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Sommario

Nel periodo 2012-2014 l'Istat ha partecipato al grant Eurostat, "Azione a supporto di specifici miglioramenti nei conti nazionali", con l'obiettivo di produrre per la prima volta le stime trimestrali di esportazioni e importazioni di beni e servizi suddivisi per area geografica. L'obiettivo del lavoro è di illustrare la metodologia utilizzata nel progetto, finalizzato a costruire indicatori in serie storica ripartiti per area geografica e a ottenere stime trimestrali di domanda estera suddivise per area, nel rispetto di vincoli simultanei: temporali (entro le variabili) e contemporanei (tra serie componenti). In questo lavoro che contempla più identità contabili e sistemi di dati in forma matriciale, la tecnica di riconciliazione a due stadi (Quenneville e Rancourt, 2005) è stata ritenuta la più adatta per ottenere la consistenza delle stime trimestrali per area geografica sia a livello temporale che spaziale. La metodologia adottata è stata validata da Eurostat.

JEL Classification: C32, C63, C82.

Parole chiave: esportazioni e importazioni di beni e servizi, tecniche di bilanciamento e di disaggregazione temporale, riconciliazione, stime trimestrali, aree geografiche.

Abstract

Over the period 2012-2014 Istat participated in the Eurostat grant, "Action to support specific improvements in national accounts" in order to release the quarterly estimation of exports and imports of goods and services broken down by geographical area for the first time. The goal of the current paper is to illustrate the methodology used in the project, which aims at building indicators in time series by area and obtaining quarterly estimates of foreign demand aggregates broken down by geographical area in compliance with simultaneous constraints: time-related (between yearly e quarterly estimates) and contemporary constraints (between variables). In the case of several accounting identities and large systems of data in matrix form, the two-steps reconciliation strategy (Quenneville and Rancourt, 2005) has been considered as the more suitable method to remove any discrepancy and achieve consistency both at time-related and geographical level. To conclude, Eurostat validated the reconciliation technique adopted in this study.

JEL Classification: C32, C63, C82.

Keywords: Exports and imports of goods and services, balancing and benchmarking, reconciliation, quarterly estimates, geographical areas.

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1. Introduction

Over the period 2012-2014, Istat participated at the Eurostat grant, Theme 2.01 "*Action to support specific improvements in national accounts"* aiming at to build up a method to estimate quarterly exports and imports broken down by geographical area and to make them consistent with total values for exports (P.6) and imports (P.7) deriving from Quarterly National Accounts (QNA) aggregates[2].

Since the aggregates broken down by geographical area were already disseminated at annual level, the project proposed the estimation of quarterly time series broken down by geographical area, in order to extend the dissemination of external trade quarterly data according to the ESA95 transmission program (Regulation EC 1392/2007).

The specific objective of the action was to develop a database of time series indicators, of exports and imports of goods and services (by geographical area starting from the first quarter of 1999, both for current flows and prices), and to estimate quarterly series according to the methodology utilized in Italy for the estimation of quarterly national accounts (QNA), that is by temporal disaggregation of annual series with reference indicators. In particular, having a large system of data in matrix form, the two-steps reconciliation technique (Quenneville and Rancourt, 2005) has been considered as the more suitable method to achieve consistency both at temporal and geographical level. Eurostat approved the methodology and the results of the project in February 2014.

Currently, QNA are compiled following the new European system of national accounts definitions and structure (ESA2010). Starting from October 2014, according to ESA2010, the full set of quarterly national accounts is released at 60 days by the end of the reference quarter providing time series going back to the first quarter of 1995. A preliminary estimate of GDP at chain-linked values is published at 30 days after the end of the reference period. Data related to the second quarter are issued a third time at 90 days to make quarterly data coherent to the updates of annual accounts issued a second time in September. Data published cover all the production side, expenditure side and income side components.

By adopting the new system of national accounts ESA2010, Eurostat also disseminates quarterly estimates of Italian exports and imports (goods+services) broken down by geographical area. With respect to the original project, some change in methodology and definitions[3] has occurred. Now they are compiled for the following 5 regions (instead of 6, as was in the past) [4], according to EU and Euro Area evolving composition:

S.21	Member States and Institutions of the EU
S.2I	Member States and Institutions of the Euro Area
S.xx (S.21-S.2I)	Member States of the EU that are not Member States of the Euro area

[2] According to ESA2010 (EU Reg. 549/2010) exports (P.6) and imports (P.7) of goods and services consist of transactions in goods and services (sales, barter, and gifts) from residents to non-residents. Exports of goods are valued FOB (free on board) while Imports of goods are valued CIF (cost, insurance, freight). Note that the transition from valuation of imported goods at CIF to FOB consists of: (a) CIF/FOB adjustment (reduces total imports and exports); (b) CIF/FOB reclassification (leaves total imports and exports unchanged).

[3] The new ESA2010 definitions use a change in ownership approach that is no more based on physical movements. Hence, the new definitions imply changes in the way the following items for exports and imports are dealt with: a) merchanting activity, that is the selling to a non-resident (by a resident) of a good purchased by another nonresident without the good entering the merchant's economy, that is now registered as trade in goods instead of services; b) the processing activity of goods sent abroad or received from abroad to be processed with a change in ownership (goods destined for processing on account of foreign customers) are excluded from the trade of goods, whereas the related processing is recorded as services. The new definitions will modify the estimation of flows of goods and services, albeit with an almost null net effect on the trade balance (and consequently on Gdp). The QNA estimates take into account the merchanting and treat the processing for only the component of service transformation.

[4] According to ESA2010 transmission program the area S.211 "EU Member State" is no longer to be compiled; while Member States whose currency is not the euro, and institutions and bodies of the European Union (except the European Central Bank and other institutions and bodies of the euro area) area are identified as S.xx (S.21-S.2I) instead of S.2112. EMU and EU breakdowns should represent the actual composition at the end of each reference period ('evolving composition') (Regulation EC 549/2013: 64-65).

S.212	Institutions of the EU (on voluntary basis)
S.22	Third countries and International organizations.

Quarterly series by area are estimated starting from 1999q1 to the latest quarter available. Nevertheless following the ESA2010 transmission program only previous year prices (PYP) series are available on the Eurostat website starting from 1999q1. The other series are sent to Eurostat confidentially, as they are provided on voluntary basis. Hence, quarterly aggregates by area are disseminated in the unadjusted, calendar and seasonal adjusted form:

- at current prices (CUP) starting from 2008q1;
- at chain-linked volumes (CVL) starting from 2012q1.

As a result, Italy is compliant with the ESA Regulation, aligning quarterly accounts dissemination to the other European countries that already provide this geographical information at quarterly level.

Against this background, the goal of the current paper is to illustrate the methodology utilized by QNA procedures to estimate the quarterly aggregates of exports and imports (goods+services) broken down by geographical area reconciled to the QNA totals (world) of exports and imports.

The simplest way to reconcile the 5 areas, calendar and seasonal adjusted (SA) series, is by prorating (Handobook on quarterly accounts, 2013); however, for the exports and imports the SA series are corrected to match the annual totals from the corresponding raw series; hence, reconciliation must preserve that constraint. We use a two-step reconciliation procedure to solve this problem.

Furthermore it allows solving computational problems and guarentees more robust results in terms of minimizing discrepancies, as several authors showed in their works[5]. In particular this approach is easy to apply. The univariate benchmarking in the first step may be achieved with any software package that implements temporal benchmarking. In the reconciliation step, the year-by-year application also reduces the dimension of the matrices involved decreasing the processing time. Hence this procedure has been considered as the most suitable method to remove any discrepancy and achieve consistency both at temporal and geographical level.

The remainder of the paper is organized as follows. Section 2 shows how the project was scheduled and illustrates the main activities and the principal sources of data. Section 3 describes the construction of quarterly indicators of exports and imports of goods and services and the corresponding prices indicators broken down by geographical area; moreover it illustrates the method chosen for the calendar and seasonal adjustment of indicators. Section 4 reports a theoretical approach of reconciliation methods widely applied in National Accounts and discusses their use in QNA external trade estimates by area while Section 5 summarizes the main findings of the project and draws the final conclusions.

2. The Theme 2.01: Main activities and statistical sources

The project began on September 2012 and it was planned to last 16 months (until February 2014). A close collaboration with other Units within Istat and other Institutions was set up in order to achieve project objectives (in particular FTS division and Bank of Italy). Such an organization was deemed crucial for the identification and collection of data available from existing data sources. The sustainability of the project and its implementation is ensured by the structure that works on quarterly accounts of foreign aggregates, within National Accounts Division.

[5] For a good overview on how this problem has been dealt with in the past, and for an extensive list of references on the subject, see Ascione and Lutero (2011) and Quenneville and Rancourt (2005).

The main activities of the project were scheduled as follows:

- Identification of statistical sources and implementation of a dataset of indicators.
- Forecast of indicators not available at t+70 (last quarter for services at current prices).
- Calendar and seasonal adjustment of the indicators where applicable.
- Temporal disaggregation of annual time series.
- Use of benchmarking techniques for achieving consistency at geo and temporal level.

Several statistical sources were considered to produce the time series of quarterly indicators by area. In particular:

- Foreign Trade statistics (FTS, Bank of Italy) as far as concern data on exports and imports of goods and unit values of exports and imports by geographical area.
- Export producer price indices for industrial products distinct between Euro and non-Euro area for constructing price indicators to deflate exports of goods.
- Quarterly Balance of Payments (BoP) questionnaire Q1 by Bank of Italy for collecting data on exports and imports of services by geographical area.
- Eurostat and Oecd price database for data on consumer and services price indices for constructing price indicators to deflate imports of services. As far as concern exports of services by geographical area a single deflator (from output prices) will be used.

The project output is expected to be a final set of quarterly data, together with a description of the processes that produced the aggregates on a regular basis.

Estimations have been performed starting from the first quarter of 1999 up to the third quarter of 2013 and the time series of indicators have been reconstructed according to the evolving composition in EU (of 28 Member States from 2013) and Euro Area (of 17 Member States from 2011)[6]; aggregates have been compiled at current prices, previous year prices and chain-linked volumes[7], unadjusted data, calendar and seasonal adjusted data, for 6 geographical areas as foreseen by the ESA95 transmission program (S.21- Member States of the EU and Institutions of the EU; S.211 – Member States of European Union; S.2I - Member States and Institutions of the Euro area; S.2112 - Member States of the EU that are not Member States of the Euro area; S.212 - Institutions of the EU; S.22 - Third countries and International organizations).

3. Quarterly indicators by geographical area

With reference to the project step. *"Implementation of a database of quarterly indicators of exports and imports of goods and services by geographical area, both for current flows and prices"* and its specific items, the following main activities have been carried out, supported by the development of dedicated procedures written in the ModelEasy+ language[8].

[6] The recent QNA quarterly estimates by area include Euro area with 19 member states (Latvia and Lithuania joined the Euro area, respectively in 2014 and 2015).

[7] Before adopting the ESA2010, the reference period for chain-linked volumes was 2005, afterward it has become 2010.

[8] ModelEasy+ is a statistical package with statistic and econometric functions utilized by Istat to elaborate Annual National accounts (ANA), Quarterly national accounts (QNA) and Quarterly sector accounts (QSA).

3.1 Identification of statistical sources and implementation of a dataset of indicators for exports and imports of goods and services

First of all, a database of indicators has been created to produce quarterly indicators on exports and imports of goods and services separately, exploring data from available information sources. Data on exports and imports of goods by geographical area were from Foreign Trade statistics (FTS, Istat) while data on exports and imports of services were from Q1 questionnaire, Balance of Payments (Bop) by Bank of Italy (2012). Each time series, broken down by geographical area, at monthly or quarterly level, covered the period from January 1999 up to September 2013.

According to the ESA95 transmission program, data (current and constant prices) reflected, for reference periods after 2006, the evolving compositions of the EU and the Euro area.
Backward data (aggregates in current prices, reference periods up to and including 2006) were also provided:

- 1999-2001: total/EMU12 (with 12 Member States as at 1.1.2001).
- 2002-2006: total/EMU12/EU-25/Institutions of the EU/third countries and international organizations.

The set of indicators has been organized in two subsets, for exports and for imports. In particular, the subsets contain:

- monthly data on goods, broken down by geographical area according to the ESA transmission program: S.21, S.211, S.2I, S.2112, S.22. Trade of goods with EU Institutions (S.212) doesn't exist so S211 coincides with S.21. Furthermore two aggregates have been defined: a sum derived from S.21 and S.22 (EU+extra-EU) and a total (world) corresponding to export of goods FOB (P.61) and, on the other hand, to imports of goods Cif, in order to verify the consistency with indicators of exports and imports of goods utilized for QNA estimations. Discrepancies between the two sums were to be attributed to some items that were not available broken down by geographical area: stores and provisions, repairs on goods (up to 2005) and adjustments made to FTS data for BoP purposes (or *coverage adjustment*)[9].
- in the imports of goods database, a specific table provides an estimation of Cif-Fob items with geographical details in order to calculate imports of goods FOB coherent with NA aggregate P.71 (in fact from FTS we can obtain only import of goods Cif while imports of goods FOB correspond to imports of goods Cif minus the Cif-fob component). Cif-Fob series by geographical area are consistent with quarterly and annual totals. Quarterly data on Cif-Fob by geographical area are from Bank of Italy;
- quarterly data on exports and imports of services broken down by geographical area according to the ESA transmission program: S.21, S.211, S.2I, S.2112, S.212, S.22. Trade of services with BCE (S.2122) is non-existent, so S.212 coincides with S.2121 (European institutions without BCE). Data have been derived from BoP questionnaire (Q1, Bank of Italy). Series by geographical area are consistent with quarterly aggregates.
- Since QNA services items P.62 and P.72, according to ESA95, included Financial intermediation services indirectly measured (Fisim)[10], in order to calculate geo services aggregates coherent with quarterly series of indicators utilized for QNA estimations, a table has been implemented with Fisim estimations broken down by geographical area. Estimations starting from 1999q1 have been derived from Bop quarterly data. Fisim series are available at current prices and consistent with quarterly and annual aggregates.

[9] Now these figures, including new items as merchanting and processing, are also available broken down by geographical area. Therefore, currently quarterly indicators of exports and imports by area consider them, reducing discrepancy between total exports/imports and the corresponding QNA aggregates.
[10] According to new ESA2010, Fisim are now reclassified from trade in services to investment income.

3.2. Deflators for exports and imports of goods and services by geographical area

In a second step, import and export price indicators for goods and services are considered, through producer prices of exported products and prices of imports integrated, where necessary, by import-export unit values.

In particular, the following price indicators have been utilized to compile more accurate deflators for exports and imports of goods:

- Export producer price indices for industrial products (EPP) considering Euro and non-Euro area separately have been used to deflate exports of goods by geographical area using: EPP of Euro area to deflate Euro area exports of goods, EU and extra-Euro area components, as a proxy[11].
- At that time, since import price indices was still under development[12], we have decided to use unit value indices (UVI) distinct among EU, Area euro and extra-EU area, to deflate imports of goods by geographical area; monthly series of unit values was available from FTS.
- an estimate was derived for imports of goods FOB deflators by geographical area[13].

According to the procedures already applied to total imports services deflators, the export prices from a foreign country are used to deflate imports of services. Adjustments may be necessary to account for exchange rate movements, on the assumption that movements in exchange rates impact directly and immediately on the price of the imports (Handbook on price and volume, 2001). Hence a database of service price indicators has been created aiming at deflating imports of services broken down by geographical area. For this purpose, synthetic price indicators have been calculated for the following areas: EU, Euro area, extra-Euro area and extra-EU, starting from the first quarter of 1999. In details:

- synthetic price indices broken down by geographical area have been computed following Paasche price index formula[14];
- domestic price indices of partner countries that are the source of Italian imports of services have been converted in Euro denominated prices using the relevant exchange rates; the resulting indices have been aggregated by geographical area.

To calculate synthetic service price indices by area the following monthly indicators have been considered:

- intra and extra-EU exchange rates to compare data available in different currencies. Notably, Eurostat database for EU exchange rates (https://ec.europa.eu/eurostat/web/exchange-rates/data/database "ert_bil_eur_m"), and Bank of Italy's database for extra-EU exchange rates (https://tassidicambio.bancaditalia.it/) have been used as data sources;

[11] At that time monthly prices indices series was available from the first month of 2002. In that case a backward data reconstruction had been developed (from 2001m12 back to 1999m1). Currently, EPP are available from 2000m1 on I.Stat database (http://dati.istat.it/Index.aspx).

[12] The import porducer price indices were implemented in QNA with the release of October 2014, according to ESA2010 dissemination program. Data are available on I.Stat database. For further information on the methodology used for the construction of exports and imports deflators in QNA see also T. Muccigrosso, C. Pascucci "The new deflators for imports and exports of goods in National Accounts", Ch. 4, Rapporto ICE, 2011-2012.

[13] The deflators of imports of goods FOB, were obtained as an estimate of the deflators of imports of goods Cif without the relative weight of Cif-Fob component, with respect to every single geographical area (on average and for the entire period the weight on imports of goods Fob was about 0.03 pp.).

[14] The index is a ratio that compares the total purchase cost of a specified bundle of current-period commodities (commodities valued at current prices) with the value of those same commodities at base-period prices; 100 multiply this ratio.

- monthly service prices excluding housing (HICP broken down by product groups indexes, from CP041 onwards) of extra-EU countries and EU countries. Data source of EU prices indices has been Eurostat database (https://ec.europa.eu/eurostat/web/hicp/data/database); the downloaded file is "prc_hicp_midx". Data source of extra-EU prices indices (item "consumer prices - services less housing") has been from Oecd database (https://stats.oecd.org/).
- imports of services from Q1 (Bop) related to each country and aggregated by geographical area, as weights for the indices.

Final import price indices per geo-area have been compiled at quarterly level with the reference to the average of the previous year (calculation base) and subsequently chained over the period chosen as a reference base in order to be able to measure price trends over a period of time longer than a year[15].

As a final step, in order to deflate exports of services by geographical area a single deflator (based on output prices) has been used as a proxy. Following the procedure already applied to total defltors, the indicator has been derived, as an implicit deflator, from the QNA estimations dividing quarterly exports of services at current prices by exports of services chain-linked volumes, unadjusted and seasonally adjusted. This is a simplifying assumption since annual deflators are indeed not the same across area but depend on the relative weight of the exports of services broken down by geographical area. As a further improvement, a more consistent deflator can be evaluate to deflate exports of services by geographical area, taking into account the annual weights by area.

3.3 Forecasts of indicators not available at t+70

When the first estimation of aggregates was worked out the following data was available:

- a complete information on exports and imports of goods by geographical area from FTS survey, even if EU data are preliminary;
- a partial information on exports and imports of services. Since timeliness of Q1 is t+90, services at current price are not available for the last reference quarter and they are not available with geographical details too. In order to complete the database of indicators at current prices at t+70, an estimation of exports and imports of services for the reference quarter has been obtained applying the same growth rate of the correspondent QNA aggregate to EU, Euro area and EU Institutions. Remaining geo components have been derived by difference.

As a further improvement, applying a procedure for forecasting based on ARIMA models we can produce more accurate estimates for the reference quarter; this procedure is available in ModelEasy+ language.

3.4 Calendar and seasonal adjustment of indicators

Each quarterly indicator used to compile QNAs is treated (where applicable) to remove seasonal and calendar effects. Since 1998 the seasonal adjustment procedure used by Istat is the model based approach of TRAMO-SEATS (Gomez and Maravall, 1997), here applied in his recent version of 2008 running in ModelEasy+.

Seasonal adjustment (SA) and Calendar adjustment (CA) in QNA production have been also performed on the indicators broken down by geographical area using Demetra+ for Windows for models identification. When possible, CA has been performed on monthly indicators.

[15] With the aim to compute chain-linked prices and base-calculation prices see methods in Eurostat (2001).

The CA considers the following effects:

1. The Trading day and Specific national holidays effect (TD);
2. The Working day and Specific national holidays effect (WD);
3. The Leap-year effect (LY);
4. The Easter effect (EE).

As for the QNA series, the model chosen for each indicator broken down by geographical area is used to derive the adjusted series, subtracting the overall effect due to calendar regressors from the original aggregates. The calendar effects also affect annual data by geographical area as the number of working/trading days normally varies from year to year. Therefore, the adjusted annual totals by geographical area (obtained transferring the quarterly adjustment to raw annual data through the estimated relationship between the annualized indicator and the annual data) should differ from the corresponding raw annual totals broken down by geographical area. However the sum of the series adjusted by calendar effects per area (EU+extra-EU) has to correspond exactly to the adjusted total (world) for calendar effects in QNA estimations.

At this stage of the action, a linearization procedure performed by TRAMO has identified parameters for CA correction in exports and imports of goods series by geographical area, at monthly level. In particular a model with a single regressor has been identified. In particular the Akaike Information Criterion (AIC) has been used to assess the goodness of fit of the models, including the regressors corresponding to the effects mentioned above and the model without any regressor for CA. The ranking resulting from AIC has been helpful in identifying the nature of the relationship of the series from calendar effects. Another aspect considered at this stage has been the significance of the estimated regression coefficients. The same tests have been carried out to detect additive and temporary change outlier. Obviously the t-test gives the statistical significance of a coefficient but does not give any information about its meaningfulness from an economic point of view. The sign of the coefficient can assess this, and to a lesser extent by its magnitude; the final step is the validation of the results (see Quarterly National Accounts Inventory, 2008). For example, positive coefficients for WD and TD regressors have been expected for variables related to exports and imports of goods and services; in these cases a negative value would have generated opposite corrections for calendar effect.

Parameters and models identified for the quarterly world totals have been coherent with the corresponding quarterly indicators used for estimations of QNA series of exports and imports of goods that corresponded to one regressor model[16].

Indicators of imports of goods FOB calendar adjusted by geographical area have been derived as calendar adjusted imports of goods Cif minus cif-fob series (not adjusted) broken down by geographical area.

In a second step, parameters and models for seasonal adjustments have been identified (where seasonality is present).

Seasonal adjustment has been performed on the indicators adjusted for calendar effects and outliers. In particular TRAMO-SEATS procedure has identified ARIMA models that adequately fit in the following series broken down by geographical area:

- exports of goods FOB;
- imports of goods Cif;
- CIF-FOB;
- exports of services;
- imports of services (series of EU Institutions had not seasonality);

[16] As CA correction has not been made on exports and imports services indicators and cif-fob series for QNA estimations, no correction of exports and imports of services and cif-fob by geographical area was performed.

- price indices for imports of goods cif and FOB (while EPP series had not seasonality);
- price indices for imports of services (in this case only EU and EMU series had seasonality).

Direct and indirect approach has been evaluated in order to derive seasonal adjusted series of imports of goods Fob by geographical area, as accurately as possible. However the indirect approach that provide imports of goods FOB seasonally adjusted, as the difference between imports of goods Cif seasonally adjusted and cif-fob series seasonally adjusted, remained the one coherent with QNA imports FOB estimations.

Seasonal adjustment has been performed at a quarterly frequency. This choice was consistent with QNA series and was supported by the results of studies that showed that performing temporal aggregation before seasonal adjustment consistently reduces the variance of the revision errors (Di Palma and Savio, 2001). Furthermore, the sum of the series by geographical area seasonally adjusted (EU+extra-EU) has to correspond exactly to the seasonal adjusted total (world) in QNA estimations.

4. Reconciliation techniques and temporal disaggregation

The adjustment of a set of data in order to satisfy a number of accounting restrictions - and thus to remove any discrepancy - is generally known as balancing or reconciliation (Dagum and Cholette, 2006). The accounting restrictions between unadjusted and seasonally adjusted series or between components series and aggregate series, can be of two types:

1. the contemporaneous constraints, assuming the form of linear combinations of the variables which should be fulfilled in every observed period;
2. temporal aggregation constraints, which require that the high-frequency adjusted series be in line with known (e.g., more reliable) low-frequency aggregates (say, the annual series of the variables of interest).

The former type of reconciliation, which aims to restore the consistency between a set of data at a time instant, is generally known as the balancing problem, while the process of adjustment in the time dimension is called benchmarking (or temporal disaggregation) of time series. In general, the benchmarking problem arises when time series data for the same target variable are measured at different frequencies with different level of accuracy, and there is the need to remove discrepancies between annual benchmarks and the corresponding sum of the sub-annual values.

4.1 The two-steps reconciliation procedures: a theoretical approach

With the aim of completing the project, use of reconciliation techniques and temporal disaggregation have been implemented for achieving consistency of exports and imports of goods and services, at current prices, and for each evaluation in raw form, calendar adjusted, and seasonal adjusted form. Since the series broken down by geographical area need to be corrected to add up to this national total calendar and seasonally adjusted, reconciliation is performed after calendar and seasonal adjustment to restore the accounting relationships that exist between the series.

The reconciliation approach embodies the following constraints, simultaneously:

- at temporal level (within quarterly and annual data by geographical area);
- at cross-sectional level (between the quarterly aggregates by geographical area and the sum of its component series that have to correspond to QNA aggregate), taking into account some discrepancies arising from items not broken down by geographical area (stores and provisions and others adjustments).

Actually the accounting representations of matrix type, sometimes need both balancing procedures and benchmarking. This is because they have a wide application with data expressed in matrix form as the series of quarterly accounts and the accounts by institutional sector[17].

However, when temporally and contemporaneously aggregated series are known, temporal and contemporaneous discrepancies can be eliminated using various reconciliation procedures. However some operational and computational issues could emerge operating with a large and complex system of data.

In order to overcome computational problems resulting from a simultaneous solution, in this work a two-step reconciliation strategy has been implemented (Quenneville and Rancourt, 2005)[18]; the steps are the following:

- **Step 1** operates a univariate benchmarking, on each single time series to guarantee annual consistency. This is an extension of the univariate benchmarking approach by Denton (1971), known as Denton PFD, founded on the well-known 'movement preservation principle'[19];
- **Step 2** applies a balancing technique based on the Stone's method to reconcile the component series with the correspondent accounting identities. The quadratic minimization adjustment, over each year (4 quarters) has been adopted[20].

STEP 1 - The method more often utilized in quarterly national accounts to restore annual consistency is the Chow-Lin approach[21]. Another widely used benchmarking procedure is the modified Denton Proportional First Differences (PFD) technique. The PFD procedure looks for benchmarked estimates aimed at minimizing the sum of squared proportional differences between the target and the unbenchmarked values and it is characterized by an explicit benchmarking formula involving simple matrix operations (Di Fonzo, Marini, 2005).

The extension of Denton's univariate benchmarking procedure is based on a rather simple and appreciable principle, according to which the dynamics of the reconciled series have to be as close as possible to those characterizing the preliminary series. The proportional variant of the method is generally preferred to the additive variant, particularly when the series to be reconciled have different magnitude, in order to avoid relatively large corrections to small aggregates, and the consequent risk of obtaining negative figures. In turn, the proportional adjustment of a system of time series mostly alters the component series with greater magnitude (Di Fonzo and Marini, 2003), and this result sometimes could be counterintuitive (e.g., if one thinks that the most reliable series of a survey are generally the greater ones, and *viceversa*).

An attempt to overcome this kind of problem could be made by applying a benchmarking approach where the movement preservation principle is explicitly referred to the growth rates.

In this case, the criterion to be minimized would be:

$$\min_{y_t} \sum_{t=2}^{n} \left(\frac{y_t}{p_t} - \frac{y_{t-1}}{p_{t-1}} \right)^2 \text{ under the constraint } \sum y_t = Y_T \text{ con } t \in T \text{ e } T=1,\ldots\ldots N \qquad (2)$$

[17] Italian quarterly sector accounts (QSA) already uses this kind of balancing procedure in order to reconcile quarterly employment by institutional sector (Ascione, Lutero 2011).

[18] See Quenneville and Rancourt (2005) and Dagum and Cholette (2006), for a generalization.

[19] For further information see also Denton (1971) and Di Fonzo, Marini (2009).

[20] See Stone et al. (1942) e Stone (1961).

[21] In Italy, benchmarking in QNA is largely based on the method proposed in Chow and Lin (1971). The authors proposed a solution of the problem based on a generalized least-squares regression that exploits the relationship with one (or more) indicator series and restricts the quarterly results to be in line with given annual benchmarks. The use of an alternative approach based on the proposal of Fernàndez (1981) has been recently introduced in QNA production on the basis of suggestions and comments received from a study commission set up by ISTAT to evaluate temporal disaggregation methods. Temporal disaggregation techniques are not always necessary: in some cases, quarterly series present only minor differences with respect to the annual values, under these circumstances a *quasi*-direct approach is followed (i.e. imports and exports of goods) that generates very small discrepancies. In such cases, the method proposed by Denton (1971) is used in place of Chow-Lin (QNA Inventory, Istat 2008).

denoting **p** and **y** respectively the preliminary values and those obtained from the reconciliation procedure (Di Fonzo, Marini 2010).

STEP 2 - The method proposed by R. Stone (1942) to balance an accounting system, is based instead on a constrained quadratic minimization problem[22]; in particular the method considers a constrained quadratic minimization problem in which the sum of the weighted quadratic adjustments to the preliminary estimates is minimized subject to the condition that the adjusted estimates need to exactly satisfy all relations among the variables, such as the accounting identities (QNA Handbook, Eurostat 2013). The Stone's technique is one of balancing procedures using regression models.

Following the notation in Ascione and Lutero (2011), the balancing procedures must solve a problem that can be expressed as follows: given a matrix of rectangular or square magnitudes P must find another final matrix Y, of the same dimensions, in which are respected linear restrictions on the same matrix values. Typically the restrictions imply that the sums for row and/or column must necessarily match the marginal values, so for example for each row might be the following restriction:

$$\sum_j y_{ij} = z_i \qquad \forall\ i=1,2,...,r \tag{3}$$

with the constraint expressed by a total marginal of row z_i; at the same time, the same method is valid for the possible column constraints: therefore the need for a balancing procedure arises when the expression (3) is not respected even for a single row *i*. The problem can be formalized as follows: a vectored matrix of preliminary data **p**, a matrix of variance-covariance of discrepancies **V**, assumed diagonal[23]:

$$V = \begin{bmatrix} \sigma_{p1}^2 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sigma_{pn}^2 \end{bmatrix} \tag{4}$$

an unknown vector of balanced data **y**, a matrix of aggregation **H**[24], a vector of constraints **z** and a vector of Lagrange multipliers λ, the Langrangian function to be minimized is:

$$L=(y-p)'V(y-p)+2\lambda(Hy-z) \tag{5}$$

The BLUE Stone estimator (the one not distorted, with the minimum variance among those of the class of linear estimators) takes the following form:

$$y = p - VH'(HVH')^{-1}(Hp-z) \tag{6}$$

from which one can see that the balanced final data are equal to the correct originating series through a linear combination of the product of the discrepancies (Hp-z) for a weight matrix. The variance-covariance matrix **V** is crucial to identify the magnitude and direction of the adjustments: it measures the accuracy of the preliminary values than the "real" balanced values [...] (Ascione and Lutero, 2011).

[22] The method proposed by Richard Stone (1942) for balancing an accounting system taking into account the differences in accuracy of the preliminary estimates of the variables in the system.

[23] Hence for construction it is hypothesized heteroskedasticity in the data, while maintaining the hypothesis of absence of longitudinal correlation.

[24] The matrix H of aggregation assumes a different conformation according to whether data are flows or stocks.

Two-steps reconciliation method takes into account the differences of accuracy in the preliminary series of all system variables (that depends on reliability of sources and variability of the series). Therefore the discrepancies (or residuals) are distributed among the variables in such a way that the more accurate estimates are adjusted less than the less accurate estimates, and the known (i.e. precise estimates) values are not adjusted at all. This is possible by applying some reliability or alterability coefficients to the series in question[25].

4.2 Reconciliation of exports and imports by geographical area at current prices

Exports and imports broken down by geographical area, calendar and seasonal adjustment, have to satisfy a double consistency constraint: temporal and spatial.

- Temporal consistency means that the sum (or the average) of the quarters of a year will give exactly the same amount of the year, ensuring a perfect alignment of quarterly data to the corresponding annual series (coherence within variables);
- Spatial consistency means that the sum of the time series by geographical area, for each aggregate, will give the amount of the corresponding quarterly aggregate for the Rest of the World, ensuring a perfect alignment of broken down data with the corresponding quarterly aggregate (coherence between variables), as shown in Table 1.

Table 1: Reconciliation scheme for QNA Exports (P.6) and Imports (P.7) by geographical area (a)

Year	quarter	EU+Inst. (S21)	EU (S211)	EMU (S2I)	Extra-EMU (S2112)	EU Institutions (S212)	Extra-EU (S22)	QNA World (P.6/P.7)
1999	Q1	$S21_{99q1}$	$S211_{99q1}$	$S2I_{99q1}$	$S2112_{99q1}$	$S212_{99q1}$	$S22_{99q1}$	W_{99q1}
	Q2	$S21_{99q2}$	$S211_{99q2}$	$S2I_{99q2}$	$S2112_{99q2}$	$S212_{99q2}$	$S22_{99q2}$	W_{99q2}
	Q3	$S21_{99q3}$	$S211_{99q3}$	$S2I_{99q3}$	$S2112_{99q3}$	$S212_{99q3}$	$S22_{99q3}$	W_{99q3}
	Q4	$S21_{99q4}$	$S211_{99q4}$	$S2I_{99q4}$	$S2112_{99q4}$	$S212_{99q4}$	$S22_{99q4}$	W_{99q4}
	TOT	**$S21_{99}$**	**$S211_{99}$**	**$S2I_{99}$**	**$S2112_{99}$**	**$S212_{99}$**	**$S22_{99}$**	**W_{99}**
...	...	....	....	....	....	....	...	...
2011	Q1	$S21_{11q1}$	$S211_{11q1}$	$S2I_{11q1}$	$S2112_{11q1}$	$S212_{11q1}$	$S22_{11q1}$	W_{11q1}
	Q2	$S21_{11q2}$	$S211_{11q2}$	$S2I_{11q2}$	$S2112_{11q2}$	$S212_{11q2}$	$S22_{11q2}$	W_{11q2}
	Q3	$S21_{11q3}$	$S211_{11q3}$	$S2I_{11q3}$	$S2112_{11q3}$	$S212_{11q3}$	$S22_{11q3}$	W_{11q3}
	Q4	$S21_{11q4}$	$S211_{11q4}$	$S2I_{11q4}$	$S2112_{11q4}$	$S212_{11q4}$	$S22_{11q4}$	W_{11q4}
	TOT	**$S21_{11}$**	**$S211_{11}$**	**$S2I_{11}$**	**$S2112_{11}$**	**$S212_{11}$**	**$S22_{11}$**	**W_{12}**
2012	Q1	$S21_{12q1}$	$S211_{12q1}$	$S2I_{12q1}$	$S2112_{12q1}$	$S212_{12q1}$	$S22_{12q1}$	W_{12q1}
	Q2	$S21_{12q2}$	$S211_{12q2}$	$S2I_{12q2}$	$S2112_{12q2}$	$S212_{12q2}$	$S22_{12q2}$	W_{12q2}
	Q3	$S21_{12q3}$	$S211_{12q3}$	$S2I_{12q3}$	$S2112_{12q3}$	$S212_{12q3}$	$S22_{12q3}$	W_{12q3}
	Q4	$S21_{12q4}$	$S211_{12q4}$	$S2I_{12q4}$	$S2112_{12q4}$	$S212_{12q4}$	$S22_{12q4}$	W_{12q4}
	TOT	**$S21_{11}$**	**$S211_{11}$**	**$S2I_{11}$**	**$S2112_{11}$**	**$S212_{11}$**	**$S22_{11}$**	**W_{12}**
	Q1	$S21_{13q1}$	$S211_{13q1}$	$S2I_{13q1}$	$S2112_{13q1}$	$S212_{13q1}$	$S22_{13q1}$	W_{13q1}
	Q2	$S21_{13q2}$	$S211_{13q2}$	$S2I_{13q2}$	$S2112_{13q2}$	$S212_{13q2}$	$S22_{13q2}$	W_{13q2}
	Q3	$S21_{13q3}$	$S211_{13q3}$	$S2I_{13q3}$	$S2112_{13q3}$	$S212_{13q3}$	$S22_{13q3}$	W_{13q3}

(a) S211 (EU Member States) is not compiled according to ESA2010.

[25] It is possible to make a subjective evaluation "a priori" about the degree of confidence of each preliminary series, to which can be attributed, conventionally, a value between zero and one in order to give it a 'probabilistic interpretation (Ascione and Lutero, 2011). In our work, the quarterly indicators of exports and imports broken down geographically come from reliable statistical sources. Therefore, the opportunity to give a subjective value to the relative weight of preliminary data, has even proposed as necessary.

In order to ensure spatial and temporal consistency avoiding computational impasses due to the number of variables, the length of series and the number of constraints, in this work we have adopted the two-step reconciliation strategy, described in the previous section.

In particular at cross-sectional level, a number of contemporaneous constraints must be respected. The exogenous one would be, respectively for total exports and imports (the last column of table 1):

a) EU (S.21) + extra-EU (S.22) = world QNA (P.6/P.7)

the endogenous accounting constraints to be observed are:

- EU (S21) = Euro Area (S2111) + extra-Euro Area (S2112) + EU Institutions (S212)
- EU (S2I) = Euro Area (S2111) + BCE (S2122)
- EU (S211) = Euro Area (S2111) + extra-Euro Area (S2112)
- EU Institutions (S212) = EU Institutions (S2121) + BCE (S2122).

Nevertheless, keeping in mind that EU Institutions (S212)=0 for exports and imports of goods and BCE (S2122)=0 for exports and imports of services, the endogenous constraints have become

for goods:

- EU (S21) = EU (S211) = Euro Area (S2111) + extra-Euro Area (S2112)

for services:

- EU (S21) = Euro Area (S2111) + extra-Euro Area (S2112) + EU Institutions (S2121)

Hence, applying the two-step strategy, the following two exogenous constraints have been included respectively for exports and imports of goods (P.61/P.71) and services (P.62/P.72) :

a1. Euro Area (S.2111) + extra-Euro Area (S.2112) + extra-EU (S.22) = world QNA (P.61/P.71)

a2. Euro Area (S.2111) + extra-Euro Area (S.2112) + EU Institutions (S.2121) + extra-EU (S.22) = world QNA (P.62/P.72).

At the same time, temporal constraints must be observed for each geographical component (the rows in grey in tab. 1):

b) $Q1_t+Q2_t+Q3_t+Q4_t= Y_t$ for t=1999, .., 2012.

The last three quarters of 2013 were obtained as extrapolated estimates because current year data by geographical area were not available and in that case only the quarterly constraint applies.

With the aim to make suitable applying the two-step reconciliation method on calendar and seasonal adjusted figures by geographical area, annual calendar adjusted data were estimated by geographical area, at current prices, previous year prices and chain linked volumes.

Having evaluated that discrepancies between preliminary and benchmark series were not large, the two-step reconciliation procedure has been run: first, on exports and imports of goods at current prices, unadjusted, calendar and seasonal adjusted form; secondly, time series of exports and imports of services have been reconciled, at current prices, unadjusted, calendar and seasonal adjusted form.

At the end of the two-step procedure, the small discrepancies between the preliminary series and the benchmark 'total economy' (here QNA aggregates) existing before reconciliation have been completely redistributed by applying benchmarking and balancing techniques.

Hence, no differences occurred between growth rates of reconciled series (EU+extra-EU) and the corresponding QNA (world) aggregates. Furthermore, reconciled series (EU+extra-EU) and the corresponding QNA (world) aggregates, both at current prices and chain-linked volumes, maintain the same seasonal ratios, calculated as the ratio between raw series and seasonally adjusted ones.

The analysis on growth rates have been carried out both on changes over the previous period and over the same quarter of previous year, checking for the respect of Denton's movement preservation principle. This was true over the entire period spanning from 1999q1 to 2013q3. At the same time no differences arose summing up the four quarters of benchmark series (for each geographical component) and their correspondent annual value, achieving temporal consistency.

All calculations relative to temporal disaggregation, models identification and reconciliation have been developed by using ModelEasy+, Demetra+ for Windows.

4.3 Chain-linked quarterly estimates and reconciled estimation of total economy (goods+services) broken down by geographical area.

In order to estimate exports and imports of goods and services and their totals (goods+services) by geo area at previous year prices and chain linked volumes, coherent with the related QNA aggregates, a step by step procedure has been developed, calculating the following variables:

Step 1 - preliminary chain linked deflators in unadjusted and seasonally adjusted form are obtained by temporal disaggregation techniques;

Step 2 - preliminary chain-linked imports and exports of goods and services by geographical area in unadjusted, calendar and seasonally adjusted form are calculated by temporal disaggregation of the corresponding annual aggregates. The indicators are obtained as ratios between quarterly figures at current prices (see section 4.2) and the preliminary deflators (see step 1);

Step 3 - preliminary imports and exports at previous year prices by geographical area are derived from the preliminary chained linked estimates (see step 2);

Step 4 - imports and exports of goods and services by geographical area at previous year prices are obtained reconciling the preliminary estimates to the total imports and exports with the two-step procedure described in section 3.2[26].

Step 5 - chain linked quarterly estimates are derived from reconciled estimates at previous year prices (see step 4)

Step 6 - reconciled chain linked deflators are calculated as ratio between quarterly figures at current prices and the reconciled quarterly chain-linked figures obtained in step 5.

As a final step of the work, quarterly estimations of goods and services by geographical area have been summed up, at current and previous year prices, in order to obtain the totals (goods+services) for exports and imports broken down by geographical area. Then chain-linked totals have been derived by suitable chain-linking procedures[27].

In the end, a remarkable point has to be underlined. While totals derived by summing up Eu+extra-Eu components for exports and imports at current prices correspond exactly to the related QNA totals (P.6 and P.7) and the rates of change have the same evolution of the QNA ones, series of chain-linked geo totals (Eu+extra-Eu), in raw form, calendar and seasonally adjusted form, maintain the same profile than the correspondent QNA chain-linked aggregates but doesn't correspond exactly to the related chain-linked QNA totals. That is because chain-linked volume measures are non-additive at spatial level (see the Appendix).

4.4 Main results

In the Appendix, graphs show trends of series of exports, and imports of goods and services broken down by geographical area, at current prices (first column), chain-linked volumes (second

[26] As preliminary estimates at previous year prices by geographical area are not perfectly aligned with temporal and cross-sectional constraints (step 3), a sort of reconciliation might be necessary. That is because the reconciliation procedure is applicable only to current values and not to deflators (it works with sums among variables and not with means among prices indicators, for example). Applying the two-step reconciliation technique to previous year prices figures is not correct, as they are not proper time series data. However, this is a good alternative preferable to proportional reconciliation methods that would modify the temporal dynamics in a potentially sub-optimal way.

[27] For further information we refer the interested reader to Eurostat (2001).

column) and deflators (third column). In all graphs, the red solid line shows totals QNA while the dotted blue line represents the sum of geo components (EU+extra-EU).

In each first row, we find calendar and seasonally adjusted series broken down by geographical area of exports and imports, respectively. After that, graphs present a comparison between quarterly percentage change over previous period (second line) and over the same quarter of previous year (third line), and the seasonal ratios (fourth line), a coefficient that explains the seasonality of reconciled series (EU+extra-EU) and the corresponding QNA (world) aggregates.

Overall totals deriving from the sum of geo components (EU+extra-EU) and QNA totals of each aggregate maintain a close profile. In particular, the totals derived by summing up EU+extra-EU components correspond exactly to the related QNA total; also their rates of change have the same evolution of the QNA ones (third line). Moreover, series of chain-linked geo totals (Eu+extra-Eu), in raw form, calendar and seasonal adjusted form, starting from 2000q1 maintain the same profile than the correspondent QNA chain-linked aggregates.

All QNA series and indicators utilized in this work refer to quarterly data before SEC2010.

5. Concluding remarks

Since October 2014 Istat - National Accounts Division has been providing Eurostat with quarterly estimates of Italian exports and imports of goods and services (P.6 and P.7 respectively, according to ESA nomenclature) broken down by geographical area as shown in figures 1 and 2 below.

Hence, Italy has complied to EU Regulation and has aligned quarterly accounts dissemination to other European countries that already provide these geographical information at quarterly level.

Istat participation at the grant Eurostat for 2012 "*Action to support specific improvements in national accounts*" and its implementation within National Accounts Division, has contributed to estimate and disseminate Italian quarterly exports and imports of goods and services by geographical area. Estimations have been performed starting from the first quarter of 1999 and the time series of indicators have been reconstructed according to the evolving composition in EU and Euro Area.

Since some figures useful to compile exports and imports of goods and services were not available broken down by geographical area, at quarterly level (eg. fisim and cif/fob items), some assumptions to perform the geographical break down have been adopted. Other assumptions have concerned the price indices used for deflation of the aggregates, particularly those applied to deflate exports of services. Furthermore synthetic price indicators have been calculated for the geographical areas aiming at deflating imports of services by area.

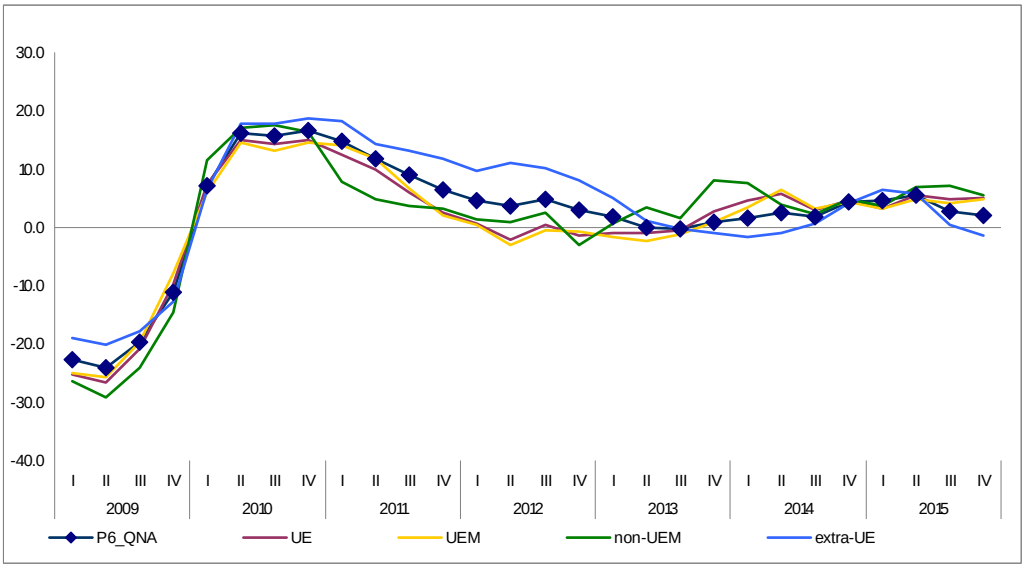
Currently QNA are compiled following the new European system of national accounts definitions and structure (ESA2010). By adopting ESA2010, new definitions and classifications relating to exports and imports aggregates have been introduced (i.e. the new estimates of processing and merchanting, and the inclusion of flows related to illegal components of the economy, see note 'Quarterly economic accounts', Istat September 2, 2015). In addition new and more accurate statistical sources are available (i.e. export and import producer price indices for industrial products applied for the deflation of exports and imports of goods).

Nevertheless, exports and imports broken down by geographical area, unadjusted and calendar and seasonal adjusted data, have to satisfy a double consistency constraint: temporal (within quarterly and annual data by geographical area) and spatial (between the quarterly aggregates by geographical area and the sum of its component series that have to correspond to QNA aggregate).

In this frsamework, balancing and temporal disaggregation techniques have been applied for eliminating any discrepancy and achieving consistency of exports and imports of goods and services, at current prices, at previous year prices and chain-linked volumes. In order to encompass computational problems resulting from a simultaneous solution, due to the double constraint, in this work a two-step reconciliation strategy has been implemented (Quenneville and Rancourt, 2005). Finally the target has been fulfilled.

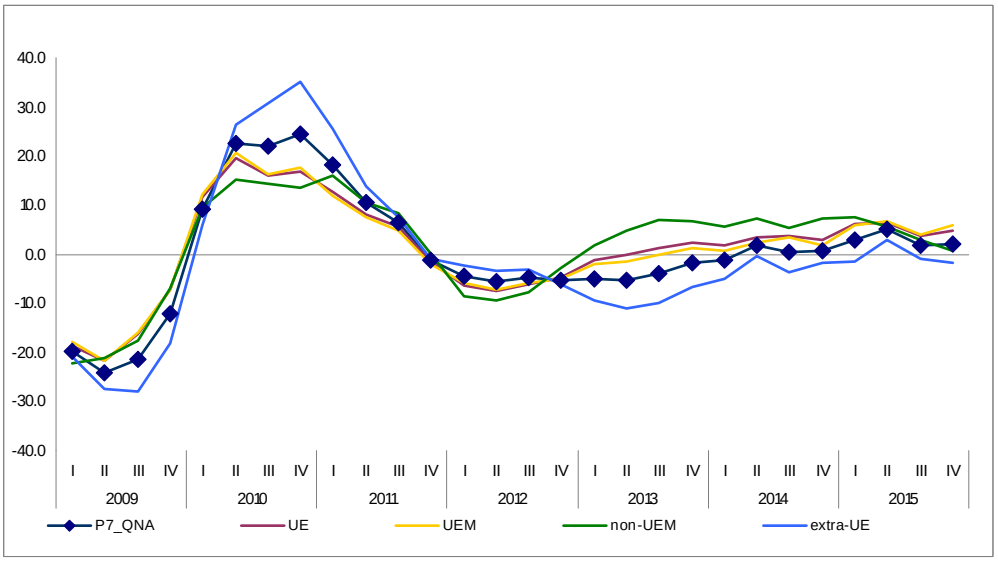
This work is an example of good practice within the European framework of QNA. Although an effort has already been made ensuring the consistency of the different estimates at annual and quarterly level broken down by geographical area, some issues could be further investigated in order to make the whole system of external trade accounts more robust from a methodological point of view. One of these concerns the implementation of more accurate computational procedures in order to extend the two-step reconciliation approach also to prices indicators, not only to variables at current values. That is, the objective function considered in the second step reconciliation procedure should also work with mean (not only with sum) in order to obtain quarterly deflators by geographical area consistent with the related deflators of total exports and imports, at temporal and spatial level. In such a way, a more rigorous calculation of chain-linked aggregates broken down by geographical area will be feasible.

Figure 1 – Exports of goods and services broken down by geographical area at current prices. Years 2009-2015 (a)



Source: Eurostat

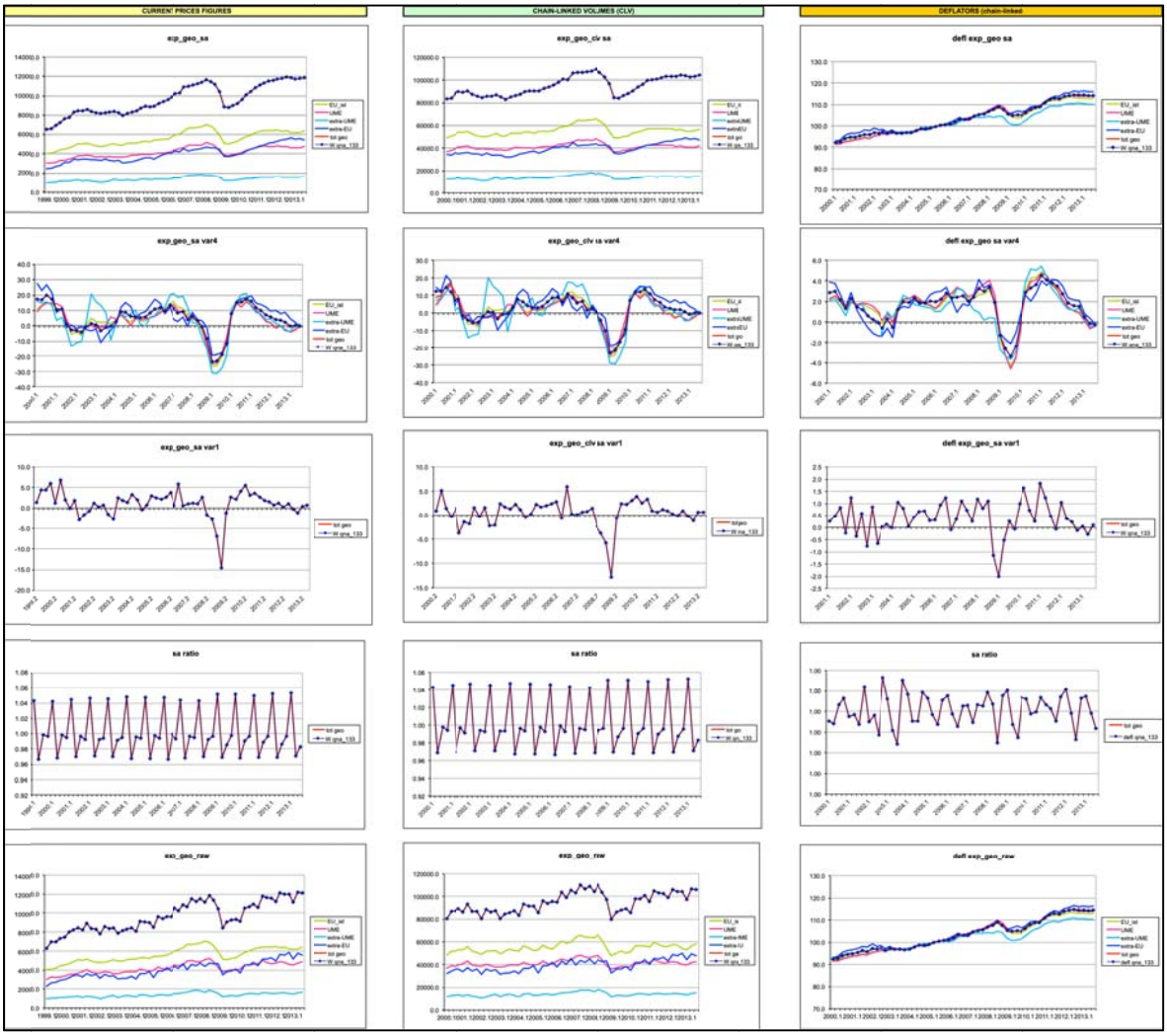
Figure 2 – Imports of goods and services broken down by geographical area at current prices. Years 2009-2015 (a)



(a) Current prices, seasonally and calendar adjusted data, % on the same quarter of the previous year.
Source: Eurostat

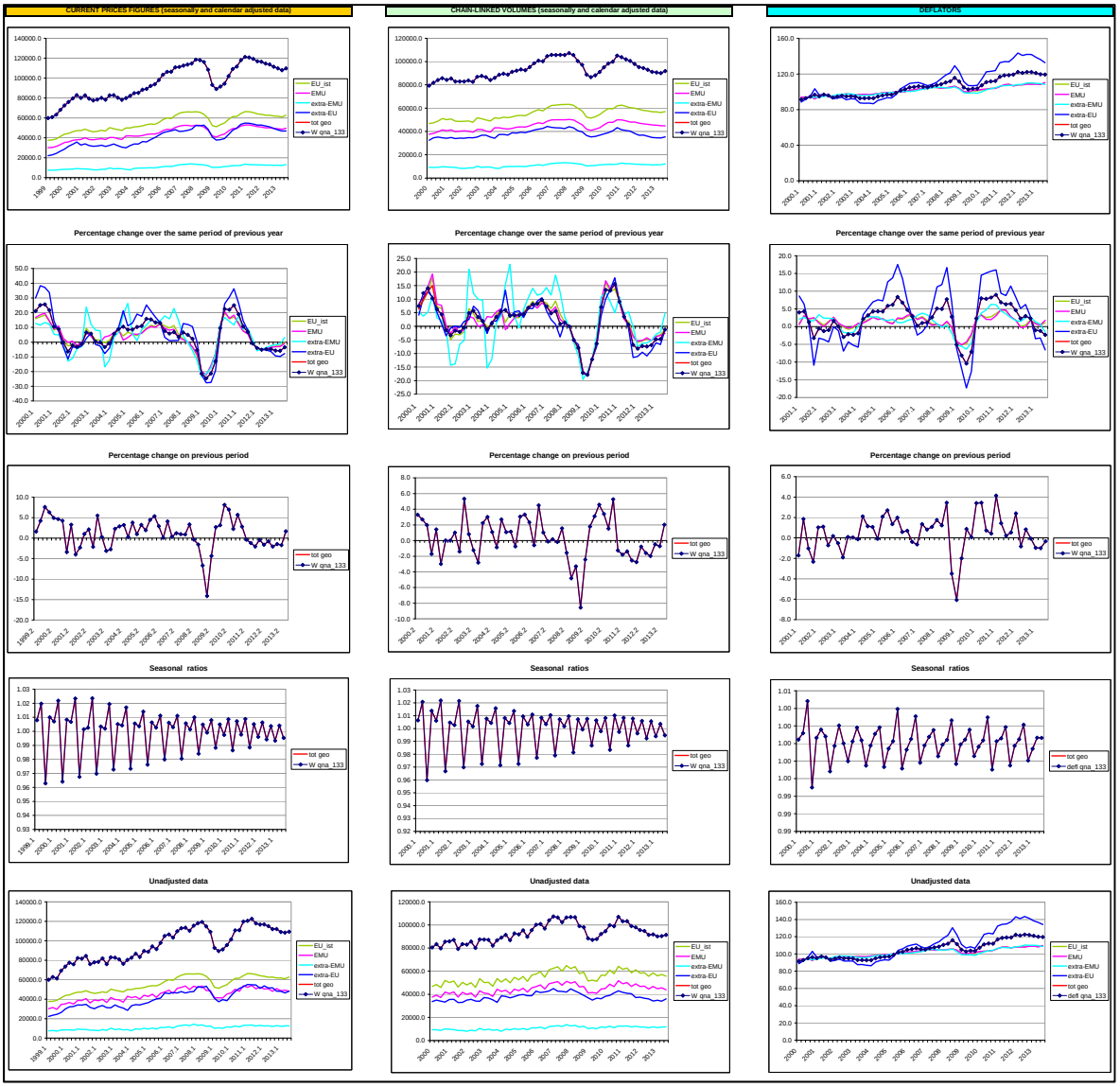
APPENDIX

EXPORTS GEO (goods+services) (a)



(a) QNA series and indicators utilized in this work refer to quarterly data before SEC2010.
Source: Author own calculation on Istat data

IMPORTS GEO (goods+services) (a)



(a) QNA series and indicators utilized in this work refer to quarterly data before SEC2010.
Source: Author own calculation on Istat data

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