,91
	842,29	789,02	441,36	442,21	320,89	321,31	20727,95	20728,69
	577,14	523,10	522,44	523,30	464,30	464,74	20997,10	20997,86
	411,75	356,68	562,70	563,56	546,93	547,38	22935,53	22936,26
2004	63,94	7,60	739,63	740,48	412,91	413,34	22981,14	22981,88
	-174,71	-231,85	686,25	687,12	447,78	448,23	23171,19	23171,95
	-619,86	-677,78	547,61	548,47	360,04	360,49	25075,59	25076,35
	-874,26	-932,84	660,16	661,04	490,39	490,86	23808,96	23809,74
2005	-1324,95	-1383,69	952,39	953,30	655,49	656,00	22939,56	22940,40
	-1385,07	-1445,02	880,30	881,21	565,20	565,74	23889,00	23889,84

	-1462,57	-1523,62	997,38	998,31	647,45	648,02	26070,40	26071,29
	-1382,81	-1445,09	903,05	903,98	515,74	516,33	30695,44	30696,36
2006	-1206,97	-1270,71	-241,14	-240,19	144,39	145,01	31921,09	31922,05
	-779,23	-844,46	-326,26	-325,31	129,31	129,96	32807,00	32807,96
	-441,14	-507,22	-302,49	-301,54	174,52	175,19	33187,90	33188,88
	-200,57	-267,29	233,30	234,26	537,68	538,37	33319,80	33320,80
2007	-438,33	-505,87	452,97	453,92	1250,03	1250,72	35519,52	35520,53
	-433,61	-502,14	703,57	704,53	1565,27	1565,98	36452,57	36453,59
	-170,84	-240,12	1083,63	1084,58	1779,06	1779,79	35522,97	35524,01
	-130,49	-201,27	768,10	769,05	1558,60	1559,38	36866,06	36867,13
2008	593,36	521,93	872,58	873,54	829,70	830,52	40811,17	40812,28
	589,15	516,76	297,49	298,43	519,18	520,04	41056,60	41057,73
	642,43	569,76	-62,81	-61,87	182,37	183,25	41282,05	41283,22
	723,99	652,33	2,96	3,85	505,92	506,76	39114,01	39115,06
2009	1186,81	1117,61	-576,83	-575,97	-1474,45	-1473,65	36997,86	36998,86
	1066,01	996,80	-1452,10	-1451,23	-1614,55	-1613,74	37062,38	37063,41
	1149,11	1079,39	-2443,49	-2442,60	-1560,44	-1559,61	38208,28	38209,34
	762,51	692,28	-2435,63	-2434,74	-1660,61	-1659,80	37981,16	37982,22
2010	338,05	267,30	-2470,13	-2469,21	-1364,20	-1363,36	39201,94	39203,04
	163,76	91,99	-2604,48	-2603,56	-903,99	-903,15	40291,38	40292,46
	-99,59	-171,91	-2751,99	-2751,05	-562,84	-562,00	38990,34	38991,43
	162,01	88,45	-2666,62	-2665,66	100,59	101,45	39979,63	39980,77
2011	635,16	560,98	-3003,31	-3002,34	630,45	631,30	41740,38	41741,54
	884,17	808,96	-2402,40	-2401,43	1110,02	1110,87	41179,38	41180,54
	324,73	248,62	-2153,40	-2152,43	1408,02	1408,86	42468,80	42469,97
	-38,93	-115,33	-2386,32	-2385,35	1604,53	1605,38	41697,29	41698,50
2012	-623,74	-700,67	-1642,55	-1641,55	1749,72	1750,59	41489,05	41490,33
	-735,73	-812,86	-1812,63	-1811,63	1957,74	1958,61	41162,96	41164,23
	-832,61	-910,17	-1632,45	-1631,47	2425,13	2425,98	41934,24	41935,48
	-1109,16	-1187,45	-1637,84	-1636,87	2549,99	2550,84	43756,15	43757,37
2013	-1920,65	-2000,25	-1724,52	-1723,56	2567,74	2568,57	43221,97	43223,18
	-2194,85	-2275,23	-1867,16	-1866,22	2732,34	2733,16	45320,18	45321,38
	-2537,45	-2618,87	-1622,72	-1621,77	2871,26	2872,08	45109,43	45110,63
	-2866,94	-2949,14	-1347,51	-1346,58	3198,69	3199,51	44540,74	44541,91
2014	-3028,94	-3111,26	-1115,63	-1114,69	3569,14	3569,95	46748,06	46749,24
	-3058,99	-3141,63	-870,22	-869,29	3737,45	3738,28	45296,88	45298,05
	-3349,83	-3433,11	-475,96	-475,03	3983,49	3984,30	47101,14	47102,28
	-3776,83	-3860,16	-143,02	-142,10	4228,62	4229,41	49284,25	49285,36
2015	-4032,43	-4115,60	570,52	571,45	4487,76	4488,55	48207,92	48209,01
	-3834,19	-3918,31	1215,36	1216,29	5021,42	5022,20	48475,00	48476,07
	-3492,31	-3577,01	1657,69	1658,61	5301,91	5302,69	47475,71	47476,76
	-2655,10	-2740,02	1835,17	1836,07	5551,50	5552,26	47813,25	47814,24
2016	-1947,97	-2033,18	2535,55	2536,44	6080,18	6080,93	50438,85	50439,82
	-1148,54	-1235,30	2532,42	2533,29	6454,24	6454,98	51868,39	51869,30
	-663,10	-750,50	2603,33	2604,17	6947,44	6948,17	52517,19	52518,06
	-462,02	-550,85	2857,24	2858,08	7391,28	7392,00	52829,06	52829,93
2017	-528,43	-617,79	3307,32	3308,17	7752,16	7752,91	50954,16	50955,07
	-590,89	-681,13	3215,53	3216,36	7957,61	7958,37	52102,57	52103,45
	-632,64	-723,58	2902,05	2902,89	8141,29	8142,08	52784,66	52785,56

	-576,64	-668,72	2878,50	2879,33	8246,70	8247,49	52442,85	52443,77
2018	-726,72	-819,76	2769,37	2770,20	7912,27	7913,11	52037,78	52038,75
	-840,11	-934,40	2832,79	2833,62	8080,77	8081,63	50720,00	50720,98
	-650,67	-745,20	3089,91	3090,74	8159,42	8160,29	51047,32	51048,33
	-366,35	-461,01	3216,88	3217,66	8507,58	8508,43	50403,63	50404,59
2019	-250,46	-345,09	3666,22	3666,96	9017,72	9018,54	49965,68	49966,55
	-110,38	-205,58	3277,49	3278,22	9207,56	9208,37	50974,66	50975,49
	159,12	63,62	3349,35	3350,07	9378,51	9379,29	49754,75	49755,57
	760,13	663,70	4064,23	4064,93	9848,91	9849,71	49770,10	49770,90

Note: Table V.C shows the differences between the treatment group and classic synthetic control group under C. Additionally, the differences between the treatment group and bias-corrected synthetic control group are presented under BC. The black horizontal line indicates treatment. All values are rounded to two decimal places.

Table V.D Classic and bias-corrected pre- and post-intervention gaps for the Netherlands, Portugal, Slovakia, and Slovenia

	The Netherlands		Portugal		Slovakia		Slovenia	
	C	BC	C	BC	C	BC	C	BC
1970	133,40	137,91	-43,03	-43,70				
	200,32	204,97	-20,79	-21,47				
	222,29	227,06	-16,27	-16,95				
	295,21	300,08	-7,04	-7,72				
1971	301,81	306,79	-2,30	-2,95				
	288,31	293,38	67,14	66,50				
	232,64	237,80	58,69	58,02				
	179,85	185,07	132,81	132,17				
1972	314,21	319,54	123,98	123,35				
	236,55	241,94	125,02	124,37				
	232,35	237,83	239,48	238,83				
	223,58	229,18	209,60	208,96				
1973	281,05	286,75	243,26	242,58				
	236,43	242,23	303,25	302,57				
	175,21	181,13	383,55	382,88				
	299,51	305,59	429,58	428,92				
1974	372,98	379,16	467,24	466,62				
	467,79	474,11	365,01	364,40				
	495,92	502,38	292,80	292,15				
	427,13	433,69	286,71	286,04				
1975	301,84	308,49	179,53	178,85				
	256,46	263,21	91,43	90,73				
	242,55	249,42	49,80	49,10				
	465,31	472,31	50,14	49,43				
1976	345,57	352,70	71,45	70,72				
	281,36	288,62	100,00	99,28				
	501,87	509,29	54,62	53,91				
	393,38	400,96	118,81	118,13				
1977	490,22	497,95	135,32	134,66				
	468,96	476,85	178,21	177,55				
	538,18	546,22	152,36	151,71				
	582,05	590,26	94,89	94,24				
1978	502,82	511,18	71,38	70,75				
	465,05	473,62	34,03	33,38				
	418,99	427,73	-9,28	-9,91				
	487,89	496,86	-19,17	-19,79				
1979	-49,51	-40,37	-24,16	-24,82				
	448,53	457,90	-38,07	-38,73				
	497,86	507,44	84,90	84,24				
	428,73	438,70	66,22	65,69				
1980	523,22	533,35	223,59	223,00				
	412,22	422,48	263,29	262,72				
	315,25	325,78	195,21	194,63				
	362,54	373,37	287,10	286,54				

1981	87,07	98,23	251,44	250,88
	-122,89	-111,45	175,14	174,59
	-237,09	-225,41	90,32	89,76
	-147,01	-135,17	64,47	63,91
1982	52,04	64,01	242,40	241,84
	-204,24	-192,11	98,72	98,15
	9,83	22,07	105,61	105,04
	-133,86	-121,54	147,57	147,00
1983	-39,13	-26,73	152,50	151,94
	205,73	218,26	70,74	70,14
	172,27	185,02	-125,31	-125,92
	-80,99	-68,03	-234,42	-235,04
1984	-155,20	-141,92	-426,72	-427,36
	-411,86	-398,39	-500,36	-500,99
	-385,63	-371,93	-385,62	-386,21
	-394,55	-380,70	-499,59	-500,20
1985	-491,26	-477,18	-490,94	-491,55
	-353,00	-338,74	-536,20	-536,82
	-744,79	-730,31	-606,79	-607,38
	-517,86	-503,22	-535,96	-536,55
1986	-527,27	-512,52	-443,32	-443,91
	-247,06	-232,17	-416,86	-417,48
	-297,93	-282,87	-416,27	-416,88
	-597,15	-581,94	-365,47	-366,04
1987	-645,45	-630,11	-266,40	-267,00
	-612,98	-597,29	-336,75	-337,35
	-598,78	-582,87	-364,88	-365,49
	-720,92	-704,76	-438,74	-439,34
1988	-898,48	-882,10	-342,17	-342,79
	-760,31	-743,81	-319,55	-320,19
	-704,86	-688,17	-353,21	-353,86
	-669,83	-652,90	-300,70	-301,38
1989	-673,29	-656,09	143,04	142,36
	-559,56	-542,15	-13,13	-13,78
	-489,62	-472,06	112,17	111,53
	-431,81	-414,02	100,76	100,12
1990	-251,91	-233,87	46,46	45,83
	-215,90	-197,56	117,12	116,52
	7,43	25,91	180,73	180,14
	108,57	127,24	525,32	524,77
1991	238,47	257,19	315,81	315,26
	391,90	410,74	573,80	573,25
	464,48	483,43	706,09	705,54
	619,48	638,50	598,02	597,47
1992	648,41	667,58	695,53	695,00
	371,12	390,36	527,28	526,75
	312,03	331,36	462,53	461,99
	266,53	285,98	387,91	387,38
1993	253,45	273,04	179,65	179,12

	231,72	251,50	101,49	100,96				
	332,79	352,74	49,05	48,51				
	-5,20	14,96	-81,79	-82,36				
1994	130,55	150,89	-340,23	-340,85				
	198,64	219,22	-394,16	-394,79				
	151,65	172,45	-375,14	-375,74				
	252,73	273,82	-213,01	-213,60				
1995	246,99	268,20	184,56	183,97				
	340,26	361,60	548,01	547,41				
	323,79	345,24	542,40	541,77				
	393,31	414,87	496,65	496,00				
1996	172,01	193,95	189,57	188,95	-434,18	-434,28	-362,15	-377,86
	273,31	295,50	47,74	47,12	-358,13	-358,23	-375,73	-391,59
	362,15	384,57	-53,19	-53,78	-140,50	-140,60	-306,82	-322,80
	311,30	334,12	-328,23	-328,77	160,81	160,73	-37,33	-53,51
1997	458,23	481,41	-134,91	-135,43	15,91	15,83	-202,69	-219,12
	444,99	468,45	-203,25	-203,77	117,05	116,97	-224,81	-241,43
	808,35	831,89	-38,19	-38,75	272,96	272,88	-95,06	-111,80
	1041,39	1065,05	86,21	85,62	142,23	142,13	-151,73	-168,59
1998	1606,01	1629,50	631,52	630,88	204,24	204,15	126,08	109,25
	1796,09	1819,80	952,24	951,61	177,98	177,90	245,52	228,58
	1855,36	1879,21	1092,61	1091,94	45,92	45,84	173,55	156,50
	1772,98	1797,09	1122,35	1121,66	704,66	704,57	93,40	76,18
1999	2021,94	2046,18	1249,41	1248,70	328,61	328,52	167,16	149,83
	2108,17	2132,61	1163,20	1162,50	17,50	17,39	548,53	531,00
	2070,35	2095,18	1085,17	1084,50	-191,59	-191,71	-164,46	-182,29
	2240,40	2265,84	913,67	913,04	-352,63	-352,75	-181,32	-199,59
2000	2245,49	2271,41	1024,43	1023,83	-178,17	-178,30	-126,79	-145,47
	2528,31	2554,61	736,59	735,99	-119,40	-119,53	-48,83	-67,82
	2602,98	2629,63	759,65	759,06	-92,71	-92,85	-35,35	-54,64
	2854,64	2881,48	865,11	864,54	-176,01	-176,16	17,10	-2,40
2001	2672,65	2699,55	628,20	627,60	-158,91	-159,07	131,42	111,80
	2750,75	2778,01	666,27	665,68	-96,01	-96,18	91,12	71,23
	3081,34	3108,58	600,86	600,24	-162,77	-162,95	52,65	32,70
	3466,24	3493,76	851,69	851,05	21,37	21,20	120,05	99,91
2002	3550,61	3578,20	788,67	788,01	-90,02	-90,19	251,73	231,43
	3459,02	3487,04	614,48	613,83	-83,89	-84,07	28,67	8,05
	3428,25	3456,44	455,05	454,39	63,86	63,67	106,73	85,92
	3091,50	3119,87	306,10	305,42	10,47	10,27	324,48	303,48
2003	2528,93	2557,37	503,70	503,01	122,72	122,51	336,42	315,33
	2197,12	2225,44	364,47	363,75	98,07	97,85	280,18	259,08
	1764,39	1793,09	297,40	296,69	-38,08	-38,30	300,38	278,94
	1705,42	1734,64	-55,31	-56,03	44,97	44,75	162,02	140,20
2004	1869,32	1899,18	-295,77	-296,46	-82,98	-83,20	142,32	119,97
	1909,62	1939,88	-461,05	-461,73	-148,48	-148,71	308,56	285,85
	1693,06	1723,72	-479,51	-480,18	91,68	91,46	489,33	466,30
	1488,36	1519,35	-507,10	-507,76	211,11	210,87	393,54	370,23
2005	1296,26	1327,33	-159,96	-160,61	347,39	347,14	366,87	343,43
	1171,64	1203,33	-54,19	-54,81	616,10	615,85	561,64	537,76

	1258,13	1290,38	-119,80	-120,40	757,58	757,32	426,96	402,59
	1323,33	1356,20	-119,31	-119,87	852,42	852,14	626,06	601,13
2006	1538,15	1571,74	56,94	56,41	1176,45	1176,17	654,91	629,34
	2305,27	2339,62	283,89	283,39	1324,98	1324,70	978,33	952,09
	2565,05	2599,84	182,20	181,71	1426,12	1425,84	933,37	906,71
	2748,86	2783,99	222,97	222,48	1774,10	1773,82	1213,70	1186,73
2007	3071,44	3106,99	201,44	200,94	1636,52	1636,23	902,36	874,95
	3170,12	3206,18	71,57	71,08	1861,45	1861,16	812,63	784,76
	3667,91	3704,35	-91,34	-91,82	2063,17	2062,85	1007,92	979,65
	4027,15	4064,36	-82,44	-82,87	3149,07	3148,74	802,73	773,81
2008	4146,98	4184,51	-173,32	-173,71	2389,48	2389,11	1219,93	1190,55
	4345,34	4383,36	-227,60	-227,96	2627,91	2627,52	1806,85	1777,01
	4249,51	4287,66	36,06	35,70	2997,94	2997,53	1679,00	1648,95
	4735,14	4772,80	545,01	544,63	3550,93	3550,53	992,16	962,53
2009	4192,43	4228,84	601,59	601,10	1473,99	1473,61	-515,96	-544,74
	3874,20	3910,63	721,31	720,85	1803,27	1802,88	-1043,50	-1072,32
	3813,31	3850,02	651,83	651,39	2134,92	2134,52	-1374,50	-1403,55
	3749,14	3786,10	557,30	556,86	2469,28	2468,88	-1892,74	-1922,06
2010	3117,13	3154,28	414,13	413,68	3103,68	3103,28	-2347,36	-2376,93
	3059,87	3097,56	130,91	130,46	3204,05	3203,66	-2402,71	-2432,72
	2934,01	2971,96	-169,92	-170,37	3263,19	3262,80	-2697,36	-2727,65
	2897,61	2936,21	-515,20	-515,61	3177,40	3177,02	-2872,48	-2903,27
2011	3017,52	3056,39	-1025,12	-1025,51	2822,83	2822,46	-2740,23	-2771,37
	2761,99	2801,40	-1265,72	-1266,08	2716,44	2716,06	-3079,70	-3111,25
	2335,06	2374,95	-1690,05	-1690,41	2557,64	2557,26	-3261,47	-3293,41
	2018,09	2058,14	-2201,24	-2201,57	2578,99	2578,61	-3171,03	-3203,12
2012	1828,31	1868,61	-2422,81	-2423,09	2756,09	2755,70	-3146,73	-3179,05
	2305,95	2346,37	-2697,25	-2697,53	2863,59	2863,21	-3496,72	-3529,15
	2562,03	2602,67	-2933,93	-2934,22	2863,69	2863,31	-3400,05	-3432,71
	2323,90	2364,91	-3046,64	-3046,94	2891,77	2891,38	-3944,40	-3977,38
2013	2198,68	2240,32	-2592,07	-2592,39	2890,90	2890,52	-4061,96	-4095,46
	1889,03	1931,08	-2194,01	-2194,33	2755,33	2754,93	-4246,16	-4280,05
	1597,28	1639,83	-2220,60	-2220,91	2659,89	2659,49	-4485,67	-4520,02
	1479,70	1522,67	-1893,19	-1893,52	2616,91	2616,51	-4073,17	-4107,85
2014	949,78	992,76	-2325,91	-2326,23	2654,06	2653,67	-4248,61	-4283,38
	1147,14	1190,28	-2405,91	-2406,23	2575,35	2574,96	-4159,20	-4194,13
	1299,66	1343,16	-2591,14	-2591,47	2556,60	2556,22	-4126,99	-4162,15
	2010,63	2054,17	-2602,62	-2602,96	2607,20	2606,83	-4301,13	-4336,34
2015	2818,92	2862,39	-2831,59	-2831,94	2676,77	2676,40	-4587,00	-4622,17
	3378,57	3422,57	-2970,34	-2970,67	2675,03	2674,68	-4524,89	-4560,38
	3652,31	3696,60	-3145,31	-3145,65	2383,26	2382,90	-4688,83	-4724,60
	3994,44	4038,86	-2946,73	-2947,12	1859,93	1859,59	-4754,62	-4790,57
2016	4254,26	4298,78	-2649,76	-2650,17	1274,62	1274,27	-4315,32	-4351,47
	4396,62	4441,94	-2557,70	-2558,11	553,41	553,08	-4040,93	-4077,74
	4863,98	4909,60	-2133,77	-2134,19	125,02	124,68	-3594,21	-3631,33
	5052,38	5098,73	-2158,08	-2158,47	-409,17	-409,50	-3622,78	-3660,50
2017	5072,21	5118,78	-2103,32	-2103,71	-778,61	-778,97	-3043,19	-3081,24
	5455,13	5502,15	-2161,18	-2161,58	-1145,88	-1146,25	-2674,70	-2713,18
	5727,65	5775,02	-2214,80	-2215,20	-1417,30	-1417,68	-2737,88	-2776,77

	6127,31	6175,26	-1977,37	-1977,74	-1671,93	-1672,32	-2085,69	-2125,14
2018	5986,66	6035,10	-1865,92	-1866,27	-1976,99	-1977,40	-2497,56	-2537,53
	6025,81	6074,87	-1610,70	-1611,05	-2158,03	-2158,45	-2415,06	-2455,63
	5767,10	5816,27	-1549,89	-1550,22	-2372,44	-2372,88	-2282,34	-2323,13
	6048,72	6097,93	-1187,20	-1187,59	-2632,45	-2632,89	-1895,23	-1936,16
2019	6311,67	6360,87	-824,94	-825,37	-2979,66	-2980,09	-1885,38	-1926,43
	6420,86	6470,33	-693,63	-694,09	-3217,60	-3218,04	-2350,02	-2391,40
	6868,59	6918,20	-680,90	-681,39	-3574,00	-3574,45	-2244,51	-2286,10
	7786,12	7836,21	-521,17	-521,65	-3748,73	-3749,18	-2075,64	-2117,63

Note: Table V.D shows the differences between the treatment group and classic synthetic control group under C. Additionally, the differences between the treatment group and bias-corrected synthetic control group are presented under BC. The black horizontal line indicates treatment. All values are rounded to two decimal places.

Table V.E Classic and bias-corrected pre- and post-intervention gaps for Spain

	Spain	
	C	BC
1970	-8,53	-11,29
	-61,30	-64,10
	-69,43	-72,27
	-95,16	-98,02
1971	-86,00	-88,87
	-67,41	-70,29
	-53,76	-56,65
	-13,85	-16,74
1972	34,09	31,19
	46,01	43,11
	103,39	100,49
	103,72	100,81
1973	60,01	57,10
	125,97	123,05
	165,13	162,20
	203,87	200,93
1974	295,44	292,51
	299,66	296,74
	319,40	316,45
	392,77	389,80
1975	384,86	381,88
	392,96	389,98
	419,95	416,98
	410,95	407,97
1976	395,75	392,77
	451,78	448,79
	431,91	428,91
	407,92	404,91
1977	441,44	438,43
	460,52	457,51
	437,26	434,27
	403,92	400,94
1978	388,53	385,57
	325,43	322,46
	279,10	276,16
	195,71	192,77
1979	138,69	135,72
	-11,93	-14,87
	51,52	48,58
	-19,54	-22,44
1980	30,92	28,04
	91,57	88,67
	21,06	18,16
	72,85	69,94
1981	-24,03	-26,94

	-112,52	-115,41
	-178,68	-181,59
	-232,14	-235,07
1982	-185,92	-188,82
	-193,44	-196,34
	-140,86	-143,75
	-109,52	-112,39
1983	-171,01	-173,86
	-154,71	-157,57
	-246,84	-249,71
	-282,63	-285,51
1984	-322,13	-325,02
	-356,48	-359,36
	-342,03	-344,89
	-430,85	-433,72
1985	-403,34	-406,21
	-550,32	-553,20
	-467,07	-469,91
	-423,03	-425,87
1986	-417,49	-420,32
	-266,09	-268,95
	-383,90	-386,74
	-423,13	-425,94
1987	-320,89	-323,72
	-342,57	-345,39
	-289,98	-292,82
	-184,34	-187,18
1988	-366,92	-369,77
	-228,38	-231,25
	-184,18	-187,07
	-368,23	-371,14
1989	-123,56	-126,45
	-81,57	-84,46
	16,88	13,99
	-77,46	-80,35
1990	-57,17	-60,07
	75,51	72,62
	48,16	45,29
	581,47	578,65
1991	275,29	272,47
	447,07	444,25
	543,84	541,03
	537,54	534,73
1992	639,47	636,67
	451,18	448,38
	488,18	485,38
	373,13	370,32
1993	175,20	172,38
	80,09	77,27

	108,62	105,82
	-17,37	-20,18
1994	-175,25	-178,10
	-262,11	-264,94
	-186,40	-189,23
	-111,57	-114,38
1995	376,98	374,18
	612,44	609,63
	576,76	573,94
	586,33	583,51
1996	379,32	376,53
	303,16	300,36
	237,14	234,39
	100,20	97,47
1997	175,76	173,04
	183,41	180,69
	326,90	324,16
	628,67	625,91
1998	1050,95	1048,15
	1294,22	1291,42
	1401,30	1398,47
	1435,16	1432,32
1999	1356,03	1353,18
	1335,63	1332,80
	1286,97	1284,19
	1201,63	1198,89
2000	1301,88	1299,18
	1412,74	1410,06
	1441,85	1439,20
	1626,29	1623,65
2001	1691,06	1688,39
	1746,49	1743,82
	1962,66	1959,96
	2183,80	2181,07
2002	2288,45	2285,70
	2405,60	2402,88
	2398,93	2396,19
	2411,13	2408,39
2003	2500,40	2497,66
	2434,27	2431,50
	2249,71	2246,95
	2081,10	2078,34
2004	1981,07	1978,34
	1984,35	1981,64
	2150,37	2147,67
	2239,29	2236,60
2005	2427,57	2424,89
	2486,37	2483,72
	2709,92	2707,29

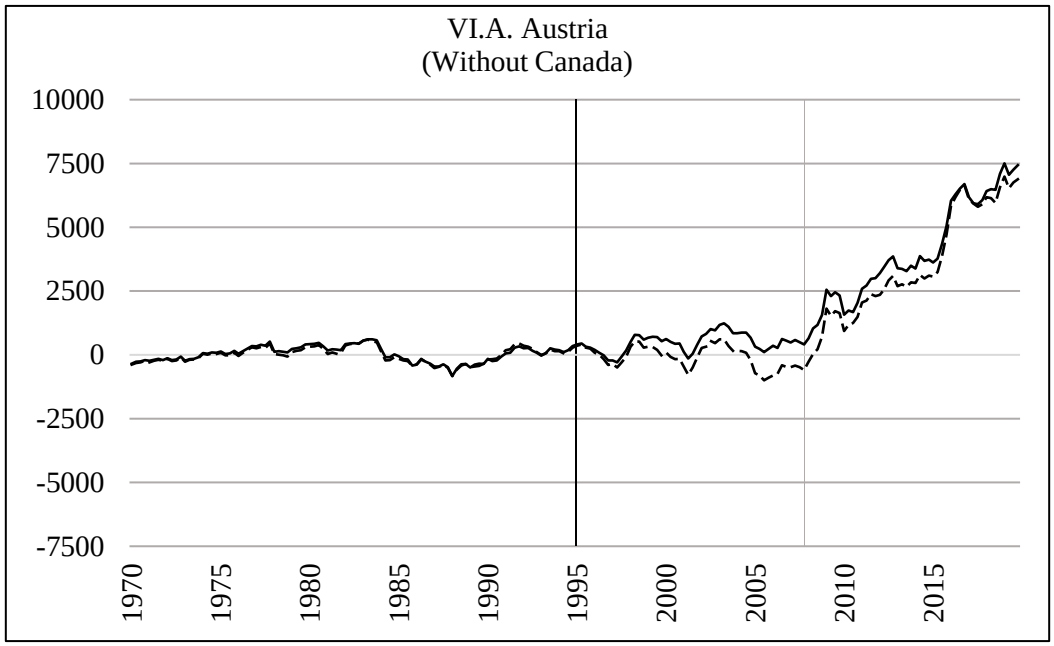
	2988,50	2985,90
2006	3421,20	3418,65
	3836,36	3833,83
	4145,24	4142,72
	4333,20	4330,66
2007	4382,74	4380,18
	4402,42	4399,86
	4367,39	4364,83
	4198,95	4196,45
2008	4015,40	4012,93
	3974,91	3972,47
	4101,18	4098,74
	4264,51	4262,02
2009	4001,97	3999,36
	3961,00	3958,41
	3601,16	3598,58
	3236,54	3233,95
2010	2558,77	2556,25
	2030,02	2027,48
	1661,28	1658,75
	1503,46	1500,94
2011	1345,59	1343,12
	1304,16	1301,69
	1080,27	1077,78
	851,74	849,26
2012	452,51	450,11
	212,27	209,85
	-72,59	-75,03
	-163,04	-165,50
2013	-243,07	-245,53
	-292,27	-294,75
	-383,68	-386,14
	-302,61	-305,10
2014	-263,99	-266,47
	-250,94	-253,42
	-187,61	-190,13
	-199,24	-201,79
2015	-289,01	-291,58
	-217,77	-220,35
	-140,73	-143,33
	178,41	175,76
2016	512,24	509,58
	725,98	723,30
	1180,88	1178,18
	1420,51	1417,84
2017	1753,57	1750,93
	2171,14	2168,51
	2199,00	2196,38
	2226,62	2224,01

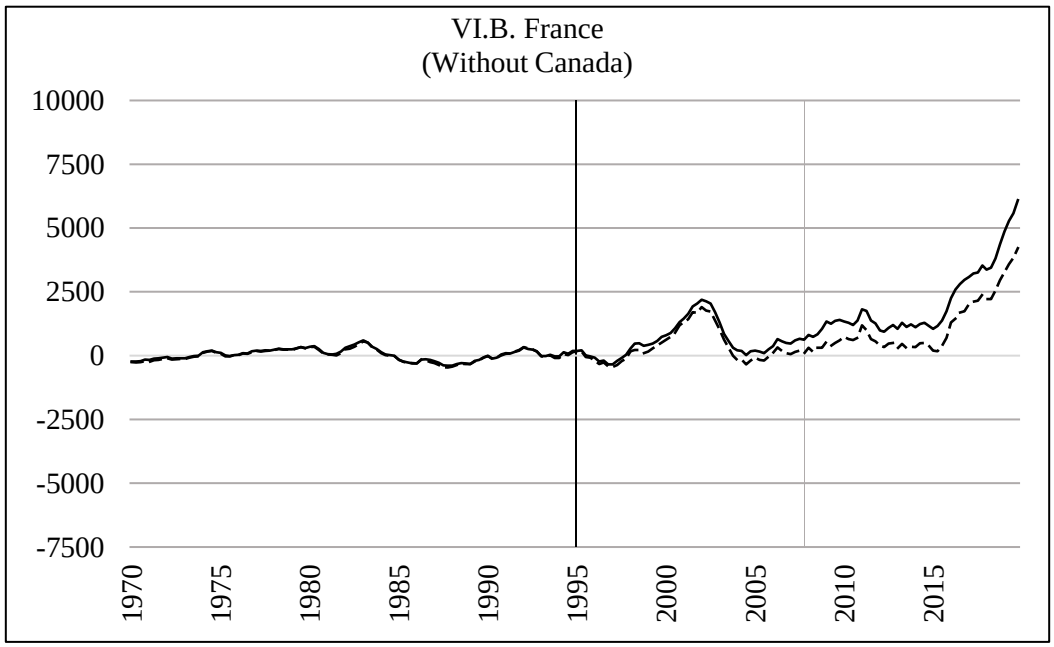
2018	1927,03	1924,44
	1869,37	1866,80
	1837,43	1834,88
	2096,74	2094,14
2019	2438,15	2435,51
	2486,46	2483,78
	2373,36	2370,64
	2208,82	2206,11

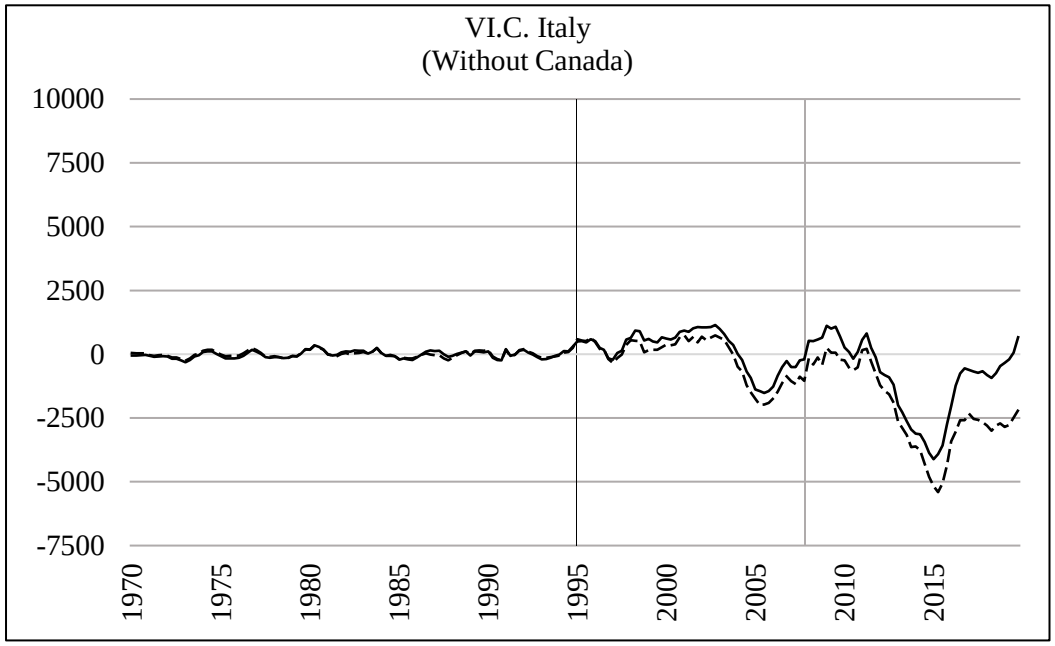
Note: Table V.E shows the differences between the treatment group and classic synthetic control group under C. Additionally, the differences between the treatment group and bias-corrected synthetic control group are presented under BC. The black horizontal line indicates treatment. All values are rounded to two decimal places.

Appendix VI – Restricting the donor pool

This Appendix presents the results of the analysis set out in section 5.1. The black solid line indicates the bias-corrected treatment effect, as presented in section 4. The dashed black line indicates the bias-corrected treatment effect, which is obtained using the restricted donor pool. The country that has been omitted from the donor pool is shows under the title in parentheses. The treatment effect, expressed in terms of GDP per capita at time t and measured in US dollars, is presented on the Y-axis. The X-axis shows time. Two vertical lines are added in order to ease readability. The black vertical line indicates treatment and the grey vertical line indicates the start of the 2007 – 2008 global financial crisis during the fourth quarter of 2007. Finally, it should be noted that the Y-axes of all graphs are scaled $[-7500, 10000]$, exceptions are denoted by an asterisk (*) in the title in order to emphasise the distorted scaling of the Y-axis. The results are obtained using the Stata *allsynth* command, beta version 0.0.9., released 2 May 2022, developed by Wiltshire (2022b).



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(Without Canada)
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2500
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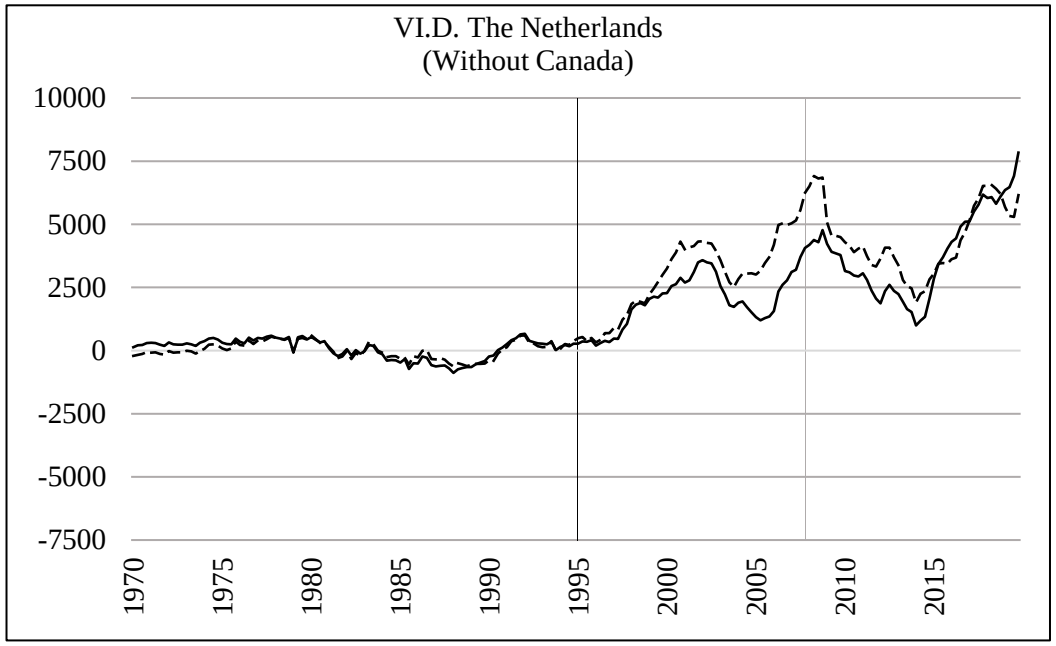
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


VI.D. The Netherlands
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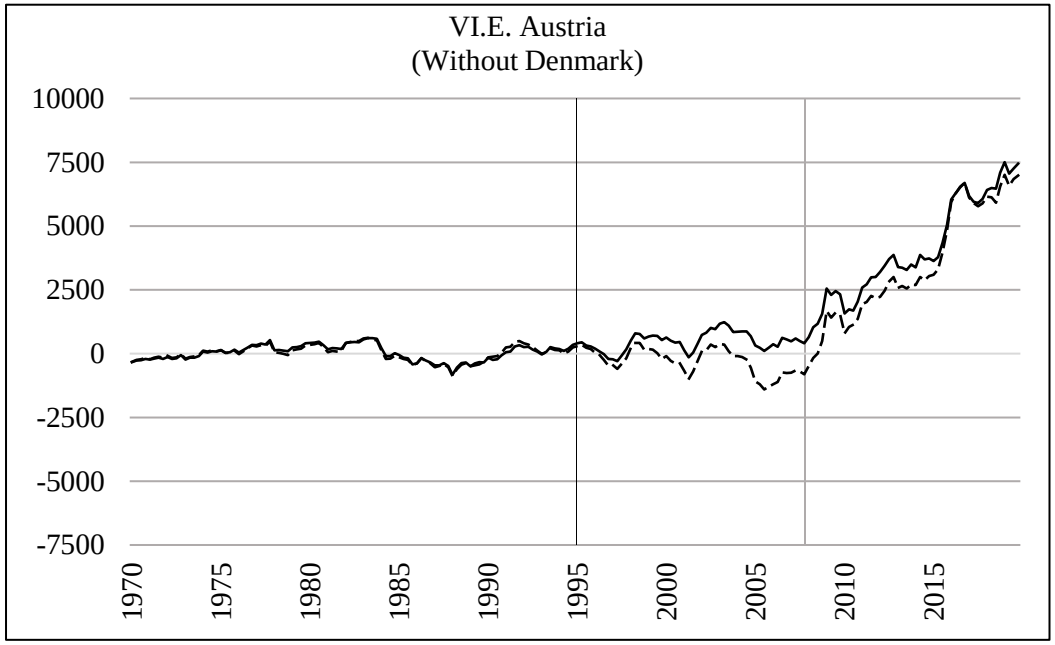
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015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-5000
-7500
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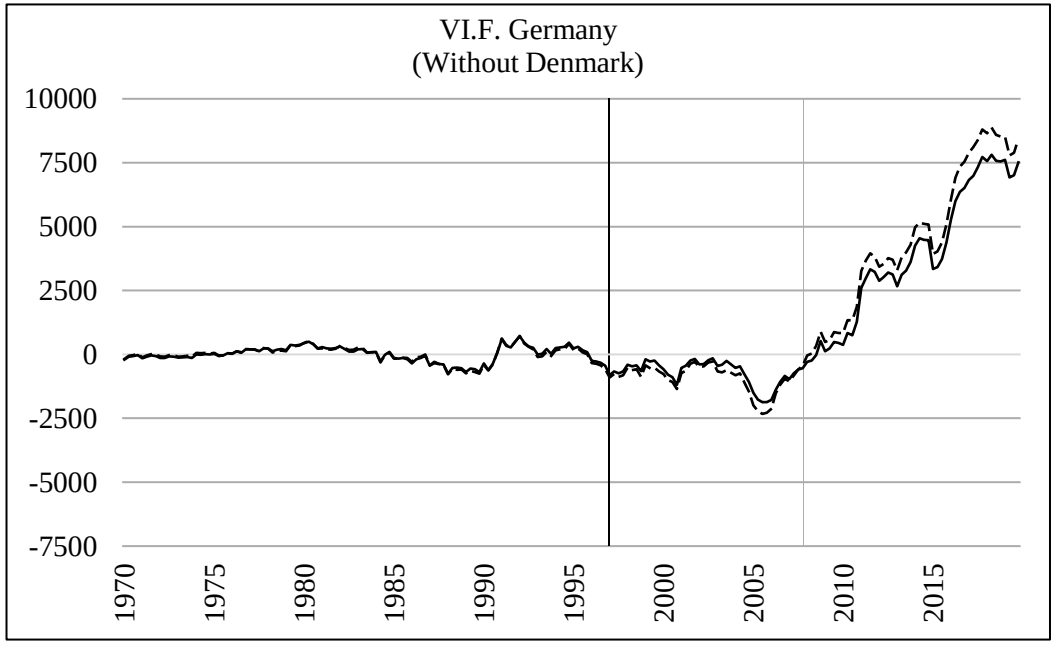
2005
2010
2015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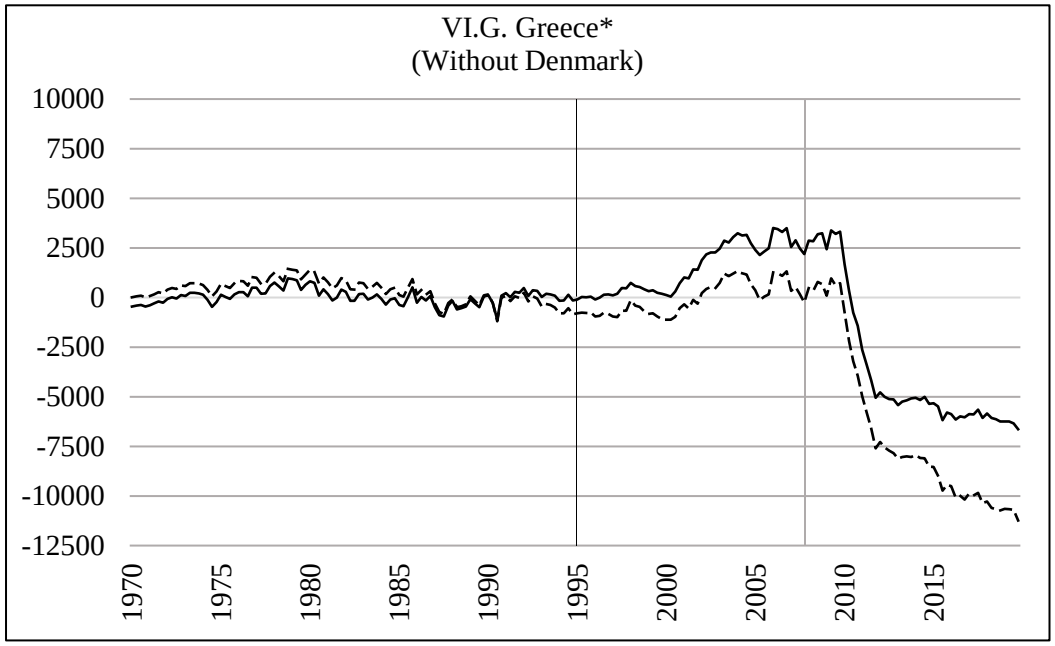
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


VI.G. Greece*
(Without Denmark)
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7500
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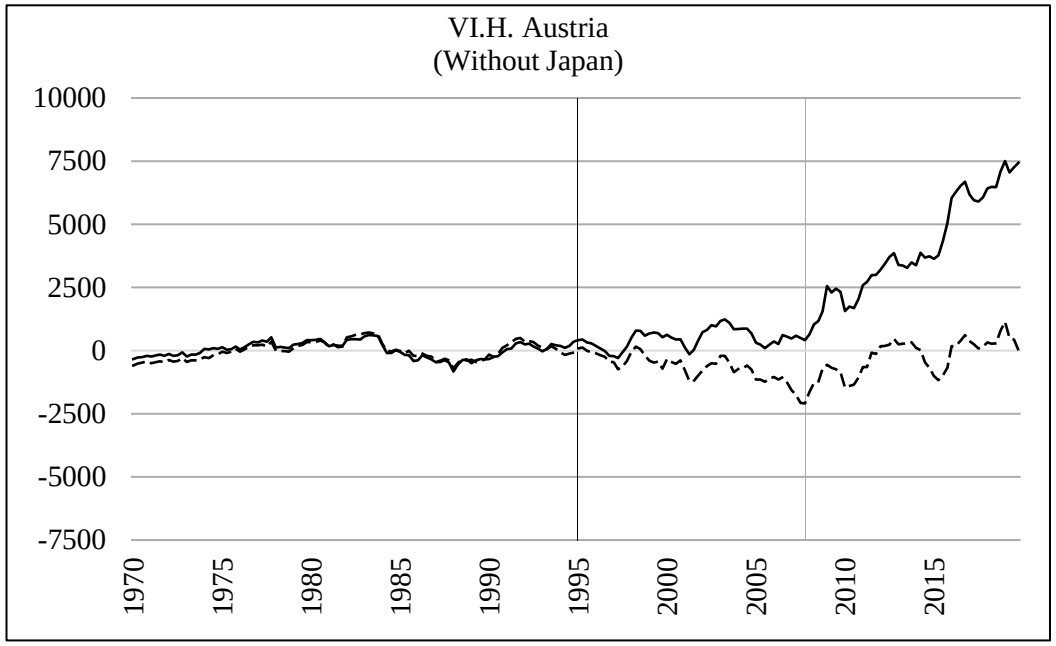
-2500
-5000
-7500
-10000
-12500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


VI.H. Austria
(Without Japan)
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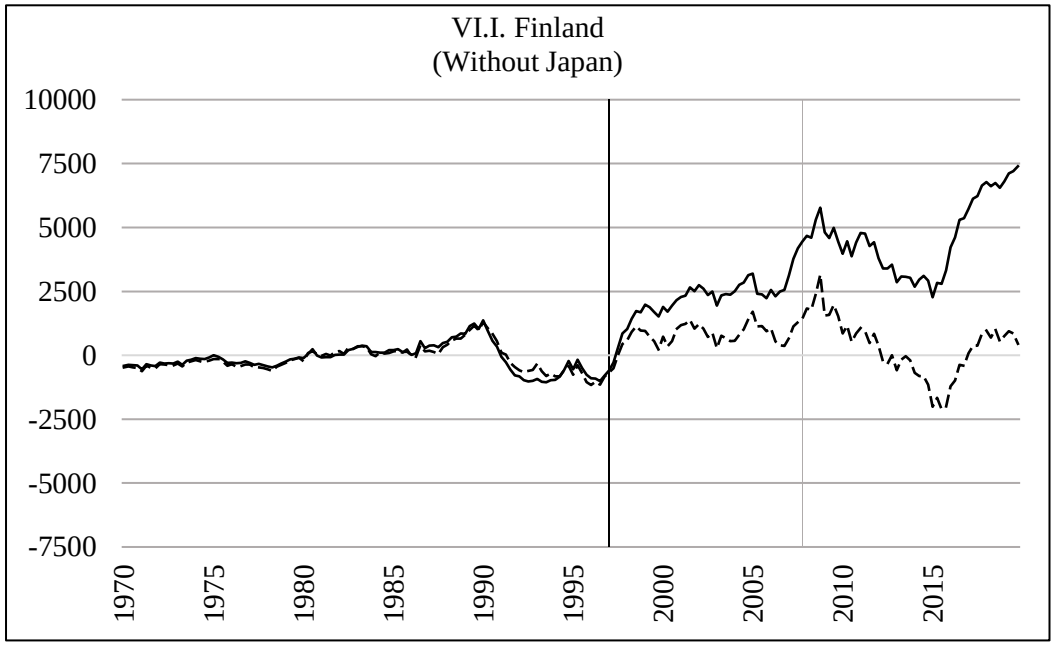
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015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2500
0
-2500
-5000
-7500
1970
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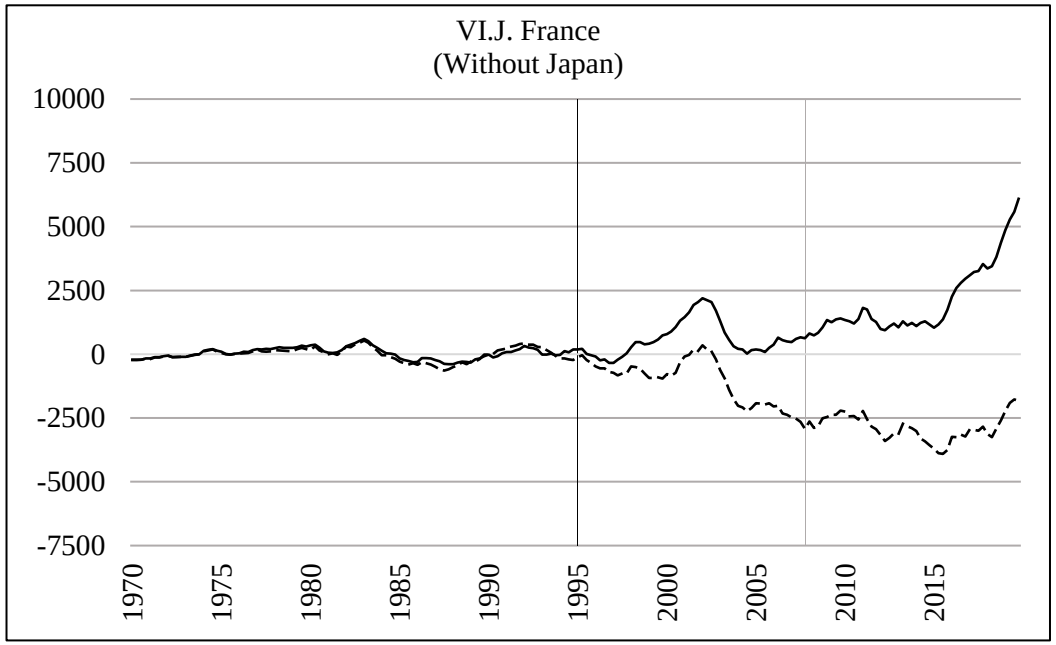
2015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-5000
-7500
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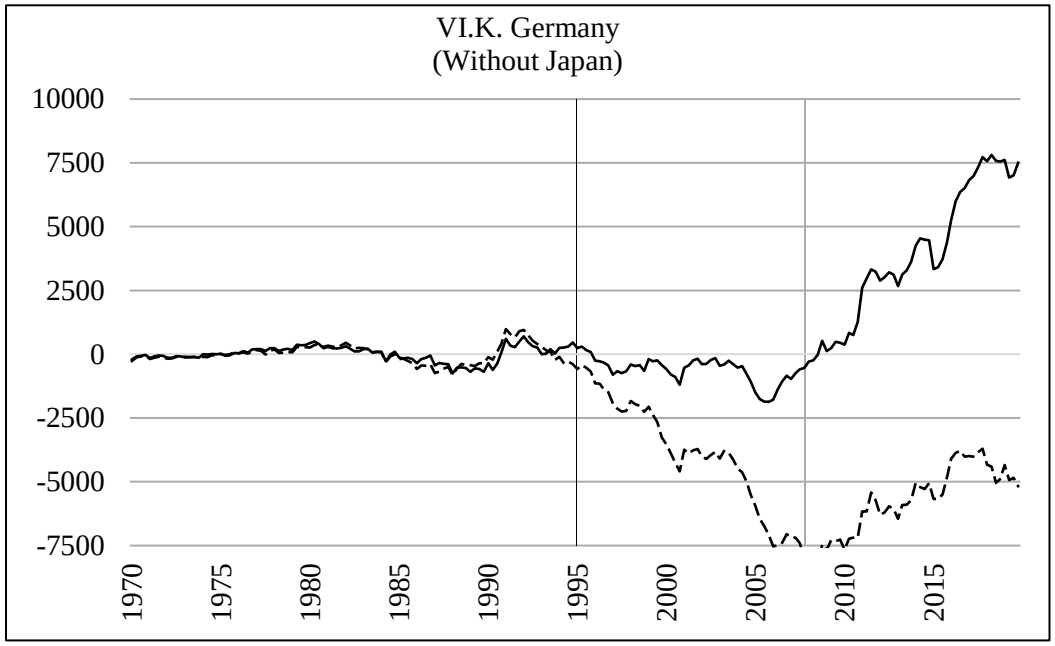
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(Without Japan)
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2500
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-2500
-5000
-7500
1970
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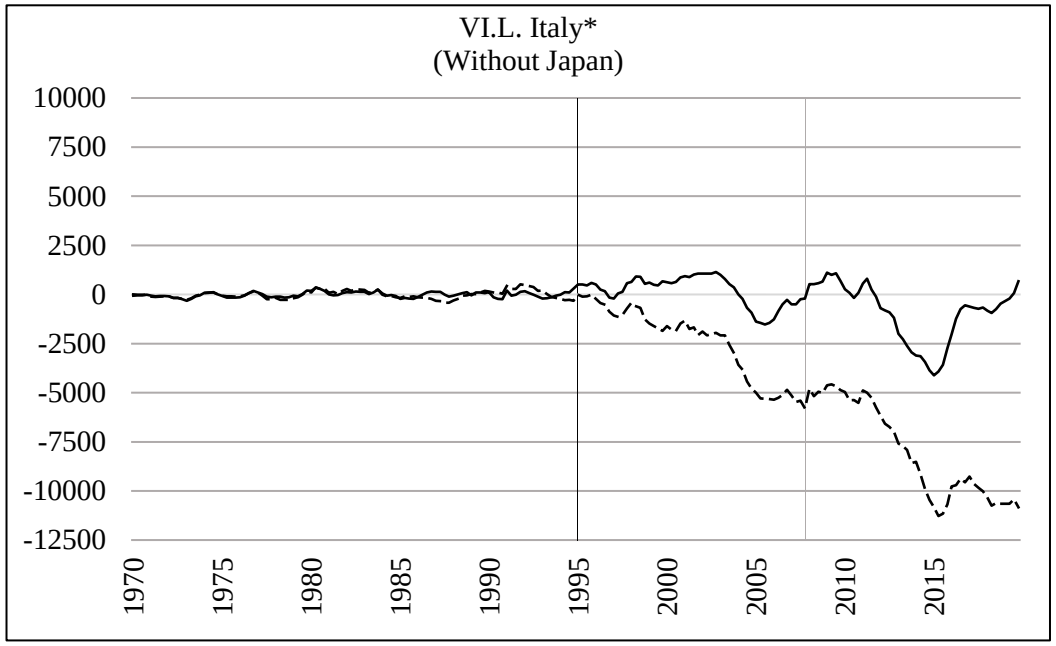
2000
2005
2010
2015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-5000
-7500
-10000
-12500
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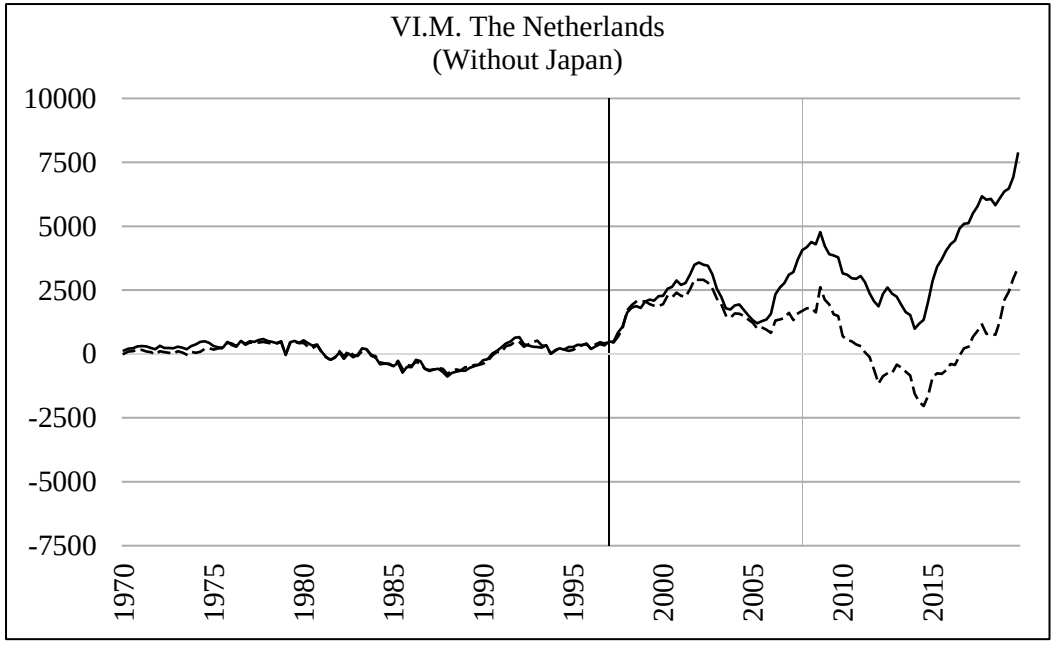
1980
1985
1990
1995
2000
2005
2010
2015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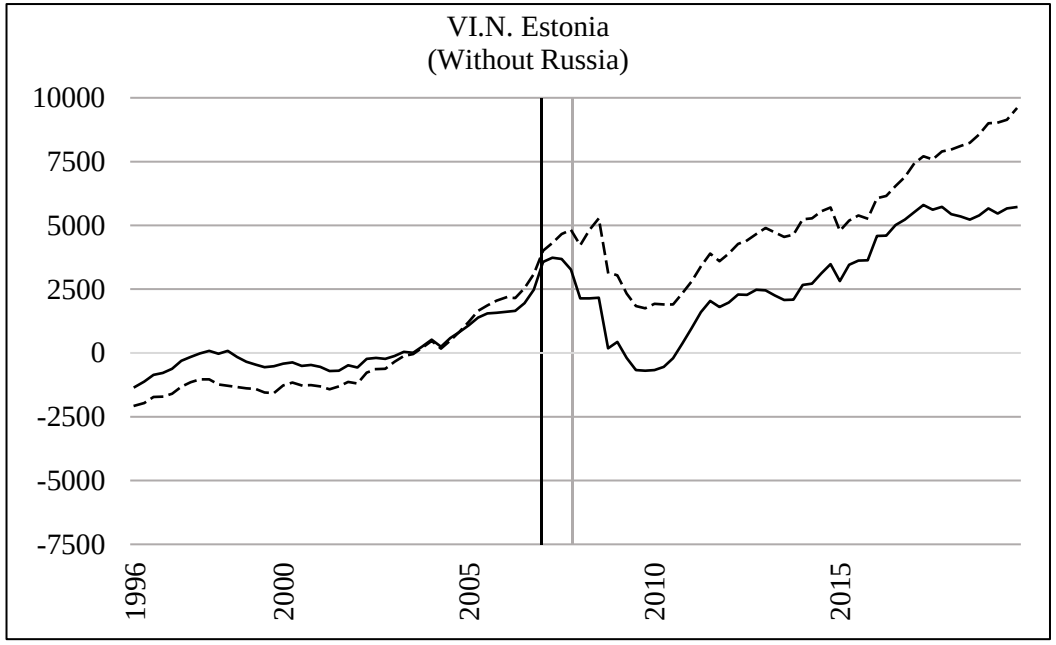
2005
2010
2015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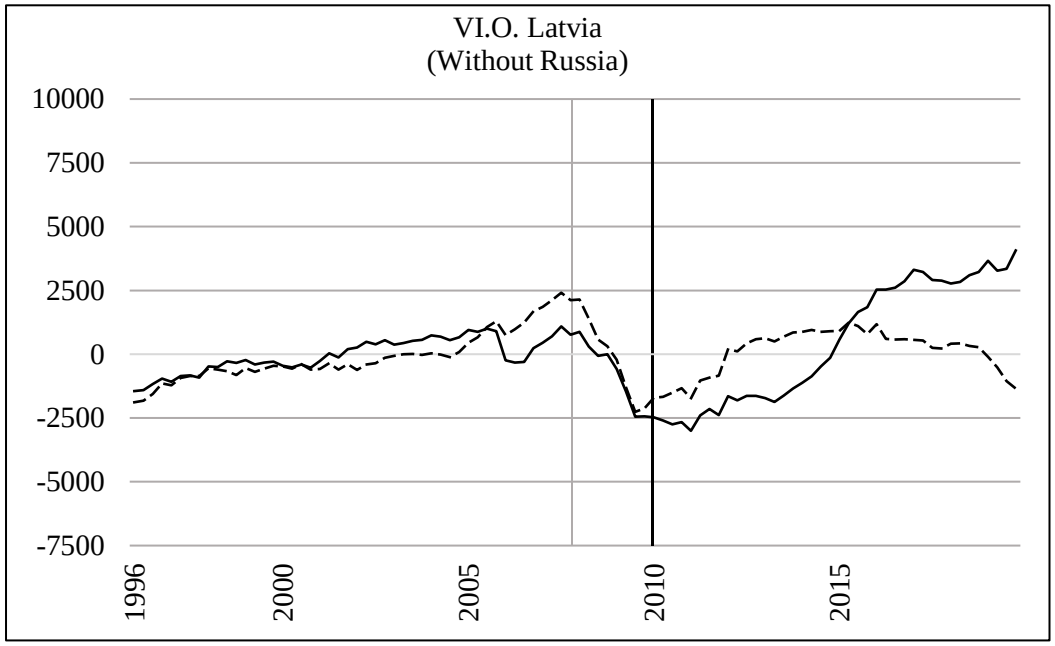
-7500
1996
2000
2005
2010
2015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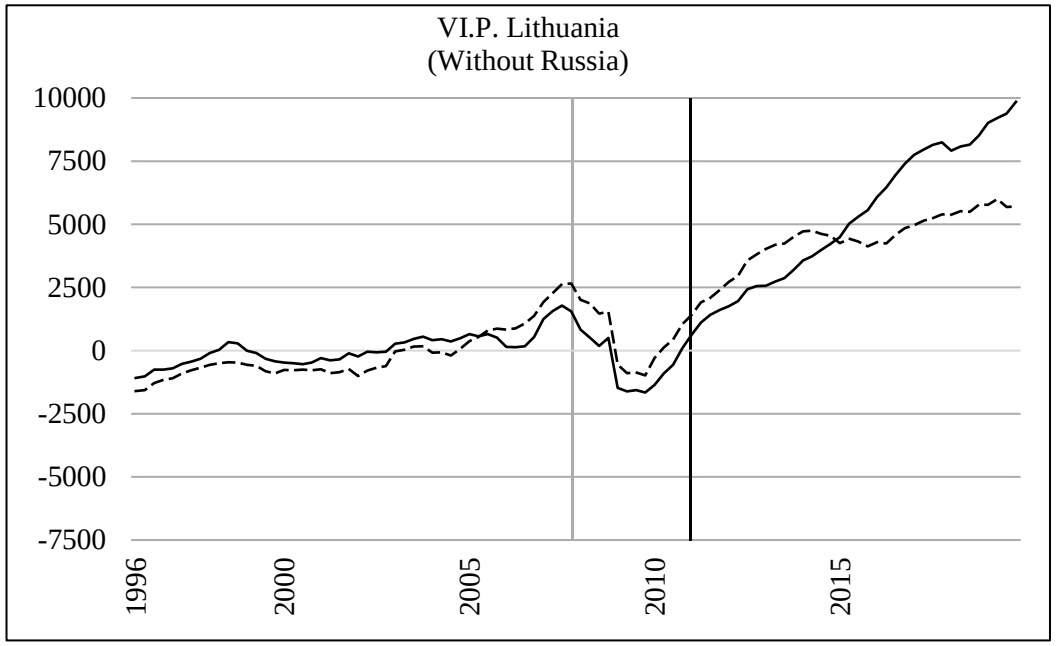
-2500
-5000
-7500
1996
2000
2005
2010
2015


VI.P. Lithuania
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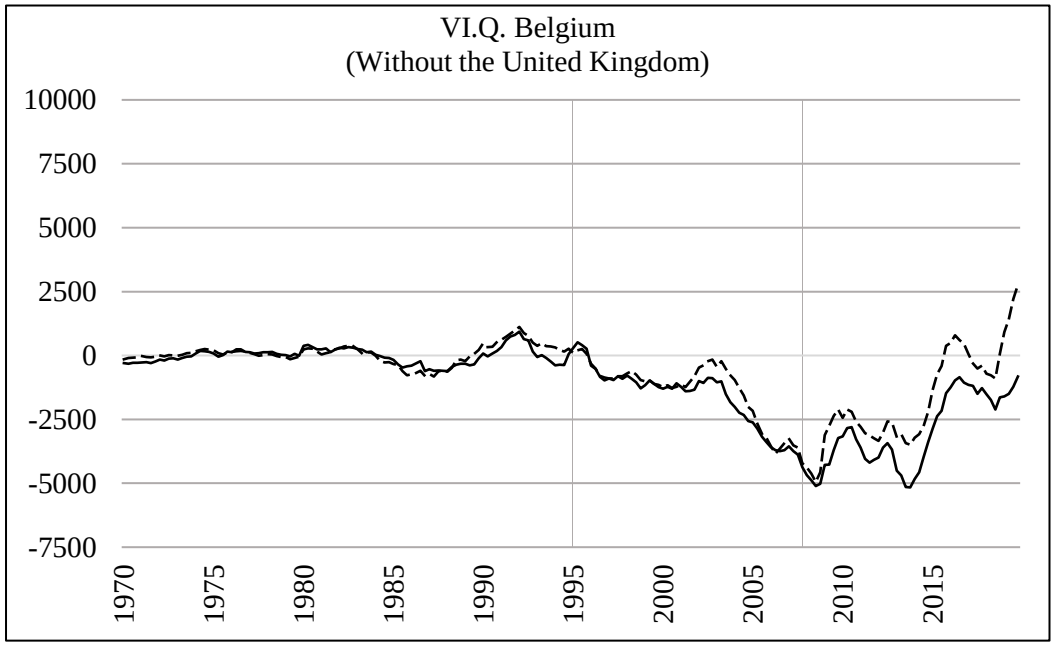
-7500
1996
2000
2005
2010
2015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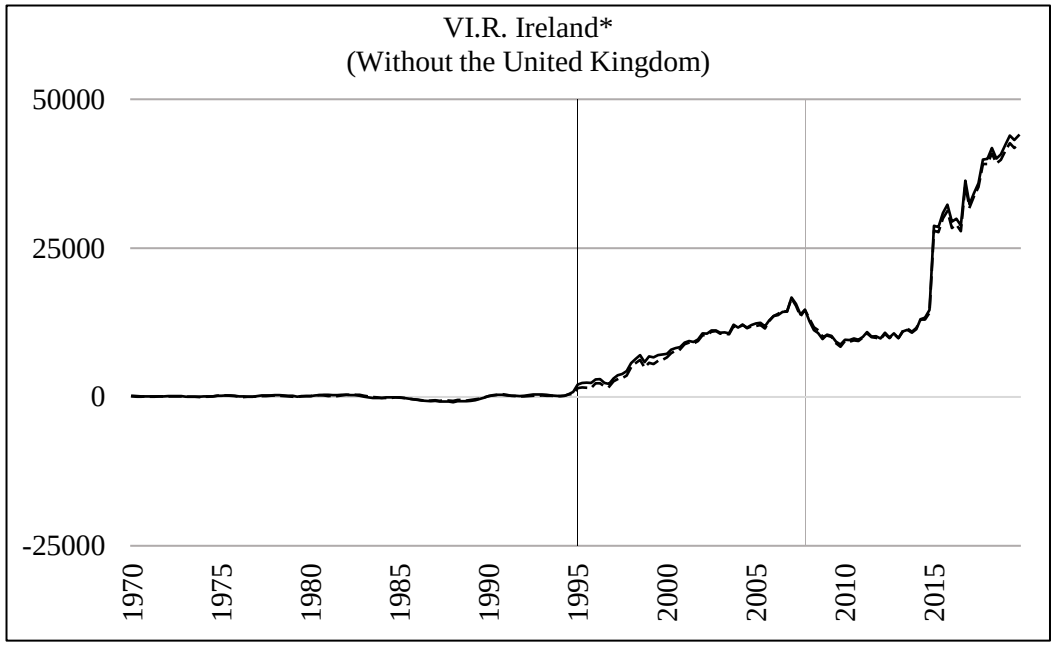
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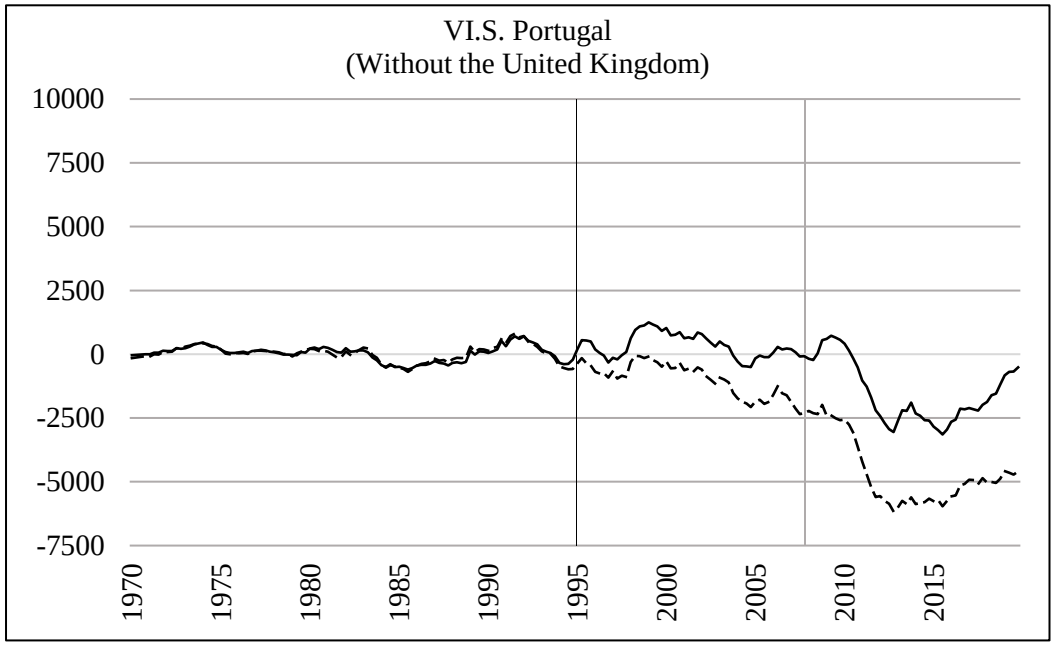
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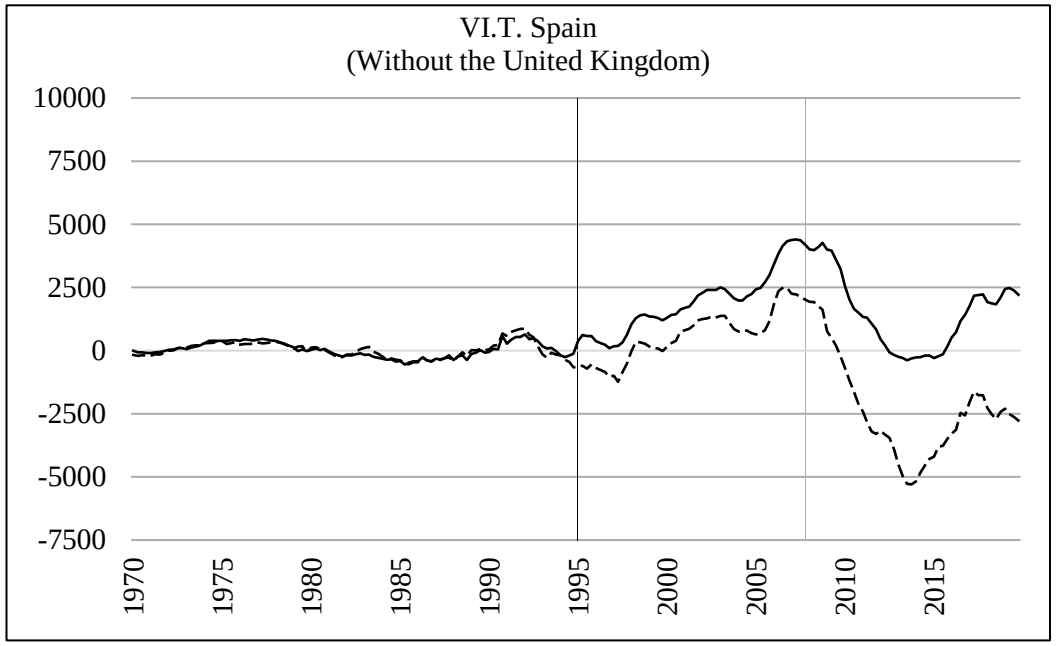
2005
2010
2015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-7500
1970
1975
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1985
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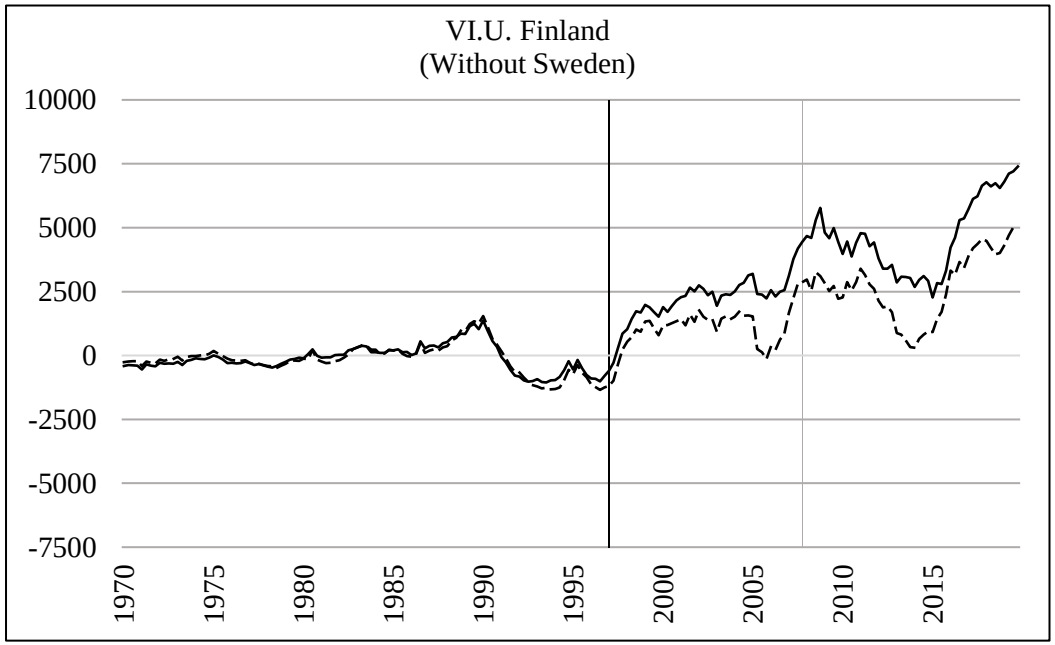
1995
2000
2005
2010
2015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-7500
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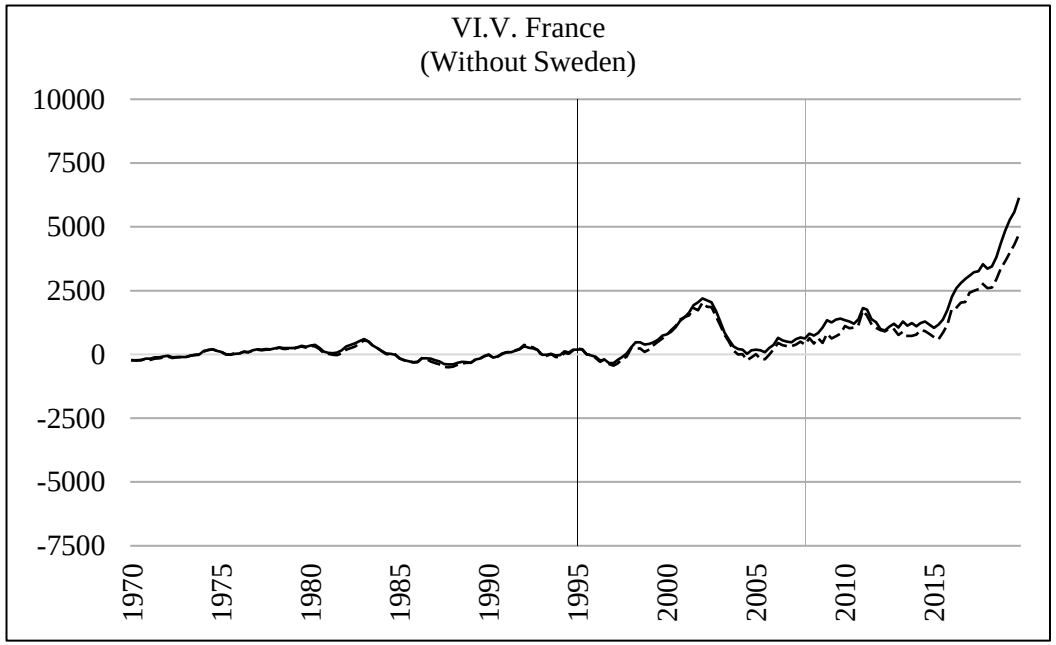
2000
2005
2010
2015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(Without Sweden)
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-5000
-7500
1970
1975
1980
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2000
2005
2010
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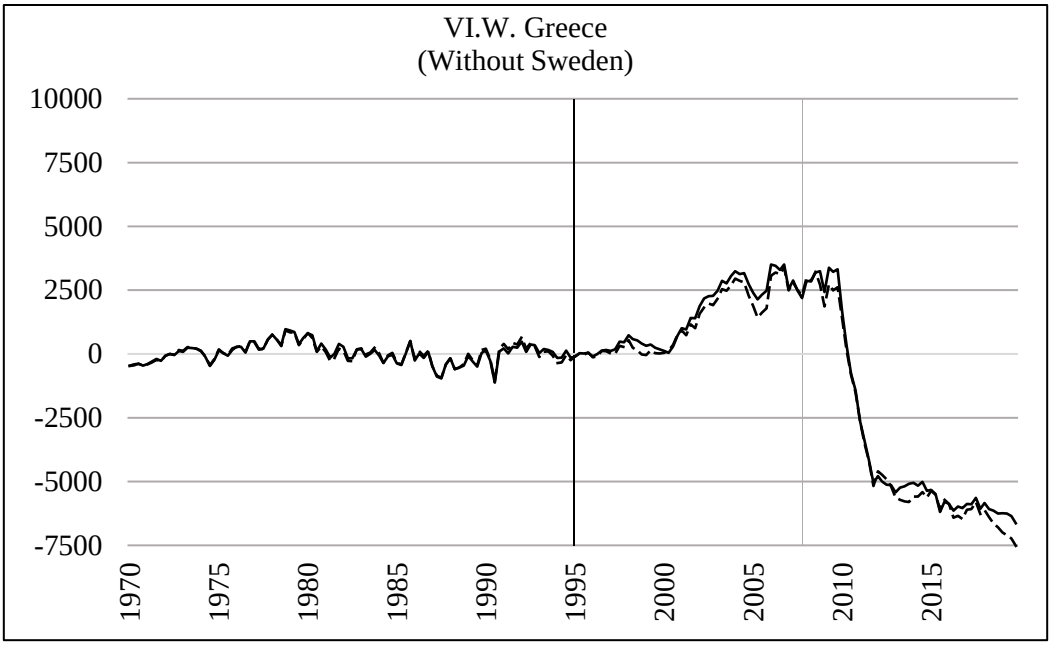
VI.W. Greece
(Without Sweden)
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2500
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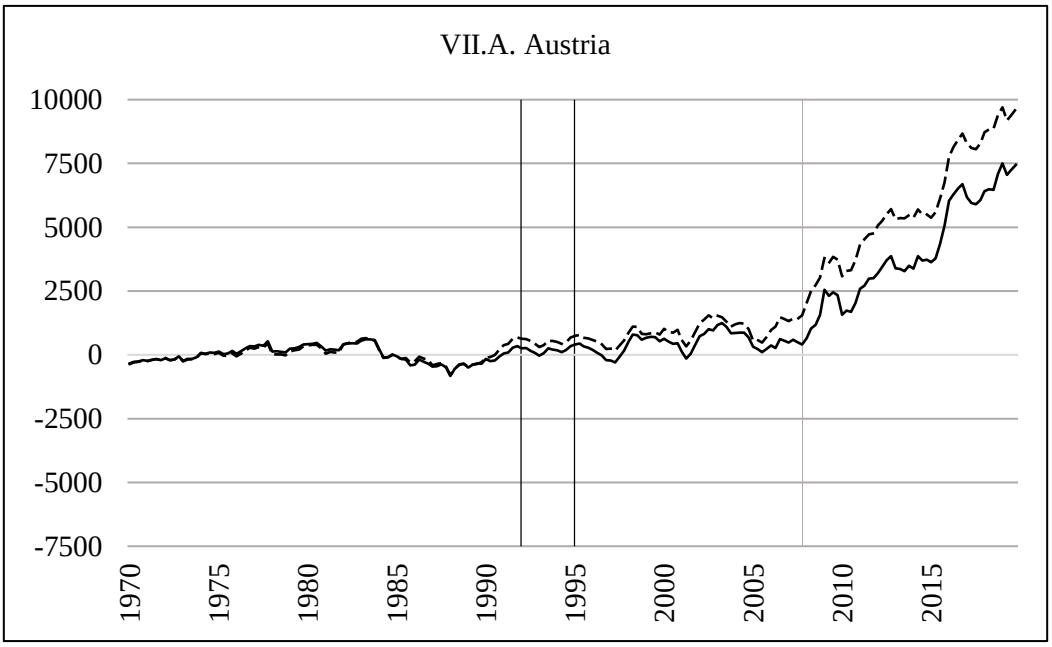
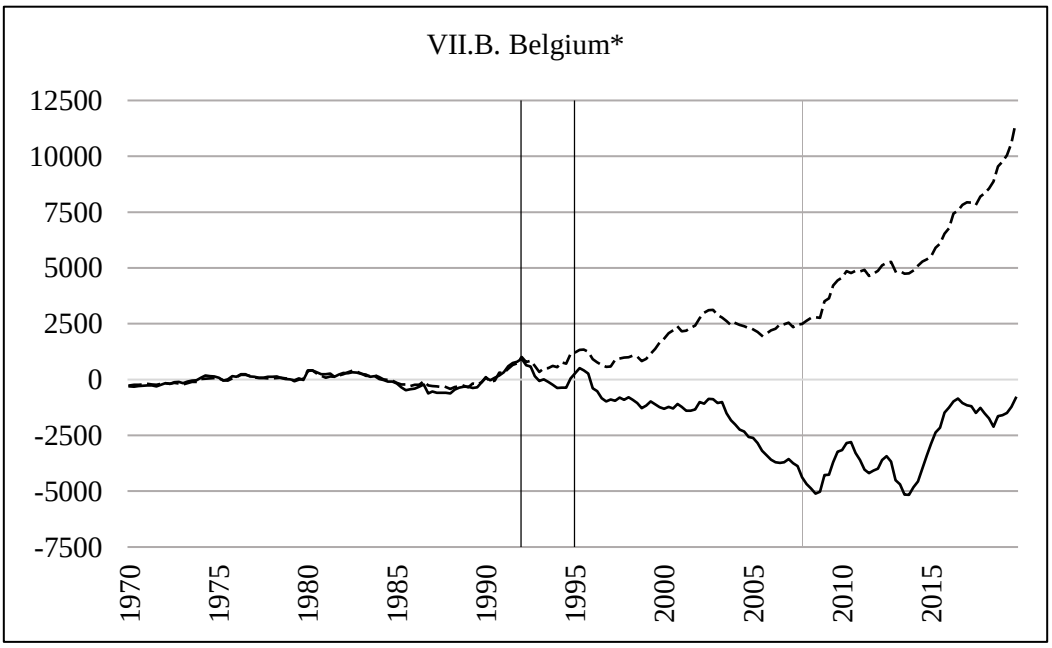
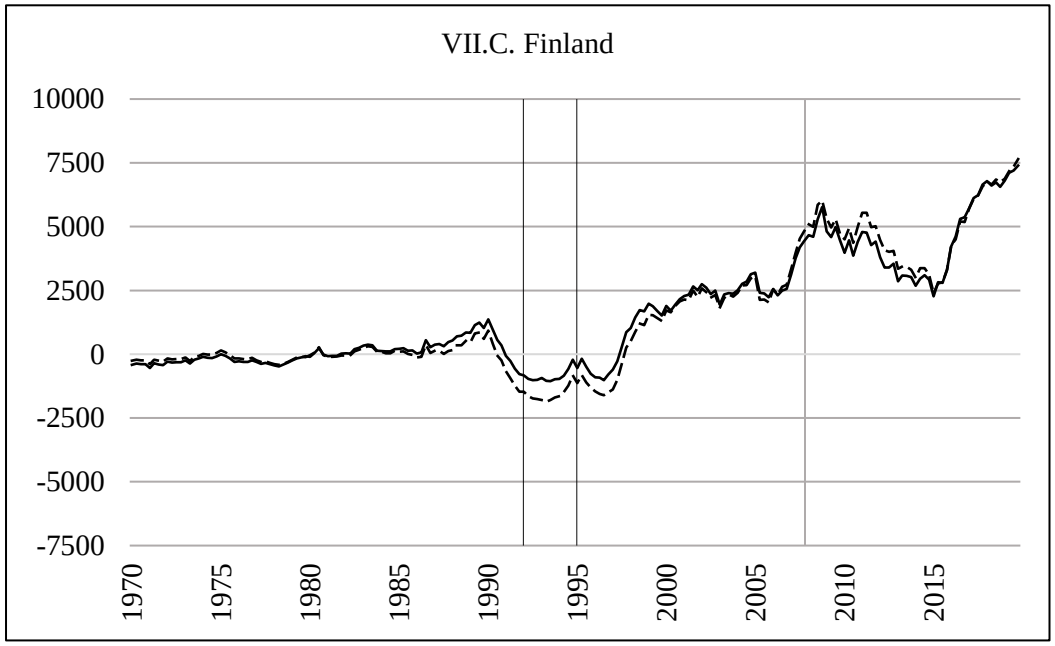
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Appendix VII – In-time placebo tests

This Appendix presents the results of the analysis set out in section 5.2. The black solid line indicates the bias-corrected treatment effect, as presented in section 4. The dashed black line indicates the bias-corrected treatment effect, which is obtained in the in-time placebo test. The treatment effect, expressed in terms of GDP per capita at time t and measured in US dollars, is presented on the Y-axis. The X-axis shows time. Three vertical lines are added in order to ease readability. The black vertical lines indicate treatment (1992 for the in-time placebo and 1995 for the main estimates). The grey vertical line indicates the start of the 2007 – 2008 global financial crisis during the fourth quarter of 2007. It should be noted that the Y-axes of all graphs are scaled [-7500,10000], exceptions are denoted by an asterisk (*) in the title in order to emphasise the distorted scaling of the Y-axis. The results are obtained using the Stata allsynth command, beta version 0.0.9., released 2 May 2022, developed by Wiltshire (2022b).



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1980
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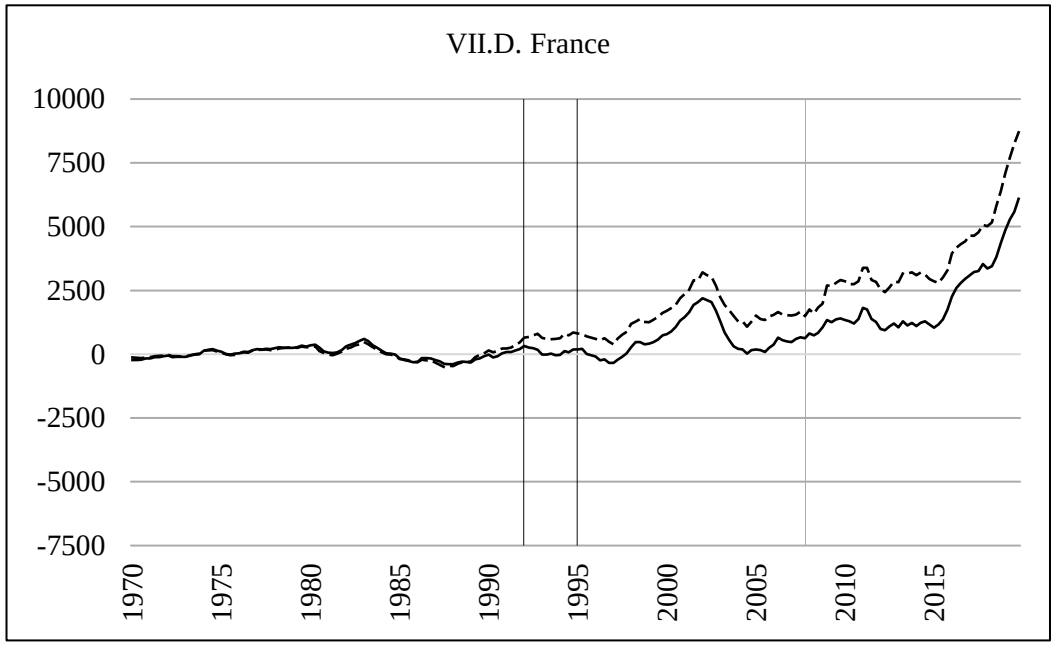
2005
2010
2015


VII.D. France
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2010
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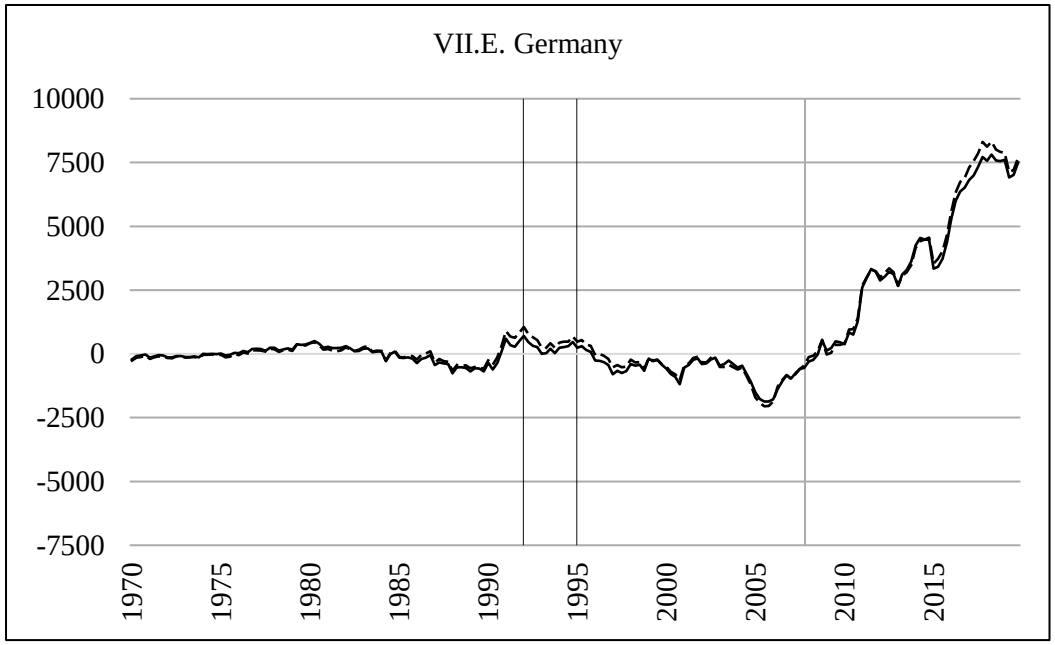
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1970
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2010
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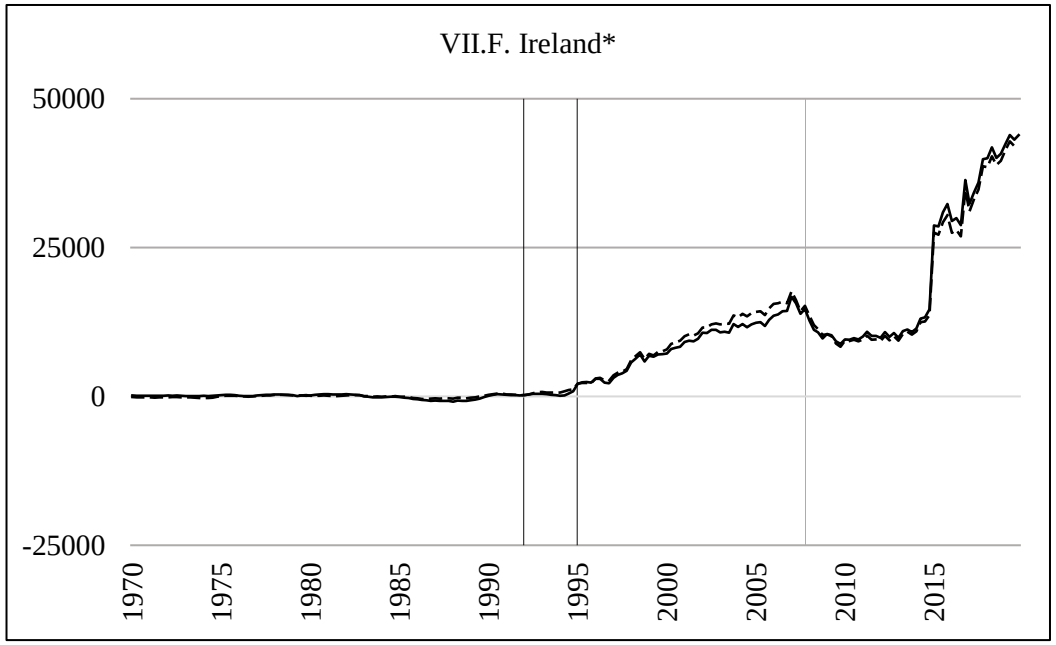
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1980
1985
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2000
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2010
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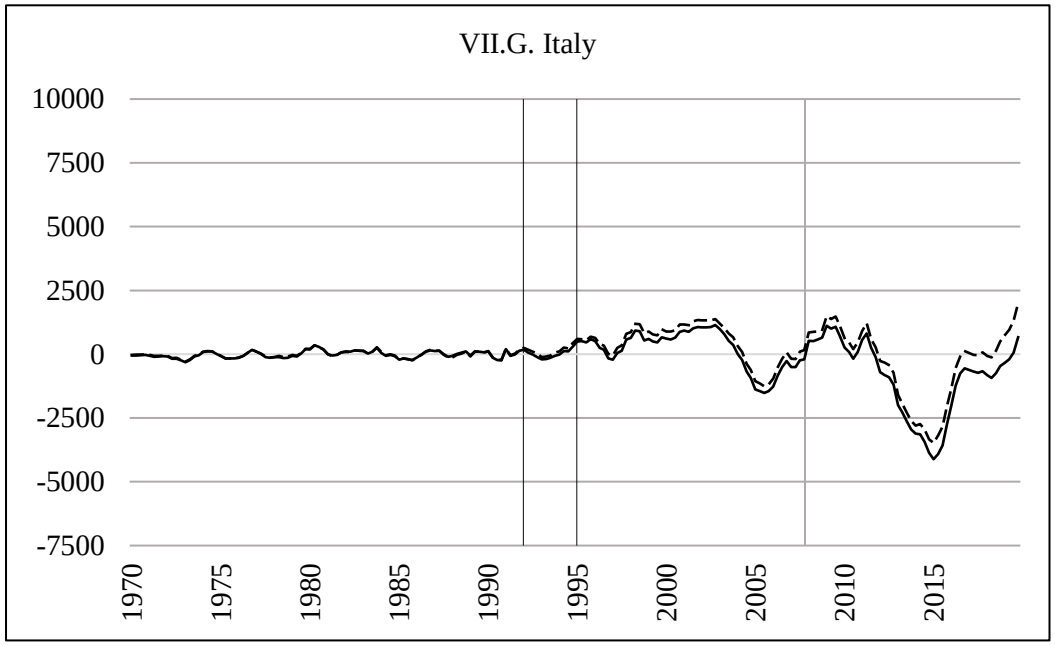
VII.G. Italy
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1975
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2010
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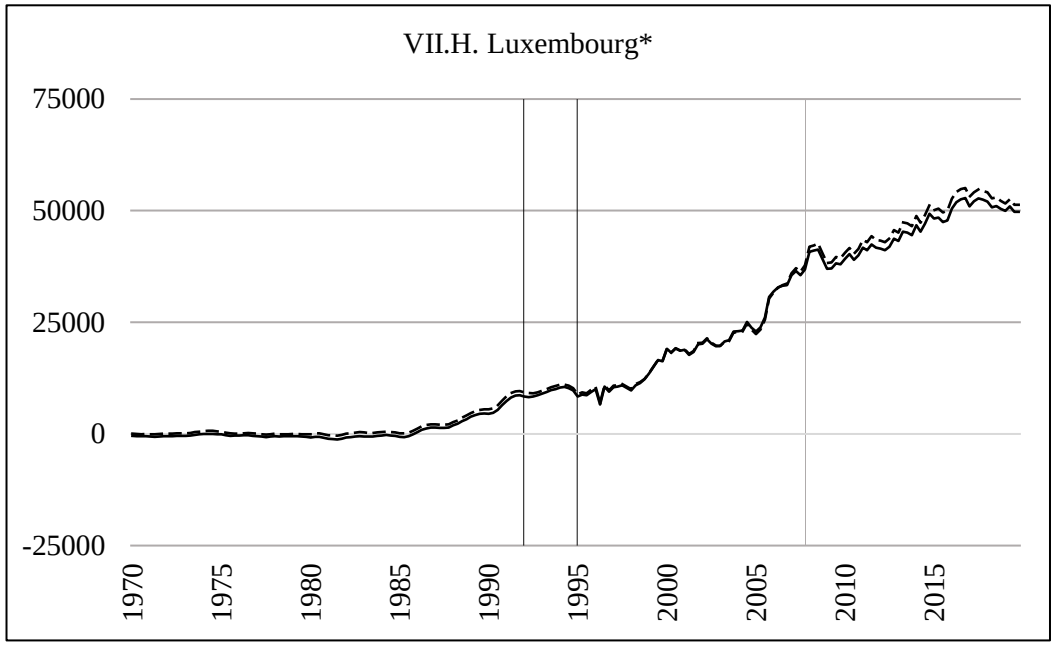
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1980
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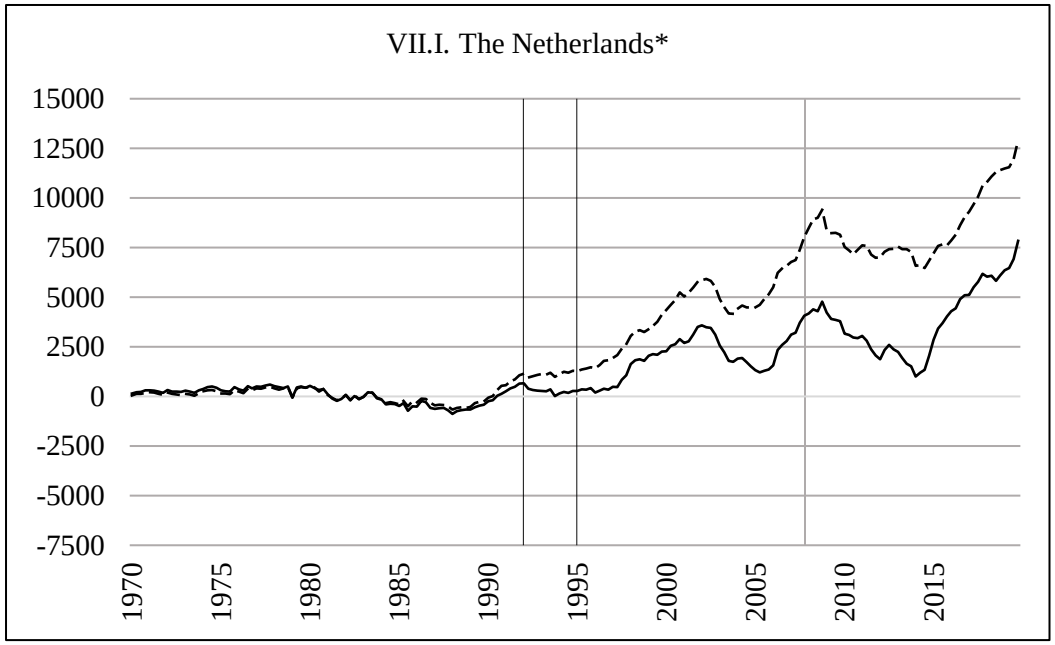
VII.I. The Netherlands*
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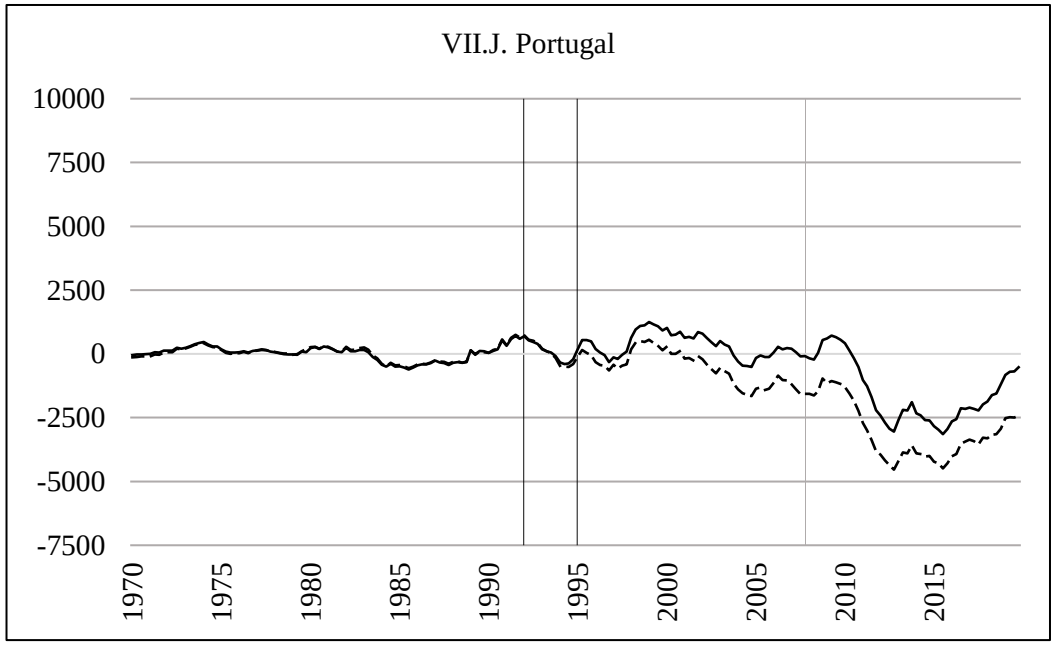
VII.J. Portugal
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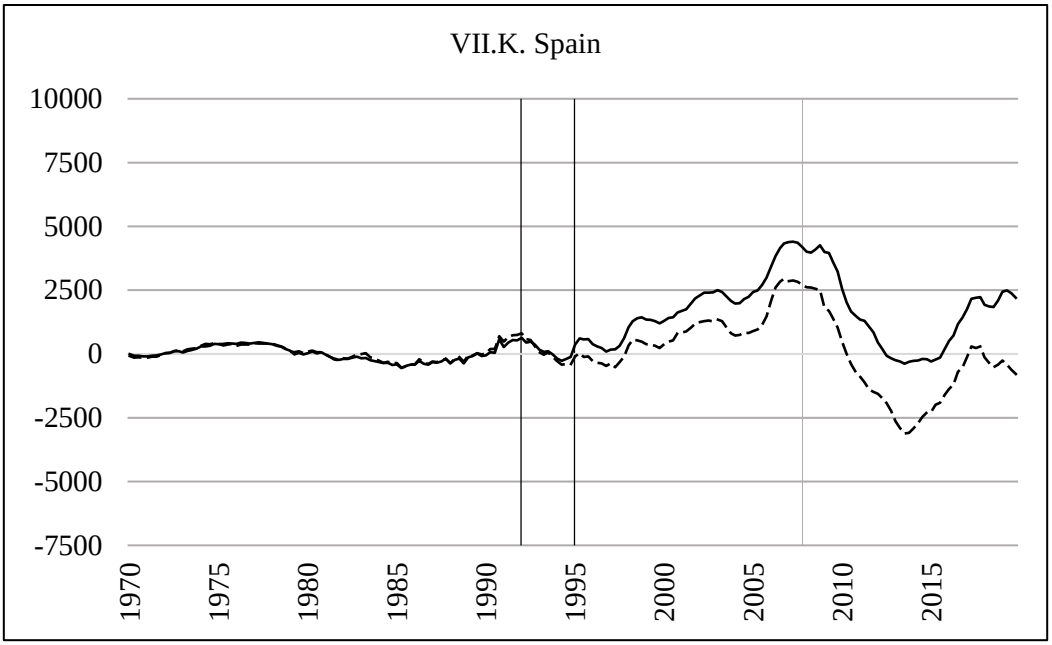
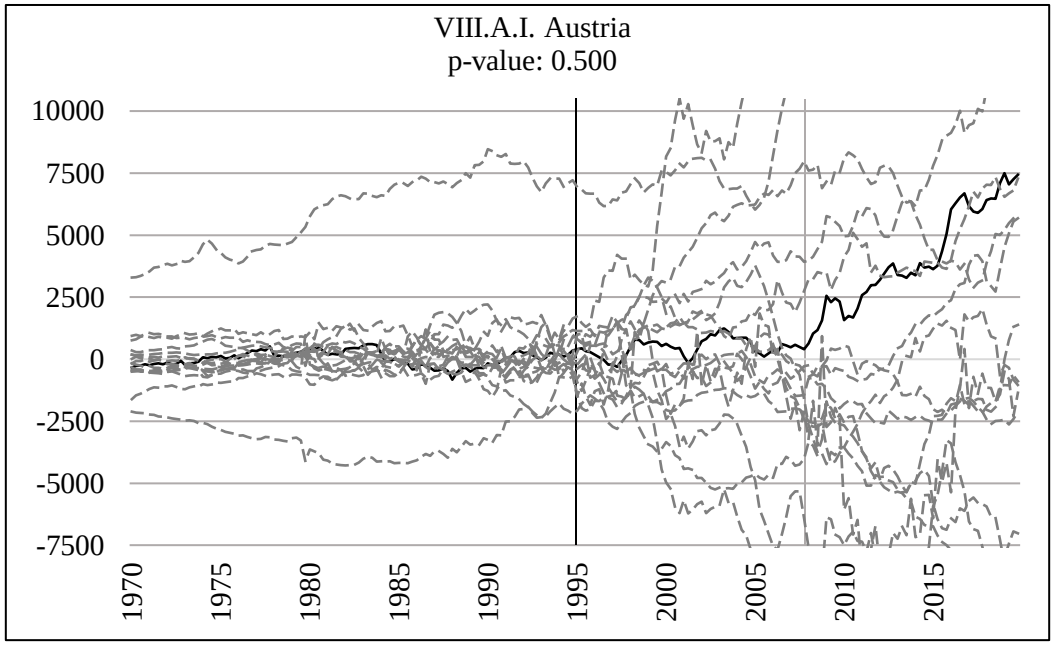
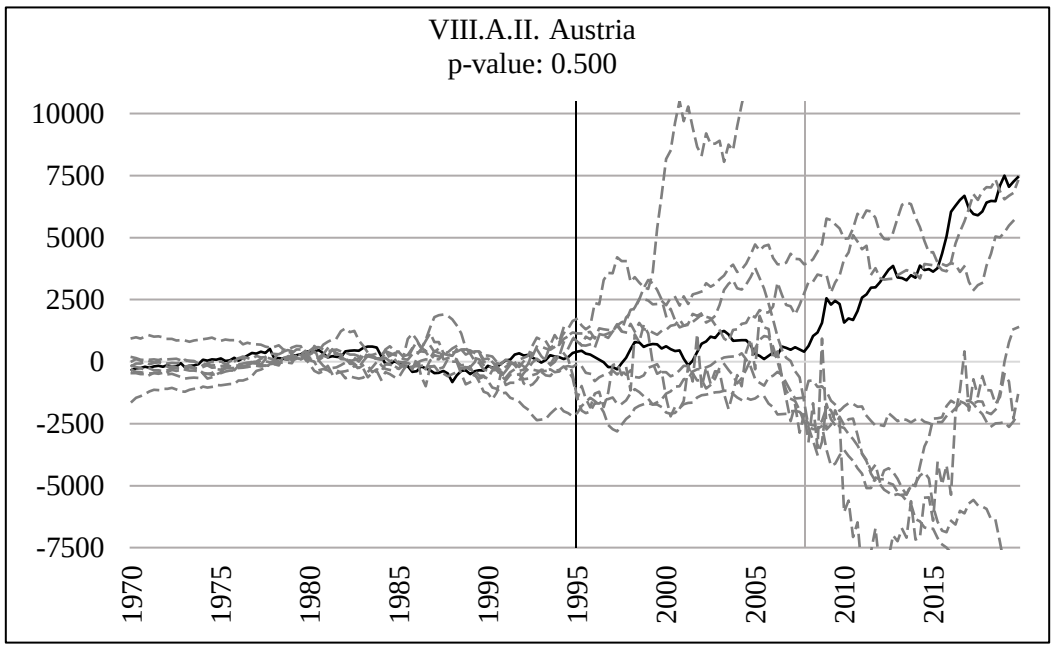
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

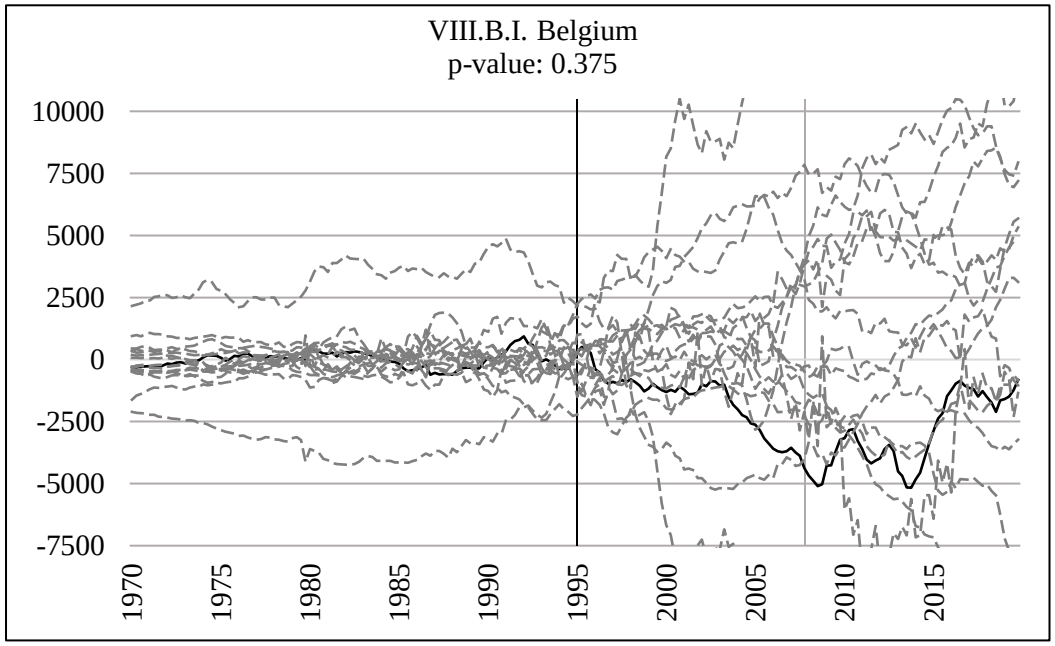

VII.K. Spain
10000
7500
5000
2500
0
-2500
-5000
-7500
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Appendix VIII – In-space placebo tests

This Appendix presents the results of the analysis set out in section 5.3. The black solid line indicates the bias-corrected treatment effect, as presented in section 4. The dashed grey lines indicate the bias-corrected treatment in-space placebo effects, which are in accordance with the methodology presented in section 5.3. The treatment effect, expressed in terms of GDP per capita at time t and measured in US dollars, is presented on the Y-axis. The X-axis shows time. Two vertical lines are added in order to ease readability. The black vertical line indicates treatment and the grey vertical line indicates the start of the 2007 – 2008 global financial crisis during the fourth quarter of 2007. Finally, it should be noted that the Y-axes of all graphs are scaled $[-7500, 10000]$, exceptions are denoted by an asterisk (*) in the title in order to emphasise the distorted scaling of the Y-axis. Finally, the p-value associated with the treated unit's estimate is presented under the tile. The results are obtained using the Stata *allsynth* command, beta version 0.0.9., released 2 May 2022, developed by Wiltshire (2022b).



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p-value: 0.375
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-7500
1970
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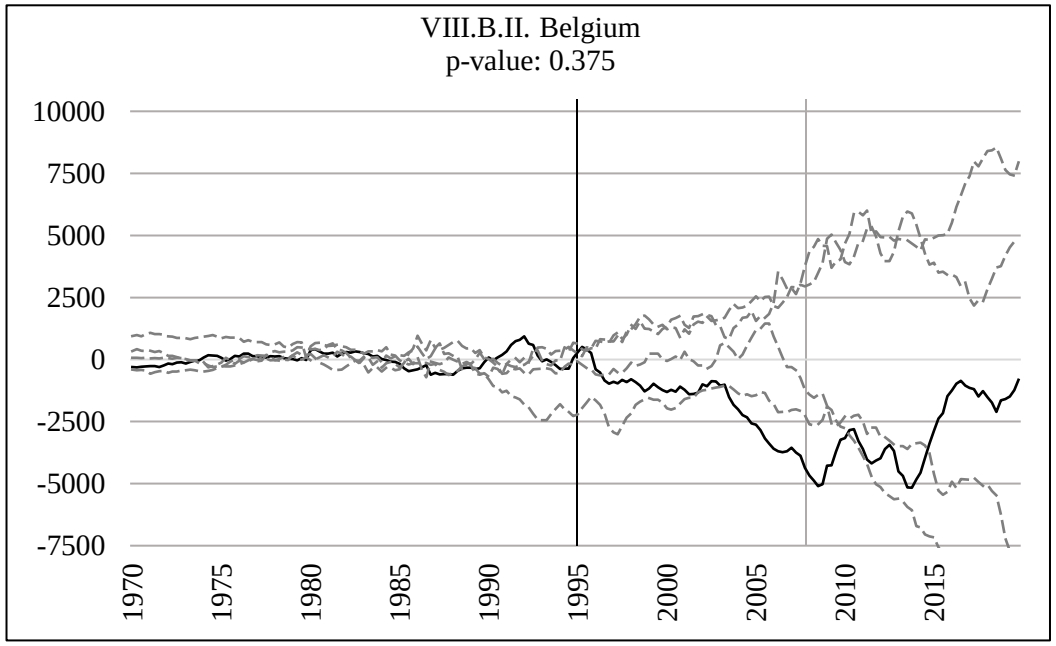
1980
1985
1990
1995
2000
2005
2010
2015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p-value: 0.375
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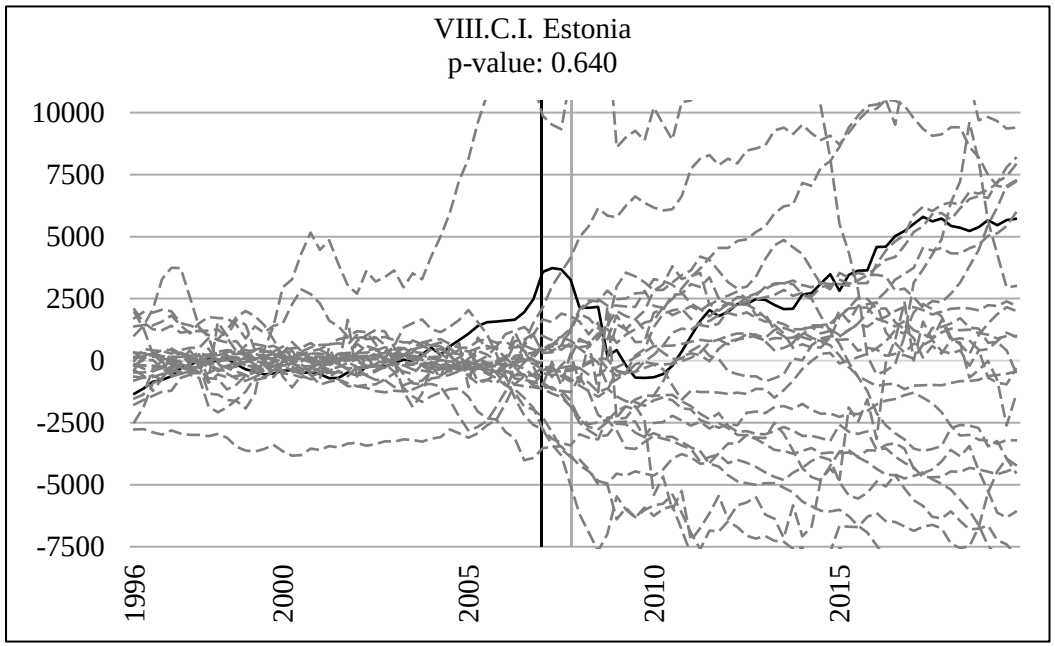
2000
2005
2010
2015


VIII.C.I. Estonia
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-2500
-5000
-7500
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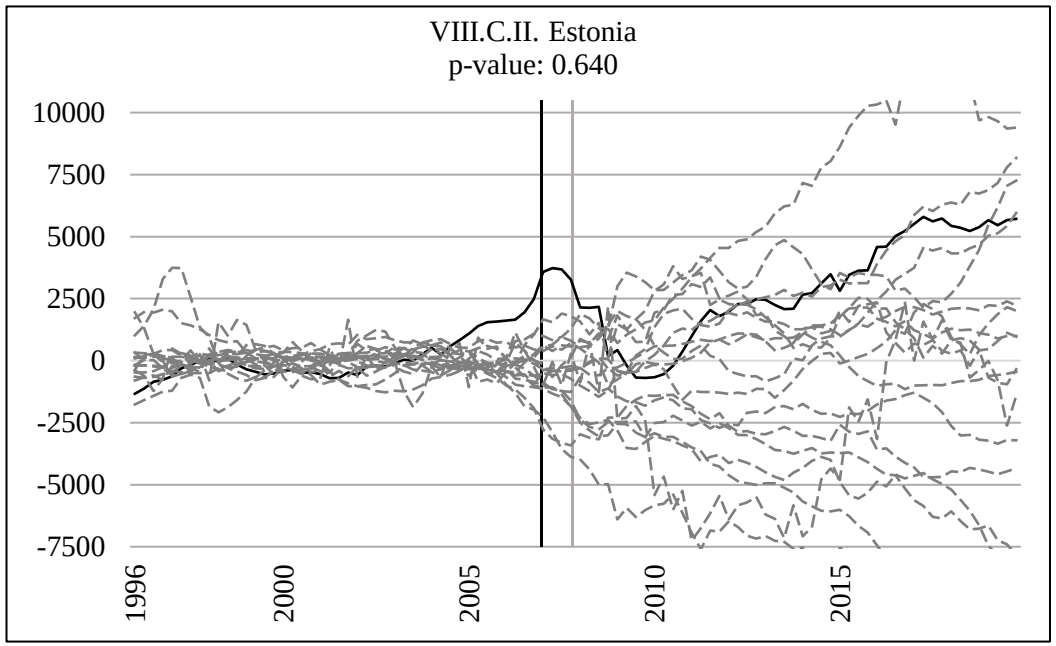
2000
2005
2010
2015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2000
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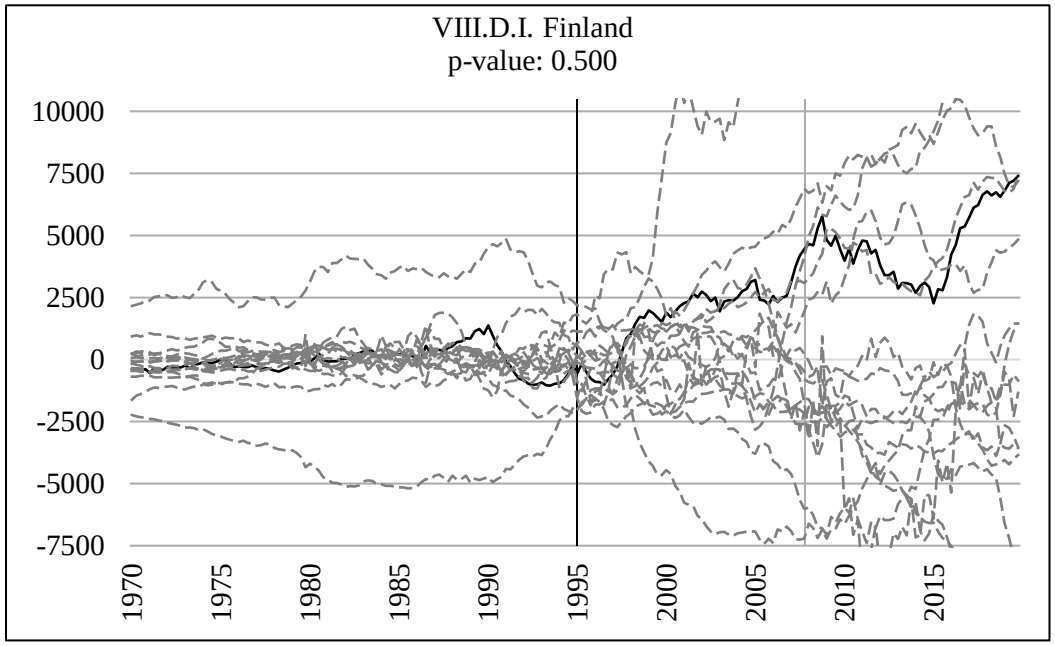
2010
2015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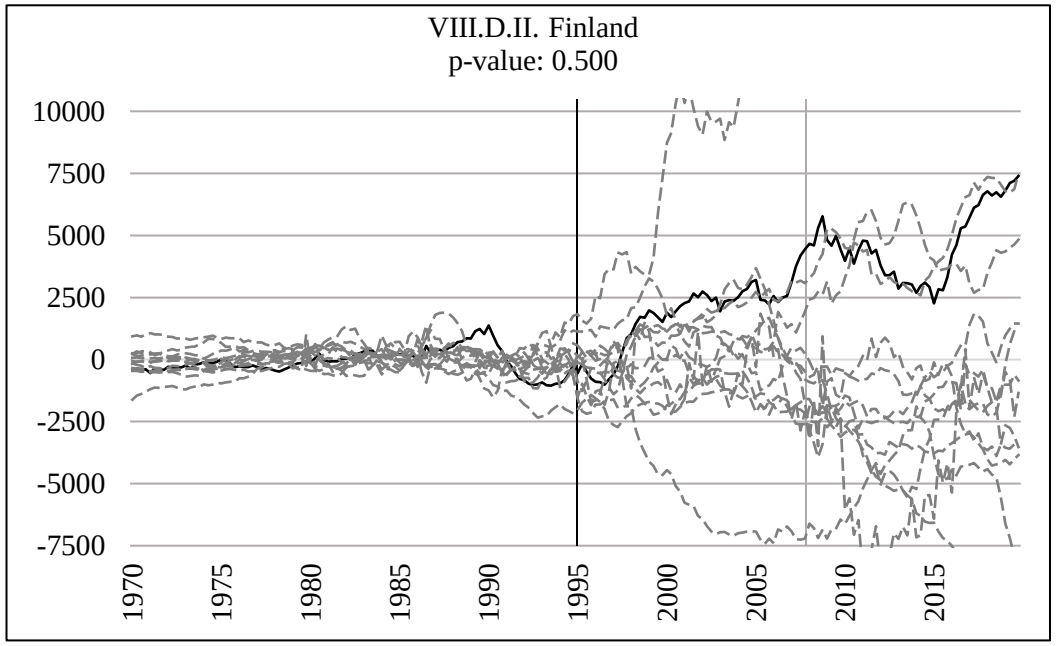
2015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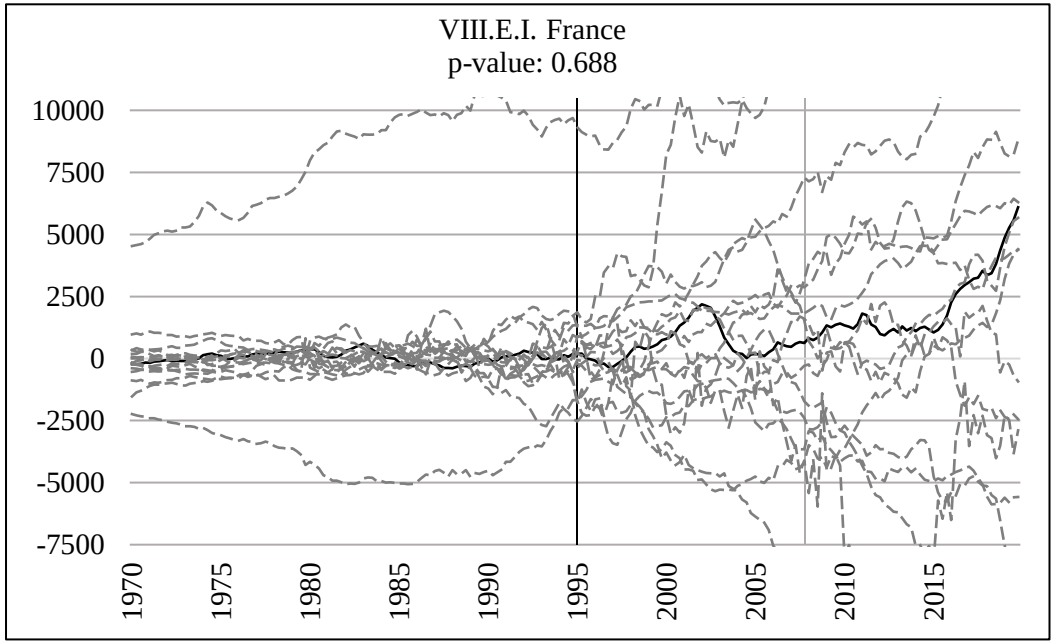
2005
2010
2015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p-value: 0.688
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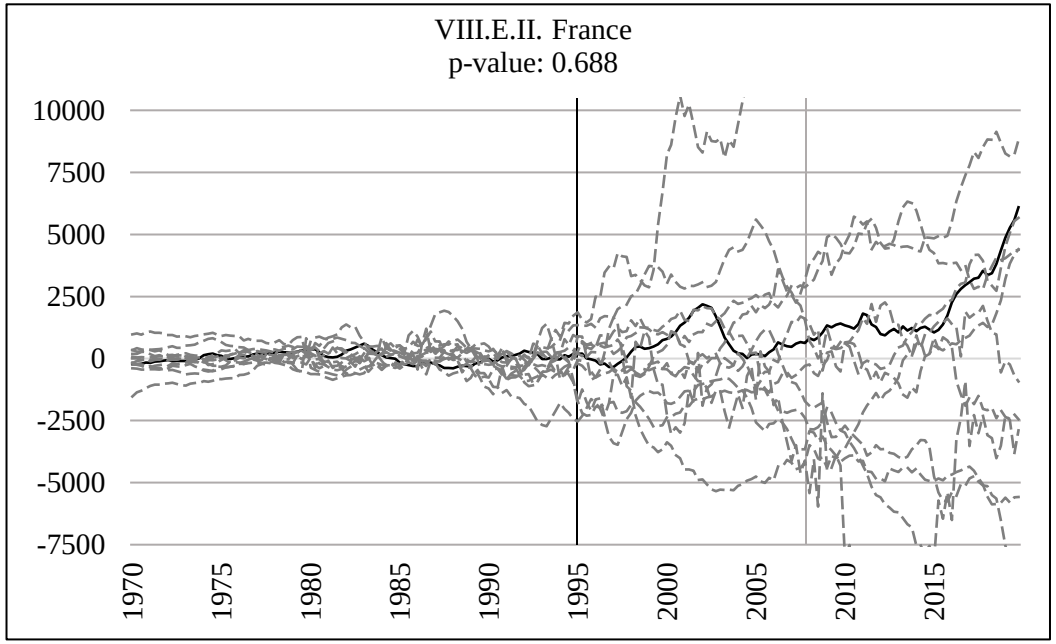
2000
2005
2010
2015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p-value: 0.688
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2500
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-2500
-5000
-7500
1970
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1990
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2000
2005
2010
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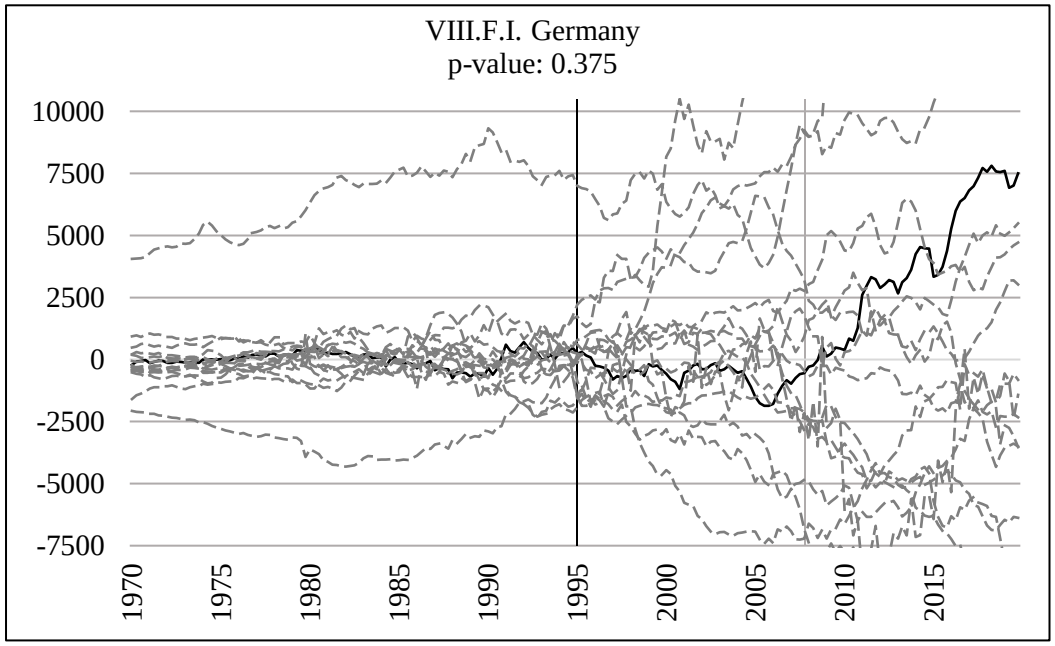
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p-value: 0.375
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2005
2010
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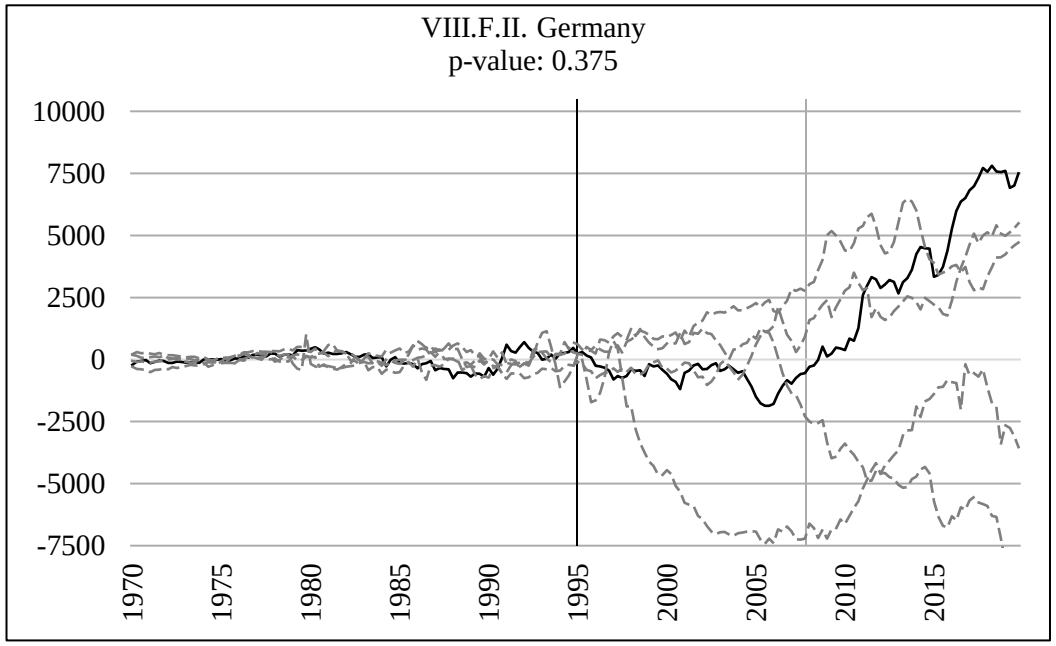
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p-value: 0.375
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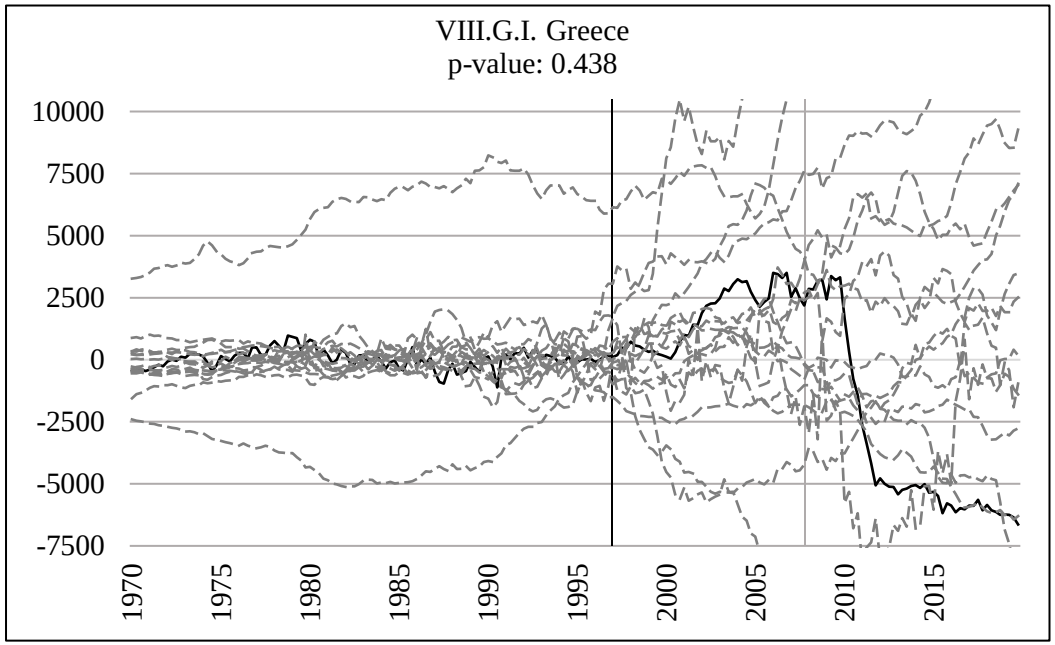
VIII.G.I. Greece
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2005
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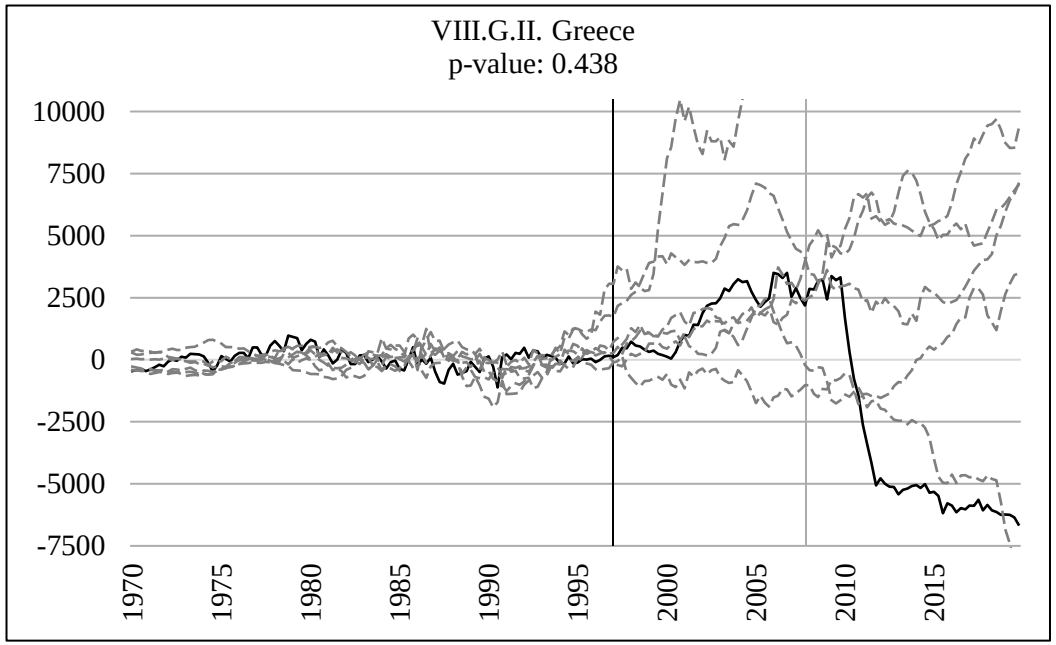
VIII.G.II. Greece
p-value: 0.438
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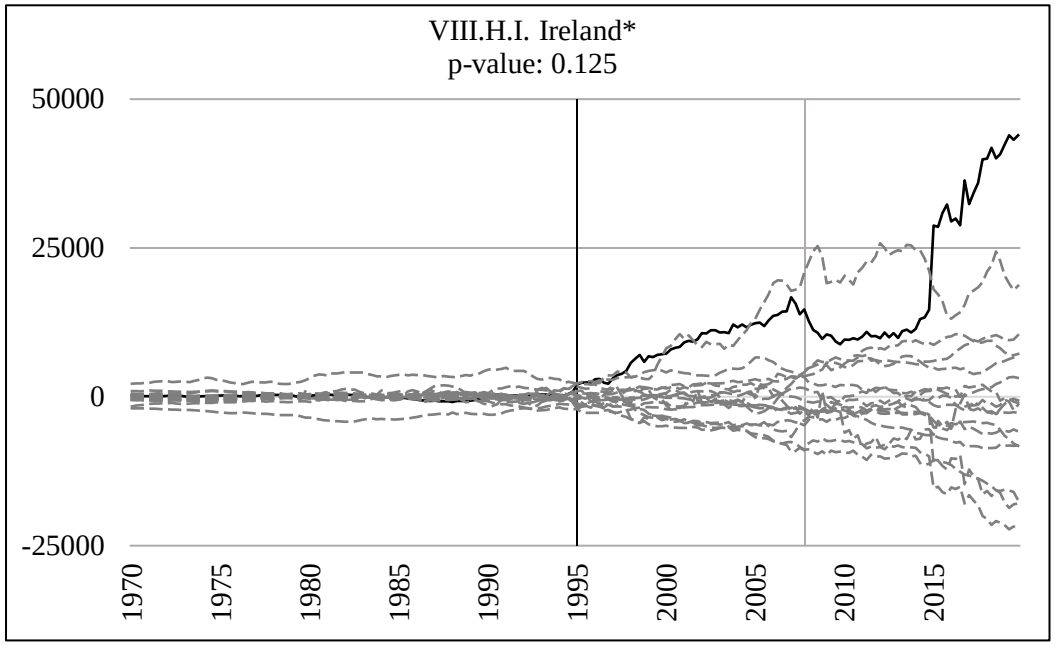
VIII.H.I. Ireland*
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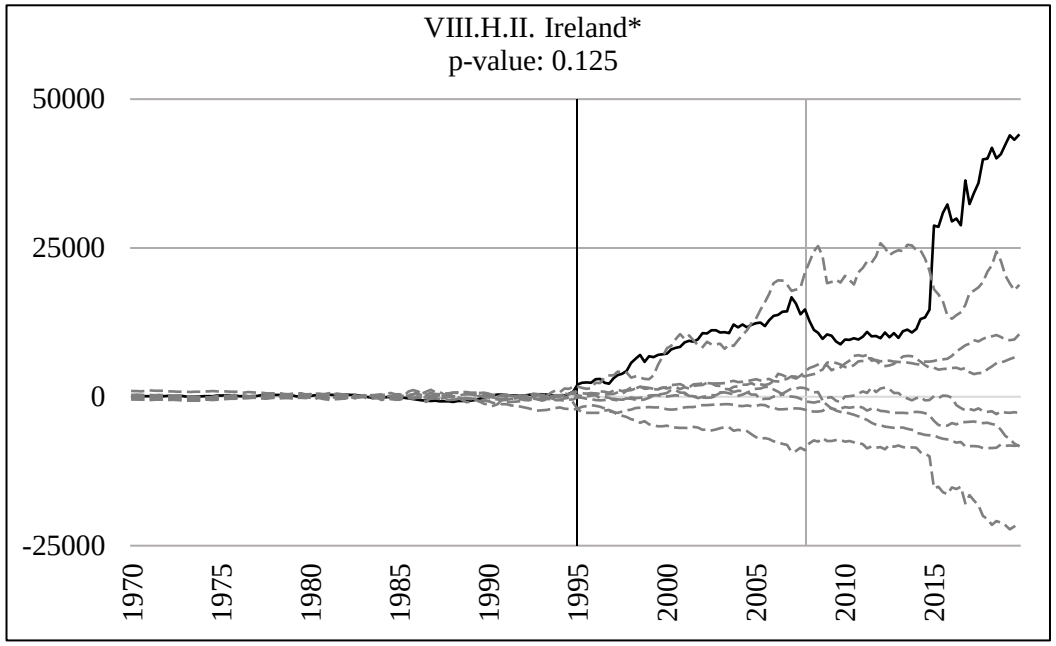
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2010
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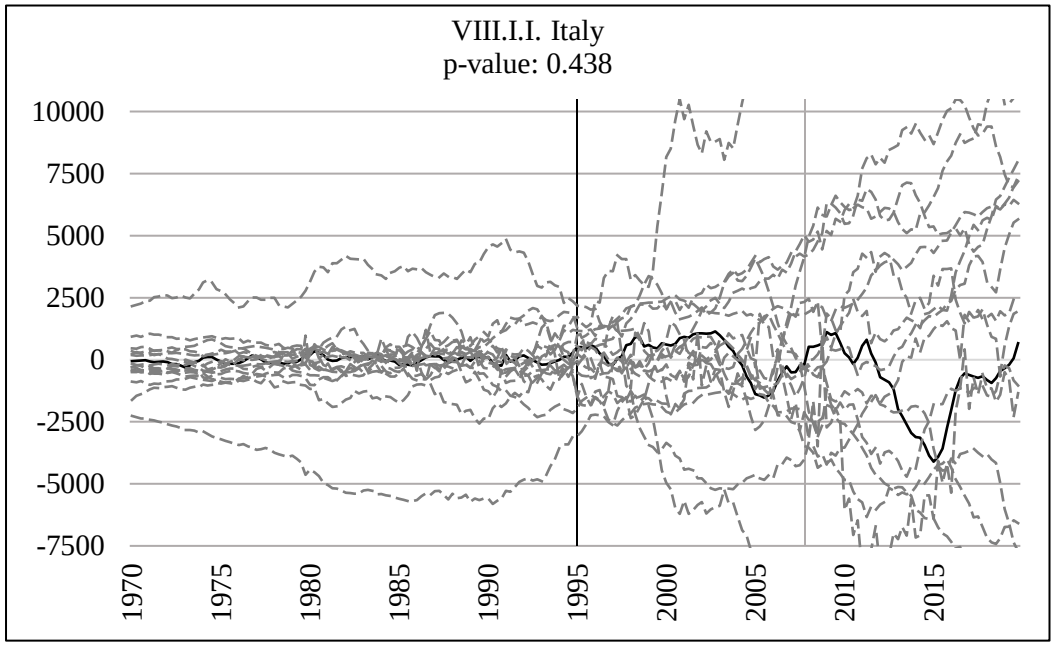
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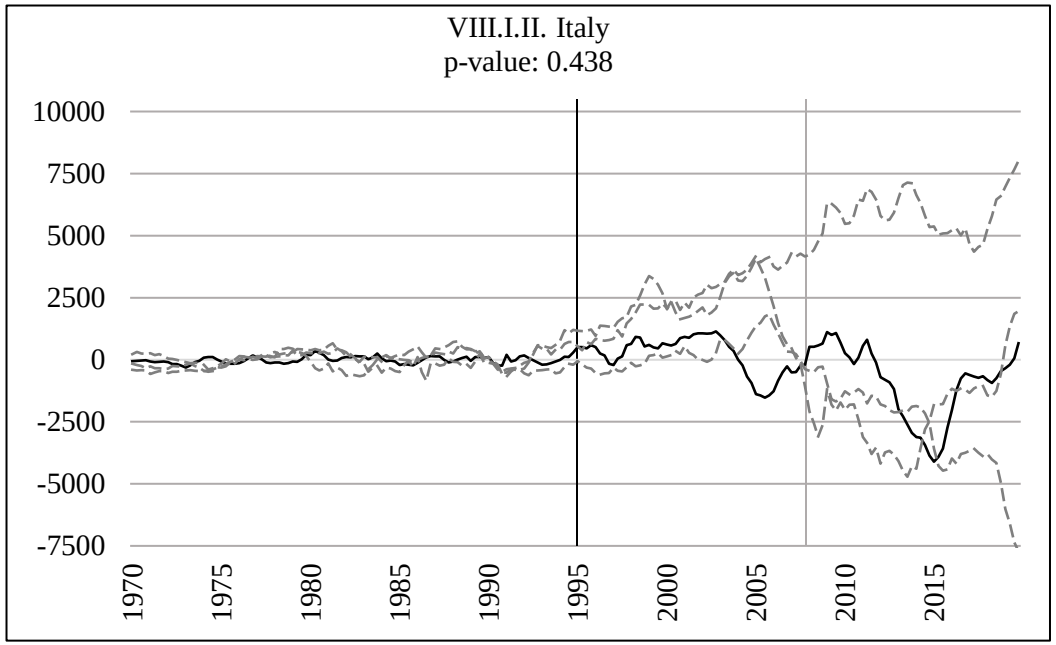
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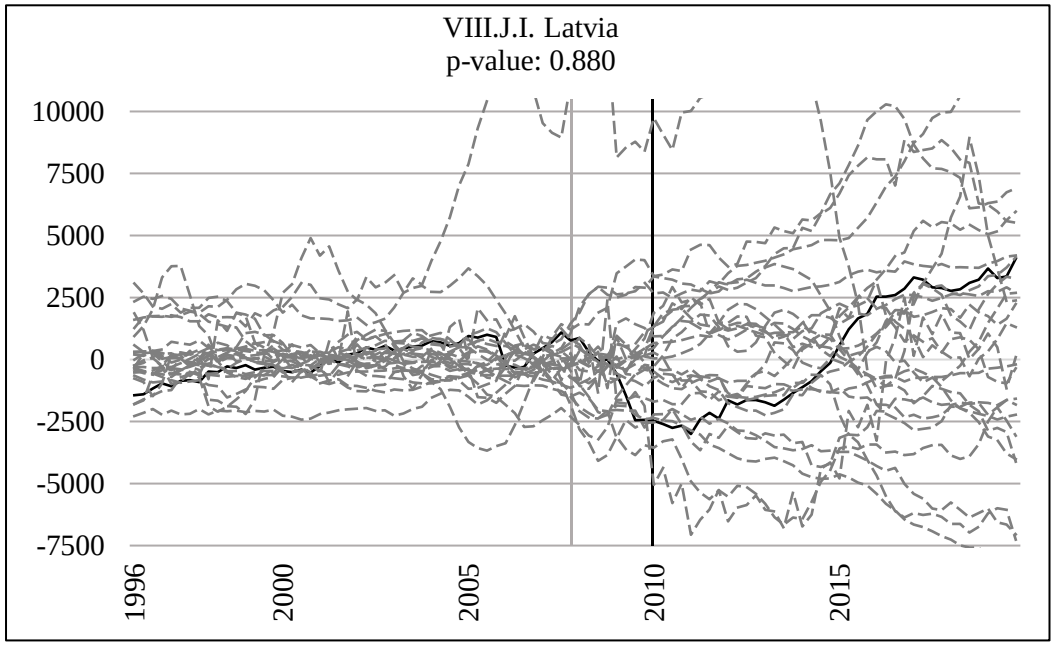
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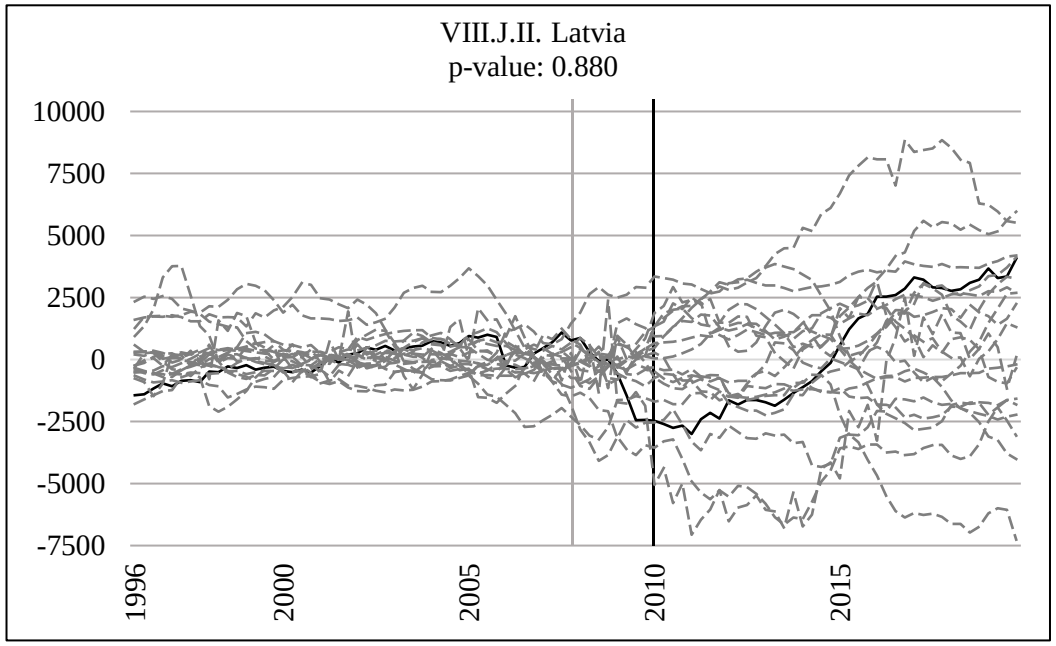
2010
2015


VIII.J.II. Latvia
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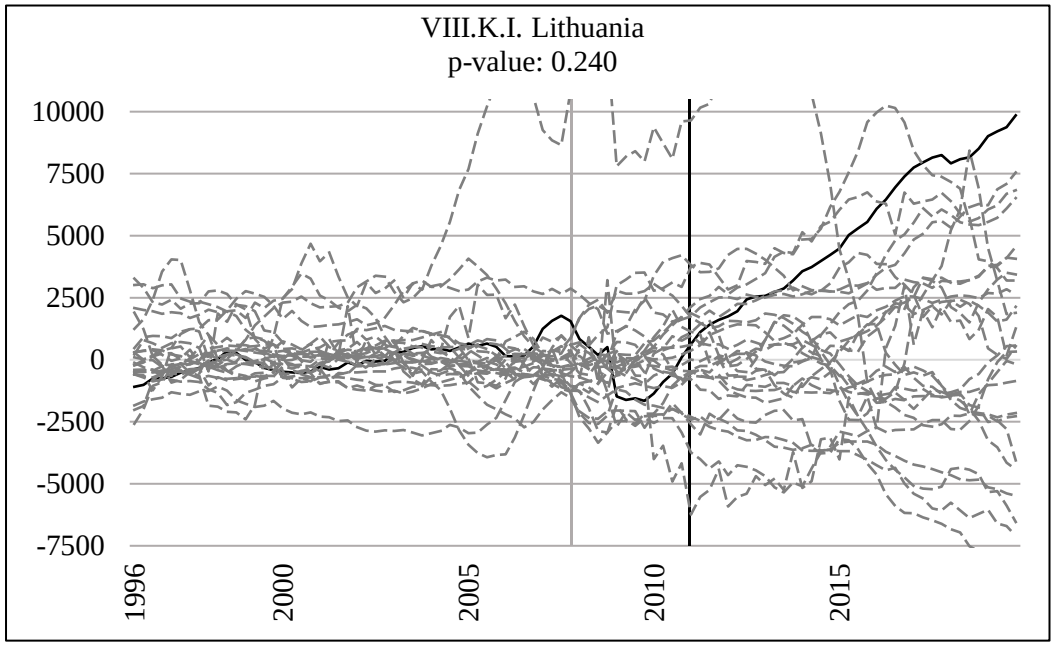
2005
2010
2015


VIII.K.I. Lithuania
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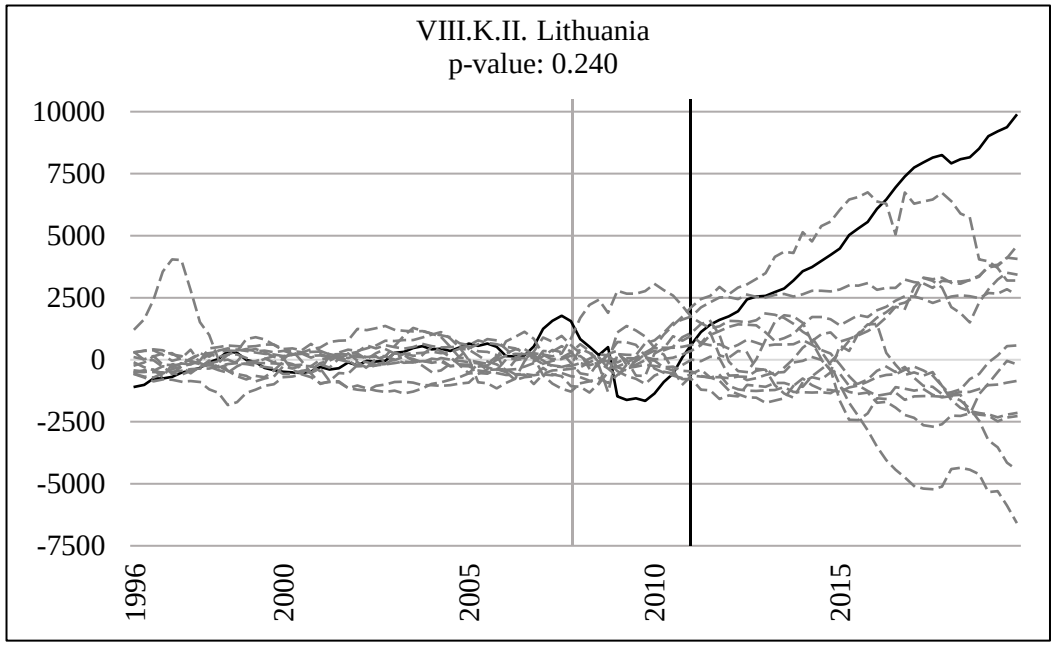
2010
2015


VIII.K.II. Lithuania
p-value: 0.240
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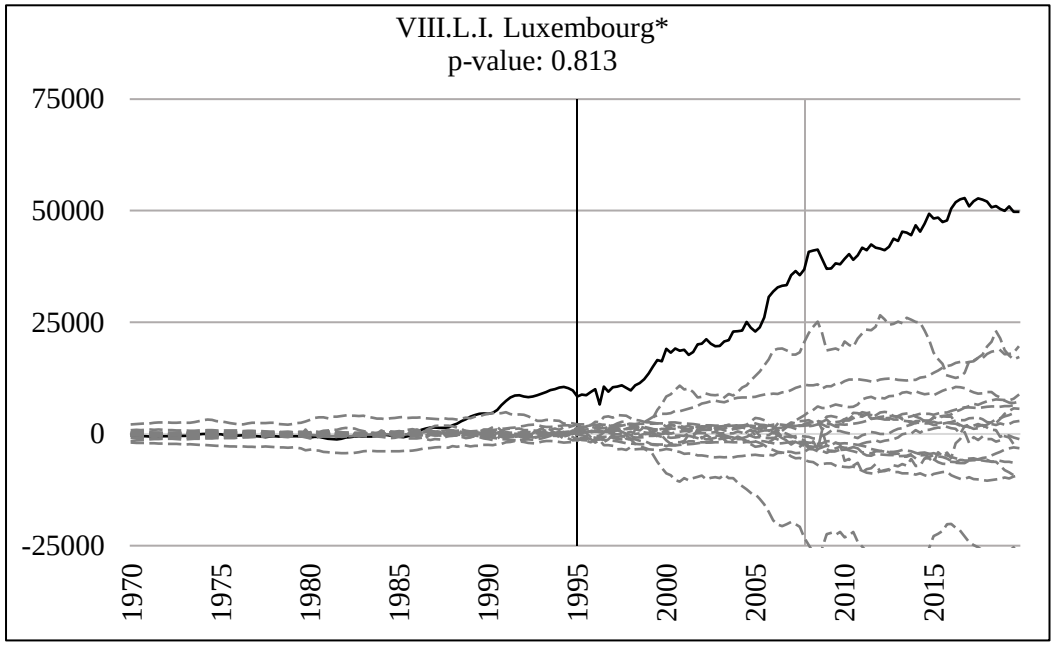
2010
2015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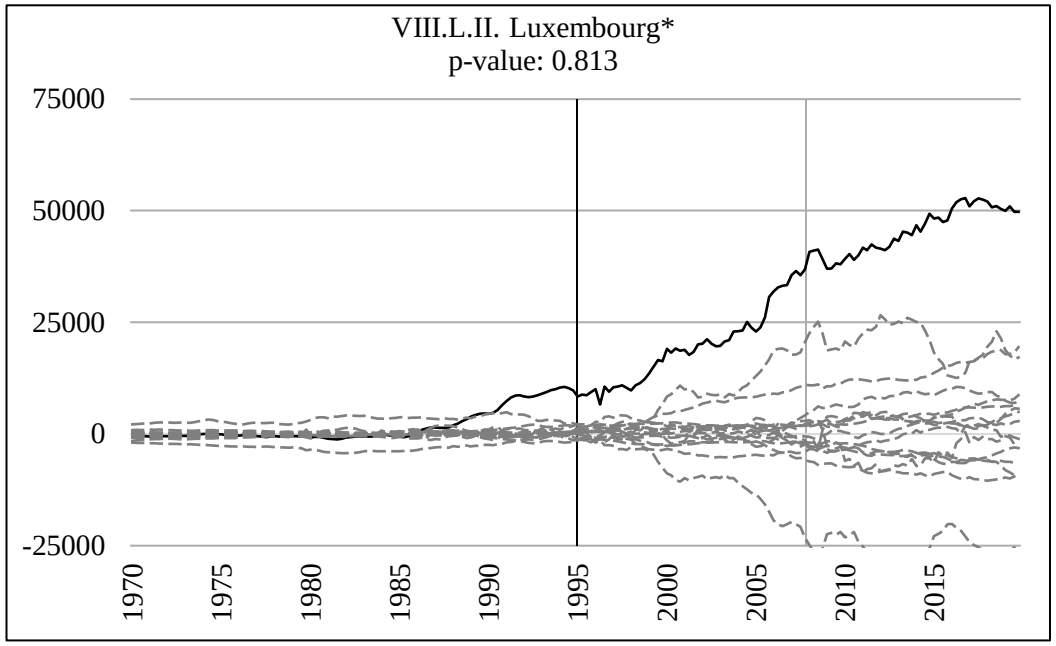
2010
2015


VIII.L.II. Luxembourg*
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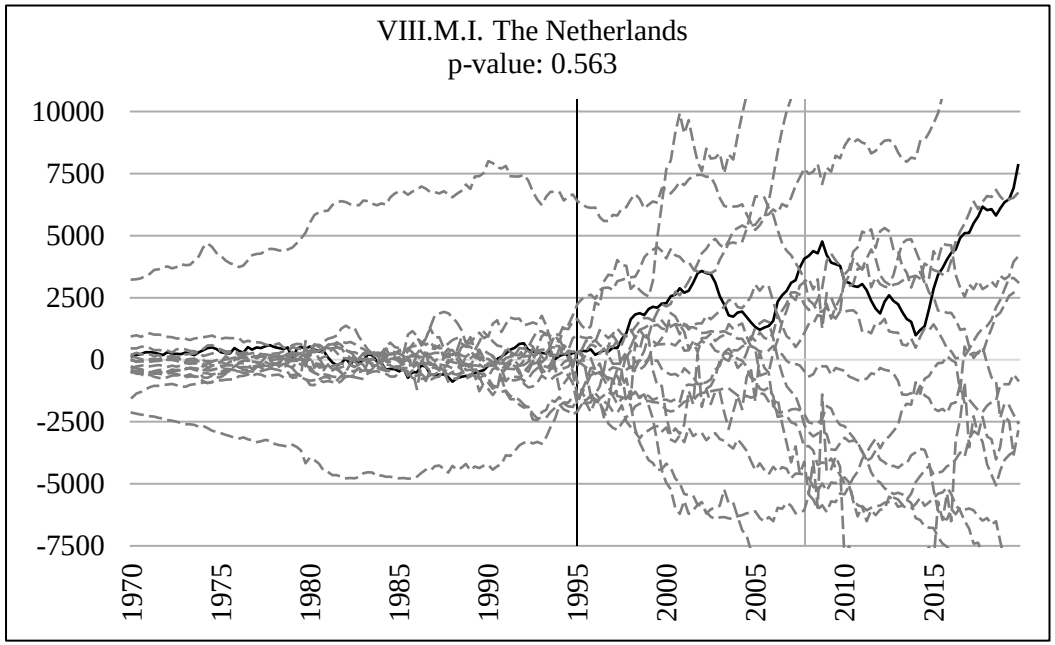
2015


VIII.M.I. The Netherlands
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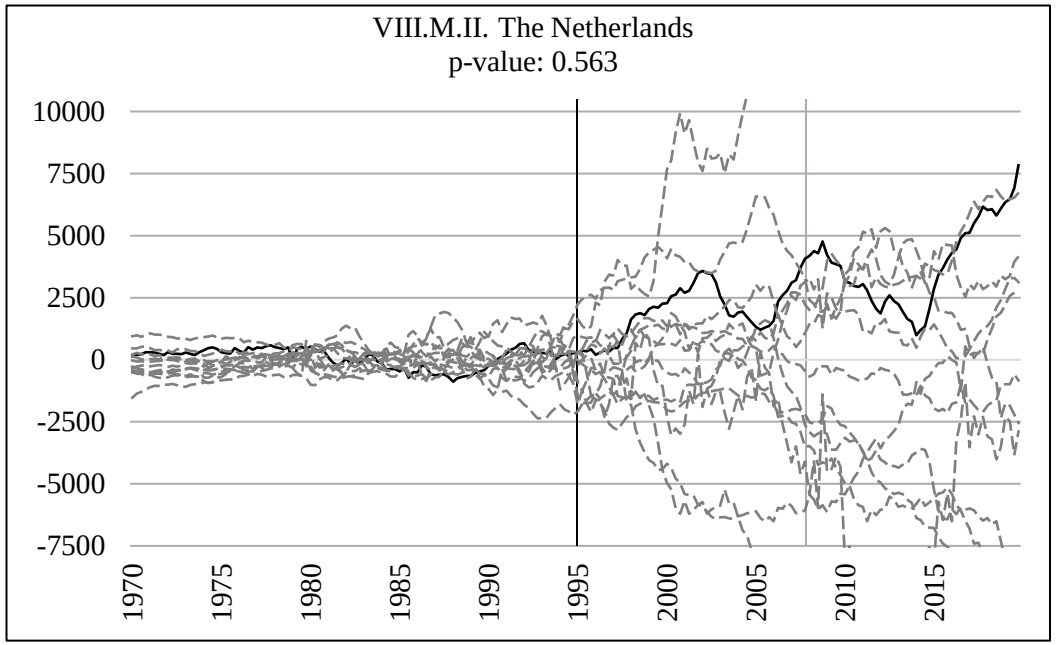
2015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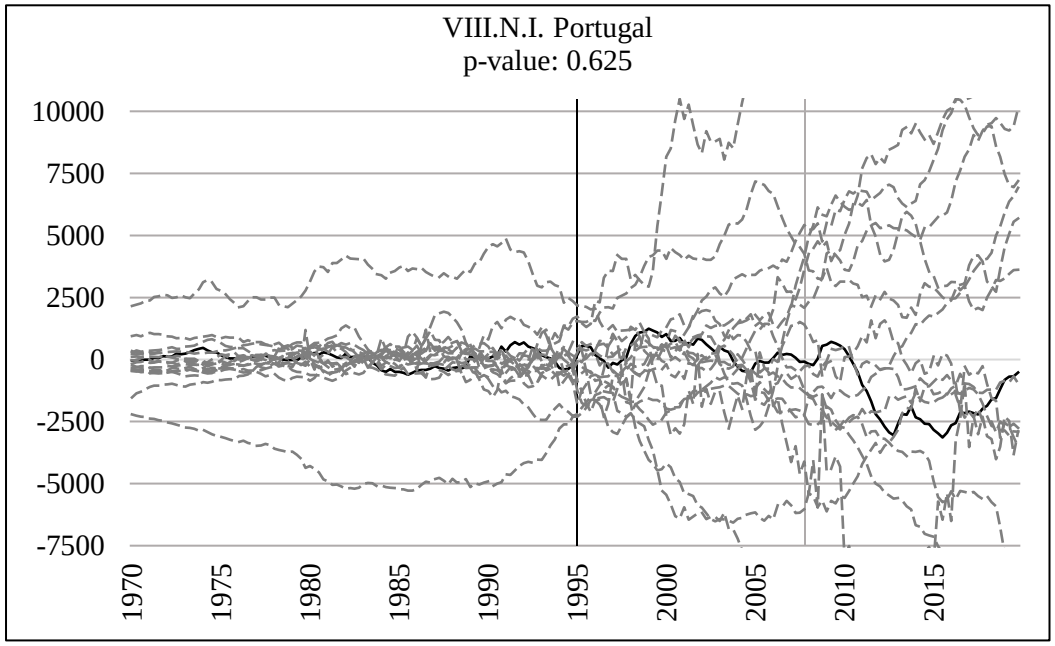
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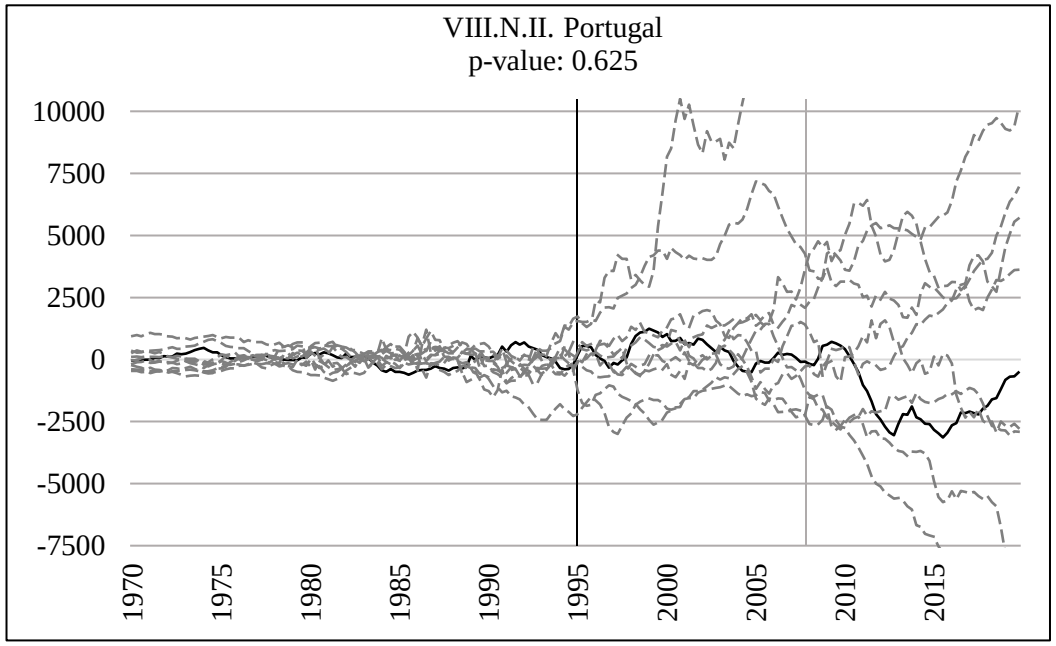
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p-value: 0.625
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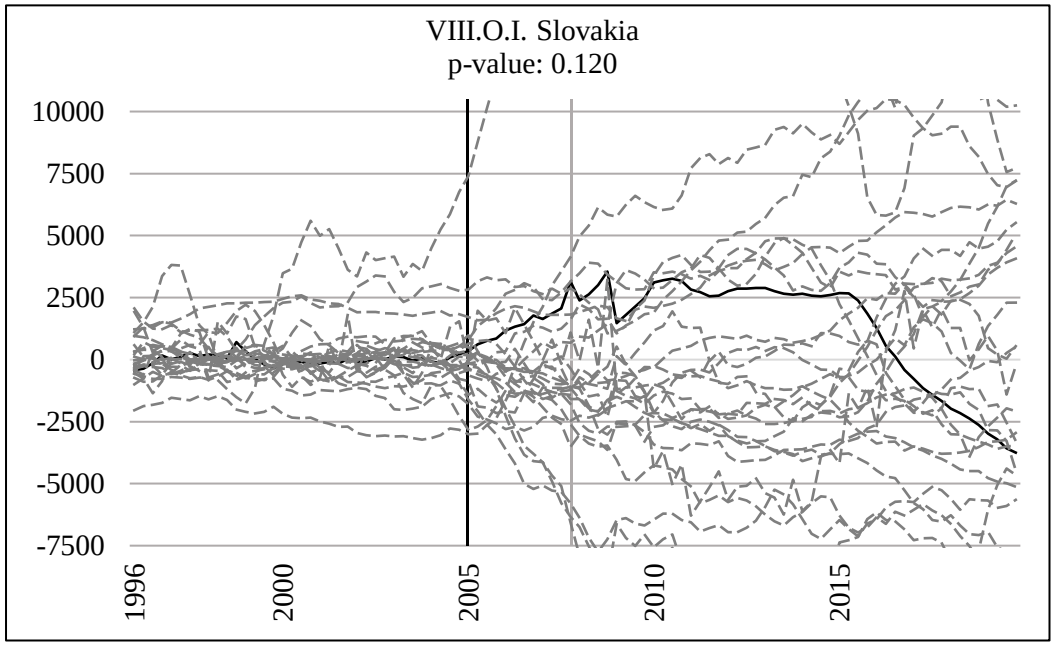
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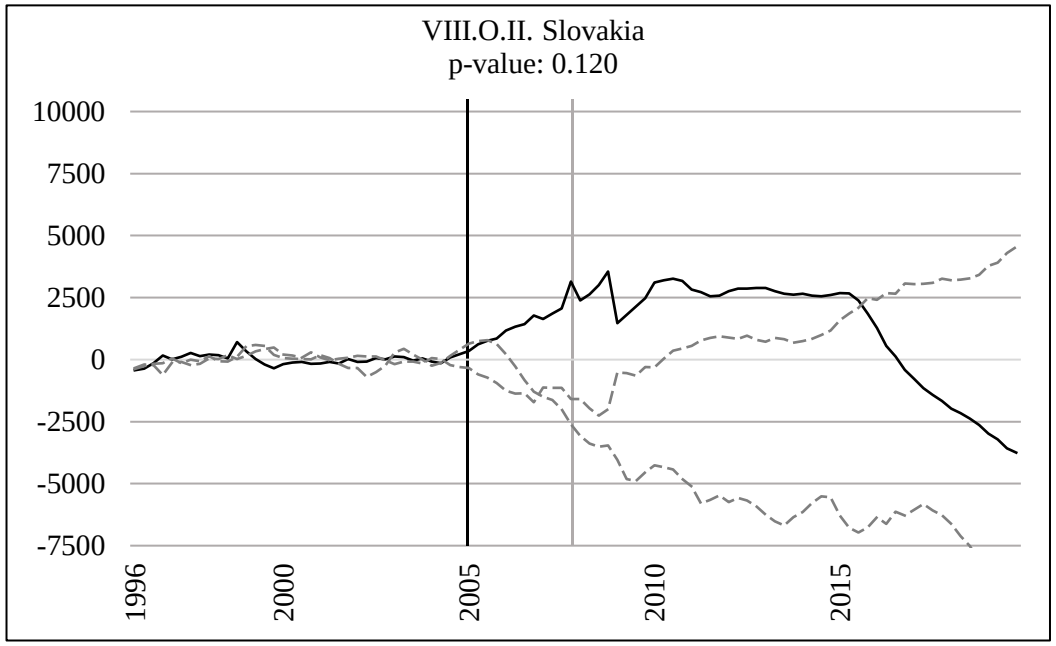
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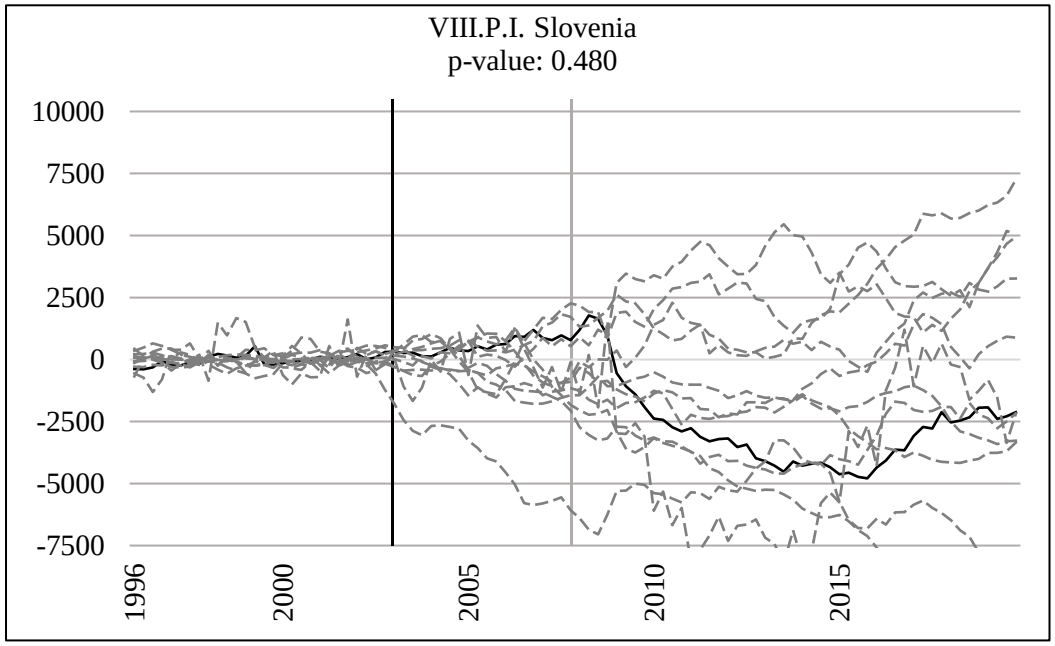
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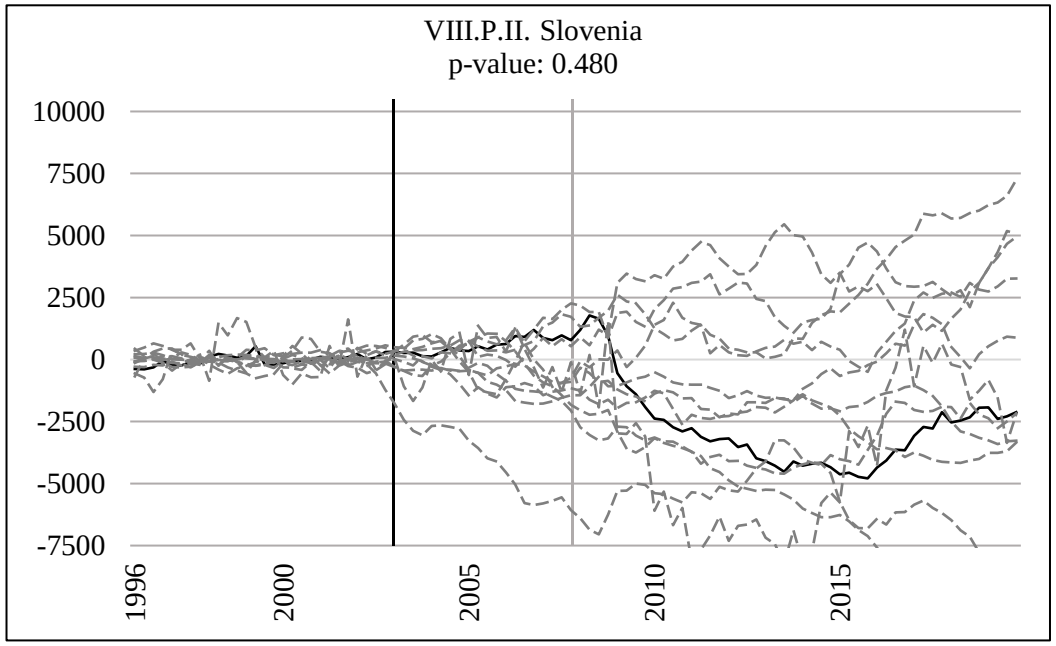
2010
2015


VIII.P.II. Slovenia
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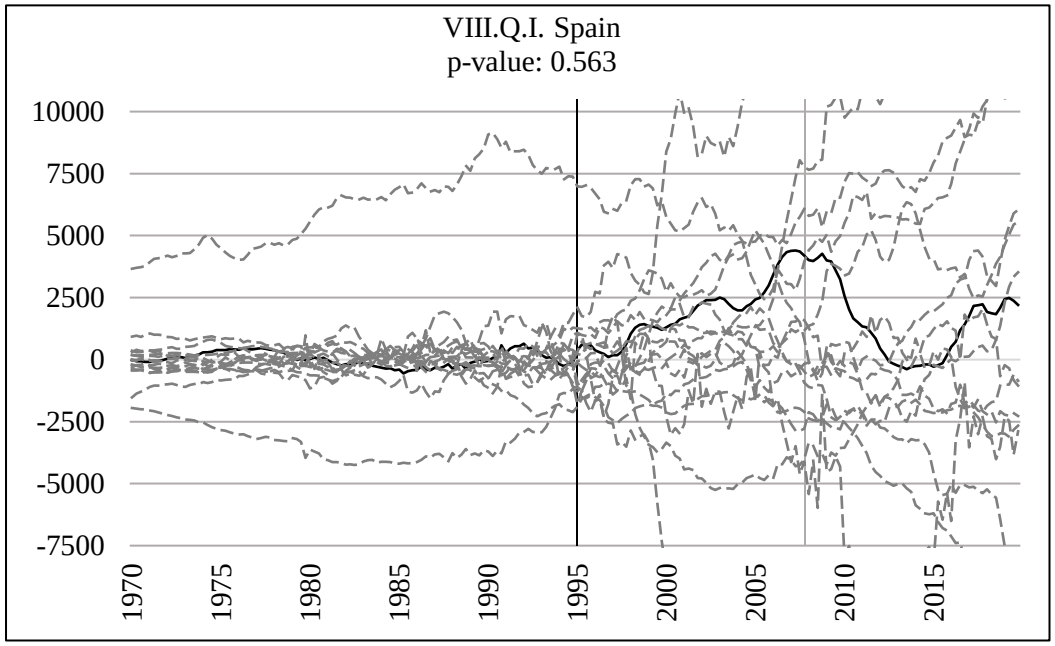
2010
2015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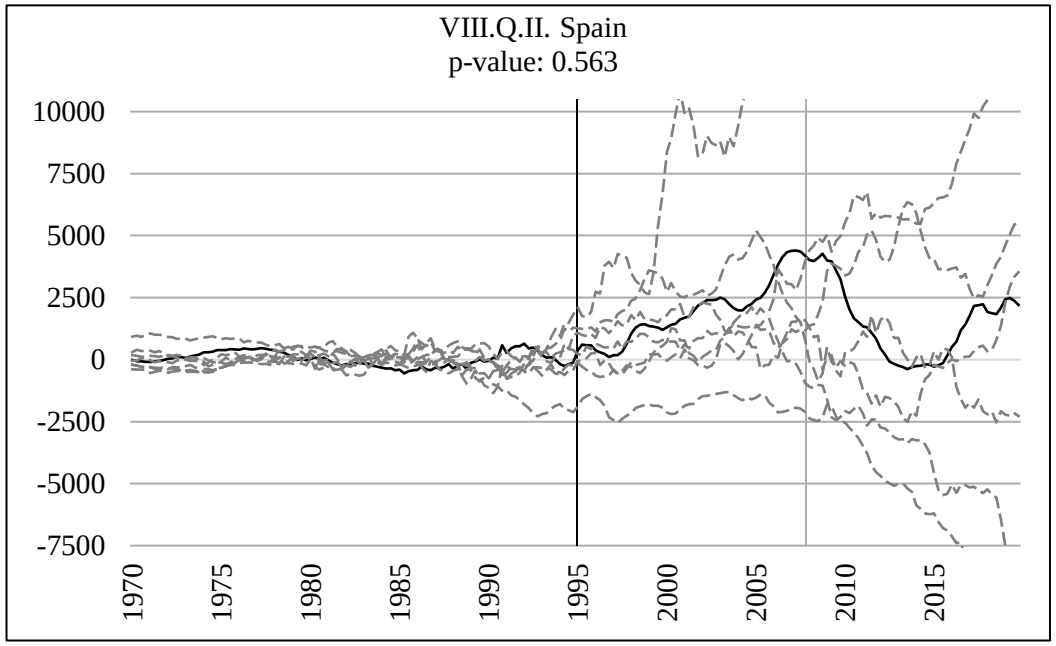
VIII.Q.II. Spain
p-value: 0.563
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2015

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