# R programming for the Quarterly National Accounts: Moroccan case

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## ABSTRACT

*The compilation of quarterly national accounts (QNA) has different methods based on the specificity of the statistical system of the country, in effect, the method of calibration adopted by the Moroccan national account department has several steps that estimates indirectly the quarterly components of the Gross Domestic Product (GDP) by using statistics indicators as regressors in a linear model. The use of R, as statistical software for the compilation of that official statistics presents some challenges for the statisticians from the first step of the data import, until the export of the results, the responsible of the compilation of the QNA must have good algorithmic coding skills so as he can build his R program by choosing the adequate packages and version of the R software. The objective of this work is to present the R program and challenges that face the Moroccan case.*

**Keywords**: *QNA, Calibration, R programming, Challenges.*
**JEL Classification**: *E01, C22*

## INTRODUCTION

Quarterly national accounts (QNA) are the macroeconomic description in the recent past of the national income cycle using on a set of worldwide agreed consistent economic and statistical concepts, definitions, and accounting rules, that helps economists to measure and undertake meticulous assessments of the recent performance of the economy in terms of production and income. There are several methods to compile QNA summarized in, indirect and direct categories. The method used in the quarterly national accounts division in Morocco is based on the indirect approach which needs to deal with econometric calculation under appropriate statistical software.

Beside the econometric core of the QNA, the software plays a center role in the work process, hence, many Official Statistics Offices decided to benefit from the free open source software R thanks to its multiple advantages in comparison with other statistical software. Many countries have chosen to work with R. United Kingdom government is an example of using R to modernize reporting of official statistics Thus, in Morocco they begin the project to migrate to R by translating the algorithm related to the work process of the national accountant.

This paper aim at presenting at the outset, an overview and objectives of the QNA as well as clearing up the method adopted by the responsible division and finally giving example of the compilation of QNA using R.

## 1. QUARTERLY NATIONAL ACCOUNTS OVERVIEW AND OBJECTIVES

Quarterly national accounts (QNA) represent a system of integrated quarterly time series harmonized through an accounting structure. QNA implement the same principles, concepts, and structure as the annual national accounts (ANA). QNA generally aim at the conjuncture monitoring of the macroeconomic aggregates of an economy. Each nation needs information about the situation of the economy to take economic policy decisions. In addition, they present several specific objectives, including the quarterly review of past yearly accounts, a picture of current economic developments and an initial estimate of economic growth in the current year.

QNA are regularly available within three months after a quarter. ANA, furthermore, are produced with a significant time lag. Thus, ANA are less appropriate than QNA for business cycle analyses because annual data cover short-term economic developments.

The methods used to elaborate the quarterly accounts can be subdivided into two major categories: direct and indirect procedures. The use of indirect procedures, which is the case of Morocco, are based on the disaggregation of annual data using econometric techniques involving short-term information, used as inputs that come from various structures such as private, public or para-public establishments, to allow extrapolations for the current year. On the other hand, direct procedures depends on the availability at quarterly intervals, with the simplifications that are required, of the same data sources as those used for the preparation of the annual accounts.

Each version of the QNA includes revisions for the entire phase, which are usually quite small for the quarters at the end of the period. These revisions may be due to four distinct causes:

- *A modification of the annual accounts*: the final accounts (year N-3), semi-final (year N-2) and provisional (year N-1) are published once a year and modify the annual estimates.
- *A change in the short-term indicator:* on last months or quarters, indicators are frequently revised, especially when the available information grows.
- *A methodological change*: usually, the change affect the indicator, either due to the adoption of a new indicator considered better than the previous one or the disappearance of a data source.

• *A base year change*: the national accounts regularly carry out "base year changes", for example in Morocco, the changeover to the 2007 base year gave rise to a major change in nomenclature. In a near future, the National Accounts Directorate will change the base year from 2007 to 2014.

## 2. CALCULATION METHOD OF THE QNA : CALIBRATION

The QNA combine with each national accounts component item a short-term (monthly or quarterly) indicator, available rapidly and finest matching the concept of the accounting item. In effect, the basic idea of the QNA is to shape the indicators to the annual accounts by estimating the statistical relationship that links the annualized indicator to the corresponding account in the past.

The econometric method of the QNA, hence, seeks to correct the systematic differences between the information contained in the cyclical indicators and the annual accounts. The calibration relationship is a simple linear equation between the annual account and the annualized indicator, which is written for all years t:

$$A_t = \alpha + \beta * I_t + \varepsilon_t$$

$A_t$ : Annual account for the year t.

$I_t$ : Annualized indicator for the year t, which means the annual sum of the four quarters in case of level indicator, or the average in case of an index indicator.

$\varepsilon_t$ : represent the fluctuations in the account that are not transcribed by those of the calibrated indicator.

The coefficients α and β are estimated over several common years of the account and the indicator, the period needs to be sufficiently long in order to have a statistically accurate estimation. The preceding equation is estimated by the method of Ordinary Least Square (OLS), so $\varepsilon_t$ become the residues of the estimate. Furthermore, so as to make sure that our model is good we can add and test the trend as regressor. Then, we make sure that our model is valid by verifying statistics in the output of the used software.

This econometric relationship between the account and the annualized indicator is assumed to be stable so that, as estimated in the past, it remains valid for the very recent past and allows the best possible forecast for years when the annual account is not known. Thus, the same relationship can be used to re-form the indicator quarterly. The equation becomes:

$$A_{t,q} = \frac{\alpha}{4} + \beta * I_{t,q}$$

$A_{t,q}$: The account of the quarter q of the year t.

After reproducing the relationship between the account and the indicator we still have the residual part which contains information that the indicator, even straightened, cannot give. Consequently, to overcome this problem, the quarterly holds result from a program of minimization of the sum of the squares of the deviations between successive residues.

The quarterly account becomes:

$$A_{t,q} = \frac{\alpha}{4} + \beta * I_{t,q} + r_{t,q}$$

$r_{t,q}$ : The quarterly residue of the quarter q of the year t.

In the QNA department we use three main softwares for the whole work process, in effect, we use Excel sheets to organize and store our data (annual account, short term information, other statistics etc), we use also JDemetra+ software [Narodowy Bank Polski, Department of Statistics, 2015] so as to do seasonal adjustment tasks and finally, we employ Eviews software for the calculation of the quarterly accounts. The project of the QNA department is to benefit from advantages and the large community of R by using it in the different step of the work process of the national accountant. The next part of this paper will present a trial of our work on R that will need more perfection in the near future.

## 3. R programming for the QNA

### 3.1. Data import

The first step in the work process is very important because it allows us to import our data from Excel sheets and transform it to an appropriate time series form. The following script is an example of importing 3 indicators and annual accounts by using the **read.xlsx( )** function from the **xlsx** library, after that we use the function **ts( )** in order to transform the data to time series.

```
> library(xlsx)
> setwd("C:/R/")
> IND<-read.xlsx("Inputs/Industrie/DATA_INDUS.xlsx", sheetName="industrie11", header=TRUE)
> OP1ED0111=ts(indvol$OP1ED0111, frequency=4,start=c(1998,1),end=c(2017,2))
> OP1ED0211=ts(indvol$OP1ED0211, frequency=4,start=c(1998,1),end=c(2017,2))
> OP1ED0311=ts(indvol$OP1ED0311, frequency=4,start=c(1998,1),end=c(2017,2))
> VA30<-read.xlsx("Inputs/Industrie/DATA_INDUS.xlsx", sheetName="va30", header=TRUE)
> OB1ED0130=ts(VA30$OB1ED0130, frequency=1,start=1998,end=2016)
> OB1ED0230=ts(VA30$OB1ED0230, frequency=1,start=1998,end=2016)
> OB1ED0330=ts(VA30$OB1ED0330, frequency=1,start=1998,end=2016)
```

*Listing 1 : Example code of data import using the package xlsx.*

### 3.2. Seasonal adjustment

After importing data, we will proceed to the seasonal adjustment before going to the calibration, in order to correct our short-term information which contain generally seasonal component. The most popular analytics tool to do this task is the X-12-ARIMA software developed by the U.S. Census Bureau's. As shown bellow in the script, we install the x12 package [Kowarik and Meraner, 2014a] available in the CRAN and the executable file of the x12 software from the website of the U.S. Census Bureau's. Then we create two objects, x12Single and x12Batch, after that we "source" a function called write( ) in order to extract regressors from the Moroccan calendar in a Excel sheet and save them in a file with "**.dat**" extension and use it in the process of the x12.

```
>library(x12)
> x12path("sources/x12a.exe"
> OP1ED0112<-new("x12Single",ts=OP1ED0111,tsName="OP1ED0111")
> OP1ED0212<-new("x12Single",ts=OP1ED0211,tsName="OP1ED0211")
> OP1ED0312<-new("x12Single",ts=OP1ED0311,tsName="OP1ED0311")
> source("C:/R/sources/write.r")
> reg_ecrit_Q(nom_reg="WeekDays",nom_fichier="reg",date_debut=1998)
> reg_ecrit_Q(nom_reg="Adha",nom_fichier="reg_Adha",date_debut=1998)
> reg_ecrit_Q(nom_reg=»Fitr»,nom_fichier=»reg_Fitr»,date_debut=1998)
> s <- new("x12Batch",list(OP1ED0112,OP1ED0212,OP1ED0312,OP1ED0412,OP1ED0712))
>series_x12<-setP(s,
list(regression.variables=NULL,regression.user="WeekDays",regression.file="reg.dat" ))
> serie_x12<-x12(series_x12)
> serie_x12
#-------------------------Display of data------------------------------
> OP1ED0112<-serie_x12@x12List[[1]]@x12Output@d11
> OP1ED0212<-serie_x12@x12List[[2]]@x12Output@d11
>OP1ED0312<-serie_x12@x12List[[3]]@x12Output@d11
#---------------Export output data to Excel sheet ----------------
> write.xlsx(OP1ED0112,file="Sorties/OP1ED0112.xlsx")
> write.xlsx(OP1ED0212,file="Sorties/OP1ED0212.xlsx")
> write.xlsx(OP1ED0312,file="Sorties/OP1ED0312.xlsx")
```

*Listing 2 : Example code of seasonal adjustment using x12 package.*

By executing the script in listing 2, we can run the x12 process and then we get the outputs results with the default parameters. Moreover, we can benefit from the x12GUI package [Kowarik and Meraner, 2014b], by interacting with the different parameters and the impact is visible immediately via graphs and tables, so the results are more clear, credible and scientifically rigorous. Figure 3.1 shows one view of executing the code in listing 3, as shown bellow.

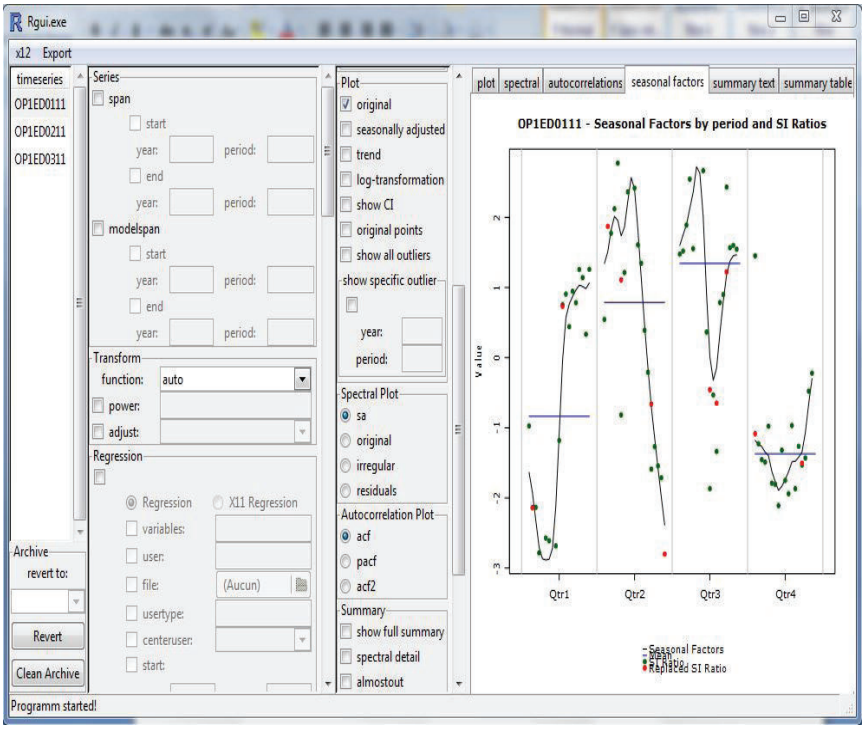
```
> OP1ED0112<-new("x12Single",ts=OP1ED0111,tsName="OP1ED0111")
> OP1ED0212<-new("x12Single",ts=OP1ED0211,tsName="OP1ED0211")
> OP1ED0312<-new("x12Single",ts=OP1ED0311,tsName="OP1ED0311")
> b <- new("x12Batch",list(OP1ED0112,OP1ED0212,OP1ED0312))
> library(x12GUI)
> seriex12GUI<-x12GUI(b)
```

*Listing 3 : Example code of seasonal adjustment using package x12GUI.*

We notice that there this listing does not differ from the previous one except the call of the x12GUI( ) function that allow us to manipulate easily the parameters related to the seasonal adjustment.

**Outlook of one window of the x12GUI package**

*Figure 3.1*




### 3.3. Calibration

In this stage we will use the outputs of the seasonal adjustment as inputs in the calibration procedure. Before going to do this task we have to install the appropriate packages that contain the right functions and the necessary thing that we will need for the calibration. *urca*, *tseries* and *quadprog* are the main packages for our method. The code bellow show the sequence of the

procedure, firstly, we begin by calling the necessary packages, then the annual account and the annualized indicator via the function aggregate2( ) which calculates the annual mean of the quarterly or annual indicator. Secondly, we create and store time variables that we will use for the graph outputs in order to keep them all in case of repeated execution of the script for analyzing purpose. Finally, we call calib1( ) function that contain all the calculation code and at the same time we verify the graphs and tables exported in pdf files so as to assure the wanted results that we will export with write.xlsx( ) function. The reason behind naming and numerating the function calib(n), is that each one can deal just with a n number of indicator.

```
>library(tseries)
> library(urca)
> library(quadprog)
> account <- OB1ED0130
> indic <- agregate2(OP1ED0112)
########################################
> mydate = as.POSIXlt(Sys.time())
> j<-round(mydate$sec)
> k<-mydate$min
> l<-mydate$hour
> i<-Sys.Date()
##############################################
> pdf(paste("Outputs/graph_D01 ", i ," ", l ," ", k ," ", j ,".pdf",sep=""))
> calibration <- calib1(account,indic,freq=4)
> dev.off()
> write.xlsx(cpt_cvs,"C:/R/Outputs/Quarterly accounts.xlsx",sheetName="va32D01")
```

*Listing 4 : Example code of Calibration and exporting the results.*

## 4. CHALLENGES

As presented previously, the 4 listings present a trial version that needs more perfection in term of seasonal adjustment and calibration because they are the main part of the QNA compilation program and they have to be detailed and well structured.

The most challenges that face any user of R and specially the QNA case are listed below:

a) R is free open source software so there is no technical support and the user have to deal with his problems by searching and exchanging with the large community in the internet.

b) The user must update his version of R and also keep eye on the new about the release of new packages and modification of others in order to improve his code and performance.

c) Most users of R are statisticians so they have to improve their algorithmic coding skills.

## CONCLUSION

The use of R can help the work process of the national accountant and makes it possible to deal with different problems that are not simply solvable with other statistical software.

In conclusion, R software represents a big challenge for the Moroccan official statistics, consequently, an ideal situation would be that where both IT specialists and statisticians from official statistics would hold the use of R in order to build an infrastructure for R including training and support.

A forthcoming proposal would be a program for creating an R-package related to the QNA and for migrating from Excel and Eviews to R. Hence, new partnerships and cooperations between countries seem promising and beneficial since all and sundry can use the product for free.

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