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SEASONAL ADJUSTMENT OF QUARTERLY GDP

Note by the OECD Secretariat

INTRODUCTION

1. Since national accounts can be constructed with varying degrees of detail and disaggregation, it is important to identify the elements which are most important for macro-economic policy formulation and monitoring. In OECD Member countries, one of the first requirements of macro-economic policy-makers is quarterly estimates of GDP on a seasonally adjusted basis, broken down by the components of expenditure, in constant prices. One of the main reasons that policy-makers prefer adjusted data is that they allow much quicker identification of economic turning points. With unadjusted data, changes in trend can only be estimated using 12 month comparisons, such as comparing the rise (or fall) in output in the latest quarter with the rise/fall in the same quarter in the previous year. Twelve month comparisons are likely to result in turning points being detected on average some six months late.

2. The aim of this short paper is first, to introduce some of the more practical decisions which need to be addressed before publishing seasonally adjusted GDP estimates (the mechanics of seasonal adjustment packages are not described in this paper). Second, to illustrate the usefulness of seasonal adjusted data for detecting economic turning points, using an example from the Baltic countries.

PRACTICAL AND PRESENTATIONAL ISSUES

3. Before starting to seasonally adjust quarterly GDP, the following questions must be addressed:

- What **length** of time series is needed for adjustment?
- Should totals be obtained as the sum of adjusted components, or should they be adjusted directly even though the result may not be consistent with the sum of the adjusted components? In other words, should totals be obtained via **indirect or direct** adjustment?
- Should the annual sum of seasonally adjusted data be forced to equal the sum of unadjusted data, i.e**.** should **time consistency** be preserved?
- Should **balancing items** be adjusted directly or derived residually?
- Should the relationships between current price values, price indices and volumes be preserved?
- How should **revisions** of adjusted data be handled?
- What should the publication policy be for seasonally adjusted data?
- How should the data be **pre-adjusted** prior to seasonal adjustment to take account of irregular effects?

Length of time series

4. The generally accepted minimum length of time series required for seasonal adjustment by different models are:

- five times the length of the seasonal pattern for the main frame versions of X11 and X11-ARIMA;
- three times the length of the seasonal pattern for the PC versions of X11-ARIMA and X12-ARIMA.

5. Of course, the minimum length depends on the stability of the seasonality, the magnitude of irregular and calendar effects, i.e. longer series are required to better adjust for trading days and moving holidays, outliers, breaks and special events. Even for very short series it might, however, be possible to make some very summary adjustments for seasonality in the main aggregates, possibly by calculating retrospective quarterly data for a few years (backcasting).

6. Increasing the length of the time series will generally increase the accuracy of estimation, but not necessarily in direct proportion to the amount of data. One of the problems with particularly long time series is that frequently the pattern changes with time and using a longer time span may in fact give less accurate results than using only the minimum number of data necessary.

Direct or indirect adjustment

7. GDP is usually published decomposed (disaggregated) into its elements, in a variety of dimensions, e.g. by expenditure category, by activity, by sector, by geographical region, etc. Since users will require adjusted series of both the elements and the totals (for each dimension), decisions will have to be made about whether adjusted totals should be derived by summing the adjusted elements (indirect adjustment), or by adjusting the total directly. Seasonally adjusting each of the elements and then summing the adjusted series is unlikely to give the same result as adjusting the total directly, i.e. the consistency in aggregation is lost.

8. Eurostat recommends that "in principle the direct method is preferable, since the seasonally adjusted series of the totals …… is of a higher quality. [However]…… the consistency requirements of users may be so strong as to oblige the use of the indirect method ".

9. Direct adjustment produces better adjustment of aggregate series because aggregation often reduces the irregular component which, at a detailed level, may be too strong for good seasonal adjustment. This may be particularly true for small countries where irregular events have a large effect on the data. Consistency in aggregation can be achieved, either by using indirect adjustment, or, by using directly adjusted series and distributing the discrepancy over the adjusted elements using a suitable criterion for distribution. However, forcing the seasonally adjusted estimates to obey accounting identities may introduce errors to the adjusted data.

10. It is possible to assess whether the discrepancy between the directly and indirectly adjusted totals is significant. This is done by comparing the smoothness of the adjusted series, where the smoothness can be quantified using two different measures:

- R1 is based on the sum of squares of the first differences;
- R2 as the sum of squares between the series and the associated trend obtained via the Henderson filter.

The R2 measure is preferred to R1 for composite series which are strongly affected by short-term variations.

Time consistency

11. Annual totals (or averages) based on seasonally adjusted data will not automatically be equal to the corresponding totals based on the original data, and in fact, would not be expected to be equal since the number of trading days and the moving holidays vary from year to year, and the treatment of outliers will have an effect. In general the differences are small, but adjustments for trading day and moving holiday effects can lead to larger differences. Users often require that the seasonally adjusted totals are consistent with original totals, since seasonal adjustment is assumed to distribute the effects of seasonality within the year. So, most adjustment software has an option for imposing time consistency. However, it is important to realise that forcing consistency can lower the quality of the adjusted series, and in many cases it would be better to educate users to accept data are that are time inconsistent.

Balancing items

12. For balancing items such as value added, seasonally adjusted estimates can be derived either by seasonally adjusting the balancing item directly, or, indirectly as the balance of seasonally adjusted components (output and intermediate consumption). As expected, the two approaches are likely to give different results, and the choice of approach should be made on a case by case basis, depending on which gives the more reasonable results. Indirect adjustment will, of course, preserve accounting consistency which is convenient for users, although it should be noted that for volume data (and price indices) this consistency will already be lost where chain-linking (or different base periods) has been used.

Consistency between value, volume and price

13. As for balancing items and aggregates, seasonally adjusted estimates for current price values, volume data and price indices can be derived either by adjusting the three series independently (directly), or, by adjusting two of them and deriving the third as a residual (indirectly). Preserving the relationships is convenient for users, so it is reasonable to derive one of the components indirectly, and choosing which one is derived should be decided on a case by case basis, to give the most reasonable result.

Revisions

14. To what extent should the seasonal adjustment model be re-estimated each quarter, and to what extent should any resulting changes to previously adjusted data be adopted as revisions? In terms of methodological accuracy it is preferable to revise all estimates whenever a new data point becomes available, i.e. each quarter. But in terms of users' needs, revisions are usually seen as a problem and to be avoided. Users will be concerned about the size of the revisions, the frequency of revision and how many data points they affect (how far back in time they stretch – this is affected by the number of moving average terms). Thus, a balance is needed between improving preliminary estimates, and publishing data which are stable over time.

15. In order to discuss the options for revisions, some understanding of moving averages is required. When using moving averages with symmetrical weights, the series needs to be extended by half the moving average length (X12 extends by one year). This produces more accurate decomposition (into trend, seasonality and irregular components) of the data points at the extremes of the series, which in turn means that the seasonally adjusted series is less prone to revisions as new data become available. Thus, to obtain the best forecasts, the model is re-estimated each quarter, as a new data point becomes available. The general scheme can be summarised as:

		A		B		C		D
New data point	➔	forecasting model re-estimated	➔	forecast data recalculated	➔	seasonal factors re-estimated	➔	earlier data re-adjusted

So, there are various options for re-estimating the adjustment model each quarter varying in the amount of re-estimation performed each quarter and consequently varying in the extent of quarterly revisions (in ascending order of likely size of revisions):

a. Forecast the seasonal factors, using a weighted average of previous factors. The seasonal factors remain fixed for the current year and thus there are no re-calculations or revisions until the end of the year when all models and factors are updated. This has been the traditional practice in many countries where seasonal adjustment models were run at the end or start of each calendar year, to give projected seasonal factors which were then used to seasonally adjust each new monthly or quarterly observation. This practice was necessary because of constraints on computer resources, but is dying out with the advent of powerful PCs.

b. Each quarter, recalculate forecast data, re-estimate seasonal factors and apply them, i.e. perform steps B, C and D, but not A. This results in revisions to earlier data each quarter;

c. Each quarter, go one step further than b, and re-estimate the forecasting model, i.e. A, B, C and D;

d. Go one step further still, and each quarter re-assess all models and options, including treatment of outliers and other irregular components. This is called concurrent adjustment.

Option d can lead to large, volatile revisions each quarter, which is generally not acceptable to users and may not add to the analytical usefulness of the adjustment. Options b and c are both reasonable approaches, but Eurostat recommends b as the revisions each quarter are usually smaller. Of course, smaller revisions each quarter often leads to larger revisions when the models are eventually re-estimated, but users are often more tolerant of larger annual, rather than quarterly, revisions.

Publication policy

16. The general policy in OECD countries is to publish both original and seasonally adjusted data for each series. Some countries treat the seasonally adjusted data as secondary to the unadjusted data, i.e. presenting them as additional to the original data and in the form of charts only. Others publish full sets of accounts, seasonally adjusted, in current and constant prices, with the original data presented as being supplementary. Adjusted and original data may be presented as levels, indices, quarter to quarter rates of change, or annualised rates.

17. Whether to present seasonally adjusted data or estimates of the trend-cycle component is the subject of debate. The IMF recommends publishing both, preferably including the form of a common graph which shows the development in the two series over time. The trend estimate for the most recent period may be suppressed as it is subject to the most severe revisions.

Pre-adjustment of data

18. Various adjustments can be made to the data prior to seasonal adjustment to optimise the estimation of seasonal factors. Many of these pre-adjustments are concerned with irregular effects.

Calendar related adjustments

19. Many monthly time series contain variations which result from the weekly/monthly cycle in the daily data. Such variations include:

- different lengths of months;
- number of Saturdays and Sundays in a month;
- official holidays and regional official holidays;
- differences in the importance of different working days (e.g. retail sales might be higher on Fridays than other weekdays) – often referred to as trading day adjustment affecting retail sales series, or working day adjustment for production data. The adjustment is made by finding the average number of each working days for each period in the series and adjusting the raw data to a standard period.

20. Variation due to moving holidays (e.g. Easter, Ramadan) is not corrected for in the calendar adjustment, but can be treated using the RegARIMA part of X12-ARIMA, which allows the user to provide a set of user-defined variables. The correction is performed by use of both external and internal evidence, i.e. usually derived from the irregular factors computed in the seasonal adjustment process.

Outlier adjustment

21. Variations due to special events, e.g. the effect of a severe strike, should be adjusted for in order not to interfere with the estimation of the seasonal factors performed in the next step.

22. In addition, the X12-ARIMA program can identify and correct the following types of outliers:

- additive outliers, which affect only one observation in the time series;
- level shifts, which increase or decrease all observations from a point in time onward by some constant amount, e.g. step change in CPI due to change in VAT;
- temporary ramps, similar to a step change but the change takes place over a number of periods, not a single period.

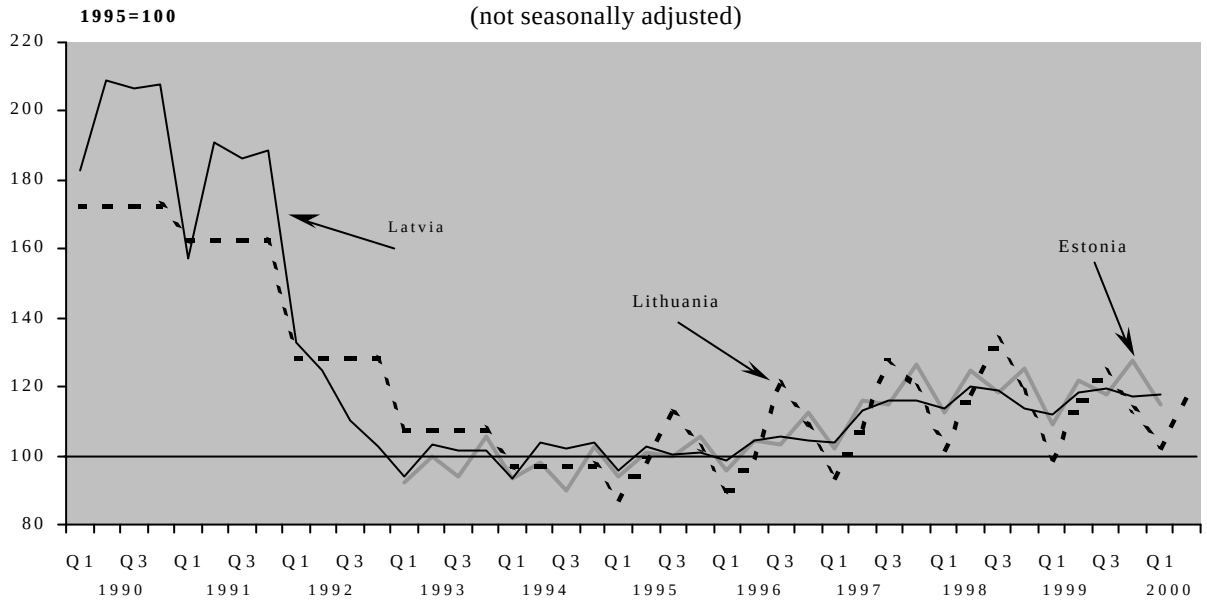
Some management considerations

- Balancing and reconciling the accounts are best done using original (unadjusted) data;
- Seasonal adjustment should be done after the original data have been compiled, and both should be presented to users;
- Unstable series with a strong irregular component (outliers, breaks, level shifts) are difficult to adjust. Expertise and experience are needed for these. However, many series are well-behaved and can be adjusted perfectly well without a great deal of experience;
- National accounts compilers should be responsible for adjusting their data – perhaps in association with specialists who have experience in dealing with difficult series.

IDENTIFYING TURNING POINTS – THE BALTIC EXAMPLE

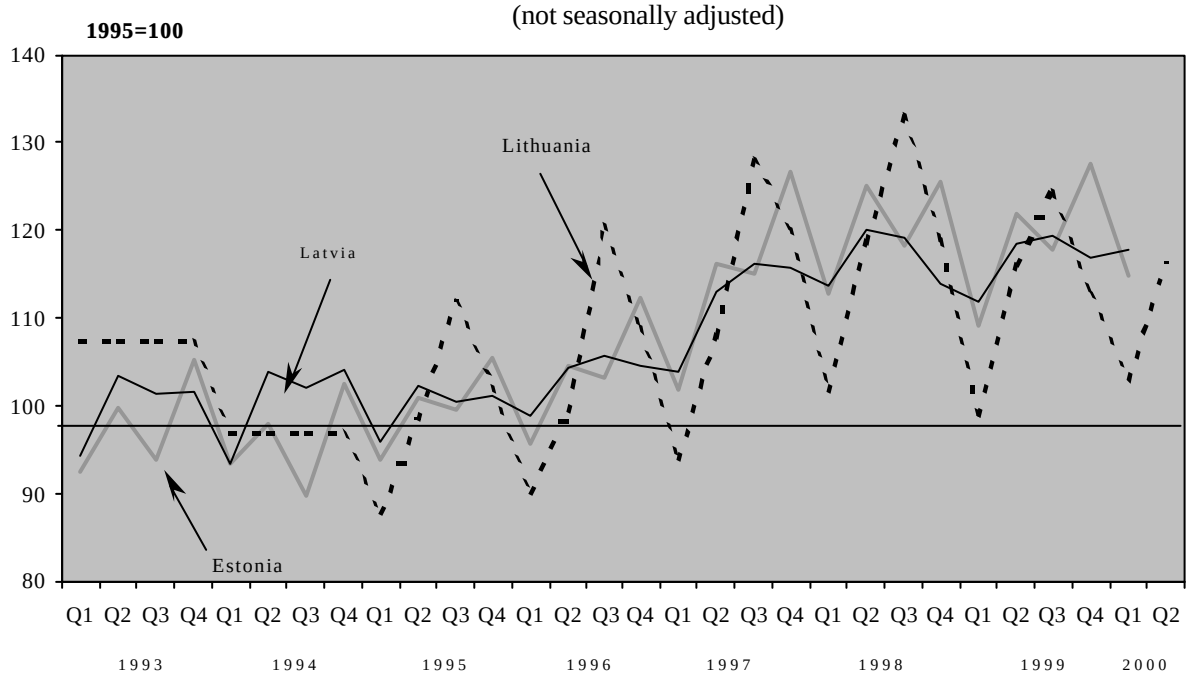
23. Chart 1 illustrates the extent of the economic changes in the Baltic countries over the past ten years – the dramatic fall in output in 1991-92, zero growth during 1993-94 and the return to positive growth in 1995.

Chart 1: Total GDP at constant prices 1990-2000



24. Chart 2 (below) focuses on the period 1993-2000, allowing closer examination of the seasonal pattern in total GDP in the three countries. It is interesting to note that Latvian GDP follows a much smoother path than Estonian, which in turn has a much less pronounced pattern (smaller amplitude) than the Lithuanian data. This is due, in part, to the differing importance of agriculture in each economy, combined with the different method used to account for agriculture in Latvia compared to the other countries.

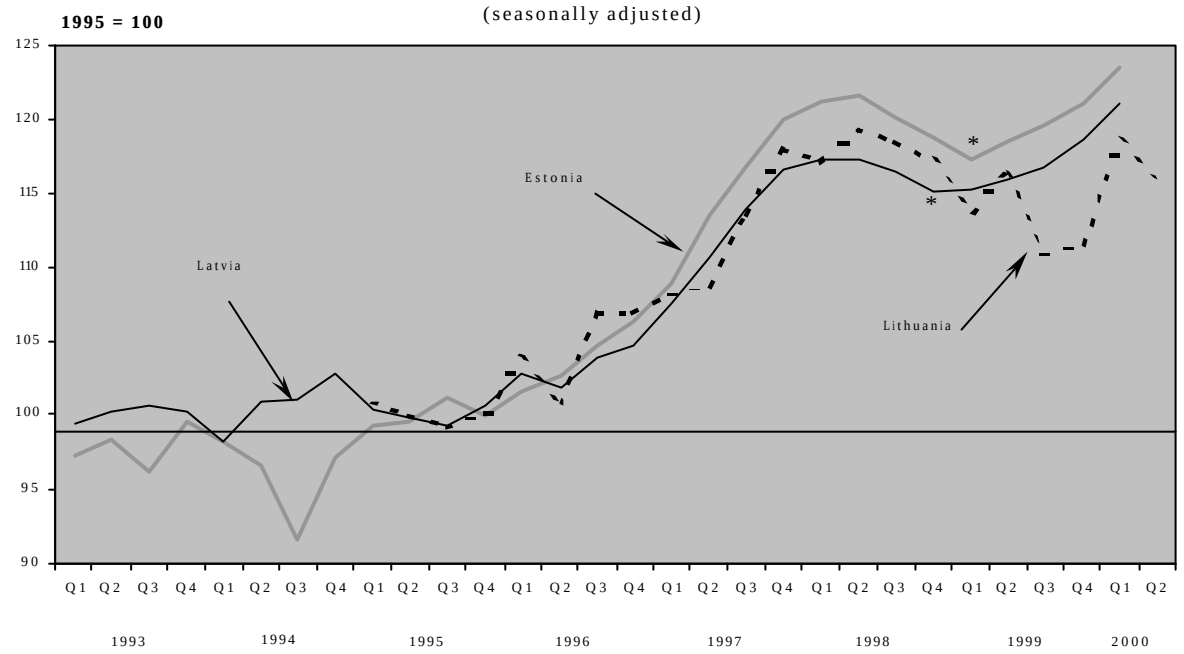
Chart 2: Total GDP at constant prices 1993-2000



25. A similar presentation for 1993-2000 is given in Chart 3, but using seasonally adjusted data. This allows a clearer analysis of trend, and clearly shows the strong growth during 1996-97, followed by a slowing down and contraction in output in 1998 associated with the Russian crisis.

26. Please note that data used in this paper have been seasonally adjusted by the OECD using X-12 ARIMA. Country practices are as follows. In Estonia seasonally adjusted total GDP at current and constant prices is published quarterly, seasonally adjusted series, from 1993, by activity (NACE 16), and institutional sector is published annually. Latvia and Lithuania are both developing their seasonal adjustment systems (using TRAMO/SEATS, in line with Eurostat guidelines), and in January 2001 Latvia published the first results, i.e. seasonally adjusted output and gross value added, by activity, in graphical form only. Lithuania is planning to publish first results later in 2001.

Chart 3: Total GDP at constant prices 1993-2000



27. This is a good illustration of the value of seasonally adjusted quarterly data – the turning points in trends are much more clearly revealed than in Charts 1 and 2. For example, chart 3 shows troughs, or turning points (*), preceding a recovery in growth, for Latvia in Q4 1998 and in Q1 1999 for Estonia. This is not so clearly seen in the Lithuanian data as the adjusted series is not so smooth (due to a combination of factors – a shorter time series, more pronounced seasonality, and poor harvest in 1999).

28. When quarterly (or any sub-annual) data are not seasonally adjusted, and the seasonal pattern is sufficiently pronounced to obscure changes in trend in the most recent periods, the usual solution is to compare the current period (t) estimate with the estimate of the same period in the previous year (t-4 for quarterly data, t-12 for monthly data). The resulting annual change (growth rate) will detect turning points in trend with a lag of six months, on average. By far the best way to monitor trends is to make comparisons with the previous period using seasonally adjusted data.

29. Diagrams 4 – 6 show, for each quarter, the change in adjusted data over the previous quarter (quarterly growth rate) as white bars, and the change in unadjusted data over the same quarter of the previous year (12 month growth rate) as black bars. Looking again at the trough in Latvia's GDP growth in Q4 1998 (chart 3), chart 5 shows that in Q1 1999, quarter on quarter growth for Latvia switched from being negative to positive, i.e. an upturn was signalled, consistent with the picture suggested by chart 3. Chart 5 shows that the annual rate in this quarter was strongly negative, however, giving no indication of recovery. Annual rates did become a little less negative in Q2 but did not actually indicate growth until Q3 1999. In other words, using annual changes only, recovery would be detected in Q3 1999, whereas quarter to quarter changes would have signalled recovery as early as Q1 1999. The Estonian data provide a similar illustration.

SOURCES

Seasonal Adjustment of Industrial Production Series in Transition Countries in Central and Eastern Europe and the Russian Federation (1997) – OECD.

Handbook on Quarterly National Accounts (1999) – Eurostat.

Handbook on Quarterly National Accounts Compilation (**Draft**) – IMF.

Chart 4 ESTONIA

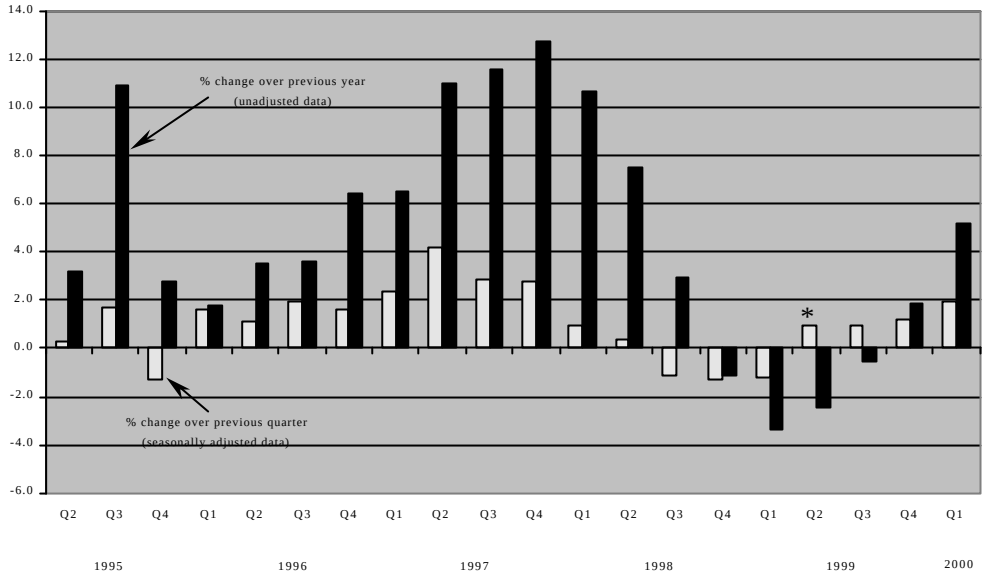


Chart 5 LATVIA

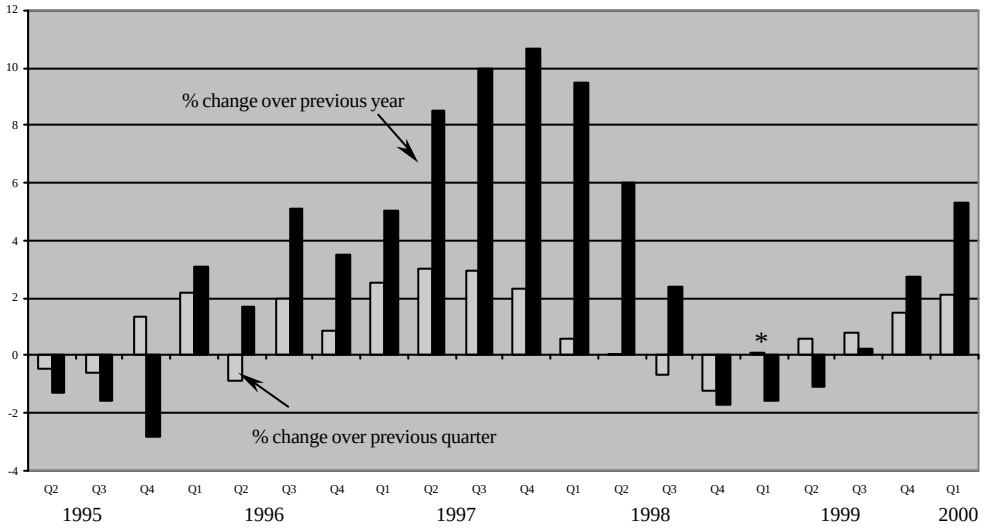
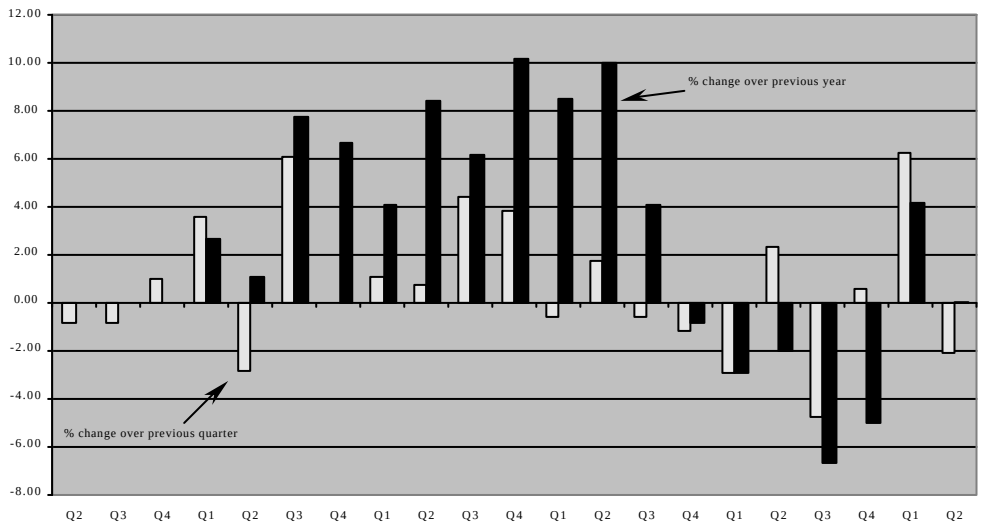


Chart 6 LITHUANIA



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