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# ECONOMETRIC METHODS WITHIN ROMANIAN QUARTERLY NATIONAL ACCOUNTS

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## **Abstract:**

The aim of the present paper is to synthesise the main econometric methods (including the mathematical and statistical ones) used in the Romanian Quarterly National Accounts compilation, irrespectively of Quarterly Gross Domestic Product (QGDP). These methods are adapted for a fast manner to operatively provide information about the country macroeconomic evolution to interested users. In this context, the mathematical and econometric methods play an important role in obtaining quarterly accounts valued in current prices and in constant prices, in seasonal adjustments and flash estimates of QGDP.

**Key-words:** Quarterly Gross Domestic Product, time series, data sources, current and constant prices, statistical users

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Romanian National Accounts are presently compiled based on European System of Accounts version 1995 (ESA95). The time span for which they are usually compiled is one calendar year. Due to an increasing need for more relevant, but also pertinent, information shown by interested users, National Accounts in Romania are issued at quarterly level (QNA) starting year 1997 based on ESA95, and on available handbooks and manuals recommended by international recognised statistical institutions.

Quarterly National Accounts (QNA) cover a system of integrated quarterly time series coordinated through an accounting framework. In practice, the constraints of data availability, time, and resources imposes that QNA are usually less complete than ANA. As in other countries which have shorter history in National Accounts, Romania has estimated, in the initial stage of implementation, only estimates of quarterly gross domestic product (QGDP) with a split by its components. Extensions were made as the use of the system becomes more established, achieving to the sequence of quarterly accounts by institutional sectors, the seasonal adjustments of quarterly series and flash estimates of QGDP.

The main purpose of QNA is to provide a picture of current economic developments that is **timelier** than that provided by the ANA and more

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comprehensive than that provided by individual short-term indicators. This could help in monitoring and assessing the current economic situation, the phases of economic cycle, constituting the basis for macroeconomic modeling. In this respect, deadlines for transmission to EUROSTAT and dissemination are very important and must be respected, these initial (provisional) estimations being afterward revised in connection with ANA. The deadlines for QGDP publication by components as raw data and seasonally adjusted are established by EUROSTAT for all Member countries, meaning in maximum 70 days by the end of reference quarter, while the relative growth rate of QGDP (raw and seasonally adjusted data) are earlier published within 45 days (so called “flash estimate”). The sequence of accounts of institutional sectors is finalized and transmitted within 90 days by end of the reference quarter.

QNA should comply with the same quality standards as ANA, being an integral part. In the same time, QNA must answer to **specific requirements** of macroeconomic decision-makers. In order to avoid confusion regarding data interpretation, the QNA consistency is a central dimension which should be respected. The temporal consistency and length of covered time series are more important in QNA. The perspective of time-series in QNA dominates the structural perspective of ANA. Moreover, the volume growth rates are more important than absolute values in QNA. The timeliness and availability are more important than the structural and regional details.

The QNA **consistency** implies many aspects. The GDP estimation approaches must be reconciled, meaning a unique QGDP value must be obtained, no matter the production or expenditure approach used. The accounting equations (the balancing, the sum of components and GDP) are strictly applied also at quarterly level.

$$GDP = \sum_n^{i=1} GVA + Net\ Taxes\ on\ products$$

= *Final consumption expenditure + Gross capital formation + Net Exports of goods and services*

*In which: n ~ industry;*

*GVA ~ Gross value added = Output – Intermediate consumption*

The time series must not present in no way, breaks in series and discontinuities, so their consistence should be maintained. The consistency with ANA must be respected, meaning that the amount of the estimates for the four quarters equals the annual estimates, for each separate component. The reconciliation between the two data sets of estimations is based on the

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combination between higher frequency data sources with less frequent data but of higher accuracy, thus implying mathematical compilations.

QNA are based on **less data sources than ANA**. In cases not enough data sources exist for actual estimates, there are used readily available information: indicators closed to the needed aggregate, available information only for two months despite for three as are actually necessary, structural information from previous years, etc. At the same time, **mathematical methods** are used in order to obtain macro economical aggregates:

- In order to obtain QNA in prices of a base year, there are used chaining techniques of data series;
- Furthermore, the modelling techniques (ARIMA, TRAMO-SEATS models) are used in order to apply the seasonal adjustments.

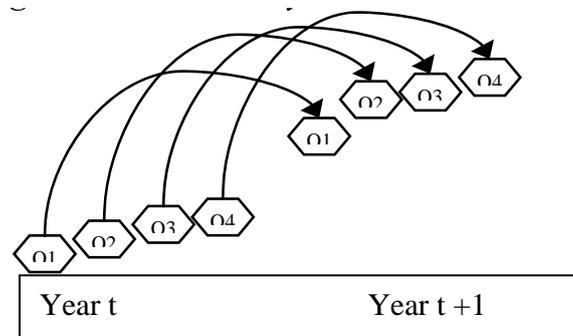
These methods will be presented in the following, according to the scope of QNA estimates.

Within Romanian QNA, two types of **constant price estimates** are compiled:

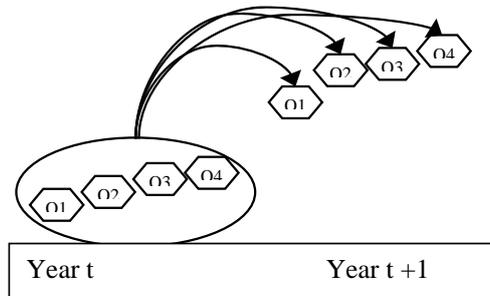
Estimates in prices of the same quarter from the previous year (“over-the-year method”).

: “Over-the-year” method

Figure 1



Estimates in average prices of a base year (based on the „annual-overlap” method).



The estimates based on prices of the corresponding quarter from previous year are part of, practically, the routine compilation of quarterly accounts, especially of QGDP. This is not only a current practice, but is also recommended. The estimates in current prices and in prices of the same quarter of the previous year are performed in the same time, being balanced based on the two approaches: the production approach from resources side, and the expenditure approaches, from uses side.

The compilation method is adapted to the availability of data corresponding to each aggregate. For certain aggregates, data are directly available in absolute values in current prices, but for other, there are available only time series of price and/or volume indices. The main data sources which offers data in absolute values are: general government budget execution, the production account of agriculture, balance of payments. The indices used for QNA compilation are: consumer price indices, industrial price indices, turnover indices, volume indices of turnover, agriculture products price indices, volume indices of industrial production, cost indices of construction, unit value indices for imported and exported goods, investment volume indices, exchange rate of currency, etc.

Series of volume and price indices are used to extrapolate, irrespectively, inflate the current values (made of price  $P$  multiplied by quantity  $Q$ ) of the previous period ( $t$ ), according to the following equation:

$$(P_t \times Q_t) \times (P_{t+1}/P_t) \times (Q_{t+1}/Q_t) = P_{t+1} \times Q_{t+1}$$

in which:  $P$  represents price in period  $t$ , irrespectively  $t+1$  (the following period),

$Q$  represents the quantity,

The growth index in period  $t+1$  comparing to period  $t$  is  $P_{t+1}/P_t$  for price, irrespectively  $Q_{t+1}/Q_t$  for volume.

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The price indices used are of **Paasche type**, which compares current prices to the level of corresponding prices of the same goods/services from a chosen base period (in our case, the same quarter of previous year). Thus, the used weights are from the current period.

The volume indices used are of **Laspeyres type**, which uses constant weights from chosen period as base, so compares the volume growth in present for a group of goods from the base period.

In order to keep consistency for estimates in current prices and in prices of the corresponding quarter of previous year, the sum of components equals QGDP. Moreover, the sum of quarters equals the annual estimate, for each component and for total GDP.

The **quarterly estimates in average prices of base year 2000** are obtained using chain-linking techniques of the year, based on already obtained data and on existing series of indices. The annual chain-linking of the quarterly data implies that each link in the chain is built using the chosen formula of index with the previous year average as base and reference period. The resulting quarterly indices must be linked in order to form a longer and consistent time series, expressed in a reference fixed period, in our case year 2000. Thus, Laspeyres indices are widely used for this scope, as expressed in the following formula:

$$LQ_{(t,a+1)(\bar{a})} = \frac{\sum \bar{p}_a \cdot q_{t,a+1}}{\sum \bar{p}_a \cdot \bar{q}_a}$$

*in which: „t” is the compilation quarter; „a” is the reference year; „a+1” is the following year.*

The starting point in this complex compilation is the estimation of macroeconomic aggregates for the four quarters of year 2000 in average prices of the year 2000. Then, continuing with year 2001, for each aggregate, the quarterly estimates in prices of year 2000 are compiled by linking the volume index of the corresponding quarter from year 2000 in average prices of year 2000. The same compilation is applied for the following years. Due to the fact that the chain-linking is compiled for each separate aggregate, in the end the additivity between the QGDP and its components is lost, being evidenced by an item called „statistical discrepancy”.

In principle, the estimates in average prices of the year 2000 (or whatever chosen base year) offers the possibility to compare any two quarters from the volume growth point of view, because the influence of the price changes corresponding to the compared quarters is removed. However, the

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influence of the seasonal factors implies huge variations among quarters, in special consecutive ones.

Even the estimates in the average prices of a base year help in comparisons over time as regards GDP volume growths and its components, the resulted time series cannot show the trend of economic evolution. This is because the time series contain also the influence of seasons, of working days, or other irregular factors. In this sense, EUROSTAT is asking to Member Countries to report **seasonally adjusted quarterly national accounts**, meaning the time series without the mentioned influences. The scope of adjustments for seasonality and for working days is to obtain the time series reflecting the real economic movement expressed as conjecture growth rates (quarter compared to previous quarter).

Before deciding to apply seasonal adjustment methods, QGDP series are **previously investigated** to verify if a regular effect of the season is present. Investigating the characteristics of time series based on graphics can offer important information regarding the existence of certain structures in the time series, by example to observe, in case of seasonality, certain maximum/minimum points at the same moment in time, which is similar to saw teeth. The investigation allows the decomposition of the series in its main components, according one of the following formulas:

Additive (applied when the amplitudes of the various components are independent among them):

$$Y = TC \text{ (Trend-Cycle)} + K \text{ (Calendar=Seasonality + working days)} + \text{Irregular component}$$

Multiplicative (applied when the amplitudes of various components are dependent among them, and the seasonal variations increases and decreases with the level of the series):

$$Y = TC \text{ (Trend-Cycle)} * K \text{ (Calendar=Seasonality * working days)} * \text{Irregular component}$$

Possible causes of the **seasonal effects** are natural, administrative and legal factors, socio-cultural traditions and stable calendar effects over the year (by example, free days for Christmas). The possible causes of systematic calendar effects which are not stable over the year are the changes in calendar (by example the effect of working days), events with changing date (as Easter and Ramadan holidays), the leap years and the effect of the period length. Thus, the seasonal fluctuations are systematic, persistent, predictable and identifiable effects. It is suppose that there are relations among the seasonal variations which could be expresses by a mathematical formula.

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The **trend-cycle** structures represent the general sense or direction, reflected by data through combining the long-term trend and the evolutions of activity cycle. They could be interrupted by shift changes in the general level, caused by real changes from economic activity, by measured changes in variables or statistical system (nomenclatures, survey techniques, etc.).

The irregular components (outliers) allocated to irregular structures could be singular extreme values or transitory changes. They are caused by extreme meteorological events, natural disasters, strikes, irregular commercial campaign, etc.

One must underline the fact that the seasonally adjusted series could be superposed by the trend series, but they differ. As much as the seasonally adjusted series is closed to the trend series, it means that less irregular components (outliers) exists, so the predictability degree of the series increases. By graphic, the trend has as a more attenuated, smooth form than the seasonally adjusted series graph.

The **decomposition of the series** by components is based on a equation, two, three non-observable components, thus driving to a infinity of solutions. The best solution does not exist, but several possible decompositions. Thus, the trend is also not unique, this depending on the applied decomposition.

There are numbered methods/models incorporated within software programs, being used in order to decompose time series. The obtained results differ, according to applied method:

- simple mathematical functions depending on a small number of parameters;
- based on hypothesis, non-parametric, on series;
- regression methods (Buy-Ballot model);
- moving averages (X-11 family, Lowess, etc.);
- ARIMA.

In general, there are **software programs** which facilitate the use of seasonal adjustment models, the following being the most widely used:

- X12-ARIMA: Fortran programme, developed by The Census Office of United States (D.Findley, B. Monsell), incorporated within other software (SAS, FAME, E-views, etc.)
- TRAMO/SEATS: Fortran programme, developed by Banco de Espana (A. Maravall, V. Gomez), as well as within other software + TSW
- DEMETRA: a software developed by EUROSTAT, having a user-friendly interface for the previous two software.

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All quarterly series must be treated by seasonal adjustment methods, using one of the existing software. Regarding the QGDP seasonally adjusted series, one must decide which method to apply for presenting seasonally adjusted series, from the following two:

- *direct method*, in which each component series of GDP is seasonally adjusted, including the GDP time series; in this case, the accounting relations are not maintained, so GDP is not equal to the sum of its component seasonally adjusted;

- *indirect method*, in which GDP time series is not directly seasonally adjusted, resulting from the sum of the component time series seasonally adjusted, thus the accounting relation being preserved at least for one approach.

Quarterly national accounts in Romania are seasonally adjusted and published starting first quarter of year 2009, covering time series **starting year 2000**. The seasonal adjustment methods are applied on quarterly series estimated in current prices, in prices of the same quarter of the previous year, and in average prices of year 2000. Series in current prices seasonally adjusted provide a view on the general evolution, in absolute valued, with seasonal factors removed. The seasonally adjusted series based on 2000 prices are used to compare in volume terms any two quarters from the whole series.

The seasonal adjustment within Romanian QNA is performed by the **DEMETRA** software, using the TRAMO/SEATS methods. Each individual time series is automatically processed, choosing the adjustment method which lead to a realistic trend and good statistical tests, as stable as possible. Usually, the chosen ARIMA model is maintained as long as possible, at least one year, when changes could occur due to revision of data. With each added or changed observation in the time series, the already adjusted back series are re-estimated. This means that running of model, based on software, integrates the new information in the estimated series, respecting the imposed conditions for a stable trend in time. At Romania level, following the adopted revision policy by NIS in this field, it was established that published seasonally adjusted time series to be updated only at the end of year, when revision of annual series is in place.

As regards the seasonally adjusted series obtained within Romanian national accounts framework, one can mention that their majority presents a multiplicative decomposition form, with logarithmic decomposition. The working day correction is not applied, because, based on statistical tests, their influence is not statistical significant. Thus, it is considered that the raw data are equivalent to working days adjusted series.

The QGDP seasonal adjustment methods are performed using direct approach, meaning the **QGDP time series is separately adjusted**. The other

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quarterly time series are also individually treated with seasonally adjusted methods. Thus, QGDP seasonally adjusted is not equal to the sum of its component. The choice of this method was consequence of several theoretical and practical reasons:

- the QGDP time series seasonally directly adjusted reflect exactly the results of the applied methods and model on QGDP, without influence of the irregular factors and results of applied models of its components;

- it is preserved the same approach as the one used to obtain flash estimates, when the operativity is important for obtaining earlier than the current provisional data, the growth volume index of QGDP.

The „**Flash estimates**” are, in fact, an estimate based on incomplete quarterly data, with the unique role to provide within shorter timeliness the earlier infra-annual information on overall evolution of a national economy.

Flash estimates of quarterly GDP are produced by many countries as there are **significant pressures** to provide economic data as soon as possible after the end of the reference period. This means that such estimates have to be based on incomplete data and various techniques are employed to bridge this gap with differing results in terms of accuracy. A substantial issue that national statistical institutes often face is the trade off to be made between timeliness and quality. Transition economies often face further problems with making earlier and earlier estimates: users may be intolerant or unfamiliar with revisions and compilers are still gaining expertise in extrapolation methods and making assumptions about growth.

Estimation methods, although evolving, are commonly based on **the same methodology** as for QNA compilation. But the earlier the estimate the more extrapolation and imputation techniques have to be relied upon. Statistical modeling (usually involving regression analysis) and econometric tools are linked to high-frequency relationships between GDP components and a number of indicator variables (such as indices of industrial production) that may be readily available at the end of the reference period. As errors in Flash estimates tend to be relatively large, countries tend to release them at higher level of aggregation than preliminary QNA estimates.

A target delay for flash estimates of t+40 to 45 days was endorsed as one of the major infra-annual macro-economic statistical improvements required of EU Member States.

In general, the first estimate of quarterly national accounts, i.e. the reference target for the flash estimate, covers GDP, expenditure components and output breakdown, usually at constant prices, raw and seasonally adjusted. Data are disseminated to institutions and private users; a news release is

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produced, mainly devoted to the analysis of the growth rates and seasonally adjusted figures.

The Romanian National Institute of Statistics (NIS) publishes „flash estimates” within quarterly accounts framework starting first quarter of year 2009, within **Press release**, based on annual calendar. They refer to volume growth of QGDP. National timeliness of these estimates is established according to a unique calendar established by EUROSTAT for all Member States, around 45 days by end of reference quarter. One must mention that these estimates are made using incomplete infra-annual data sources available within statistical system. The production approach for QGDP compilation is applied in the same way as for provisional estimates. There are not used econometric models within this process, but only seasonal adjustment methods. This makes that “flash estimates” to be significantly closed to the “provisional” version ones.

At EU level, there is demand for **improving the availability of QNA**, as a natural answer to the requirements of the main users (political decision-makers) to dispose of timely view on the economic evolution. As consequence, improving the timeliness of releases (in average with 10 days) from the reference quarter represents an important goal for European Statistical System.

QNA release:	Current timeliness	Desired timeliness (EUROSTAT)
<i>Flash estimates of QGDP</i>	<i>T+45 days</i>	<i>T+30 days</i>
<i>Provisional release</i>	<i>T+70 days</i>	<i>T+60 days</i>
<i>Second provisional release</i>	<i>T+90 days</i>	<i>T+80 days</i>

Given this framework, at the level of NIS-Romania it was limited the publication timeliness for “provisional estimates 1” to 65 days (see the dedicated section for Press releases from NIS web-site: <http://www.insse.ro/cms/rw/pages/press2013.ro.do> ). The effort to improve the availability of QGDP cannot be made only by national accounts experts, but a commune statistical effort is necessary in order to improve the availability of source-data for QGDP at maximum 25 days from the reference period for „flash estimates” for QGDP, irrespectively 55 days for provisional estimates 1”.

Certain Member Countries estimate QNA based on econometric models. Practically, they firstly obtain the seasonally adjusted quarterly series, and then they are adjusted to obtain “raw series”. By contrast, in Romania QNA series are obtained from direct and readily available data sources, and then they are adjusted. These countries dispose, in general, of long time series as well as relative stability of economy, with a high degree of predictability. Anyway, the shocks implied by nowadays economic crisis have revealed the

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instability of these econometric estimates, while the direct **methods based on existing data sources**, even incomplete, proved more robust, linked to economic reality. In Romania case, this type of econometric approach cannot be applied, from several reasons:

- not long enough time series;
- less predictability of economy, with important impact of irregular factors (as long time drought, unpredictable political decisions, etc.);
- human resources in NIS not specialised in econometric methods, and limited in number, due to the specialised profile for various statistical activities.

Another goal of EUROSTAT at EU level is to **extend the seasonal adjustment methods for more quarterly series**, in especially on transactions and balancing items of quarterly sector accounts. In this context, the need for specialised human resources, besides statistics, in econometrics in general and in seasonally adjustment methods in particular and in using the dedicated software programmes is recognised at NIS level. EUROSTAT is the main institution which can provide the necessary knowledge and know-how in the field, by training programmes offered to all Member States, including Romania. It is not too late to use this opportunity by offering the appropriate conditions to NIS experts to attend these programmes.

### *Conclusions*

The current state of Romanian Quarterly National Accounts is the result of tremendous work of statistical experts involved in national accounts and not only, which are called to provide answers for a natural evolution of the economical information complexity within a continuous changing and faster world.

The present paper intended to highlight the main fields of Romanian national accounts in which the econometric models are mostly used, as well as the perspectives for developing their use. **Extending their application** represents a goal, but should be made with caution in order to maintain the link with economic indicators entering in the compilation of GDP and its components, thus the link with economic reality. Another aspect regards the general **level of statistical culture** of the statistical data users, which have to become more flexible towards the changes imposed by national revisions and by EUROSTAT requirements regarding the methodologies and data dissemination.

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