Italian Economic Journal
https://doi.org/10.1007/s40797-021-00160-5

RESEARCH PAPER - EUROPE AND ITALY

Currency Unions and Global Value Chains: The Impact of the Euro on the Italian Value Added Exports

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Received: 22 October 2020 / Accepted: 8 June 2021

Abstract

Many estimates of the effect of the common currency on trade have been made, although a clear answer has yet to be given. This work analyses the trade effect of the euro by providing a twofold contribution. First, one of the main stylised facts that has emerged from the recent literature is that trade flows in gross terms can differ substantially from those measured in value added terms. Accordingly, we focus on the structure of global value chains rather than conventional gross trade. To this aim, we provide an estimate of the value added trade flows that would have existed between Italy and its main trading partners if Italy had not joined the monetary union and show how, and to what extent, international production sharing has been affected. Second, we use a methodology that is different from traditional, parametric ones. Specifically, we apply the synthetic control method to construct appropriate counterfactuals and estimate the causal impact of the euro. Our empirical analysis provides a relevant case for considering value added in addition to gross trade since it shows that the euro facilitated the forward integration of Italian exports, whereas it slowed down backward integration. Overall, these results suggest that the euro had an impact on Italian global value chain participation by altering value added flows across member as well as non-member states, with great heterogeneity in the results across value added trade components and sectors.

Keywords Euro trade effect · Trade in value added · Synthetic control method · Italy

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Published online: 29 June 2021

JEL Classification F14 · F15 · F33

1 Introduction

The development of global value chains and euro area have notably affected intraregional trade in Europe and European economies integration both within and outside the region. This paper provides an assessment of the consequences on Italian trade in value added flows of joining the Economic and Monetary Union (EMU). The motivation comes from two strands of the literature. First, there is renewed interest in the impact of currency unions. The issue of the adoption of the euro and its economic consequences has been—and continues to be—at the centre of both the academic and political debate. The introduction of the euro is expected to affect trade with a positive effect because currency conversion costs and exchange rate uncertainty with other euro members are eliminated. Accordingly, a large body of applied literature on international trade has been devoted to assessing the impact of the adoption of the euro on trade: estimates vary widely across studies and often have ambiguous results (see the survey by Baldwin et al. 2008, and more recently Rose 2017, and Polák 2018).

In recent decades, production processes have undergone a profound transformation, driven by a fall in transportation costs and a reduction in obstacles to international trade. Stages of production that used to take place within a country have become dislocated beyond national borders (Amador et al. 2015). To manufacture a final product, firms source intermediate inputs from many providers, often located abroad. Value is added at each stage of the production process and products may cross borders several times before being finally consumed. This kind of international production sharing arrangement is known as a "global value chain" (GVC). The increasing fragmentation of production processes has led to an increase in the importance of trade definitions based on the value added at each stage of the production process as opposed to conventional gross trade, which affects how several economic indicators are computed and examined. GVCs are important for the euro area as a whole and regional production linkages in Europe are highly significant (Baldwin 2011). Between 1990 and 2015, the average ratio of intermediate goods exports to GDP increased more than twofold globally and nearly fourfold in the euro area (Gunnella et al. 2019). The increase in trade in intermediates is driving the dynamics of trade responsiveness to global demand and is leading to greater interconnectedness among firms and sectors in different countries. This has important consequences for market integration, prices, productivity and the labour market.

Are the results of the literature on the impact of currency unions applicable to trade in value added as it is to gross trade? One of the contributions of this paper is that we explicitly account for the dual nature of products that can be used as either intermediate inputs or final goods. Indeed, the (regional) fragmentation of production—with the consequent increase in trade flows of intermediates—could be particularly reactive to the reduction of financial and administrative transaction costs and constant nominal exchange rates due to the currency union. We aim to test whether the adoption of the single currency had an impact not only on trade flow levels but also on their structure in terms of value added.

In the Euro area, intermediate inputs trade accounts for a growing share of trade. Within the Euro area countries, we focus on Italy, which is an ideal case study for several reasons. First, it is one of the leading *hub economies* in the framework of the European regional value chains, since it simultaneously provides a significant amount of valued added to other EU member countries' exports and it is one of the world's top ten largest exporters of final goods worldwide (source: WTO data). Concerning trade in intermediates, the share of intermediate inputs in total imports of Italy is structurally higher than that of Germany and France (65% on average compared to 59 and 56% respectively in the period 2005–2011; OECD data). Second, from a political point of view, in Italy, the debate between pro- and anti-euro factions is still alive. For some, the euro is the only anchor to prevent from drifting into default, and must be defended; for others, it is the cause of unemployment and social cuts and must be abandoned. This paper provides new and relevant insights into the impact of the euro on Italy compared to previous studies that limited the analysis on gross trade (see for instance, Manasse et al. 2013) losing the complexity of trade links that characterize GVCs. More specifically, we focus not on the volume of Italy's trade, but rather on the structure of trade, more specifically the extent of participation in GVCs. By "GVC participation" we mean the proportion of the Italian gross exports represented by two components: (i) the domestic value added embedded in third-country exports (forward, or "upstream" GVC participation); and (ii) the foreign value added embedded in own exports (backward, or "downstream" GVC participation). The availability of sound empirical-based evidence on the role of the euro in determining the size of domestic vs foreign value added would definitively help to inform the EU policy debate.

To track value added trade flows we use Multi Region Input Output data (specifically the World Input–Output Database—WIOD) that combine input–output data with bilateral trade statistics and apply the methodology developed by Wang et al. (2013) to decompose gross exports flows in bilateral and sectoral value added components.

Most similar to the present paper is a recent study by the European Central Bank (2019), which focuses mainly on the participation of the euro area in GVCs. By contrast, our goal is not to add new findings to the GVC literature, but rather to assess the value chain adjustments due to the adoption of the euro. Second, from an empirical point of view, we use a methodology that is different from traditional, parametric ones. Many amendments to the gravity-type estimates have emerged since Rose (2000) demonstrated generous effects from currency unions to trade. More recently, Glick and Rose (2016) have shown that the estimates of the currency union effect are sensitive to the exact econometric methodology. Although the relationship between EMU and trade remains very much an open question and is far from being settled on empirical grounds, the recent literature provides new and varied empirical methods that address many of the concerns raised about earlier studies. Our goal is to let the data speak for themselves, with our opinions interfering as little as possible to allow for a more structured "counterfactual" scenario against which to judge the outcome of the adoption of the euro. The sharper counterfactual is not whether (value added) trade flows are larger after the introduction of the euro than before but whether trade flows are larger than they would have been if there were no single currency. Answering this question depends on an explicit modelling of what would have happened to an economy had the policy shock not taken place.

The objective of this paper is to estimate the impact of the euro on Italian trade integration and its distribution across sectors using measures of value-added trade flows. We estimate the flows that would have existed between Italy and its main trading partners if Italy had not joined the euro by applying the synthetic control method (SCM) developed by Abadie and Gardeazabal (2003) and expanded by Abadie et al. (2010) to construct an appropriate counterfactual. While SCM has been a very popular approach in many micro and macro studies, there are relatively very few studies in international trade using this approach (Billmeier and Nannicini 2013; Campbell and Chentsov 2021; Hosny 2012; Hannan 2016; Saia 2017).

Using the synthetic control method to construct appropriate counterfactuals, we show that the euro had an impact on GVC participation, altering value added flows towards member as well as non-member states. Since the adoption of the euro, value added shares in Italian exports have evolved differentially from a control group constructed using the synthetic control method, with great heterogeneity in the results across value added trade components and sectors. In particular, we find that the EMU has facilitated forward integration of Italian exports, whereas it had the opposite impact on backward integration.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature on the trade effect of the euro. Section 3 describes the trade in value added indicators; Sect. 4 introduces our SCM model whereas Sect. 5 presents and discusses the empirical results, including the robustness analysis and the placebo tests. Section 6 concludes.

2 The Debate About the Trade Effects of the Euro

A common currency has been the objective of the European Union (EU) and its predecessors since the 1960s. In 1993, the Maastricht Treaty came into force intending to create an economic and monetary union for all its members by the end of the millennium. Formally established through the EMU in 1992, the formation of the monetary union was a long process—preparations took more than a decade—until the exchange rates got fixed and the euro was launched in 1999 in 11 EU countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain). Greece entered in 2001, Slovenia in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015.

From a theoretical point of view, Mundell (1961) identified the benefits of joining a Monetary Union. He predicted that a currency union would have led to an increase in trade through several channels. The introduction of the euro has provided the set-up for a natural experiment to research into how currency unions affect trade. The main channel is the fall in trade prices that comes from lower transaction costs and increased competition. Baldwin et al. (2008) conclude that the transaction costs effect cannot be the main channel because if this effect were the main mechanism, it would have led to trade diversion in non-euro area EU countries. However, the trade diversion effect has not found empirical support. The second main channel behind the positive trade effect from the euro is the newly traded goods channel. Baldwin et al. (2008) show that EU firms inside and outside the euro area started to export more goods to the euro area after the euro was introduced. Another source of transaction costs is the reduced cost of foreign exchange. The European Commission (1990) estimated that the expected gains from foreign exchange brought about by the euro were from 0.1 to 1% of GDP and were higher for small euro area countries. These savings included financial transaction costs originating from sales and purchases of euros and administrative transaction costs related to foreign currency management, accounting of foreign exchange losses and gains, additional reporting and other costs. Finally, Baldwin and Taglioni (2007) show that countries that have lower trade barriers before the introduction of a common currency have larger expected gains. This implies that countries with close proximity to other euro area countries or which trade a lot with other euro area countries have larger expected gains for exports.

In addition to the traditional trade cost reduction due to the elimination of transaction costs, we can expect increased competition due to more transparent prices and increased capital flows. The EU's Single Market programme and the subsequent introduction of the single currency have altered commercial realities in the euro area by lowering the cost of business, reducing transaction costs and facilitating the movement of capital. All these elements should make it easier for firms based in one euro area country to produce in other euro area countries, in turn potentially changing the weight attached to the various factors that determine firms' FDI decisions.

The consensus emerging from the literature is that the euro has been pro-FDI, in particular as regards FDI flows between monetary union countries. More specifically, following the introduction of the euro, factors such as relative unit labour costs and fixed costs of doing business (i.e. institutions and economic structures) gained prominence, thereby pointing to the increased relevance of vertical FDI. By contrast, horizontal or market seeking FDI motives became less relevant among euro area countries. For investors outside the monetary union, the proximity to large euro area markets and the country specific fixed cost become more relevant. In terms of FDI stemming from countries outside the monetary union, the greater integration of the Eurozone market has made it more attractive to have a production platform inside the Eurozone (Sondermann and Vansteenkiste 2019).

There appears to have been a lot of research into how the adoption of the euro has affected trade, especially at the country level and the aggregate product group level—starting from the work of Rose (2000). Estimates of the EMU trade effect vary in magnitude going from + 50% (Glick and Rose 2016; Glick and Rose 2016; Larch et al. 2017) to a null or even negative effect (Santos Silva and Tenreyro 2010; Baldwin and Taglioni 2007; Berger and Nitsch 2008; Figueiredo et al. 2016; Mika and Zymek 2018; Hou 2020). Recent surveys provided in Rose (2016) and Polák (2018) highlight different data sources and different techniques. As far as the data are concerned, Hou (2020) estimates the trade effects of the EMU using trade data retrieved from IMF DOTS and UN Comtrade databases and finds that different data sources can even cause opposite signs for the coefficient. To evaluate the trade effect of currency unions, researchers typically rely on a standard gravity equation framework and insert a simple currency union dummy variable as a right hand side regressor (e.g., Rose 2000). One potential concern with gravity estimation relates to the possibly endogenous nature of currency unions (Persson 2001; Alesina et al. 2003). Reverse causality may arise because countries that trade intensively with each other are more likely to join a currency union, leading to an overestimation of the trade effect of common currencies. The high sensitivity of coefficient estimates to the specific sample composition (Rose 2016; Glick and Rose 2016) and the difficulty of addressing endogeneity issues suggest that alternative techniques should be used such as non-parametric techniques (Persson 2001; Chintrakarn 2008; Egger et al. 2008; Baier and Bergstrand 2009).

In this work, we focus on the effect of the adoption of the euro in terms of value added rather than the intensity of the trade flows. In other terms, we investigate whether the euro has changed the shares of domestic and foreign value added in Italian export flows regardless of the intensity of these flows.

There have been several works describing the evolution of the structure of EU trade in value added. Nagengast and Stehrer (2014) and di Mauro and Pappada (2014) show that it is undesirable to assess intra-EU (intra-EMU) imbalances in terms of gross trade flows since a sizeable share of these are in value added terms imbalances with countries outside of the European Union (euro area). Cappariello and Felettigh (2015) propose an analysis for the largest euro area countries, tracing value added in a country's exports by source and use. The diffusion of GVCs is one reason why the domestic value-added content of exports has been showing a declining trend in the economies under examination. Amador et al. (2015) show that, in 2011, for the euro area taken as a whole, GVCs were as important as in China and more important than in the US and Japan. When euro area countries are taken individually, there is substantial heterogeneity in the evolution of GVCs from 2000 to 2011. More specifically, the foreign value added content of euro area countries' exports increased, on average, by 4.5% points. However, the sign of the change is not enough to establish the impact of the single currency: as a matter of fact, both increases or reductions may have been larger/lower without the euro. Finally, Gunnella et al. (2019) confirm that despite the world GVC slowdown, euro area countries remain extensively involved in cross-border production chains, and their GVC participation is relatively high compared with the world average. Also, the euro area countries are more involved in regional than in global supply chains. The smaller euro area countries need to source a greater share of inputs from abroad and so their participation in GVCs is, therefore, higher than that of the bigger economies. Compared with the world average, euro area countries are moderately downstream, meaning that the foreign content of euro area production is larger compared with other countries. However, the causal analysis of the impact of the euro on trade in value added has received much less attention. Felbermayr and Steininger (2019) employ a structural gravity model and apply it to bilateral sectoral trade data: the changes in sectoral value added for Germany are relatively small. Van Limbergen and Vermeulena (2020) analyse intra- and extra-euro area trade flows for the five largest euro adopting countries in order to gauge the importance of value chains. They bridge input–output table analysis with a time series approach finding evidence of value chains for all trade patterns but most pronounced within the euro area. However, they do not assess the impact of the euro adoption per se. Some papers have assessed the impact of the euro on Italian (gross) trade using non-parametric techniques (Saia 2017; Manasse et al. 2013). Manasse et al. (2013)–using the SCM to focus on the effect of the single currency on Italian trade flows–find that bilateral flows between Italy and the other European countries have all increased, compared to the counterfactual, with the exception of Italian trade with the UK.

While the relationship between exchange rates and GVCs is beginning to gain recognition (Banerjee and Zeman 2020; Ahmed et al. 2017; and de Soyres et al. 2018), the impact of a currency union on the GVC has so far not been investigated. By combining literature on both euro effects and trade in value added, this work exploits the SCM methodology in a novel manner to gather fresh insights into GVC integration in Italy.

3 Trade in Value Added Indicators and Data Sources

As previously stated, the focus of this paper is on trade in value added since we are interested in catching the effect of the euro on Italy's participation in GVCs. The increasing international fragmentation of production has increased trade in intermediates that now cross borders several times along the chain, often passing through many countries more than once. As a result, conventional trade statistics become increasingly misleading as a measure of value produced by any particular country. Scholars have suggested different data sources and methods studying the GVCs and quantifying the participation of countries in these chains (see, among others, Hummels et al. 2001; Johnson and Noguera 2012; Koopman et al. 2014; Cattaneo et al. 2013; OECD–WTO 2012). In this work, we use the World Input–Output Tables—WIOD (Release 2013) which combine input–output data with bilateral trade statistics for 40 countries[1] and 35 sectors (ISIC Revision 3) over the period 1995–2011.[2] Moreover, we apply the methodology developed by Wang, et al. (2013) to decompose gross exports flows in bilateral and sectoral value added components.

Specifically, we use the following key components of value-added in exports:

1. the *direct domestic value added* (DDVA), that is, the share of domestic value added in intermediates and final goods exports absorbed and consumed by the

[1] The EU-27 countries plus Turkey, Canada, USA, Mexico, Japan, Korea, Taiwan, Australia, Brazil, Russia, India, Indonesia and China.

[2] We use the 2013 release of the dataset since the new one—which covers the period 2000–2014—is not directly comparable or matchable with the previous one, and we need the 1995–1999 data for the pre-treatment period. Even if the post-treatment is longer than the pre-treatment one, there are not alternative data available and other studies assessing the effect of the euro introduction through the SCM adopt a similar time span (Addessi et al. 2019). When we test the robustness of the results, we take into consideration a longer pre-treatment period that goes from 1995 to 2001.

direct importer.[3] It captures the contribution of the domestic economy to the country's exports. It is the result of a single exchange of goods, and consequently, it does not enter into the computation of GVC participation (we use it as a proxy for gross exports);
2. the *indirect domestic value added* (IDVA), that is, the share of domestic value added in intermediate goods further re-exported by the partner country. It measures the joint participation of the trade partners in a GVC since it contains the exporter's value added of a specific sector that passes through the direct importer for a (or some) stage(s) of production before it reaches third countries. More specifically, it captures the contribution of the domestic country to the exports of other countries and indicates the extent of involvement in GVC for relatively upstream industries. In our analysis, we use this component as a measure of *forward* GVC participation[4];
3. the *foreign value added* (FVA) used in the production of a country's exports, that is the share of value added provided by intermediate inputs imported from abroad and then exported in the form of final or intermediate goods. It measures the contribution of the foreign country to the country's exports. We use this component as a measure of *backward* GVC participation.[5]

Our dependent variable (the "outcome" of the SCM) is, in turn, one of the above value-added components of the annual bilateral gross exports (in millions of current US dollars), measured as shares of gross exports.

Concerning the other data used, we take advantage of the theory underlying the gravity trade relationship for selecting the covariates to be considered in the SCM (Baier and Bergstrand 2009; Montalbano and Nenci 2014; Saia 2017). The gravity equation has been used as a workhorse for analyzing empirically the determinants of bilateral trade flows for over fifty years (Tinbergen, 1962; Anderson, 1979, 2011; Anderson and van Wincoop, 2003; Bergstrand and Egger, 2013; Head and Mayer, 2014; Chaney, 2018). In particular, gravity literature explains cross-sectional variation in country pairs' trade flows in terms of the economic size of the countries (represented by the gross domestic products—GDPs), geographical distance, and additional factors related to geographical and cultural proximity (such as common border and common language). Following this solid literature, we selected the following variables and their sources: the countries' GDPs (in current US dollars) from the World Development Indicators database of the World Bank; geographical distance and the other economic geography variables (i.e., adjacency dummy and language dummy) from the CEPII Gravity Dataset. We use the first year of the dataset, 1995, as the year of reference for all the covariates.

To start the analysis of the trade in value added components, we first introduce some stylized facts. Figures 1, 2 and 3 report the trends in DDVA, IDVA, and FVA

[3] This term corresponds to the sum of the T^* and T_2 terms in the Wang et al. (2013) 'decomposition (see Wang et al, 2013, p. 23).

[4] This corresponds to $T_3 + T_4 + T_5$.

[5] This corresponds to $T_{11} + T_{12} + \mathrm{T}14 + T_{15}$ (see Wang et al. 2013, p. 24).

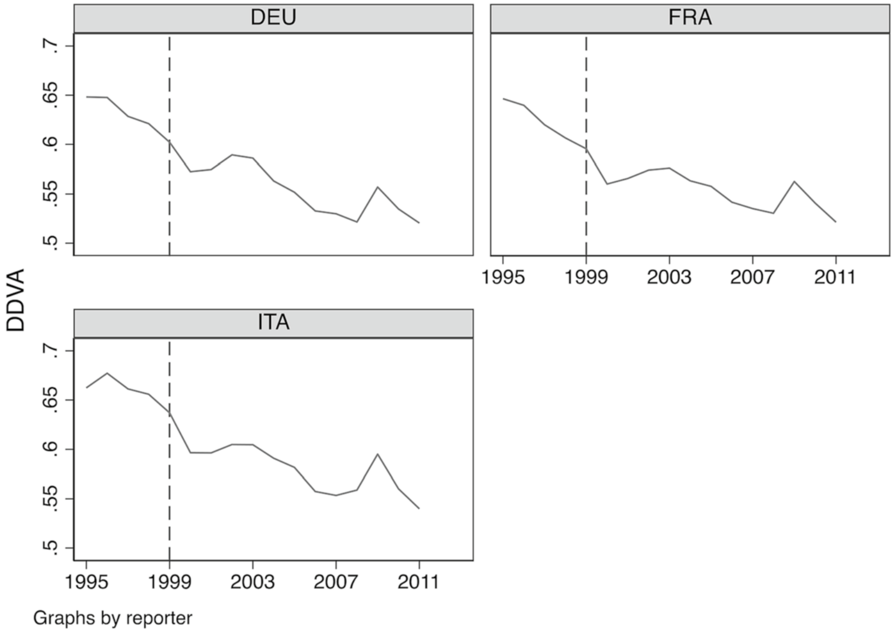

Fig. 1 DDVA trend (share). Source: Authors' calculation

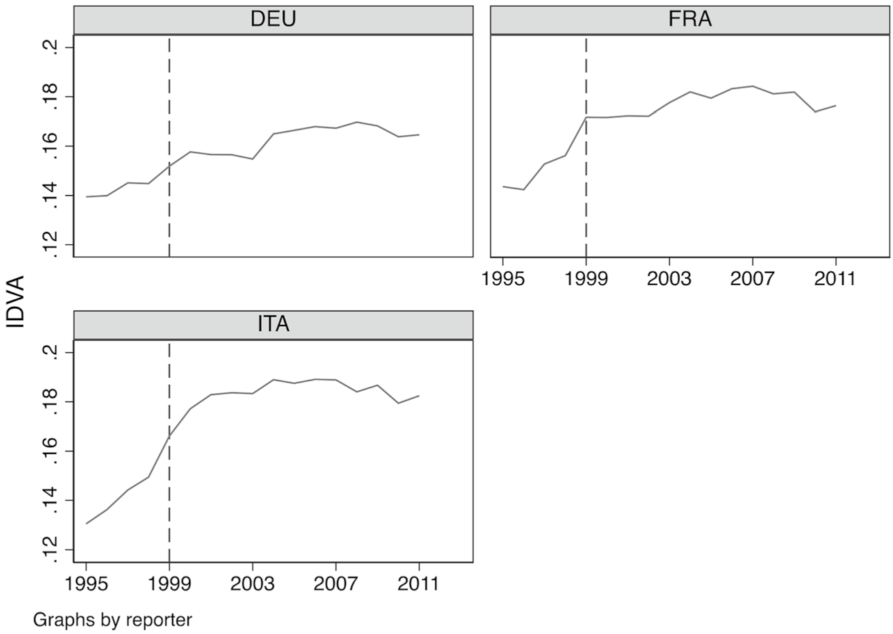

Fig. 2 IDVA trend (share). Source: Authors' calculation

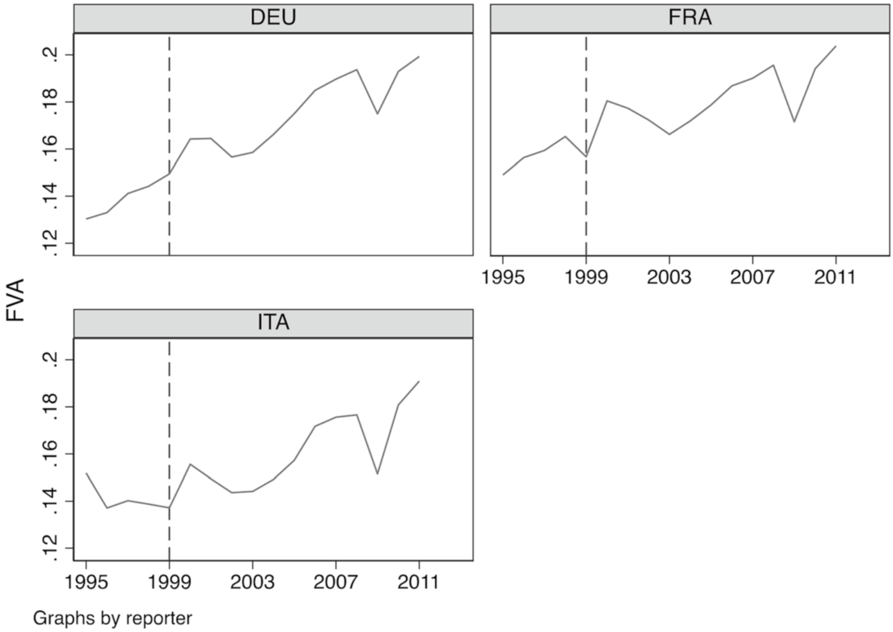

Fig. 3 FVA trend (share). Source: Authors' calculation

for selected countries with the rest of the world over the period 1995–2011.[6] Looking at the trend of these value-added components provides useful information on the process of fragmentation that occurred just before and after the adoption of the euro. We compare Italy with its main euro trade partners, namely Germany and France, and we do not observe any major differences among the three euro economies. Coherently with the increasing process of international fragmentation, all countries registered a decreasing trend of the share of DDVA embedded in exports absorbed and consumed by the direct importer which dropped from about 65 per cent in 1995 to less than 55 per cent in 2011 for Italy and its main euro partners (Fig. 1). Moreover, the increased share of domestic value added in intermediates re-exported by the partner country (IDVA) can be read as a growing GVC "forward" participation of all these economies (Fig. 2). Finally, the share of FVA embedded in exports shows an increasing trend (not just driven by the hike in resource prices), underlying a growing GVC "backward" participation of Italy and its main partners, as firms operating in these economies took advantage of differences in technologies, factor endowments and factor prices across countries (Fig. 3).

To better analyze the trends highlighted by the above stylized facts, we tested the trend difference of each value added component before and after the euro (see Table 1), i.e. the so-called "before-after estimator". This difference is negative and

[6] The destination countries used are the set of 28 countries (euro, EU and Extra European countries) included in the SCM analysis (see p. 16–17).

Table 1 Before-after euro estimator for some selected countries and variables

	(1) DDVA for ITA	(2) FVA for ITA	(3) IDVA for ITA	(4) DDVA for DEU	(5) FVA for DEU	(6) IDVA for DEU	(7) DDVA for FRA	(8) FVA for FRA	(9) IDVA for FRA
Post-Euro vs. Pre-Euro	– 0.081*** (0.014)	0.018* (0.009)	0.043*** (0.004)	– 0.080*** (0.014)	0.037*** (0.008)	0.020*** (0.003)	– 0.072*** (0.012)	0.023*** (0.007)	0.029*** (0.003)
N	17	17	17	17	17	17	17	17	17
Adj. R^2	0.667	0.172	0.884	0.649	0.538	0.710	0.701	0.380	0.851

Standard errors in parentheses; euro reference year: 2001; $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$

Source: Authors' calculation

statistically significant for the DDVA component in all countries, whereas it is positive and significant for the IDVA and FVA.

Although suggestive, the "before-after estimator" does not allow a causal conclusion to be drawn regarding the impact of the euro on trade in value added. This depends on the fact that this estimator neglects the behaviour of the counterfactual condition, namely, what would have been happened to euro countries had they not adopted the common currency. Thus, for impact evaluation purposes, such a counterfactual needs to be appropriately built as will become clearer in the following sections where we will first present and then apply the Synthetic Control Method.

4 Methodology

To evaluate the effects of a specific policy, we observe the behaviour of a variable of interest in the (treated) unit affected by the said policy before and after the intervention. The path observed in the treated unit can be compared to that of one or more unexposed units that were not influenced by the policy intervention (control group or counterfactual). When using policy evaluation techniques, one of the most difficult tasks is defining the control group, which has to mimic the counterfactual situation.

The SCM is a method of policy evaluation analysis that allows for the investigation of causal inference in the presence of a limited number of observations that are typical in comparative case studies with aggregate data, as described by Abadie and Gardeazabal (2003) and extended by Abadie et al. (2010, 2015).

The novelty of the SCM as a tool for comparative studies is considering as counterfactual a "composite" or "synthetic" control group, rather than a single unit. For a treated country, the SCM generates a synthetic (or counterfactual) control based on the similarity between the treated and a pool of untreated countries (the so-called *donors*) before the treatment took place. The principle of this procedure lies in the future path of the synthetic control group, which will mimic the path that would have been observed in the treated unit in the absence of the treatment. In other terms, the evolution of the actual outcome of the treated country post-treatment is then compared with the outcome of the synthetic pattern and the difference is interpreted as the treatment effect (i.e., the average treatment effect—ATE).

The SCM is a powerful statistical tool: first, it provides a transparent estimation of the counterfactual outcome of the treated country simply expressed by a linear combination of untreated countries; second, unlike most of the treatment effect estimators developed in the literature, it can deal with endogeneity problems due to omitted variables bias by accounting for the presence of time-varying unobservable confounders; third, it can be easily generalized to a non-parametric estimation of the optimal weights as shown in Cerulli (2019).

Within this framework, we ask whether the hypothetical non-adoption by Italy of the euro would have led to a different value added composition of the trade flows with its euro and non-euro partners. We observe value added trade share of various country pairs $\{P\}$. When we carry out the analysis on Italy with a specific euro member (say Germany), we start by creating a counterfactual from the various value added export flows between countries. Thus, given that the non-euro sample includes 18 countries and that we exclude one country's trade with itself from the analysis, we have 153 pairs ($18 \times 17/2$) and a further 18, including Italy. We denote the latter as the treatment group, {T}; and the former as the control group {NT}.

As an example, let us take a specific treated value added share in exports – the one between Italy and Germany, which we denominate as $TVA_{t,\ IT-D}(T)$. We can compare this treated share with a counterfactual, had the treatment not occurred, which we designate as $TVA_{t,\ IT-D}(NT)$. Hence, in principle, we can compute the treatment effect at any time t as follows:

$$TVA_{t,\ IT-D}(T) - TVA_{t,\ IT-D}(NT). \tag{1}$$

The problem is that $TVA_{t,\ IT-D}(NT)$ is not observable. Hence, we need to construct a credible counterfactual that is able to replicate the bilateral share between this treated pair.

We use the SCM, which constructs the counterfactual as a weighted average from the list {NT} of country pairs, using a best-fit algorithm to choose the weights. We have one treated unit and J available control units. We want to assign weights $\omega = (\omega_1,\ldots,\omega_J)'$ – which is a $(J \times 1)$ vector – to each control unit:

$$\omega_j \geq 0 \quad with \quad \sum_{j=1}^{J} \omega_j = 1, \tag{2}$$

We want to choose weights so that the synthetic treated unit most closely resembles the actual one *before* treatment. Let $\mathbf{x}_1$ be a $(K \times 1)$ vector of pre-treatment outcome predictors in the treated unit. Let $\mathbf{X_0}$ be a $(K \times J)$ matrix which contains the values of the same variables for the J possible control units. Let V be a diagonal matrix with non-negative components reflecting the relative importance of the different outcome predictors. The vector of weights $\boldsymbol{\omega}^*$ is then chosen to *minimize*:

$$D(\boldsymbol{\omega}) = (\mathbf{x_1} - \mathbf{X_0}\boldsymbol{\omega})'\mathbf{V}(\mathbf{x_1} - \mathbf{X_0}\boldsymbol{\omega}). \tag{3}$$

Weights are selected using a transparent data-driven procedure so that the pre-treatment outcome and the covariates of the synthetic control are, on average, very similar to those of the treated unit. Since each combination of weights produces a different synthetic unit, we select the weights that minimize the distance between the pre-euro characteristics of our unit of interest and the pre-euro characteristics of the potential counterfactual units.

Some caution is needed to select the most relevant pre-treatment (pre-euro) characteristics of the country (Italy) affected by the treatment (euro membership). As underlined (see Sect. 3), we select a set of characteristics theoretically motivated by the gravity model, the workhorse of the applied international trade literature. As a baseline, we perform the synthetic matching by considering the following as our pre-euro characteristics: exports in value added (components; share on total exports); the sum of the logs of country pair GDPs (averaged over the period 1995–1999) as a proxy for economic size; and the log of the bilateral distance between the two countries, a country pair adjacency dummy, and a country pair language dummy, all as proxies for trade costs.

In order to construct the counterfactual using the optimal weights previously calculated, we follow this procedure: let $\boldsymbol{tva_{IT}(T)}$ be a $(N\times 1)$ vector whose elements are the values of outcome values for N years in the treated unit; let $\boldsymbol{TVA_0}$ be a (N x J) matrix whose elements are the outcome values for N years in the control units. We construct the counterfactual outcome pattern (i.e. in the absence of treatment) as:

$$\boldsymbol{tva}(\boldsymbol{NT}) = \boldsymbol{TVA_0} \times \boldsymbol{\omega}^*. \tag{4}$$

Under the SCM assumptions, the counterfactual (namely, the synthetic control) is constructed as a weighted combination of control countries (i.e. countries which have not joined the euro) to approximate trade (i.e. exports in value added) of Italy before adopting the euro. In other words, the synthetic control algorithm estimates the missing counterfactual as a weighted average of the outcomes of the potential controls. In terms of our example:

$$tva_{t,IT}(T) - \sum_{j\in\{NT\}} \omega_j^* tva_{t,j}(NT). \tag{5}$$

As long as the synthetic unit provides a good approximation of the country pair prior to 1999, any subsequent differences between the actual unit and the counterfactual unit should then represent what would have happened if Italy had not joined the euro.

To measure the SCM goodness-of-fit, we use the Root Mean Square Pre-treatment Error (RMSPE):

$$RMSPE = \sqrt{\frac{1}{T^* - T_0 + 1} \sum_{t=T_0}^{T^*} \left(tva_{t,IT}(T) - tva_{t,IT}(NT)\right)}, \tag{6}$$

where T_0 is the first pre-treatment time, and T^* the last pre-treatment time. The *RMSPE* measures the distance between the actual (tva(T)) and the synthetic (tva(NT)) pre-treatment treated time-series of the outcome. In the pre-euro period 1995–1998, the synthetic counterfactuals provide a good approximation of the units in question.[7] The actual exports in value added and the synthetic start to diverge usually *just after the euro* was introduced in 1999 (see Figs. 4, 5 and 6).

The SCM presents some potential caveats. First, the results may be affected by "contagion effects" if, for example, the new currency also affects control countries that did not adopt the euro. Second, the presence of "confounding effects": Italy and the control group may be differentially hit by shocks that are contemporaneous with

[7] In our case, the pre-treatment period is bound by the availability of trade data in value added. Even if it would be obviously useful to have access to longer pre-treatment observations, it remains true that pre-treatment data that are closer to the treatment year provide much more valuable information to build the synthetic control. In Sect. 5.4 we extend the pre-treatment period using 2002 (euro currency circulation date) as the treatment year, obtaining that our results are substantially confirmed.

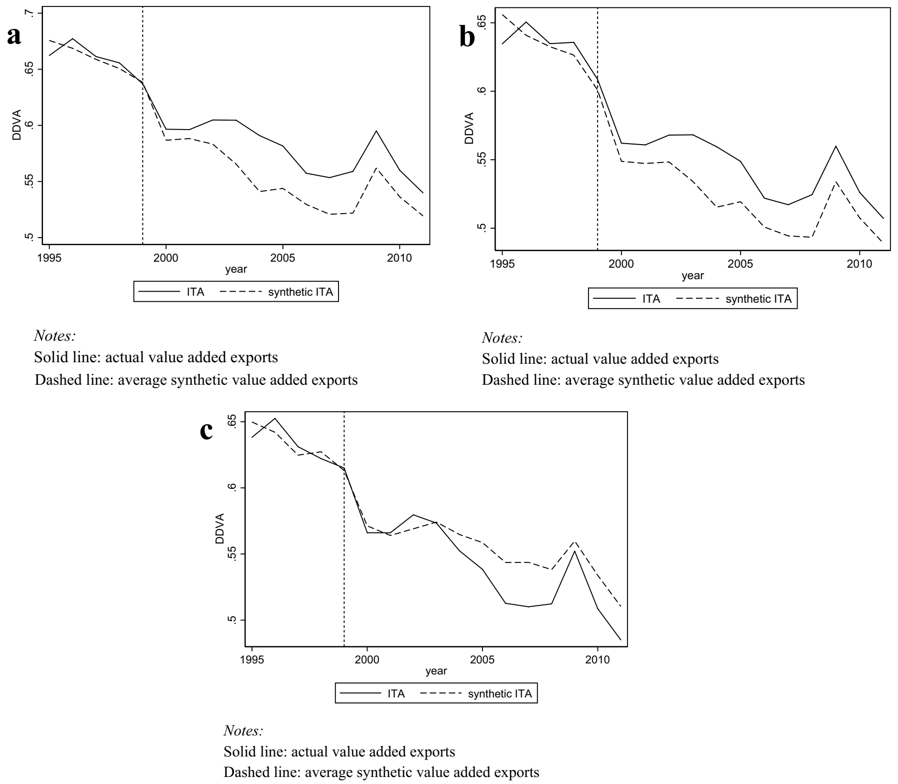

Fig. 4 **a** Direct domestic value added (DDVA) exports components between Italy and ALL COUNTRIES vs its synthetic counterfactual. Year of treatment: 1999. **b** Direct domestic value added (DDVA) exports components between Italy and EURO COUNTRIES vs its synthetic counterfactual. Year of treatment: 1999. **c** Direct domestic value added (DDVA) exports components between Italy and EU (NON-EURO) countries vs its synthetic counterfactual. Year of treatment: 1999. Solid line: actual value added exports. Dashed line: average synthetic value added exports. Source: Authors' calculation

the introduction of the euro and whose effects may be erroneously attributed to the euro. Finally, there may be 'anticipation effects' so that the consequences of the euro arise before the introduction of the single currency itself.

5 Empirical Analysis

5.1 Experimental Design

Our application of the SCM proceeds as follows. The sample is divided into two periods: a control period, before the EMU, and a treatment period, following the introduction of the euro. The sample includes Italy plus the other initial EMU members as well as the EU member states that have kept their national currencies. We then added a list of non-EU countries—both developed and emerging

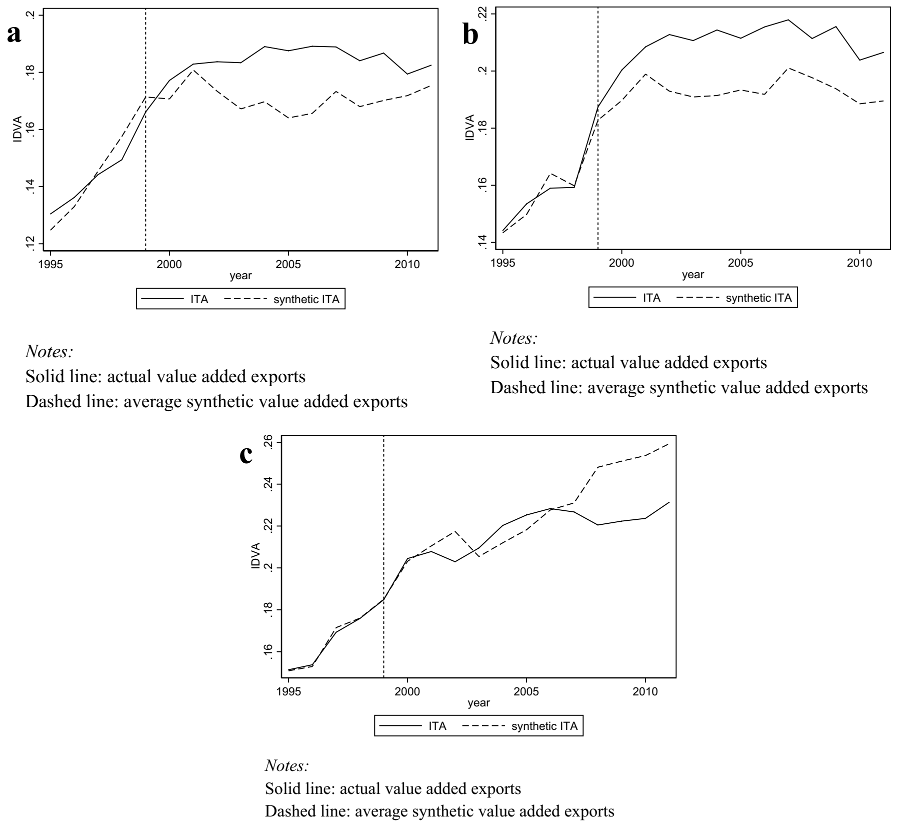

Fig. 5 **a** Indirect domestic value added (IDVA) exports components between Italy and ALL COUNTRIES vs its synthetic counterfactual—All donors. Year of treatment: 1999. **b** Indirect domestic value added (IDVA) exports components between Italy and EURO COUNTRIES vs its synthetic counterfactual—All donors. Year of treatment: 1999. **c** Indirect domestic value added (IDVA) exports components between Italy and EU (NON-EURO) countries vs its synthetic counterfactual—All donors. Year of treatment: 1999. Solid line: actual value added exports. Dashed line: average synthetic value added exports. Source: Authors' calculation

economies—that play an important role in the international trade scenario (the complete list of countries included in the analysis is reported in Table 6 in the Appendix). Specifically, we split the sample into the following groups:

- *EURO members* 10 EU countries that adopted the euro in 1999 (Austria, Belgium, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, Spain, and Portugal) plus Italy;
- *EU members* 7 EU countries that are not EMU members (Czech Republic, Denmark, the United Kingdom, Hungary, Poland, Romania, Sweden);
- *Extra European countries* 11 non-European countries (Australia, China, India, Indonesia, Japan, South Korea, United States, Canada, Mexico, Brazil, and Turkey).

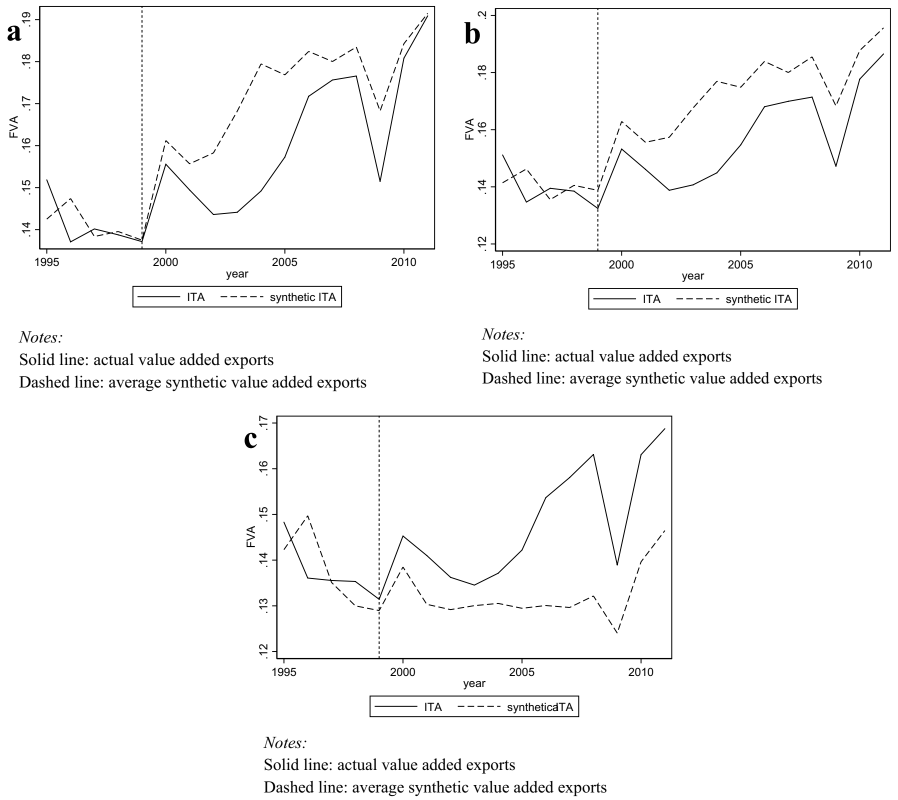

Fig. 6 **a** Foreign value added (FVA) exports components between Italy and ALL COUNTRIES vs its synthetic counterfactual. Year of treatment: 1999. **b** Foreign value added (FVA) exports components between Italy and EURO COUNTRIES vs its synthetic counterfactual. Year of treatment: 1999. **c** Foreign value added (FVA) exports components between Italy and EU (NON-EURO) countries vs its synthetic counterfactual. Year of treatment: 1999. Solid line: actual value added exports. Dashed line: average synthetic value added exports. Source: Authors' calculation

As a starting date (i.e., the *treatment year)*, we considered 1 January 1999 (when exchange rates were irrevocably fixed). Since impact may be triggered by anticipation of the policy change, we checked the robustness of the results considering 1 January 2002 (the circulation date).

As already underlined above, the synthetic control method is based on the observation that a combination of units in the donor pool may approximate the characteristics of the affected unit substantially better than any unaffected unit alone. It is commonly defined as a weighted average of the units in the donor pool (Abadie 2020). In our exercise, the synthetic control is constructed as a weighted average of potential control countries in the donor pool. In selecting these potential control countries, we exploit the flexibility of the method. Our set of potential comparisons is a sample of non euro-members (i.e., EU members and Extra European countries) available across all regions. As EU members that are not EMU members, we include

Czech Republic, Denmark, the United Kingdom, Hungary, Poland, Romania, and Sweden. As Extra European countries, we selected those countries available in the WIOD dataset that are important economic players at the international level, namely Australia, China, India, Indonesia, Japan, South Korea, the United States, Canada, Mexico, Brazil, and Turkey. We selected this large set of countries to increase the sample size and thus the reliability of our analysis. To avoid a possible bias, we excluded the countries that joined the EMU after 1999 (i.e., subsequent entrants) from the analysis (both in the EURO and in the EU group). We distinguish between value added export that is due to demand of the Euro trading partners, and value added export that is due to demand in third countries. The difference between these two categories proves to be important from a policy perspective since trade adjustments are expected to take place between Euro member countries. Accordingly, as partner countries of Italy, we alternately consider all partner countries (EURO, EU and Extra European countries), EURO members and EU (non-euro) members. Since we consider three value added components and three destinations, the algorithm constructs nine synthetic controls. Table 7 in the Appendix reports the weights for the SC in the nine cases. More specifically, the Table shows the weights of each country in the synthetic version of the three value-added components for Italy. By construction, for each trade in value added component and partner group, the set of weights sums up to one. Although—as expected—weights change for each trade in value added component and partner countries—the synthetic control is a weighted average of mainly three countries: two neighbouring countries that are Poland and the United Kingdom, and a big partner, that is China. Czech Republic, Japan, and Denmark also contributing to the synthetic control with weights in decreasing order. This feature is true both in the case of all partners and EURO members. In the case of EU (non -euro) partners, the United Kingdom receives the highest weight in each trade in value added component. All other countries in the donor pool obtain zero weights. The sparsity of the weights is typical of synthetic control estimators and is a consequence of the geometric characteristics of the solution to the optimization problem that generates synthetic controls.[8]

5.2 Main Results

Results of the SCM estimates are presented in Figs. 4, 5 and 6. Each figure shows for each value added component (direct domestic value added—DDVA; indirect domestic value added—IDVA; foreign value added—FVA) the actual and the counterfactual value for different destinations: (a) all countries, (b) EURO members, (c) EU non-euro members. In all cases, the two series track each other closely in the pre-treatment period.

Figures 4a–c show a decreasing share of the domestic value added directly exported. This suggests that the process of international fragmentation of

[8] "Because synthetic control weights define a weighted average and because they are sparse, the specific nature of a synthetic control counterfactual estimate is particularly transparent, relative to competing methods" (see Abadie, 2020, p. 7).

production has continued. However, the single currency has slowed down the process: if Italy had not joined the EMU, the domestic value added of its exports would have been lower than the actual one (Fig. 4a). Within a common trend, there are significant differences between euro and non-euro destination markets (Fig. 4c), and the domestic value added intensity is higher in the case of euro partners (Fig. 4b).

Figure 5a–c confirm that Italy has not been affected by the GVC slowdown to the extent that the indirect domestic value added component has kept increasing consistently with the process of international fragmentation of production. In Fig. 5a, the Italian IDVA share is consistently higher than the synthetic one. The EMU had a positive impact on GVC integration: if Italy had not joined the EURO, the re-exported domestic value added of its exports would have been lower than the actual one.

However, the overall result (Fig. 5a) is the outcome of different trends according to the export destination. The share of Italian value added re-exported through the other (non-euro) countries is not consistently different from the synthetic one (Fig. 5c). On the contrary, the euro impact is positive and consistent over time in the case of the Italian value added re-exported by euro member countries (Fig. 5b). In other terms, the EMU has reinforced the "Factory Europe" effect among euro partners.

If Fig. 5a–c show increasing forward integration, Fig. 6a–c confirm the lack of a GVC slowdown also in terms of backward integration. However, contrary to the previous case, the overall FVA share in Italian exports is never higher than the synthetic one (Fig. 6a). The EMU had a depressing effect on the backward integration and this is due to the slower growth of the FVA share in the exports towards euro members (Fig. 6b). On the other hand, the use of foreign inputs has been boosted by the euro in the case of exports to other (non-euro) EU countries (Fig. 6c). Since we do not know the FVA origin, it may still be the case that the EMU increased the sourcing from euro partners. Regardless of the origin of the value added, the euro accelerated the use of foreign inputs to guarantee export competitiveness in non-euro markets.

Table 2 summarizes our results through the computation of the "rates of return" (i.e., the ratio between a change in the value added exports' shares to what a country would have done without the single currency) of adoption of the euro for Italy in two post-adoption time spans: immediately after the adoption of the euro (2000–2005) and after five years (2006–2011). The single currency has increased the "forward" integration of the Italian GVCs by 6% to 8%. Such an increase is mostly explained by the dynamics of exports to euro member countries since the forward integration has increased at a slower pace in the non-euro EU markets (-9% in the most recent period).

On the other hand, "backward" GVC integration has been slowed down by the single currency. Euro had a depressing effect on the foreign component, -10% in the five years after the adoption of the euro, although the negative impact has been less apparent in the following five years (-4%). Also, in this case, the overall impact is explained by the dynamics of the euro member countries (-12% and -8% in the two time periods considered). On the contrary, in the case of exports to non-euro EU markets, backward integration seems to be higher than would have been the

Table 2 Percentage rate of returns of the euro adoption for Italy in two post-adoption time spans: 2000–2005 and 2006–2011

Destinations	Value added export's components	Time span	Rate of return (%)
All countries	DDVA	2000–2005	3.96
		2006–2011	5.19
	IDVA	2000–2005	5.54
		2006–2011	7.73
	FVA	2000–2005	− 9.67
		2006–2011	− 4.32
EURO countries	DDVA	2000–2005	4.11
		2006–2011	4.36
	IDVA	2000–2005	7.19
		2006–2011	8.50
	FVA	2000–2005	− 12.18
		2006–2011	− 8.08
Other EU countries	DDVA	2000–2005	− 0.65
		2006–2011	− 4.87
	IDVA	2000–2005	0.14
		2006–2011	− 8.75
	FVA	2000–2005	5.20
		2006–2011	15.11

Authors' calculations

case if Italy had remained out of the EMU (+ 5% and + 15% in the two time periods considered).

The overall impact on the Italian value added directly exported is positive since the share of DDVA is 5% to 6% higher than those presented by the synthetic control. Also, in this case, results for the euro and non-euro markets present opposite signs.

In conclusion, the single currency has accelerated the increase of the Italian value added exported through the euro partners. On the other hand, the single currency has slowed down the rate of increase of FVA embedded in Italian exports to the euro partners.

5.3 Sectoral Results

Since the literature studying the currency unions highlights a reduction in trade costs, the latter result is somewhat unexpected. To shed some light, we split the sample between trade flows in different sectors and construct a separate synthetic control series for each sector presenting non-missing values (the list of all sectors is reported in Table 8 in the Appendix). We only consider the case of all partners (i.e., Euro, EU and Extra European countries) as a destination. Figures 7, 8 and 9 report the difference between the Italian value added shares and the synthetic control

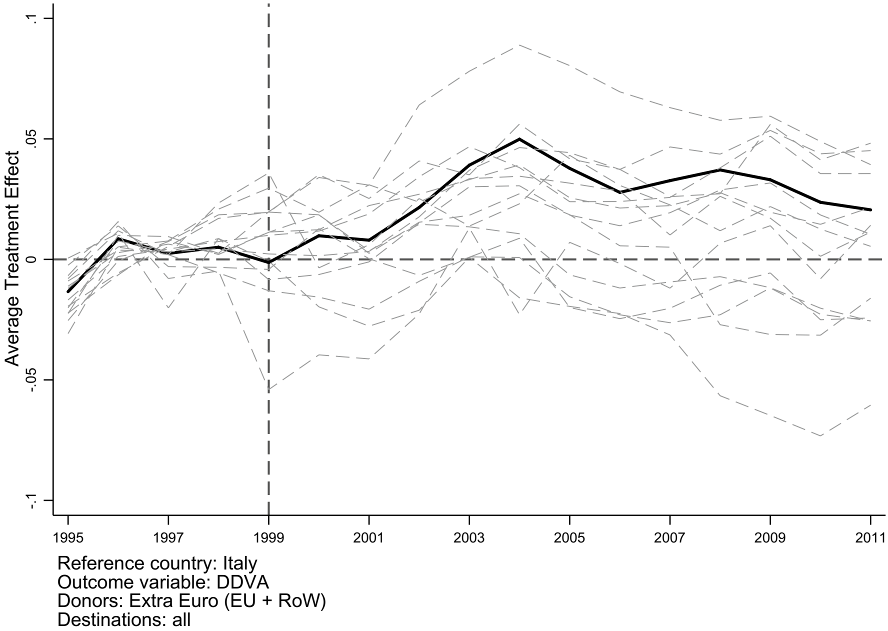

Fig. 7 ATE Sectoral DDVA. Source: Authors' calculation

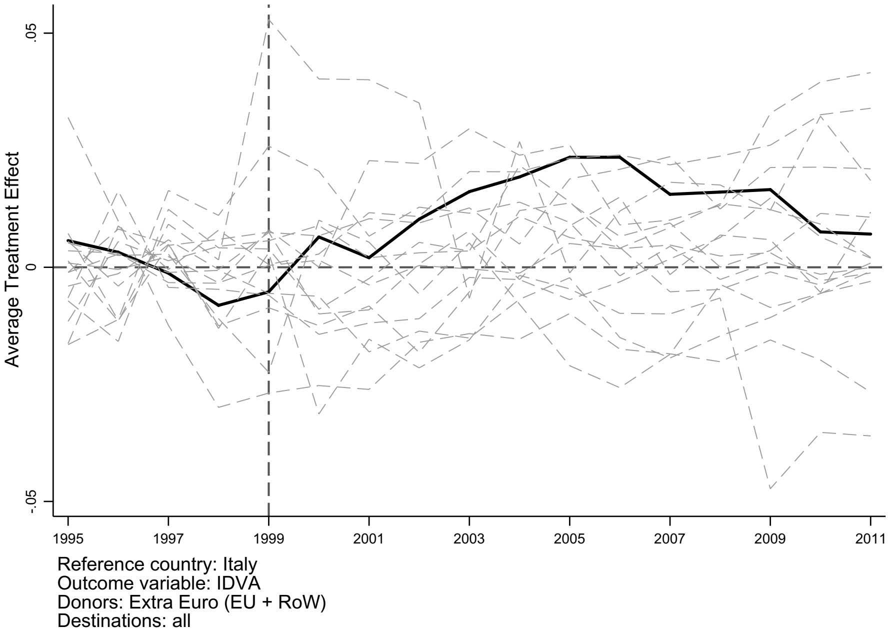

Fig. 8 ATE Sectoral IDVA. Source: Authors' calculation

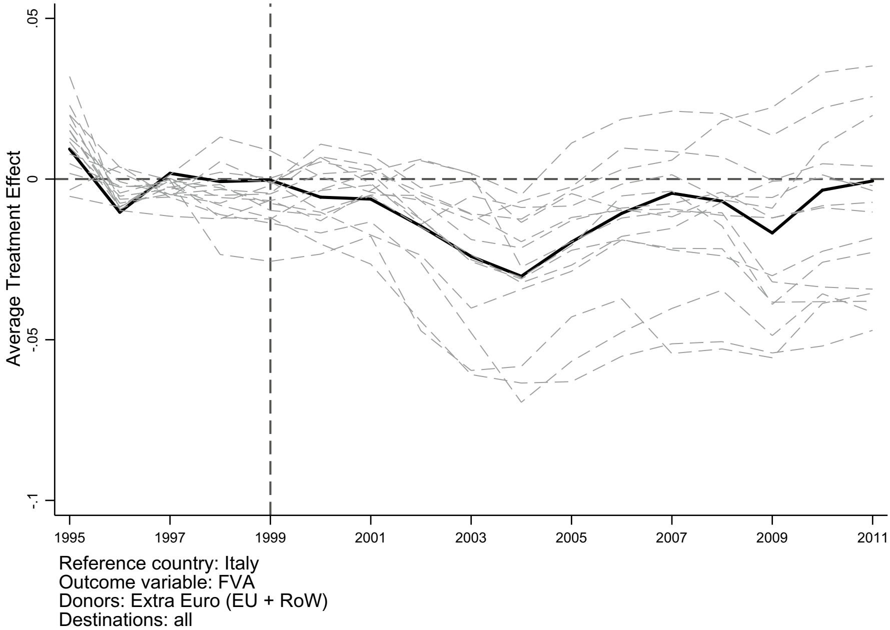

Fig. 9 ATE Sectoral FVA. Source: Authors' calculation

ones (the average treatment effect, or ATE, see Sect. 4). The bold line refers to the total values, that is the difference between actual and counterfactual values shown in Figs. 4a, 5a, and 6a respectively, whereas the dashed lines present the same difference for the available sectors.

The overall positive ATE is confirmed for most sectors, but there are a few notable exceptions (see Fig. 7). The most prominent negative effect has been registered by the "Agriculture, Hunting, Forestry and Fish" sector (the most declining dotted line). Since the domestic value added share in direct exports is lower than it would have been without the adoption of the euro, this implies the single currency has increased the GVC integration of the primary sector. The opposite is true for the "Electrical and Optical Equipment" (the highest dotted line) and the "Machinery" sectors.[9]

A similar evolution has been registered for the IDVA sectoral component, although Fig. 8 shows a higher variability at the sectoral level. Even if the single currency has an overall positive impact on forward GVC integration, especially in the case of "Coke, Refined Petroleum and Nuclear Fuel" and "Chemicals and Chemical Products", we get opposite results. On the other hand, the overall positive ATE is driven mostly by the "Basic Metals and Fabricated Metal", "Electrical and Optical Equipment", and "Inland Transport" sectors.

[9] Details on the sectoral results are available upon request.

Finally, Fig. 9 confirms the overall negative impact in terms of FVA. Such a result is mostly explained by the performance of the following sectors: "Electrical and Optical Equipment", "Machinery" and "Textiles and Textile Products". It is worth noting that the single currency can have opposite impacts on different value added components: in the case of "Electrical and Optical Equipment," it increased the forward GVC integration but slowed down the backward component. On the other hand, sectors are moving in the opposite direction, especially after a few years since the adoption of the euro. In particular, this is the case for "Agriculture, Hunting, Forestry and Fish", and "Food, Beverages and Tobacco". The negative impact on the share of agricultural DDVA would seem to be explained by the increased use of foreign inputs.

The analysis at the sector level is insightful for two main reasons. On the one hand, it shows that several sectors are moving in the opposite direction to the overall impact. On the other hand, the apparent reduction of the overall impact is not a consequence of a temporary impact of the adoption of the euro, but the combination of permanent trends at the sector level moving in opposite directions.

The analysis by a single sector could be further developed by focusing on the sectors that have shown greater sensitivity to adopting the single currency and reconstructing the backward and forward links, with a detail of the origin of foreign inputs and the destination of domestic inputs. We reserve this development in possible future work.

5.4 Robustness Analysis and Placebo

As a robustness check of the main analysis, we run the SCM analysis by changing the date of treatment from 1999 to 2002 (the year of departure of actual cash transactions in euros) for the nine cases investigated in this paper. This provides an estimate of the euro effect with a longer pre-treatment period. We compare the differences between the actual and synthetic patterns using 1999 as treatment year, with the differences resulting from 2002 as treatment. If the different treatment years provide consistent results, we should expect flat lines around zero in Fig. 10.

In most cases, we observe a flat line. The only exceptions (case 2, 6, and 9) are the results for all country destinations in the case of the IDVA components and the euro members and EU non-euro destinations for the FVA component. Even in this case, we can conclude that results would have been not dramatically changed by changing the year of treatment. This lends sufficient robustness to our baseline findings and shows that euro circulation has not affected the impact on exports out of the EU.

A severe drawback of the SCM is that it does not allow for standard inference regarding the estimated treatment effects. In other words, SCM does not provide standard p-values for testing the difference between the treated and the synthetic time pattern based on standard asymptotic inference. To overcome these limits, Abadie et al. (2010) have suggested a permutation test that in this context, takes the form of a placebo test. The test is performed as follows: first, the SCM exercise is rerun by taking as treated unit each of the untreated donors; second, the result

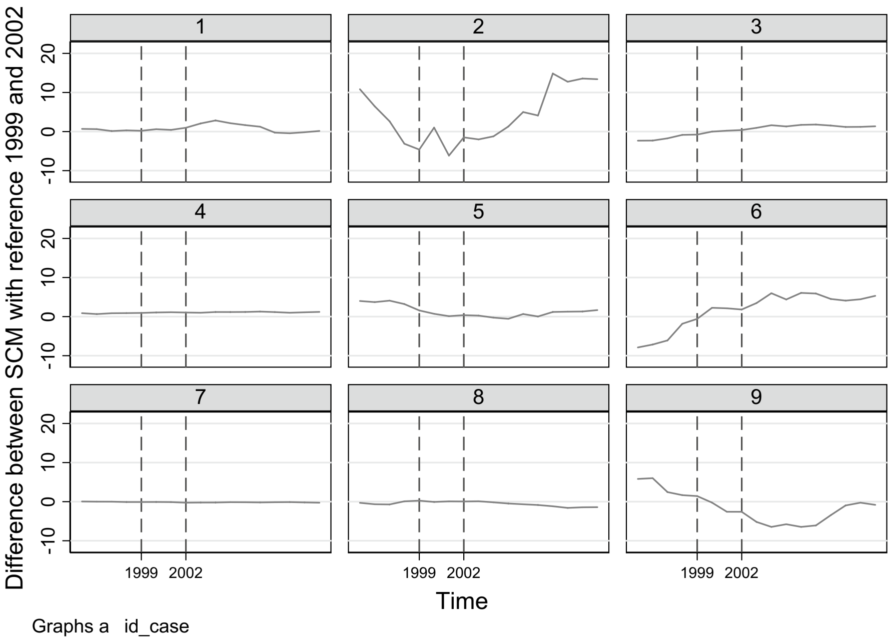

Fig. 10 SCM results: difference between the 1999 and 2002 outcomes. By column: DDVA, IDVA, FVA. By row: all countries, euro members, EU non-euro members. Source: Authors' calculation

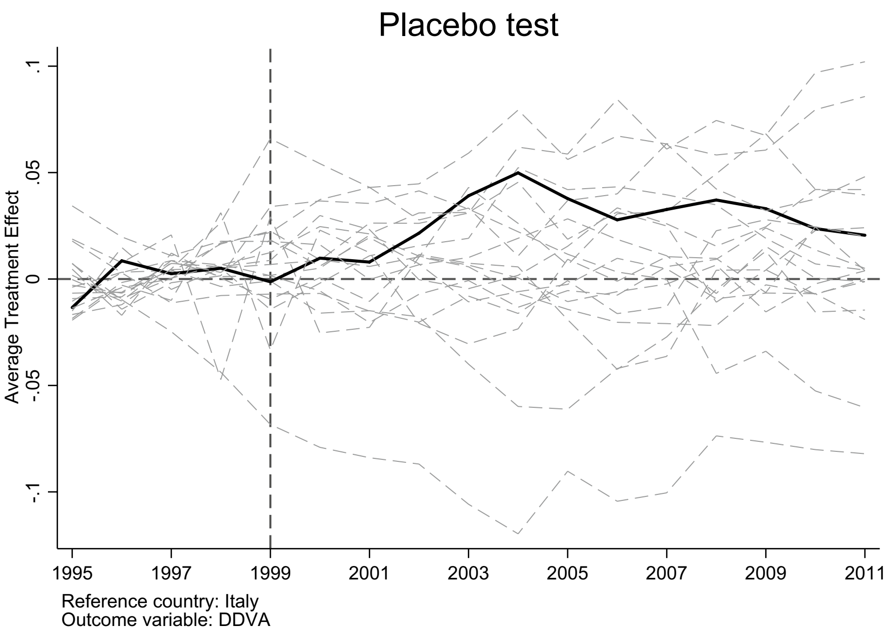

Fig. 11 DDVA – Placebo test (all donors and all countries). Source: Authors' calculation

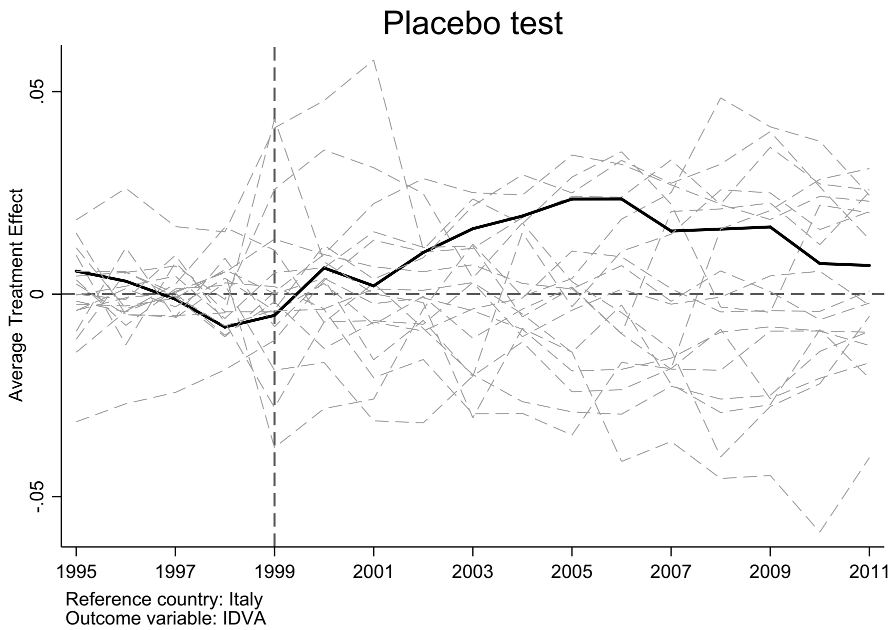

Fig. 12 IDVA – Placebo test (all donors and all countries). Source: Authors' calculation

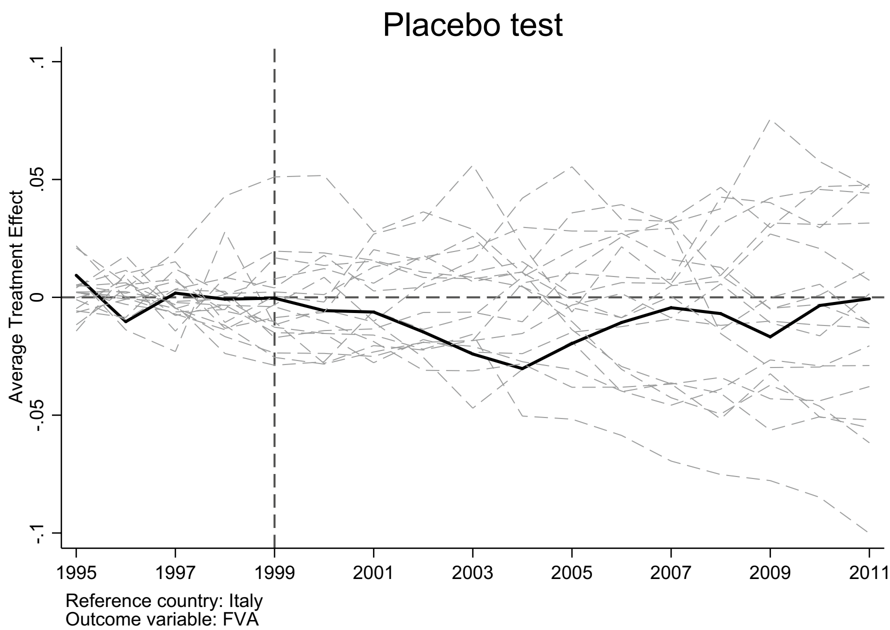

Fig. 13 FVA – Placebo test (all donors and all countries). Source: Authors' calculation

of each of these SCM patterns is jointly plotted by emphasizing the comparison with the true treated country's pattern (that of Italy in our case). The average of the donors' patterns should be centred around zero, while the Italian pattern should come as relatively unusual, thus lying in the tail of the distribution.

Figures 11, 12 and 13 set out the results on DDVA, IDVA, and FVA. Overall—if we exclude a few last post-treatment years—the results show that the Italian pattern is firmly far from zero and quite unusual compared to the placebos, especially in the years from 2002 to 2006. This means that the results we obtained for this period are sufficiently robust. Of the three placebo tests, the one for FVA seems a bit less significant, but this is due only to the fact that there is less variance in the placebos patterns than for DDVA and IDVA. In other words, results are close for all the variables.

Although graphical inspection can help detecting the significance of the estimated effects, it seems wise to provide more detailed analytical inference than just relying on eyeball comparative plots. Recent literature has provided more formal tests for assessing the significance of SCM results than graphical inspection. Among the inferential approaches to SCM reviewed by Abadie (2020), we implement the method of Abadie et al. (2015), Cavallo et al. (2013), and Galiani and Quistorff (2017).[10]

This method is based on the idea—if the distribution of the placebo effects sets out untreated effects that are on average as large as the effect of the treated unit—then it is likely that the latter was observed just by chance. Formally, this occurrence can be measured by the following p-value:

$$\text{p-value}(t) = \frac{\sum_{j \neq 1} 1\left(\left|\hat{\alpha}_{jt}^{pl}\right| \geq \left|\hat{\alpha}_{1t}\right|\right)}{J} \tag{7}$$

where $\hat{\alpha}_{jt}^{pl}$ is the j-th placebo effect at time t, $\hat{\alpha}_{1t}$ is the treated unit effect at time t, and J is the total number of placebos. The larger this value, the likelier that we observed the treated effect by chance. Observe that this p-value can be computed time-by-time. Also, in order to assess the joint effect across all post-treatment periods, this approach suggests comparing the treated post-treatment RMSPE $\vec{s}_1$ to the corresponding placebos' RMSPE $\vec{s}_j^{pl}$ so to produce an overall p-value.

Finally, as the placebo effects may be quite large when units are not matched well in the pre-treatment period, the previous p-values may be too conservative, leading to easily rejecting the presence of an effect for the treated unit. To control for such occurrence, Galiani and Quistorff (2017) propose to adjust the p-values by the pre-treatment fitting performance measured by the pre-treatment RMSPE,

[10] Other SCM robustness tests, such as the one proposed by Firpo and Possebom (2018), represent a generalization of the method used in this paper. On the other hand, the exact robust t-test based approach proposed by Chernozhukov, Wüthrich and Zhu (2020) provides an interesting methodological alternative. Unfortunately, applying this approach requires a rather long pre-treatment time span period. In our context, due to data availability constraints, we do not have access to a large pre-treatment time series, thus making the application of this procedure unfeasible within our dataset.

Table 3 Post-treatment effect, p-values, and standardized p-values of the effect of joining the Euro. Outcome: DDVA (all donors and all countries)

Year	Treatment year: 1999			Treatment year: 2002		
	Effect	p-values	Standardized p-values	Effect	p-values	Standardized p-values
2000	− 0.001	0.833	0.889			
2001	0.010	0.667	0.500			
2002	0.008	0.889	0.778			
2003	0.022	0.278	0.389	0.016	0.235	0.000
2004	0.039	0.167	0.111	0.027	0.294	0.059
2005	0.050	0.278	0.222	0.033	0.235	0.176
2006	0.038	0.278	0.222	0.025	0.235	0.176
2007	0.028	0.500	0.389	0.019	0.588	0.353
2008	0.033	0.333	0.278	0.026	0.353	0.176
2009	0.037	0.333	0.167	0.039	0.235	0.118
2010	0.033	0.333	0.167	0.036	0.235	0.059
2011	0.024	0.500	0.333	0.025	0.294	0.176

indicated by $\overleftarrow{s}_1$ and $\overleftarrow{s}_j^{pl}$ respectively for the treated and the placebo units. The standardized p-values thus become:

$$\text{p-value}^{\text{STD}}(t) = \frac{\sum_{j\neq 1} 1\left(\left|\hat{\alpha}_{jt}^{pl}/\overleftarrow{s}_j^{pl}\right| \geq \left|\hat{\alpha}_{1t}/\ \overleftarrow{s}_1\right|\right)}{J} \tag{8}$$

Year-by-year, one can assess the robustness of the detected treatment effect by looking at this quantity. Of course, the smaller are these p-values, the lower the probability that a high treatment effect has occurred by chance. Before commenting on our results, it is important to notice that the p-values obtained using formula (8) are only empirical approximations of the true p-values, as they do not rely on proper asymptotic theory. This means that we have to carefully take them just as an indication of the effect's statistical significance as they are not based on proper theoretical derivation.

Table 3 sets out the results for the impact of joining the Euro on DDVA. We present the results for both the 1999 and 2002 treatment years. Unlikely p-values, standardized p-values tend to be fairly smaller as expected. Although not below the usual 5% significance, it is interesting to notice how the standardized p-values initially decrease as the post-treatment time increases. They show an initial descending pattern reaching their minimum in 2004, followed by a back-and-forth trend in the subsequent years. This pattern is by and large confirmed for the 2002 treatment year. This finding suggests that the euro's impact on DDVA is quite ambiguous and surely less precisely estimated in the long run.

Table 4 Post-treatment effect, p-values, and standardized p-values of the effect of joining the Euro. Outcome: IDVA (all donors and all countries)

Year	Treatment year: 1999			Treatment year: 2002		
	Effect	p-values	Standardized p-values	Effect	p-values	Standardized p-values
2000	– 0.005	0.667	0.556			
2001	0.006	0.611	0.556			
2002	0.002	0.889	0.833			
2003	0.010	0.389	0.278	0.013	0.278	0.056
2004	0.016	0.444	0.389	0.020	0.222	0.000
2005	0.019	0.222	0.167	0.022	0.222	0.000
2006	0.023	0.389	0.222	0.021	0.222	0.111
2007	0.024	0.333	0.333	0.014	0.444	0.333
2008	0.016	0.722	0.444	0.008	0.667	0.611
2009	0.016	0.667	0.500	– 0.011	0.667	0.556
2010	0.017	0.667	0.500	– 0.007	0.778	0.778
2011	0.008	0.833	0.611	– 0.017	0.444	0.278

Table 5 Post-treatment effect, p-values, and standardized p-values of the effect of joining the Euro

Year	Treatment year: 1999			Treatment year: 2002		
	Effect	p-values	Standardized p-values	Effect	p-values	Standardized p-values
2000	0.000	1.000	1.000			
2001	– 0.006	0.778	0.722			
2002	– 0.006	0.889	0.833			
2003	– 0.015	0.667	0.389	– 0.015	0.353	0.059
2004	– 0.024	0.333	0.222	– 0.025	0.235	0.000
2005	– 0.030	0.222	0.167	– 0.033	0.118	0.059
2006	– 0.020	0.333	0.444	– 0.022	0.471	0.353
2007	– 0.011	0.722	0.778	– 0.014	0.824	0.647
2008	– 0.004	0.833	0.778	– 0.008	0.882	0.765
2009	– 0.007	0.833	0.722	– 0.010	0.824	0.706
2010	– 0.017	0.722	0.667	– 0.019	0.706	0.529
2011	– 0.003	0.944	0.889	– 0.006	0.941	0.824

Outcome: FVA (all donors and all countries)

Table 4 reports the results on IDVA for both the 1999 and 2002 treatment years. Standardized p-values are, in general, higher than those found in the case of DDVA (although quite variable over time). However, for the 2002 treatment year, values are mostly below the 10% significance in the period 2003–2006. This finding confirms the overall positive effect of joining the euro on the IDVA.

Results on FVA for both the 1999 and 2002 treatment years are presented in Table 5. The standardized p-values are highly variable over time. As in the case of the DDVA, the standardized p-values register an initial descending pattern reaching their minimum in 2004, but they sharply increase afterwards. Also in this case, then, the impact of the joining the euro on FVA seems less precisely estimated in years far from the one of treatment.

Overall, results for the 2002 treatment year validate the analysis for 1999. The p-values confirm that the euro's impact on the trade in value added components is quite clear in the short run, mainly in the period 2003–2005, whereas it becomes ambiguous and less precisely estimated in the long run.

6 Conclusions

The perspective of GVCs helps give a more accurate picture of the consequences of the euro adoption. This paper is the first to assess the impact of the euro on the value added structure of trade. By measuring the impact of the euro through the lens of value-added exports instead of gross exports, we get a better understanding of how single currencies weigh on trade. Our contribution is twofold. First, the paper provides evidence of the effect of the euro on forward and backward GVC integration of Italian exports. Second, the SCM methodology is applied where observed value added shares are compared with the shares that would have taken place if the euro had not been adopted in Italy.

The creation of the euro has reinvigorated research on the impact of currency unions on trade integration. However, an investigation based solely on standard trade statistics is not sufficient in a world characterized by cross-border production chains where production processes consist of several stages and involve firms located in several countries. The establishment of these production networks increases the interlinkages between economies and the distinction between production and assembly should be taken into account to correct gross exports for the source of value added.

In this paper, we fill this gap by assessing the impact of the euro integration process on Italian value added trade flows. We distinguish the main components of statistics on gross export flows based on the decomposition in domestic and foreign value added. Within the domestic value-added component, we distinguish between trade flows that are absorbed by the importer and those that are re-exported to other countries and thus depend on the demand of those countries. These latter are considered as forward participation in GVC. Backward participation in GVCs is measured as the value added embedded in the foreign inputs utilized in the production of exports.

From a methodological point of view, the results from gravity models are subject to considerable methodological uncertainties. The SCM represents a way of setting up a reasonable counterfactual scenario for what would have occurred in the absence of the single currency. We constructed the counterfactual control as a weighted combination of potential comparison countries with the weights chosen such that the resulting synthetic control resembles the actual Italian trade flows in the pre-euro period as closely as possible. The main feature of the SCM is that it provides a procedure that reduces discretion in the choice of the control group by “letting the data speak”.

However, like for any other statistical procedure (and especially for those aimed at estimating causal effects), the credibility of the results depends crucially on whether contextual and data requirements are met in the empirical application at hand. In this respect, we are limited by the quantity and quality of the data available regarding the trade in value added flows. Moreover, it is worth recalling the main limitations of the analysis in terms of sampling-based inference, external validity, and the identification of the channels through which the effect of the euro adoption operates.

Our results show that the process of international fragmentation of production has continued after the euro adoption and the single currency has influenced the value added structure of Italian exports. Within an overall trend of GVC increasing integration, the euro has accelerated the Italian forward participation by 6% to 8% compared with the synthetic control. Higher IDVA shares in exports to euro partners have been accompanied by lower shares in exports to non-euro markets. Higher forward integration takes place regardless of the Italian trade specialization since it is stronger in sectors such as Basic metals (comparative advantage) and Electrical and Optical Equipment and Inland transport (comparative disadvantage). The same is true for the sectors that registered a negative impact since we find both Chemical products (a new comparative advantage) and Coke (the traditional comparative disadvantage).[11]

On the other hand, the adoption of the EMU has slowed down the Italian GVC backward integration process mostly in the first years after adoption (10% less than the synthetic control). The process is driven by exports towards euro member markets and the decrease is concentrated in traditionally export-oriented sectors, such as the Machinery and Textiles, as well as the Electrical equipment sector. Also in this case, there are sectors moving in the opposite direction, such as Agriculture and Food.

Taken together, these results would thus suggest that on the one hand, the introduction of the euro provided a boost to the Italian role as a provider of inputs to ‘factory Europe’. On the other hand, the euro has reduced the reliance of Italian exports on foreign inputs: an unexpected result for a currency union that should reduce transaction costs. A possible explanation could lie in the direct investments favoured by the single currency: firms may have decided to produce locally rather than import the intermediate goods needed for their exports. As many advocates of currency unions have argued, a common currency should foster deeper and more liquid financial markets, and possibly higher levels of cross-border investment, given lower transaction costs and the elimination of exchange-rate risks: indeed, the most recent empirical evidence shows that the introduction of the euro has increased inflows into the monetary union, both among monetary union countries but also from investors outside the union.

It is nonetheless worth acknowledging that most of the long-run effects we find in our empirical analysis are not precisely estimated. However, we cannot disentangle to what extent this depends on poor placebo test’s power or the

[11] For an illustration of the Italian comparative advantages measured in value added terms, see Dell’Agostino and Nenci (2018).

absence of a true effect. Given the finite size of our sample and the absence of a placebo test's rigorous asymptotic theory, the issue remains open.

In terms of future research, it would be interesting to extend our empirical framework in two main directions. First, the literature focusing on the impact of the euro on (gross) trade has found that effects are different across countries. Accordingly, it is worth investigating to what extent the results we obtained for the Italian value added flows are common to other EU members. Second, the WIOD database allows the origin of FVA to be disentangled, even at sectoral level. It would therefore be possible to assess the impact of the euro on the sourcing choices of the Italian firms in terms of foreign input purchases.

Appendix

See Tables 6, 7 and 8.

Table 6 Sample countries

EURO Members	10 EU countries that adopted the euro in 1999: Austria, Belgium, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, Spain, and Portugal
EU Members	7 EU countries that are not EMU members: Czech Republic, Denmark, the United Kingdom, Hungary, Poland, Romania, Sweden
EXTRA EUROPEAN Countries	11 non-European countries: Australia, China, India, Indonesia, Japan, South Korea, United States, Canada, Mexico, Brazil, and Turkey

Table 7 Second experiment: SCM weights (Trade in value added components; Partner countries)

	All countries		Euro members		EU (non-euro)	
DDVA	CHN	0.16	CHN	0.11	GBR	
	GBR	0.11	CZE	0.09	TUR	
	JPN	0.06	GBR	0.15	USA	
	POL	0.67	POL	0.64		
FVA	CHN	0.18	CHN	0.14	GBR	0.78
	GBR	0.40	GBR	0.34	POL	0.07
	POL	0.42	POL	0.52	TUR	0.08
					USA	0.07
IDVA	CHN	0.61	CHN	0.12	GBR	0.50
	CZE	0.33	DNK	0.14	TUR	0.34
	DNK	0.06	GBR	0.12	USA	0.17
			POL	0.60		

Source: Authors' calculation

Table 8 Complete list of sectors

Sectors
Agriculture, Hunting, Forestry and Fish
Air Transport
Basic Metals and Fabricated Metal
Chemicals and Chemical Products
Coke, Refined Petroleum and Nuclear Fuel
Construction
Education
Electrical and Optical Equipment
Electricity, Gas and Water Supply
Financial Intermediation
Food, Beverages and Tobacco
Health and Social Work
Hotels and Restaurants
Inland Transport
Leather, Leather and Footwear
Machinery, Nec
Manufacturing, Nec; Recycling
Mining and Quarrying
Other Community, Social and Personal Services
Other Non-Metallic Mineral
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
Post and Telecommunications
Private Households with Employed Persons
Public Admin and Defence; Compulsory Social Security
Pulp, Paper, Paper, Printing and Publishing
Real Estate Activities
Renting of M&Eq and Other Business Activities
Retail Trade, Except of Motor Vehicles
Rubber and Plastics
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
Textiles and Textile Products
Transport Equipment
Water Transport
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles

Please note that only sectors presenting non-missing values are included in the sectoral SCM analysis.

Acknowledgements The authors would like to thank participants in the following conferences for their useful comments and suggestions: the International Workshop on Computational Economics and Econometrics (IWcee), National Research Council of Italy, Rome, June 21–23 2017; the European Trade Study

Group Annual Conference, Warsaw, Poland, 13-15 September 2018. Also, we thank the Grape research group members for the opportunity to present and discuss the preliminary results of this study. All remaining errors are the responsibility of the authors.

Funding Open access funding provided by Università degli Studi Roma Tre within the CRUI-CARE Agreement. No funds, grants, or other support was received.

Availability of data and material The datasets generated during the current study are available from the Authors.

Declarations

Conflicts of interest The authors have no relevant financial or non-financial interests to disclose.

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