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THE WORKING/TRADING DAY ADJUSTMENT OF ITALIAN QUARTERLY NATIONAL ACOUNTS: METHODOLOGY AND PRESENTATION OF THE MAIN RESULTS

Paper submitted by ISTAT, Italy[1]

INTRODUCTION

1. Official measures of economic activity are generally observed at certain discrete frequencies (daily, weekly, monthly, quarterly, ...). Their movements can be influenced by the composition of the calendar. For example, a monthly series can vary remarkably according to the number of days in each month (from 28 days in February in a non-leap year to 31 days in various months). Furthermore, the weekly cycle shifts the number of working (and non-working) days across months, so that the same month might have a different number of working days from year to year. Moving holidays (like Easter) and leap years are further calendar effects which might explain part of the variability of an economic time series.

2. The variations determined by the seasonal and calendar components are not considered of primary interest in the analysis of the business cycle and are generally removed because they can obscure movements that are of primary interest. The series with such components removed is called adjusted for calendar and seasonal effects. The decomposition of time series into stochastic (unobserved) components like trend, cycle

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[1] Paper prepared by Francesca Di Palma and Marco Marini.

and seasonality is by now a well-known practice used by National Statistical Institutes (NSIs) in their data production process. The deterministic nature of the calendar component requires the introduction of ad-hoc statistical procedures in order to identify, estimate and remove the effects due to calendar factors.

3. On the occasion of the release of the first quarter 2003, ISTAT issued for the first time estimates of quarterly national accounts (QNA) aggregates adjusted for calendar effects. The purpose of this article is twofold. Firstly, we present the methodology used for the adjustment of QNA aggregates and its integration in the process of compilation of quarterly economic accounts by ISTAT. The next step is to show some interesting results highlighting the dependence of several economic measures of output, consumption and investment from calendar effects.

4. The paper is organised as follows. The following section discusses the necessity of adjustment of QNA aggregates, in light of the recommendations given by the joint Eurostat/ECB task force on the treatment of seasonality and calendar effects. The topic of theoretical and methodological aspects of working/trading day adjustment is analysed in-depth in the third section. In the fourth section, we explain the way in which the adjustment method has been integrated in the process of QNA compilation. The fifth section illustrates some interesting results with which to assess the impact of calendar effects on QNA aggregates. Conclusions and open-issues are drawn in the final section.

THE NECESSITY OF ADJUSTMENT OF QNA AGGREGATES

5. Most sub-annual time series show intra-year variations – seasonal fluctuations – which recur regularly every year, sometimes slowly evolving. The presence of a seasonal component in a time series can represent a problem for the aims of the analysis, so it is often necessary to isolate these regularly repeating intra-year variations. Seasonal variations, irrespective of their causes, are a reflection of the fact that each period has its own characteristics with respect to other periods of the year (due to climate or administrative factors, for instance). Hence, the direct comparison of different periods of the same year is generally not statistically meaningful if the series presents seasonal variations. Seasonal adjustment is therefore a fundamental step in the short-term analysis of time series.

6. Similarly, the different number of working/trading days in a given period can strongly influence a time series. In some cases holidays or other causes of absence from work can determine non-negligible effects. Only the practice of adjusting time-series for seasonal and calendar components offers to users and policy makers the possibility of making meaningful comparisons among different quarters. Methods of time series analysis are used to isolate such components from the rest of the series in order to obtain appropriate measures of the state of the economy.

7. When comparisons are extended from the national to the international level, a proper identification of these effects becomes essential. This is a focal point in the compilation and analysis of Euro area (and/or EU) QNA. The comparability of QNA data among Euro area and EU countries is essential for European Institutions such as Eurostat and European Central Bank (ECB) which are expected to provide more and more timely economic analysis. The standardization of quarterly raw data achieved through the implementation of ESA95 rules risks being disturbed by differences in the process of data

adjustment for calendar effects. In addition, the Euro area QNA compiled by Eurostat are derived from national data and are therefore consistent with the Member states' QNA. To reduce to a minimum the differences in adjustment processes across Europe, Eurostat and the ECB established a joint Task Force in order to develop recommendations for a policy on QNA seasonal and working/trading day adjustment for the Euro area and EU aggregates.

8. After the conclusion of the works, the joint Eurostat/ECB TF submitted a set of recommendations for the compilation of QNA aggregates in order to get a complete harmonisation across EU countries. The main conclusions regarding working/trading day adjustment can be summarised as follows:

- between the proportional and regression approach preference should be given to the regression approach;

- the regression approach should include appropriate additional regressors for special holidays in a country;

- QNA data should be working/trading day adjusted (except the stock data on population and the labour force). In any case the adjustment should be made for those variables for which there is statistical evidence and an economic rationale for calendar effects;

- in order to obtain accurate seasonal factors, the trading-day adjustment should be performed prior to seasonal adjustment;

- working/trading days effect should be identified on the indicator and not on the target series because the first approach offers greater precision;

- when available, adjustment should be performed on monthly series keeping in mind that the working/trading days effect is more significant on a monthly basis;

- working/trading days adjustment should also include moving holidays adjustment as well as a correction for leap year effects. The length of the Easter effect should be tested and appropriately adjusted for;

- other pre-adjustments (outliers and intervention variables) should be carried out to improve the estimate of the seasonal and working/trading day components. They should be based either on information directly available or on a regression framework;

- all the effects estimated in the pre-adjustment phase should be clearly identified as separate components as well as Easter and leap year effects. The final trading day and seasonally adjusted series should exclude only the seasonal component;

- concerning time consistency with annual data, purely seasonally adjusted data should be referred to the sum of the raw data (annual unadjusted data), while seasonally and working/trading day adjusted data should be referred to working/trading day annual adjusted data.

THEORETICAL AND METHODOLOGICAL ASPECTS OF WORKING/TRADING DAY ADJUSTMENT

9. In the classical decomposition of time series, the calendar component captures the variability associated with the calendar structure. There is no uniform and general definition of the calendar component. Calendar effects can be distinguished in two main groups, in line with the treatment of traditional seasonal adjustment softwares :

<u>Working/trading days effect</u>

10. If daily series were used to measure business or consumer activities, a likely result would be that such activities vary over the different days of the week. Economic series observed at daily frequency are rarely available however; to a great extent, short-term analysts are used to dealing with monthly and quarterly series. Each month or quarter encloses a varying number of Mondays, Tuesdays, … and Sundays from year to year; economic aggregates can thus vary.

11. The working days effect catches the differences between the working days (i.e. Monday, Tuesday, …, Friday) and the weekend days (Saturday and Sunday) under the general hypothesis that the two patterns determine differences in economic activity. For some activities the effect might be different for each working day (e.g. a Wednesday could be quite different of a Friday); if this is the case, we denote it as the trading days effect.

<u>Special calendar effects</u>

12. Calendar effects can also be related to the variation of economic activity around some special dates in the year, like Christmas or Easter. The treatment of such effects depends on the impact they have on economic activity. The Christmas effect always occurs in December (for monthly series) or in the fourth quarter (for quarterly series). Because of this regularity, the effect can be totally assigned to the seasonal component. Conversely, the effect of Easter may concern different months or quarters of the year (March or April, the first or the second quarter). For this reason, the effect of Easter, as well of any other existing moving holiday, requires a special statistical treatment to be identified.

13. As we explain later, the overall moving holiday effect is normally distributed via a quantitative translation on two adjacent months/quarters. As far as the Easter holiday is concerned, the effect is supposed to cover some days before and some days after the Easter day. Since the date of Easter moves from year to year because of ecclesiastic rules, the adjustment of the series will be imputed totally in March or in April, or proportionally to the number of days falling in each month.

14. A second calendar effect is due to the presence of leap years. Every four years an additional day occurs in February. The leap years effect is usually considered as a separate effect in the literature. For reasons explained later, we have preferred not to use an additional regressor.

15. Whenever a calendar effect is seen to be significant in a time series, it should be

identified and estimated through appropriate statistical techniques. Subtracting the overall effect from the original time series, we obtain a series corrected for calendar effects. Two approaches are commonly used to this purpose, the proportional adjustment method and the regressive method (or model-based approach).

16. In the former approach the observed variable y_t is proportionally adjusted on the basis of the number of trading days in the reference period t. Formally, the corrected series g_t in the reference period *t*. Formally, the corrected series y_t^a is computed as

$$y_t^a = y_t \frac{\bar{g}_b}{g_t} \text{ for } t = 1,\ldots, T \qquad (1)$$

where $\bar{g}_b$ represents the average number of working/trading days in a base year. This approach has often been demonstrated to overadjust the working/trading days effect; in fact, it entails a proportional adjustment of y_t irrespective to the real dependence of the series on the length of period *t*. The weaker the true effect, the larger the bias introduced by the proportional adjustment.

17. On the contrary, the regressive approach does not impose any prior dependency but correction factors are derived on the basis of estimated linear regression models. The calendar composition is summarised by means of some variables and these are used in a regression model as exogenous variables.

18. More generally, given the variable y_t we suppose the existence of the following model with ARIMA disturbances

$$\begin{aligned} y_t &= \mathbf{x}_t' \mathrm{b} + v_t \\ f(L)d(L)v_t &= q(L)e_t \text{ for } t = 1,\ldots,T \end{aligned} \qquad (2)$$

where $f(L), d(L)$ and $q(L)$ [2] are finite polynomials in the lag-operator *L* with possible seasonal components, $\mathbf{x}_t$ is the (*k x* 1) vector containing the *k* deterministic regressors considered useful for the explanation of y_t, b is the column-vector with the corresponding regression coefficients and e_t is the residual term. Clearly, $f(L), d(L), (L)$ and b are unknown and must be estimated through econometric methods.

19. In the QNA framework, the component $\mathbf{x}_t' \mathrm{b}$ is seen as a set of deterministic effects which, subtracted by the original series, allows for improvements in the quality of the seasonal adjustment process. The most obvious effect is the mean, but intervention variables, outliers and calendar effects can also be considered. All these effects should be properly removed before running the decomposition into unobserved components (trend, cycle, seasonal and irregular). The effects connected with the composition of the calendar can be expressed by means of deterministic regressors. Let us denote with $\mathbf{x}_{d,t}$ (k_d *x* 1) the set of such variables. The adjusted variable y_t^a for working/trading days effect can thus be computed as

$$y_t^a = y_t - \mathbf{x}_{d,t}' \hat{\mathrm{b}} \qquad (3)$$

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[2] The polynomial $d(L)$ contains the unit roots associated with regular and seasonal differencing, $f(L)$ is associated with the stationary autoregressive component, $f(L)$ denotes the invertible moving average polynomial.

with $\hat{b}$ the vector of estimated coefficients of model (2). As we explain later, the significance of the coefficient (in the statistical sense) represents the main information on which the reliability of the adjustment is assessed.

20. We restrict our analysis on the effects deriving from:

- the different number of trading days (net national holidays);
- the moving Easter problem.

21. Each period of time (month, quarter, etc.) is characterized by a different number of Monday, Tuesday, ..., Sunday; economic activity can be affected according to the dependency from each day. One working day guarantees a certain level of production for a firm in manufacturing sectors; on the other hand, it can generate less profits for the activities connected with tourism. Similar considerations can be done for the demand side aggregates. Such effects can be estimated by considering the regression model (2) with the series of working days as regressor. The *working days effect* separates the working days (Monday,..., Friday) from the weekend days (Saturday and Sunday). The variable we_t in the period *t* is derived as the difference between the number of working days (w_t) and non-working days (nw_t)

$$we_t = (w_t - \frac{5}{2} nw_t) . \qquad (4)$$

22. The number nw_t is pre-multiplied by the factor 5/2 to make we_t a zero-mean regressor in every single week. A holiday is considered as it was a Saturday or Sunday. Correspondingly, w_t (nw_t) would decrease (increase) by the number of holidays in period *t*. After running the regression, the adjusted series is computed as

$$y_t^a = y_t - \hat{ß}\, we_t . \qquad (5)$$

23. The value of $\hat{ß}$ represents thus an estimate of the effect of y_t due to an additional working day. Generally, this regressor turns out to be highly significant in those firms (mainly in the industrial sector) organising their production on five working days.

24. Nevertheless, there exists many activities for which it is important to keep separate each day of the week. The *trading-days* effect is composed by the following six regressors

$$w_t^1 = (mon_t - sun_t) - h_t^1 ,\, w_t^2 = (tue_t - sun_t) - h_t^2 ,\, ..., w_t^6 = (sat_t - sun_t) - h_t^6 \qquad (6)$$

where $mon_t, tue_t, ..., sat_t$ are the number of Monday, Tuesday, ..., Saturday in the period *t* and $h_t^1, h_t^2, \ldots, h_t^6$ the national holidays falling in Monday, Tuesday, ..., Saturday. The data adjusted for the trading days effect is obtained by

$$y_t^a = y_t - \sum_{i=1}^{6} \hat{b}_i w_t^i . \qquad (7)$$

25. Particular attention must be given to the counting of national holidays. Fixed holidays, such as Christmas, New Year's day or Mid-August, occur on different days of the week. Whenever they happen between Monday and Friday (or Saturday for the trading days effect), the regressors (4) and (6) are decreased according to the corresponding expressions. The underlying assumption is to make equal the effect of a holiday to that of

a general Sunday. An alternative approach would be that of introducing directly the number of the holidays in model (2). Unfortunately, following this way would generate at least two shortcomings in the adjusted series. A certain level of interaction between the holiday regressor and the regressors (4) and (6) would exist, because the same day is considered as working on one hand and as non-working on the other hand. This could reduce the accuracy of the regression estimates. Secondly, the estimate of a separate coefficient for the holidays effect might be in contrast with those derived from (4) or (6), so as to negatively affect the economic interpretation of results.
26. At present, in Italy there are two additional public holidays, April 25th (Liberation day) and June 2nd (anniversary of the Republic). As a matter of fact, the number of Italian festivities has continuously changed in the last decades. In the early 70's there were four additional holidays, later on suppressed, and other minor modifications were made to the calendar up to now. Such differences turned out to be harmful for the estimation of model (2), inasmuch as they reduce the significance of the estimated regression coefficients. To guarantee a better quality of adjustment of data, we have thus decided to correct QNA aggregates starting from 1977[3]; in fact, beyond that date the public holidays remain more stable.

27. The second calendar effect considered concerns the Easter holidays. While any fixed-holiday effect on economic activity is always caught by the same month, the effect of Easter, as well as other moving holidays, may affect different months (March or April) or quarters (first or second) according to the year. This implies instability of the seasonal component of model (2) in a time-series context; a special statistical treatment is therefore required to bring in appropriate corrections. Let us denote by *d* the duration of the Easter effect (in days). The monthly regressor for the Easter effect is:

$$e_t = \begin{cases} 0 & \text{if } t \neq \text{March, April} \\ pM - mM & \text{if } t = \text{March} \\ pA - mA & \text{if } t = \text{April} \end{cases} \tag{8}$$

where *pM* and *pA* are the proportion of the *d* days respectively in March and April in period *t*, while *mM* and *mA* represent long-term averages for the same proportions. A good approximation for both the averages is 0.5 (*mM* = *mA* = 0.5). For the quarterly case, the regressor is simply derived by considering first and second quarters in place of March and April.

28. The Eurostat/ECB Task Force has also pointed out a third type of correction caused by the presence of leap years, the so called *leap year effect*. The leap year is characterized by an extra day in February every four years; such a cyclical periodicity is generally caught in a regression model by the variable:

$$ly_t = \begin{cases} 0.75 & \text{if } t = \text{February in a leap year} \\ -0.25 & \text{if } t = \text{February in a non leap year} \\ 0 & \text{otherwise} \end{cases} \tag{9}$$

29. Anyway, the presence of leap years is already caught by regressors (4) or (6). Entering regressor (9) into model (2) would lead to an unpleasant over-adjustment of the

[3] Italian QNA time series start from 1977q1 but are published from 1980q1; data are freely downloadable from the ISTAT web-site con.istat.it

series, especially in the first quarters of leap years. Moreover, the estimated coefficient for ly_t is found to be a lot larger than those for (4) and (6); in this way a major importance of the extra-day in February would be given with respect to any other working day of the year. For these reasons, the regressor ly_t has not been introduced in model (2) because implicitly considered in the definitions of (4) and (6).

30. The estimate of calendar effects has been performed using the programme TRAMO (Gomez and Maravall, 1997) which, along with the seasonal adjustment routine SEATS, are presently employed by ISTAT for the treatment of sub-annual time-series (data irregularities, seasonal adjustment, trading/working days correction, outliers removal, etc.). The parameter set of model (2) is jointly estimated by TRAMO through the exact maximum likelihood approach. The programme offers to users some facilities for working days adjustment. The regressors (4), (6) and (8) can be used by changing the values for the parameters ITRAD and IEAST in the input file. The programme does not consider national holidays. For this reason, the regressors (4) and (6) were built using the national calendar and given afterwards to the programme as external regressors.

31. The trading day effects produce periodic movements in a monthly/quarterly series at particular frequencies. These corresponds to a fractional part of the number of weeks in an average month. Let us explain this point better. Suppose the length of all months were equal to 365.25/12 days, which corresponds to 30.4375 days. The working/trading days effect can be thought of as a cycle with a period of seven days. Then, for a monthly series we have :

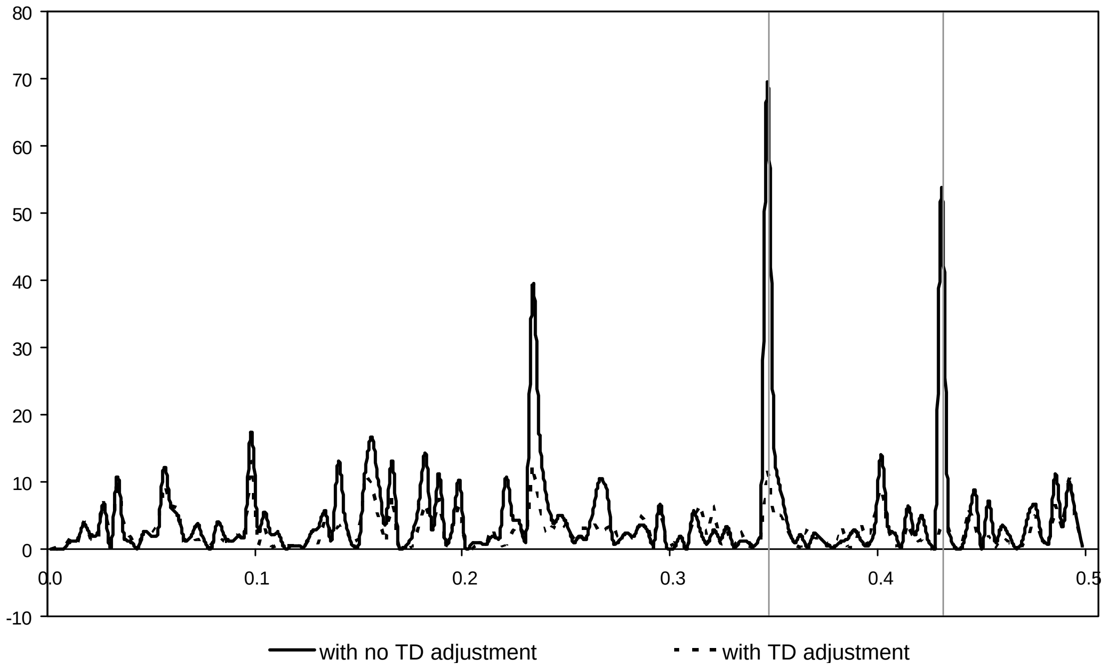
$$\frac{\text{cycle}}{7\,\text{days}} = \frac{30.4375/7\ \text{cycle}}{\text{month}} = 4.348\,\text{cycles/month}\,.$$

32. While four cycles are expected to complete their period over a month, a component with fractional frequency (0.348) can still be present in the aggregated monthly series. Cleveland and Devlin (1980) identify a second important frequency at 0.432. Spectral analysis can be used to detect the presence of periodic components (Soukup and Findley, 1999). In particular, the working/trading days effect can be detected if the periodogram shows peaks at the two frequencies. To be useful, the periodogram must be calculated on a transformed series. In fact, the original series usually contains trend and seasonal components which obscures the movements of higher frequencies. For this reason, we decided to calculate and display the spectrum of the residuals of the ARIMA decomposition performed by SEATS.

33. Figure 1 compares the periodogram of the residual series from two seasonal adjustment of the industrial production index of manufacture of food products, beverages and tobacco. The index is seasonally adjusted without considering any calendar effects (solid line). Then, the same index is first adjusted for working days effect using regressor (4) and then seasonally adjusted (dotted line). As can be seen, the solid line shows higher amplitudes at the frequencies of 0.348 and 0.432. In this case, the working days adjustment is necessary to perform a correct modelling of seasonality of the original series.

34. For further theoretical discussions on working/trading days adjustment we suggest the work of Sookup and Findley (2000).

Fig. 1 – Industrial production index of manufacture of food products, beverages and tobacco. Spectral density matrix of residual components : seasonal adjustment with and without trading day adjustment



THE ADJUSTMENT OF ITALIAN QNA : MAIN STEPS

35. In this section we consider the different steps followed to obtain QNA aggregates adjusted for calendar effects.

36. It is worth remembering that Italian QNA are estimated using an indirect method. The reduced availability of quarterly information with respect to the annual one imposes the use of related time series. These series are called indicators and are observed at higher frequency (quarterly or even monthly); they are used to derive coherent quarterly figures from annual national accounts. The method is based on the quarterly disaggregation technique proposed by Chow and Lin (1971).

37. As far as the relationship between working/trading days adjustment and temporal disaggregation is concerned, the Eurostat/ECB joint TF considers two different options. The first is to adjust QNA target series, the second is to adjust the underlying monthly/quarterly indicators used to compile them. Anyway, when monthly indicators are available the latter approach is strongly advised. In addition, working/trading days adjustment must be performed prior to seasonal adjustment which in Italian QNA is carried out on related indicators. Accordingly, adjustment is done to the set of indicators used to disaggregate the annual aggregates.

38. As a first step, the presence of calendar effects was carefully assessed for each indicator. The choice has been driven either by economic and statistic criteria. In general, aggregates expressed as averages over a period, such as employment, are normally not affected by the differing incidence of holidays or other calendar effects. Then, full-time equivalent employment, population and compensation of employees (derived as per-capita compensation by employment) have not been adjusted.

39. For all other indicators three regression models were tested. Firstly, we estimated model (2) without any regressor for calendar effects. From now on, this is called the not adjusted (NA) model. The working days adjusted model (WD) was estimated using regressor (4). Finally, the trading days adjusted model (TD) considered the six regressors defined by (6). The Akaike Information Criterion (AIC) was used to assess the goodness of fit of the three models. The AIC leans toward a more complex model with respect to other criteria, such as Bayesian information (BIC) or Hannan-Quinn (HQ). This feature is suitable to select a correction model for quarterly indicators, in which calendar effects are less evident than in monthly series (for further issues on information criteria for model selection see Grasa, 1989).

40. The ranking resulting from the AIC values is helpful in identifying the dependency of the series from calendar effects. Another aspect considered in the model selection was to assess the significance of the regression coefficients through their t-statistics. To this end, we chose to accept a maximum level of 5% of probability error, corresponding to a t-value of around 2.

41. Once the model was defined, we tested for the presence of the Easter effect by using the regressor (8). Again, the effect was assessed by looking at the corresponding t-value. We estimated the model with different lengths (from 1 to 12) and, on average, we found that the significance of the coefficient was higher with a 6-days length. Accordingly, the length of the Easter effect was fixed to 6 days (IDUR = 6 in TRAMO) for all the series.

42. As far as the estimated coefficients are concerned, two aspects are worth noting. The t-test informs us about the statistical significance of a coefficient but does not give any information about its meaningfulness from an economic point of view. The economic interpretation of a regressor is provided by the sign of the coefficient, and to a lesser extent by its magnitude. For example, positive coefficients for (4) and (6) are expected to arise for variables related to industrial activities; in these cases a negative value would generate opposite corrections for working/trading days effect. Secondly, the estimate of a coefficient can dramatically change over time and this could cause different correction mechanisms. To avoid such consequences, a stability analysis was performed on the coefficients of the working/trading days and Easter regressors (see the next section for some evidence on parameter stability).

43. The model finally chosen was used to derive the adjusted series, subtracting the overall effect due to calendar regressors from the original aggregates. The calendar effects also have an impact on annual data as the number of trading days normally varies from year to year. Therefore, the adjusted annual totals (obtained as the sum or the average of the monthly/quarterly adjusted data) should differ from raw annual totals. Using an indirect method, we had to derive for each aggregate an adjusted annual benchmark. Let us denote with Y_t an annual aggregate and with Y_t^a the same aggregate adjusted for trading days. Given the annual relationship between Y_t and the related short-term indicator (X_t), we suppose the following assumption:

$$Y_t = f(X_t) \Leftrightarrow Y_t^a = f(X_t^a)$$

44. Given the estimated regression model at annual level

$$\hat{Y}_t = X_t'\hat{b} + \hat{u}_t \,, \tag{10}$$

the Chow-Lin's technique derives the quarterly series $y_{t,q}$, for q = 1,...,4 from the equation

$$\hat{y}_{t,q} = x_{t,q}'\hat{b} + \hat{\mathbf{L}}_w \hat{u}_t \tag{11}$$

where ($\hat{b}$, $\hat{u}_t$) are GLS estimates of (10) (see the appendix for more details). Consider now the indicator adjusted for calendar effect and denote it as X_t^a. Replacing X_t^a in (10), we obtain an estimate of the annual adjusted aggregate $\hat{Y}_t^a$ as

$$\hat{Y}_t^a = X_t^a \hat{b} + \hat{u}_t \,. \tag{12}$$

45. At quarterly level, we have:

$$\hat{y}_{t,q}^a = x_{t,q}^a{}'\hat{b} + \hat{\mathbf{L}}_w (Y_t^a - X_t^a{}'\hat{b})$$
$$\hat{y}_{t,q}^a = x_{t,q}^a{}'\hat{b} + \hat{\mathbf{L}}_w (X_t^a{}'\hat{b} + \hat{u}_t - X_t^a{}'\hat{b})$$
$$\hat{y}_{t,q}^a = x_{t,q}^a{}'\hat{b} + \hat{\mathbf{L}}_w \hat{u}_t \,.$$

46. Subtracting the last expression with (11)

$$\hat{y}_{t,q}^a - \hat{y}_{t,q} = x_{t,q}^a \hat{b} - x_{t,q} \hat{b} = \hat{b}\,(x_{t,q}^a - x_{t,q}) \tag{13}$$

we note that the adjustment for the aggregate $y_{t,q}$ depends on the correction made on $x_{t,q}$ weighted by the estimated regression coefficient $\hat{b}$.

47. It is appropriate to remember that the dynamics of adjusted series can be different from that of non-adjusted ones. As a consequence, annual growth rates can vary from year to year according to the relative number of days.

48. The next step consists of removing the seasonal component from the indicators. In our approach, seasonal adjustment is performed at quarterly frequency. The main difference with the past is that now seasonal adjustment is applied to $x_{t,q}^a$, not to $x_{t,q}$. Removing any deterministic effects from a time series improves the process of decomposing the time series into stochastic components (trend, cycle, seasonality and residual). In particular, calendar effects are expected to disturb mainly the seasonal component. The most important improvement in this new approach is in the quality of the seasonal adjustment process. Each aggregate, being adjusted for both seasonal and working/trading day components, will turn out to be the most appropriate for the analysis of the business cycle.

49. As a final step, annual aggregates (both in adjusted and non-adjusted forms) are disaggregated by using the corresponding indicators. Then, quarterly indicators adjusted for calendar effects ($x_{t,q}^a$) are used to decompose the annual adjusted series ($\hat{Y}_t^a$).

THE ADJUSTMENT OF ITALIAN QNA : MAIN RESULTS

50. As said before every indicator used in QNA, excluding employment and revenues data, were analysed to check the existence of a trading/working days effect. Tests have been carried out on indicators following the methodology described before. When possible a trading/working days adjustment has been performed on monthly indicators knowing that temporal aggregation partially smoothes calendar effects frequencies (see Findley, 2000). This implies that the availability of indicators at different frequencies could lead to quite dissimilar adjustments among QNA aggregates.

51. Figure 2 shows a graphical representation of a working/trading day adjustment for a monthly industrial production index of the manufacturing sector by means of spectral analysis. On the left-side the estimated spectral density is computed on residuals of merely a seasonal adjustment of the indices, while the right-side shows the same measure on residuals of seasonal and working/trading days adjustments. Comparing the two graphs, it can be noted that the adjustment for calendar effects completely removes from residuals variations at the frequencies commonly associated with the trading/working days effect. On the contrary, these movements are still evident in the left-side spectral densities.

52. After having estimated the adjustment model for each indicator, we calculated rolling estimates of the coefficients of working/trading days and Easter regressors in order to assess the stability of the correction mechanism. Table 1 shows some statistics for the coefficient and t-statistic of the working days regressor (4) for the industrial production index of the manufacturing sector over the period 1996q4-2003q1. The coefficient remains stable, positive and highly significant. The highest variability is found for the index of manufacturing of paper and paper products (standard deviation of 0.0044, standardized range equal to 0.212).

53. Similar analysis have been made on the whole set of QNA indicators, finding evidence of calendar effects for a number of them. Uses and resources account aggregates for which a calendar effect has been observed are; GDP, household consumption, gross fixed capital formation and consequently inventories. No effects have been detected for external trade; this is probably due to the fact that decisions on imports/exports depend on plannings not affected by calendar changes.

54. Table 2 shows the main results of working trading day adjustment on supply side aggregates. For the value added of each branch of activity the regression model used for the related indicator is shown.

55. For the agricultural sector no calendar effect have been detected. All branches of manufacture, except for the manufacture of coke and refined petroleum products, have been working day adjusted. It is worth remembering that the indicator used to quarterly disaggregate these branches, the industrial production index, is available on a monthly level; this ensured a strong significance for regressor (4), the sign of the coefficient being always positive. The Easter effect was only considered for the food products, beverages and tobacco sector. For the construction sector, AIC criterion suggested an adjustment with six regressors (TD). Among the service sectors, WD/TD effects have been observed in the wholesale and retail trade, hotels and restaurants, transports, communications and cultural and entertainment services.

56. Tables 3 and 4 illustrate the adjustment models used for the indicators of household consumption functions and investment items. For household consumption, the

Easter effect has been detected in 4 out of 8 adjusted functions, with quite clear economic interpretation (consumption for food and beverages, recreational and cultural services and hotels and restaurants are influenced by the Easter effect). Purchases of food and beverages, and transport, recreational, hotel, and restaurant services have been adjusted with the six-regressors model (TD); purchases of vehicles, fuels and communication services have instead been adjusted with the WD model.

57. No Easter effect has been found in gross fixed capital formation aggregates, while working/trading days adjustment has been performed on 6 out of 10 investment items. The TD model was chosen for one of the two indicators used to quarterly disaggregate metal products and machinery and for investment in construction. The WD model was applied to the other indicator for metal products and machinery, to transport equipment (including maintenance and repairs of motor vehicles) and to other investment goods.

58. Table 5 presents coefficients and t-statistics for the working/trading days and Easter regressors for all indicators from the supply and demand side for which a calendar effect was detected and therefore removed. Looking at the t-statistics it can be observed that models estimated at the monthly level are much more significant then those estimated at the quarterly level. The economic meaning of regressors can be interpreted through the sign and the magnitude of their coefficients. Most indicators from the supply side are adjusted by means of a WD model with positive coefficients. The branch of electricity, gas and water supply presents the lowest coefficients (? =0.02) while the most adjusted is the production of cars (? =1.24). The economic rationale of the two coefficients is quite clear: the pace of slow down in the production of electricity, gas and water is slower than for automobile factories, which are generally closed on a non-working day, thus a marked break in the production of cars can be seen. For indicators of household consumption the TD model prevails. The signs of Monday, ..., Saturday regressors are different from function to function, and not all coefficients are significant. A significant (positive) effect arises for the Saturday regressor over most of the household consumption functions. The Easter effect is also positive and extremely significant; as expected, the highest effect is found for hotel services expenditure.

59. Table 6 shows the overall adjustment of annual GDP constant prices from 1980 to 2002. A maximum correction in levels is observed in 2000 (888 millions of euro), when there were 5 working days more than in 1999. The 2000 GDP growth rate would have been higher (3.3% rather than 3.1%) with the same number of working days as 1999.

60. The difference in days and the difference between adjusted and not-adjusted growth rates are related by a quasi-perfect inverse linear relationship. One additional working-day with respect to the previous year causes an average reduction of about 0.2 decimals in terms of GDP growth rates. For the period 1980-2002, the linear correlation between the difference of days and the difference between adjusted and not-adjusted GDP growth rates is -0.9054.

61. In tables 7 and 8 we compare quarter on quarter growth rates of both seasonally and working/trading days adjusted and purely seasonally adjusted QNA aggregates over the period 2000q1-2003q1. The stars in the third column indicate the quarter in which the Easter holiday occurs. It can be easily seen that the Easter effect has a particularly strong impact on household consumption growth rates (4 decimal points less in 2000q2 and 2 decimal points less in 2001q2 and 2002q1).

62. Table 9 presents some synthetic measures of adjustment over the period 1980q1-2003q1. The average effect of a working day on GDP growth rates is 0.07 decimal points; the linear correlation between the difference in days and the difference between adjusted and non-adjusted growth rates is -0.8036, slightly less than those found on a yearly basis.

63. As a result of opposite effects (positive correlation for goods consumption, negative for expenditures in hotels and restaurants and entertainment and cultural services), the linear correlation between days and adjustment on household consumption is weaker (-0.1548) than on other aggregates. Nevertheless, the average effect by working day remains relatively high (0.08 decimal points).

64. On average, the bigger effect is found on gross fixed capital formation for which working days determine a 0.17 difference in terms of growth rates. The linear correlation between the difference of days and the difference of growth rates is -0.4238.

CONCLUSIONS AND OPEN ISSUES

65. In this paper we have presented the methodological framework used by ISTAT for the adjustment of QNA aggregates for calendar effects. The main aspects can be summarised as follows:

- the methods used are in line with the recommendations of the joint Eurostat/ECB task force on QNA seasonal adjustment;
- we restrict our analysis towards two calendar effects, the working/trading days effect (with the exclusion of national holidays) and the moving Easter effect;
- adjustment for calendar effects is performed on indicators in a raw form (at a monthly frequency where possible);
- seasonal adjustment is now applied to the indicators adjusted for calendar effects, but always at the quarterly level;
- consistency between annual and quarterly data is assured by computing annual QNA aggregates adjusted for calendar effects;
- statistical significance of calendar effects is found in various production (and value added), consumption and investment indicators;

- consequently, the main QNA aggregates adjusted for calendar effects are GDP, household consumption and gross fixed capital formation (and, being the balance of the resource/uses account, changes in inventories);
- on the other side, no statistical evidence is found for indicators of external trade; any correction is then applied to imports and exports;
- according to our results, the average effect by day on GDP growth rates is 0.07, 0.08 on household consumption, and 0.16 on gross fixed capital formation;
- the linear relationship between the adjustment and trading/working days is stronger for GDP (-0.77) than for investment (-0.43) and consumption (-0.14).

66. To conclude, we wish to bring to the attention of the reader two problematic aspects of our approach. Firstly, we noticed empirically that the significance of calendar effects on a time series is highly correlated to its sample frequency. In other words, the

amount of correction for a series might be much stronger in monthly than in quarterly frequency. This is explained, from a theoretical point of view, by the fact that quarterly aggregation cancels out movements at the frequencies associated with the calendar component. As we have indicated in the previous tables, our system of indicators is not completely available at the monthly level. This might generate an unbalanced adjustment in the accounts, with some aggregate “more adjusted” than others because of the different frequency of the related indicator. The change in inventories aggregates, being derived in our system as balance of the resource and use account, might suffer for such inconsistencies.

67. The second problem is connected with the assumption of linearity between indicators of economic activity and the working/trading days regressors. The condition implies a proportional correction to the series, whatever the phase of the business cycle in which the economy is moving. However, the impact of an additional working day on the level of production, for instance, might be very different in phases of expansion from those of depression. The presence of non-linearity needs to be carefully studied and tested and it is left for future research.

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Figure 2. Spectral density of the residuals after seasonal adjustment

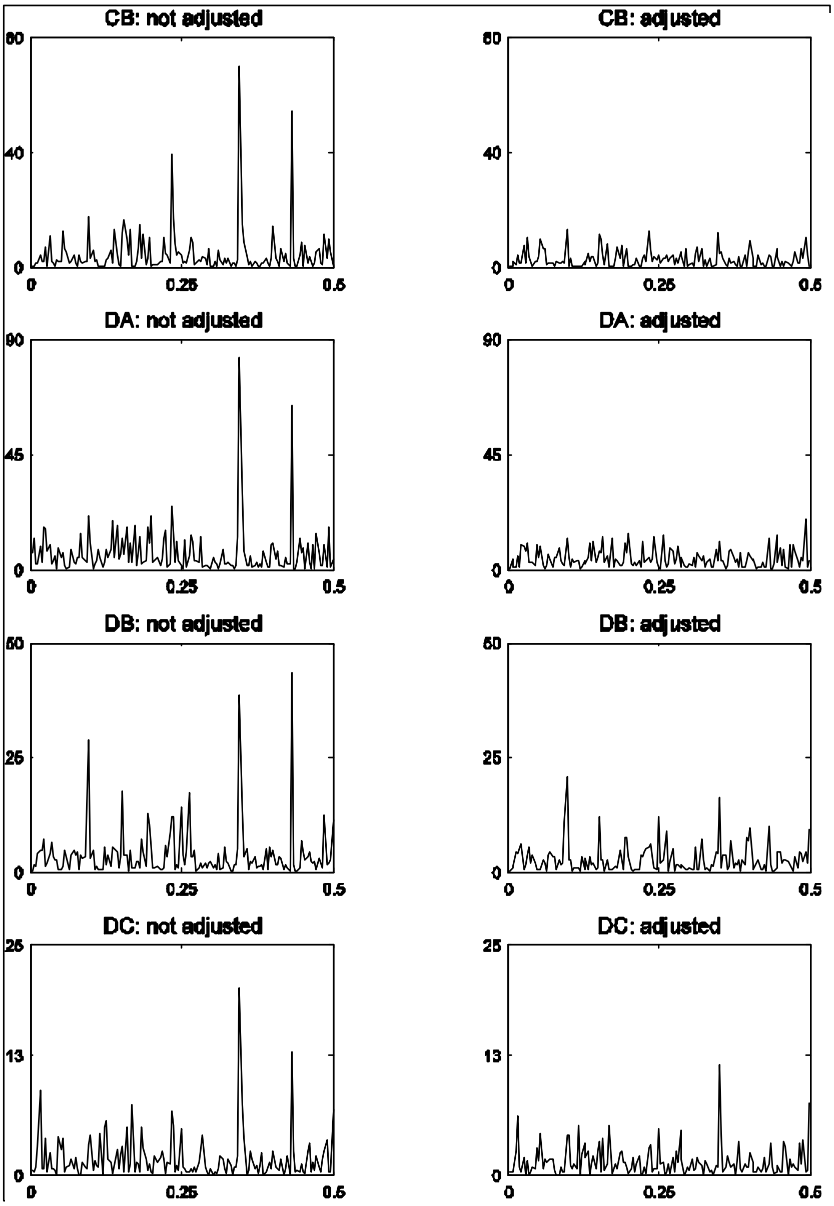

Figure 2 (follows). Spectral density of the residuals after seasonal adjustment

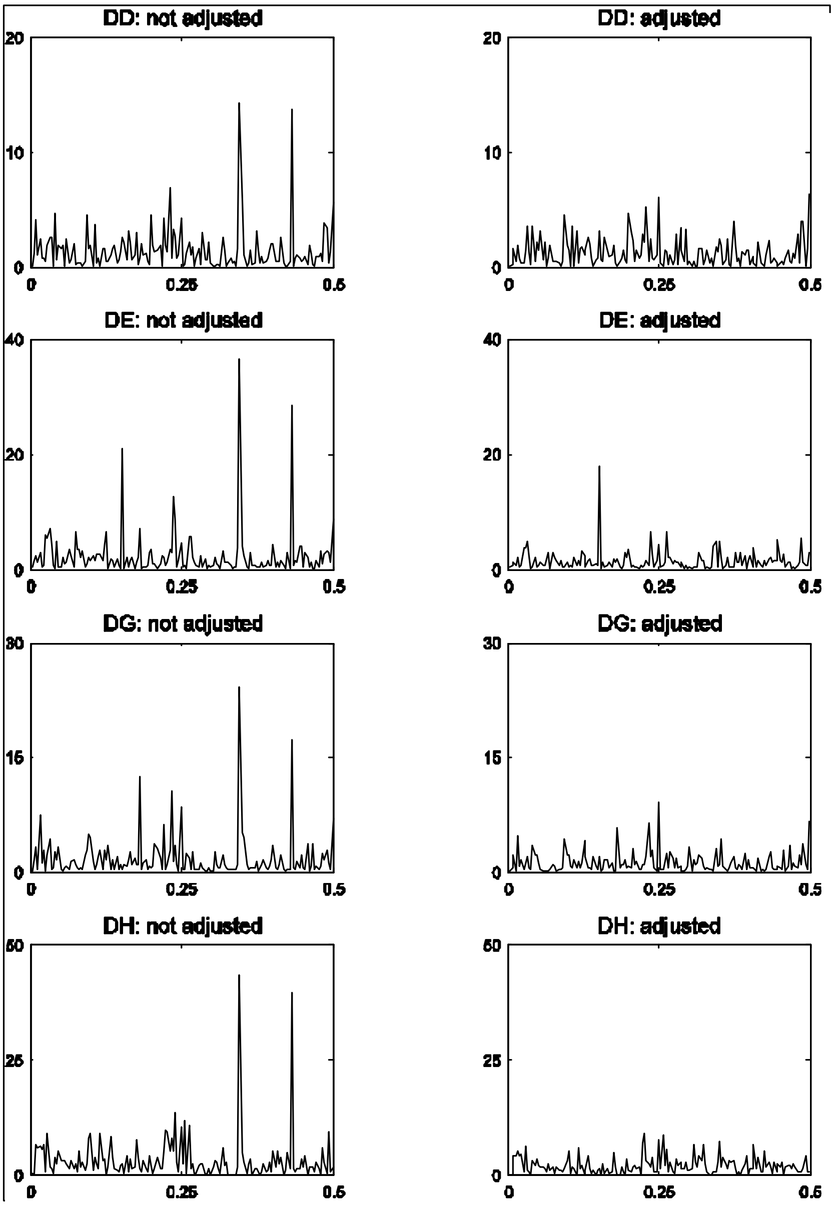

Figure 2 (follows). Spectral density of the residuals after seasonal adjustment

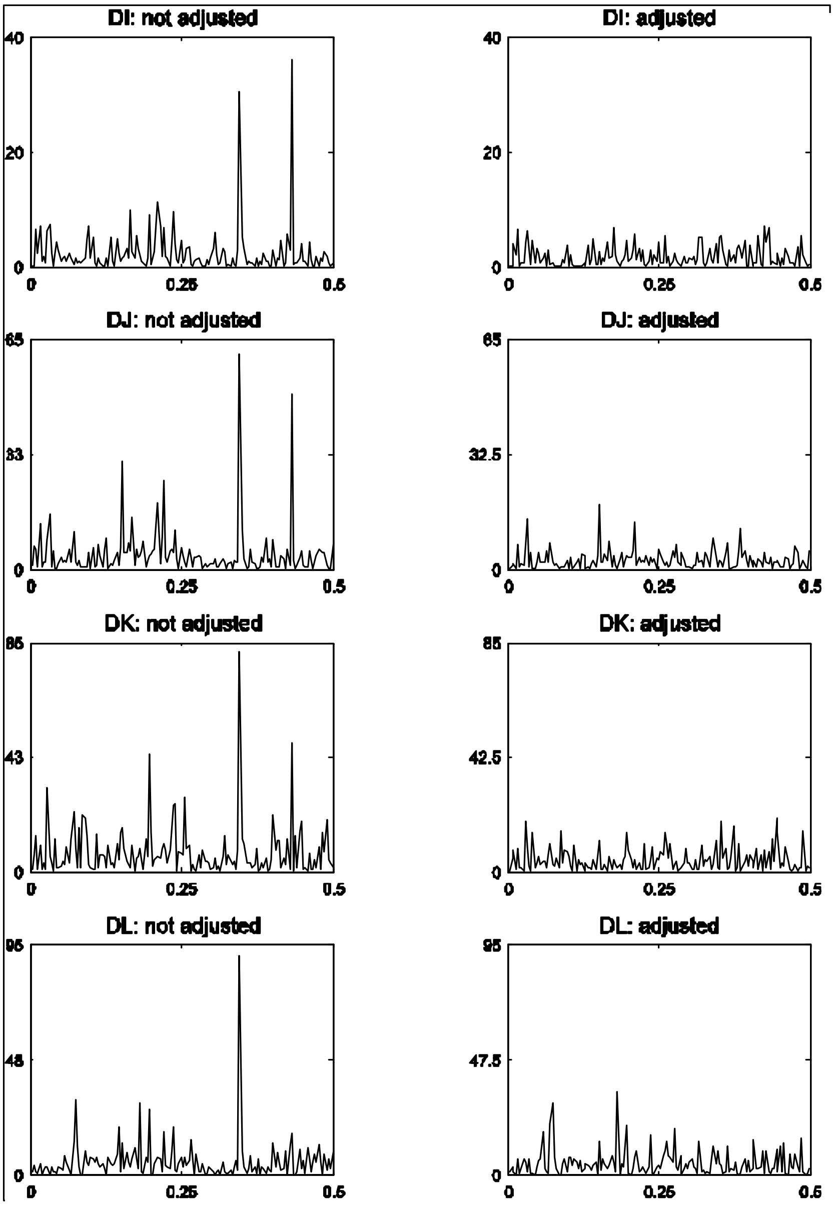

Table 1. Rolling estimates for the coefficient of the working day regressor over the period 1996.4-2003.1. Industrial production index of manufacturing sector

		Mean	Max	Min	Standard deviation	Range/ mean
1 Mining and quarring exc. energy producing mater.	?	0.6098	0.6786	0.5633	0.0019	0.1890
	t-stud	4.9184	5.6700	4.3100	0.0329	0.2765
2 Manufacture of food products; beverages and tobacco	?	0.9122	0.9661	0.8362	0.0024	0.1424
	t-stud	15.6412	18.1800	13.3100	0.1321	0.3114
3 Manufacture of textiles and textiles products	?	0.9479	1.0005	0.9096	0.0006	0.0959
	t-stud	14.3916	16.3800	12.7400	0.0882	0.2529
4 Manufacture of leather and leather products	?	1.0215	1.0433	0.9872	0.0003	0.0549
	t-stud	13.9292	15.2300	12.3800	0.0596	0.2046
5 Manufacture of wood and wood products	?	0.8295	0.8970	0.7583	0.0018	0.1672
	t-stud	11.3500	12.8400	9.7100	0.0915	0.2758
6 Manuf. of paper and paper products; publishing and printing	?	0.4732	0.5250	0.4245	0.0021	0.2124
	t-stud	8.3304	9.5800	7.2700	0.0614	0.2773
7 Manuf. of chemicals, chemicals products and man-made fibres	?	0.4191	0.4567	0.3830	0.0009	0.1759
	t-stud	8.7368	9.8100	7.7600	0.0587	0.2346
8 Manufacture of rubber and plastic products	?	0.8814	0.9170	0.8071	0.0010	0.1246
	t-stud	16.8664	19.1800	14.4900	0.1328	0.2781
9 Manufacture of other non-metallic mineral products	?	0.6672	0.6857	0.6365	0.0002	0.0738
	t-stud	15.0212	16.3000	13.4900	0.0626	0.1871
10 Manuf. of basic metals and fabric. metal products	?	0.9007	0.9284	0.8702	0.0003	0.0646
	t-stud	14.7528	16.3300	12.6100	0.0672	0.2522
11 Manufacture of machinery and equipment n.e.c.	?	0.8164	0.8636	0.7379	0.0020	0.1540
	t-stud	14.6280	16.1200	12.9300	0.0990	0.2181
12 Manufacture of electrical and optical equipment	?	0.9814	1.0012	0.9606	0.0001	0.0414
	t-stud	15.5004	16.6400	14.2300	0.0389	0.1555
13 Manufacture of transport equipment: cars	?	1.2337	1.2527	1.2105	0.0001	0.0342
	t-stud	13.4672	15.0000	11.8300	0.0904	0.2354
14 Manufacture of transport equipment: except cars	?	0.0113	0.0116	0.0106	0.0000	0.0819
	t-stud	11.2988	12.9600	9.6400	0.0927	0.2938
15 Manufacturing not elsewhere classified	?	0.9507	0.9845	0.8927	0.0007	0.0965
	t-stud	9.8932	10.4800	9.4900	0.0062	0.1001

Table 2. Working/trading day adjustment of supply side indicators

	Economic activities by industry	Frequency	Working/Trading day adjustment	Easter effect
1	Agriculture, hunting and forestry	Quarterly	___	___
2	Fishing	Quarterly	___	___
3	Mining/quarrying of energy producing materials	Monthly	___	___
4	Mining/quarrying except energy producing materials	Monthly	WD	NO
5	Manufacture of food products; beverages and tobacco	Monthly	WD	YES
6	Manufacture of textiles and textiles products	Monthly	WD	NO
7	Manufacture of leather and leather products	Monthly	WD	NO
8	Manufacture of wood and wood products	Monthly	WD	NO
9	Manufacture of paper and paper products; publishing and printing	Monthly	WD	NO
10	Manufacture of coke, refined petroleum products and nuclear fuel	Monthly	___	___
11	Manufacture of chemicals, chemicals products and man-made fibres	Monthly	WD	NO
12	Manufacture of rubber and plastic products	Monthly	WD	NO
13	Manufacture of other non-metallic mineral products	Monthly	WD	NO
14	Manufacture of basic metals and fabricated metal products	Monthly	WD	NO
15	Manufacture of machinery and equipment n.e.c.	Monthly	WD	NO
16	Manufacture of electrical and optical equipment	Monthly	WD	NO
17	Manufacture of transport equipment: cars	Monthly	WD	NO
18	Manufacture of transport equipment: except cars	Monthly	WD	NO
19	Manufacturing n.e.c.	Monthly	WD	NO
20	Electricity, gas and water supply	Monthly	WD	NO
21	Construction	Monthly	TD	NO
22	Wholesale and retail trade; repair of motor vehicles, motorcycles etc.	Quarterly	TD	YES
23	Hotels and restaurants	Quarterly	WD	YES
24	Transport and storage*	Quarterly	WD/TD	NO/ YES
25	Communication	Quarterly	TD	NO
26	Financial intermediation	Quarterly	___	___
27	Real estate, renting and business activities	Quarterly	___	___
28	Public ad ministration and defence; compulsory social security	Quarterly	___	___
29	Education	Quarterly	___	___
30	Health and social work	Quarterly	___	___
31	Other community, social and personal service activities	Quarterly	TD (part)	YES
32	Private households with employed persons	Quarterly	___	___

* To quarterly disaggregate transport sector two adjusted indicators are used

Table 3. Working/Trading day adjustment of household consumption indicators

	Consumption functions	Frequency	Working/Trading day adjustment	Easter effect
1	Food	Quarterly	TD	YES
2	Beverages and tobacco	Quarterly	TD	YES
3	Clothing and foot-ware	Quarterly	___	NO
4	Repair of clothing and foot-ware	Quarterly	___	NO
5	Housing, water, electricity, gas and other fuels	Quarterly	___	NO
6	Regular maintenance and repair of house	Quarterly	___	NO
7	Furnishings	Quarterly	___	NO
8	Household equipment	Quarterly	___	NO
9	Routine maintenance of the house	Quarterly	___	NO
10	Medical and pharmaceutical products	Quarterly	___	NO
11	Medical services	Quarterly	___	NO
12	Purchase of vehicles	Monthly	WD	NO
13	Fuels and vehicles accessories	Quarterly	WD	NO
14	Transport services and repairs of vehicles	Quarterly	TD	NO
15	Communication products	Quarterly	___	NO
16	Communication services	Quarterly	WD	NO
17	Leisure,entertainment and culture	Quarterly	___	NO
18	Non durable equipment for entertainment	Quarterly	___	NO
19	Recreational and cultural services	Quarterly	TD	YES
20	Education	Quarterly	___	NO
21	Hotels cafes and restaurants	Quarterly	TD	YES
22	Jewels and watches	Quarterly	___	NO
23	Personal effects	Quarterly	___	NO
24	Other services	Quarterly	___	NO

Table 4. Working/Trading day adjustment of gross fixed capital formation indicators

	Capital formation items	Frequency	Working/Trading day adjustment	Ester effect
1	Products of agriculture, forestry, fisheries and aquaculture	Quarterly	___	NO
2	Metal products and machinery*	Monthly	TD/WD	NO
3	Motor vehicles, trailers and semi-trailers	Monthly	WD	NO
4	Other transport equipment	Quarterly	WD	NO
5	Construction	Monthly	TD	NO
6	Other investment goods	Monthly	WD	NO
7	Maintenance and repairs services of motor vehicles	Quarterly	WD	NO
8	Software	Month/Quart	___	NO
9	Literal and artistic originals	Quarterly	___	NO
10	Mineral explorations	Quarterly	___	NO

Table 5. Working/trading day adjustment on indicators (supply-side)

Supply side indicators Reference branch	Related indicator	Freq	Mod. Log/level	Working/Trading day adjustment ? 1 (t-stud)	? 2 (t-stud)	? 3 (t-stud)	? ? (t-stud)	? ? (t-stud)	? ? (t-stud)	Easter effect ? e (t-stud)
4	Production index of mining and quarrying except energy producing materials	M	level	0.67 (5.6)						—
5	Production index of manufacture of food products; beverages and tobacco	M	level	0.88 (18.8)						-3.14 (-4.5)
6	Production index of manufacture of textiles and textiles products	M	level	0.95 (15.4)						—
7	Production index of manufacture of leather and leather products	M	level	1.04 (15.2)						—
8	Production index of manufacture of wood and wood products	M	level	0.88 (12.8)						—
9	Production index of manuf. of paper and paper prod; publishing and printing	M	level	0.53 (9.6)						—
11	Production index of manuf. of chemicals, chemicals prod. and man-made fibres	M	level	0.44 (9.7)						—
12	Production index of manufacture of rubber and plastic products	M	level	0.92 (18.1)						—
13	Production index of manufacture of other non-metallic mineral products	M	level	0.68 (16.3)						—
14	Production index of manufacture of basic metals and fabricated metal products	M	level	0.91 (16.3)						—
15	Production index of manufacture of machinery and equipment n.e.c.	M	level	0.86 (16.0)						—
16	Production index of manufacture of electrical and optical equipment	M	level	0.98 (16.6)						—
17	Production index of manufacture of transport equipment: cars	M	level	1.24 (15.0)						
18	Production index of manufacture of transport equipment: except cars	M	log*	1.16 (13.0)						
19	Production index of manufacturing n.e.c.	M	level	0.93						

				(10.3)						
20	Production index of electricity, gas and water supply	M	level	0.02 (5.2)						-0.04 (-5.7)
21	Production index of construction activities	M	level	0.15 (0.9)	0.26 (1.5)	0.25 (1.5)	-0.08 (-0.5)	0.40 (2.4)	-0.62 (-3.8)	___
24	Goods freight (in millions of euro)	M	log*	0.10 (2.4)						___
24	Railway passengers traffic (n. of passengers per kms)	M	level	0.90 (1.9)						132.69 (3.7)
24	Railway goods traffic (tons of goods per kms)	M	level	27.33 (3.1)	28.37 (3.4)	6.63 (0.8)	3.98 (0.5)	-0.04 (-0.1)	-8.72 (-1.1)	-64.86 (-3.3)
25	Turnover index of telecommunication	Q	log*	-0.05 (-0.4)	0.13 (1.0)	0.08 (0.6)	0.34 (2.4)	0.00 (0.0)	0.05 (0.4)	___
25	Turnover index of postal activities	Q	level	0.09 (1.9)						___

* Log coefficients multiplied by 100

Table 5 (follows). Working/trading day adjustment on indicators (demand-side)

Demand side indicators (household consumption) Reference function	Related indicator	Freq	Mod. Log/level	Working/Trading day adjustment ? 1 (t-stud)	? 2 (t-stud)	? 3 (t-stud)	? ? (t-stud)	? ? (t-stud)	? ? (t-stud)	Easter effect ? e (t-stud)
1	Household budget survey of food consumption	Q	log*	-0.46 (-2.6)	0.13 (0.6)	0.22 (1.0)	0.41 (2.0)	-0.08 (-0.4)	0.43 (2.2)	0.96 (2.8)
1	Turnover index of food industry	Q	log*	-0.33 (-1.6)	-0.56 (-2.3)	0.58 (2.5)	0.00 (0.0)	-0.10 (-0.4)	0.31 (1.3)	0.97 (2.8)
2	Household budget survey of corresponding beverages and tobacco consumption	Q	log*	-0.24 (-0.7)	0.69 (1.7)	-0.86 (-2.2)	0.97 (2.4)	-0.09 (-0.2)	1.17 (3.1)	1.01 (1.5)
12	New car registration	M	log*	10.5 (8.3)						___
13	Household budget survey of fuels and vehicle accessories consumption	Q	level	15.06 (1.8)						___
14	Goods and passenger traffic data for rail transport; Goods and passeng. traffic data for air transport; Motorway traffic for road transports; Employment statistics	Q	level	0.12 (0.3)	0.03 (0.1)	0.43 (1.3)	0.35 (0.7)	-0.61 (-1.8)	-1.09 (-3.2)	___
16	Turnover index of communication enterprises	Q	log*	-0.04 (1.9)						___
19	Household budget survey of recreational and cultural services consumption	Q	log*	0.81 (1.1)	-1.18 (-1.4)	-0.94 (-1.5)	1.63 (1.9)	-1.04 (-1.3)	1.90 (2.4)	4.80 (0.3)
21	Overnight says in hotels	Q	log*	-0.06 (-0.2)	0.51 (1.5)	0.36 (-1.1)	0.36 (1.0)	-1.06 (-3.0)	-0.35 (-1.0)	2.21 (3.6)

Demand side indicators (gross fixed capital formation)				Working/Trading day adjustment						Easter effect
Reference item	Related indicator	Freq	Mod. Log/level	? 1 (t-stud)	? 2 (t-stud)	? 3 (t-stud)	? ? (t-stud)	? ? (t-stud)	? ? (t-stud)	? e (t-stud)
2	Turnover index of metal products and machinery (part)	M	log*	0.03 (0.7)	0.34 (0.9)	0.34 (0.9)	0.70 (1.9)	0.60 (1.6)	-0.90 (-2.3)	—
2	Turnover index of metal products and machinery (part)	M	log*	0.53 (4.8)						—
3	New car registration, other vehicles and repairs	M	log*	0.69 (6.4)						—
5	Production index of construction activities	M	level	0.15 (0.9)	0.26 (1.5)	0.25 (1.5)	-0.08 (-0.5)	0.40 (2.4)	-0.62 (-3.8)	—
6	Turnover index of other investment goods	M	log*	0.70 (10.8)						—

* Log coefficients multiplied by 100

Table 6. Working/Trading day adjusted Gross Domestic Product: millions of euro constant prices (1995=100) and growth rates

years	Unadjusted GDP	Adjusted GDP	Working days	Unadjusted GDP: growth rates	Adjusted GDP: growth rates	Working Days (difference)
1980	692.772	692.806	253	-	-	-
1981	698.182	697.462	256	0,8	0,7	3
1982	702.588	701.800	257	0,6	0,6	1
1983	711.275	711.426	254	1,2	1,4	-3
1984	730.894	731.063	254	2,8	2,8	0
1985	752.636	752.564	253	3,0	2,9	-1
1986	771.646	771.859	251	2,5	2,6	-2
1987	794.679	794.228	255	3,0	2,9	4
1988	826.059	826.433	253	3,9	4,1	-2
1989	849.780	850.301	251	2,9	2,9	-2
1990	866.555	866.479	253	2,0	1,9	2
1991	878.602	878.578	253	1,4	1,4	0
1992	885.284	884.716	256	0,8	0,7	3
1993	877.460	876.934	256	-0,9	-0,9	0
1994	896.830	897.098	253	2,2	2,3	-3
1995	923.052	923.571	251	2,9	3,0	-2
1996	933.142	932.964	254	1,1	1,0	3
1997	952.050	952.065	252	2,0	2,0	-2
1998	969.130	968.682	255	1,8	1,7	3
1999	985.253	984.678	256	1,7	1,7	1
2000	1.016.192	1.017.080	251	3,1	3,3	-5
2001	1.034.549	1.034.492	253	1,8	1,7	2
2002	1.038.394	1.038.405	253	0,4	0,4	0

Table 7. Working/Trading days effects on uses and resources account: constant prices seasonal adjusted data, quarter on quarter growth rates

quarter	WD (difference)	Easter	Gross Domestic Product		Household consumption		Gross Fixed Capital Formation	
			adjusted	unadjusted	adjusted	unadjusted	adjusted	unadjusted
2000 I	0		1,1	1,1	1,1	1,0	3,7	4,1
2000 II	-2	*	0,5	0,5	0,8	1,2	1,3	0,6
2000 III	2		0,6	0,6	0,7	0,5	1,1	0,9
2000 IV	-3		0,8	0,6	0,3	0,3	-0,9	-1,3
2001 I	3		0,7	1,1	0,6	0,6	3,0	4,4
2001 II	-2	*	0,0	-0,1	-0,1	0,1	-0,7	-1,1
2001 III	2		0,0	0,0	-0,5	-0,7	-0,6	-1,1
2001 IV	-1		-0,1	0,0	-0,2	-0,1	0,2	0,4
2002 I	0	*	0,0	0,0	-0,2	0,0	-0,8	-0,6
2002 II	-1		0,3	0,2	0,7	0,4	-0,4	-0,7
2002 III	3		0,1	0,3	0,5	0,7	2,3	2,6
2002 IV	-2		0,4	0,3	0,8	0,7	3,7	3,3
2003 I	-1		-0,1	-0,1	0,0	-0,2	-5,0	-4,9

Table 8. Working/Trading days effects on value added: constant prices seasonal adjusted data, quarter on quarter growth rates

quarter	WD (difference)	Easter	Manufacturing and Energy		Construction		Wholesale and retail trade, hotels and rest., tranport and communications		Other services	
			adjusted	unadjusted	adjusted	unadjusted	adjusted	unadjusted	adjusted	unadjusted
2000 I	0		1.3	1.3	2.2	2.3	2.5	2.4	0.1	0.2
2000 II	-2	*	0.0	-0.4	-0.1	-0.5	0.9	1.2	0.1	0.2
2000 III	2		0.1	0.0	0.3	0.3	1.4	1.2	0.8	0.8
2000 IV	-3		0.9	0.5	-1.0	-1.2	1.1	1.0	1.3	1.2
2001 I	3		0.6	1.8	4.2	4.8	1.1	1.2	0.5	0.5
2001 II	-2	*	-0.9	-1.4	-0.2	-0.5	0.1	0.2	-0.2	-0.2
2001 III	2		0.0	-0.1	0.6	0.5	-0.3	-0.5	-0.4	-0.4
2001 IV	-1		-0.4	-0.3	0.8	1.1	0.0	0.1	0.8	0.9
2002 I	0	*	0.2	0.3	-0.3	-0.5	-0.6	-0.5	0.4	0.3
2002 II	-1		-0.7	-0.8	-1.8	-1.7	0.8	0.5	0.7	0.7
2002 III	3		0.0	0.5	1.9	2.1	-0.3	-0.1	0.6	0.6
2002 IV	-2		0.1	-0.3	1.6	1.5	0.3	0.3	0.7	0.8
2003 I	-1		-0.3	-0.4	-0.1	-0.3	0.1	-0.1	-0.2	-0.2

Table 9. Some measures on working day adjustment of Gross Domestic Product (GDP), Households Consumption (HC) and Gross Fixed Capital Formation (GFCF) over the period 1980q1-2003q1

	GDP		HC		GFCF	
Average effect per day	0.07	(0.08)	0.08	(0.09)	0.16	(0.21)
Linear correlation days-adjustment	-0.8036		-0.1548		-0.4238	
Concordance days-adjustment	-0.5752		-0.1284		-0.3706	
Average adjustment in levels (standard deviation)	205	(261)	115	(141)	91	(124)
Maximum adjustment in levels (quarter)	705	(1995q4)	353	(1995q2)	362	(2001q1)
Average adjustment in fourth quarter growth rates (standard deviation)	0.1	(0.1)	0.1	(0.2)	0.3	(0.4)

ANNEX 1
Temporal disaggregation technique used for Italian QNA

The Italian quarterly national accounts are compiled through the decomposition of annual aggregates by means of related quarterly indicators. Such estimates are mainly derived following the method of interpolation proposed by Chow and Lin(1971) in the version presented in Barbone et al. (1981).

The approach is based on the estimation of a generalised least squares regression between aggregates and indicators on an annual basis; the properties of such a model are then used to estimate the unknown quarterly pattern of the national aggregates of interests.

Let Y_t be a *N* x *1* vector of annual observed data, consisting of a sum or a mean of quarterly figures $y_{t,q}$. It is assumed that the following model between $y_{t,q}$ and $\mathbf{x}_{t,q}$, a *4N x k* matrix of quarterly variables, is true

$$y_{t,q} = \mathbf{x}_{t,q}'\text{ß} + u_t \qquad (1)$$

Obviously, the matrix $\mathbf{x}_{t,q}$ may include related economic indicators, trend variables, dummy variables or simply an intercept.

The main hypothesis on model (1) is the presence of a first-order autoregressive structure in the error

$$u_t = r u_{t-1} + e_t$$

with $E(e_t) = 0$ and $E(e_t^2) = s_e^2$.

The covariance matrix *V* is then given by

$$Cov(u) = V = s_u^2 \begin{bmatrix} 1 & r & r^2 & \cdots & r^{n-1} \\ r & 1 & r & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r^{n-1} & \cdots & \cdots & \cdots & 1 \end{bmatrix}.$$

Model (1) cannot be estimated, given that $y_{t,q}$ is not available. Making use of *B*, a *N x 4N* matrix

$$B = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & \cdots & \cdots & \cdots & \cdots & 0 & 0 & 1 & 1 & 1 & 1 \end{bmatrix},$$

the relationship becomes

$$By_{t,q} = B\mathbf{x}_{t,q}\text{ß} + Bu_t$$

$$Y_t = X_t'\text{ß} + U_t \qquad (2)$$

An efficient estimate of ß vector in (2) is obtained through the GLS estimator

$$\text{ß} = \left(X'\tilde{V}X\right)X'\tilde{V}^{-1}X \qquad (3)$$

where $Cov(U_t) = \tilde{V} = BVB'$.

The quarterly series $y_{t,q}$ is then interpolated using the formula

$$y_{t,q} = X_t{}'\hat{ß} + \tilde{V}B'\left(B\tilde{V}B'\right)\left(Y_t - BX_t{}'\hat{ß}\right) \qquad (4)$$

The first term in (4) represents an "unadjusted" estimate of $y_{t,q}$ while the second term smoothes the forecasting error in (2) for each year over the corresponding quarters, taking into account the autoregressive structure imposed on quarterly errors.

The main problem in the process of estimation of (2) is that V is unknown, because the autoregressive coefficient r is unknown. It is possible to obtain a maximum likelihood estimator of r assuming the normality for the error e_t. Hence, the likelihood is equal to

$$L = -U'\tilde{V}^{-1}U \ ,$$

and the set of estimates ($\hat{ß}; \hat{r}$) for which L is maximum provides their *ML* estimators.

The maximization of L is performed through a numerical procedure that scans the value for r between the grid [-1:+1].

One of the most important advantages of the Chow and Lin technique is the possibility of extrapolation of a quarterly series when the current annual figure is not yet available. Following model (1), we have

$$\hat{Y}_{t+1} = X_{t+1}{}'\hat{ß} + U_{t+1} = X_{t+1}{}'\hat{ß} + \hat{r}U_t \qquad (5)$$

Using the relationship

$$\hat{u}_{t,q} = \frac{\hat{r}^3 U_t}{\left(1 + \hat{r} + \hat{r}^2 + \hat{r}3\right)}$$

(5) can be written as

$$\hat{Y}_{t+i} = X_{t+i}{}'\hat{ß} + \hat{r}^i \frac{\hat{r}^3 U_t}{\left(1 + \hat{r} + \hat{r}^2 + \hat{r}^3\right)} \qquad (6)$$

with i=1,2,3,4

For more details on the approach, refer to Barbone, Bodo and Visco (1981).