ALTERNATIVE SEASONAL ADJUSTMENT METHODS FOR AGGREGATE IRISH MACROECONOMIC DATA

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1. Introduction

Three distinct strands can be identified in the literature on seasonality. Economists have long been interested in removing high-frequency 'noise' from individual economic time series, or 'de-seasonalising the data' in common parlance. The second strand, on which an extensive technical literature has been developed over recent decades, treats seasonality as just one element to be encompassed in multivariate dynamic time series modelling, while a final strand seeks to model the economics of seasonality as the outcome of maximising behaviour by producing and consuming agents. See Brendstrup *et al.* (2002).

Official statistical agencies around the world typically publish all main monthly and quarterly economic series in both primitive and seasonally-adjusted form, removing the high-frequency noise in the spirit of the first of the three strands. Sophisticated models and software packages have been developed to accomplish this task, the best-known of which are the empirical US Census Bureau's X-11 package and its derivatives, and the model-based Tramo-Seats

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routines, developed by the Bank of Spain. Both are widely used by official agencies.

Aggregate economic time-series like GDP or industrial output can be deseasonalised by direct application of a seasonal adjustment procedure to the aggregate data. Alternatively the component series can be seasonally adjusted one by one and summed to give an estimate of the aggregate seasonally adjusted series. The two methods are called the direct and indirect methods respectively. In Ireland, the Central Statistics Office has been producing quarterly national accounts since Q1 1997, and seasonally adjusted data have been furnished since Q2 2003. The Central Statistics Office (CSO) has been preparing seasonal factors for the macro data using the direct method, and also publishes seasonally adjusted estimates for the sub-aggregates. In this paper, we will show that estimates using the indirect method (which are just the sums of the adjusted data for the sub-aggregates as published by the CSO) give radically different results in many cases. This is particularly noticeable where the seasonal adjustment is used to facilitate calculation of the underlying rate of growth. We show that the direct method often indicates one-period growth where the indirect alternative shows decline and vice versa. They will not give coincident estimates of the aggregate series except in special (and empirically infrequent) cases.

Thus if

$$Y = C + I + G,$$

and the seasonally adjusted series are denoted with an asterisk, the accounting identity in deseasonalised form

$$Y^* = C^* + I^* + G^*$$

will not hold in general, and a choice has to be made. The *direct* estimate Y^* can be used, obtained through the application of the seasonal adjustment procedure directly to Y, or the sum $C^* + I^* + G^*$ can be used as the estimate of the deseasonalised aggregate, the *indirect* estimate.

There are two difficulties with the direct method. It will not, except in a special case, deliver consistent aggregation. In a quarterly macro model for example, the budget constraints and national accounting identities will be breached if all series, including the aggregates, are seasonally adjusted independently. (It is worth noting that, from Q1 2005, the CSO has moved from a fixed to a chain-linked methodology for the constant-price national accounts, and the application of chain-linking independently to the aggregate series also sacrifices consistent aggregation.) With direct seasonal adjustment, it can also happen that each (seasonally-adjusted) sub-component shows a decline in a particular month or quarter, but the aggregate rises according to the direct estimate. Additionally, there are grounds for expecting that the direct method will not deliver a satisfactory seasonal adjustment in many circumstances. But in a particular instance, it is possible that the two methods will deliver near-identical estimates of the seasonally adjusted aggregates. If all the component series have a similar additive seasonal pattern, the

best direct estimate of the aggregate will also be additive and the direct and indirect estimates will coincide. If the components have almost-additive patterns, the alternative adjustments for the aggregate should come close to coinciding, and such results have been reported. See Cabrero (2000), who finds generally small differences between direct and indirect adjustments for Spanish monetary aggregates, or Atuk and Ural (2002), who draw similar conclusions for Turkish monetary data.

But seasonal adjustment using standard packages such as X-12 or Tramo-Seats is in general a nonlinear transformation (even if the filter is linear) and will accordingly violate adding-up constraints, and may also yield very different deseasonalisations of aggregates as between direct and indirect adjustments. Results have been reported where the direct and indirect estimates differ significantly, for example Maravall (2002) on Japanese trade data. Intuitively, if the components of an aggregate have very different seasonal patterns (and they often will: the change in inventories, a GDP component, can hardly be expected to follow the seasonal pattern of investment, or consumption), the indirect method ought to be superior, since the direct approach, in these circumstances, is operating on an aggregate whose seasonal behaviour is a mish-mash of heterogeneous components. The number of sub-aggregates will typically be small, so reliance on some Central Limit Theorem notions about well-behaved aggregates is not appropriate. While there appear to be no definitive theoretical or Monte Carlo results pointing to the superiority of either method, most national statistical offices favour the indirect method, as does Eurostat. See Planas and Campolongo (2003), who conclude

> …*when series have similar patterns, direct adjustment is more accurate*…, but they continue
>
> …*when series have dissimilar patterns, indirect adjustment is more accurate than direct adjustment, both for final and revision errors and regardless whether the adjustment is model-based or X11-based.*

Simple linear structures for the filter applied to the component series, which can be shown to imply coincidence of the direct and indirect estimates where all component filters have the same lag length, are not frequently encountered. The UK's Government Statistical Service (1996) found, in a trawl of UK agencies conducting seasonal adjustment, mainly using variants of X-11, that 949 out of 1,463 monthly series had multiplicative patterns, and so did 1,621 out of 2,464 quarterly series.

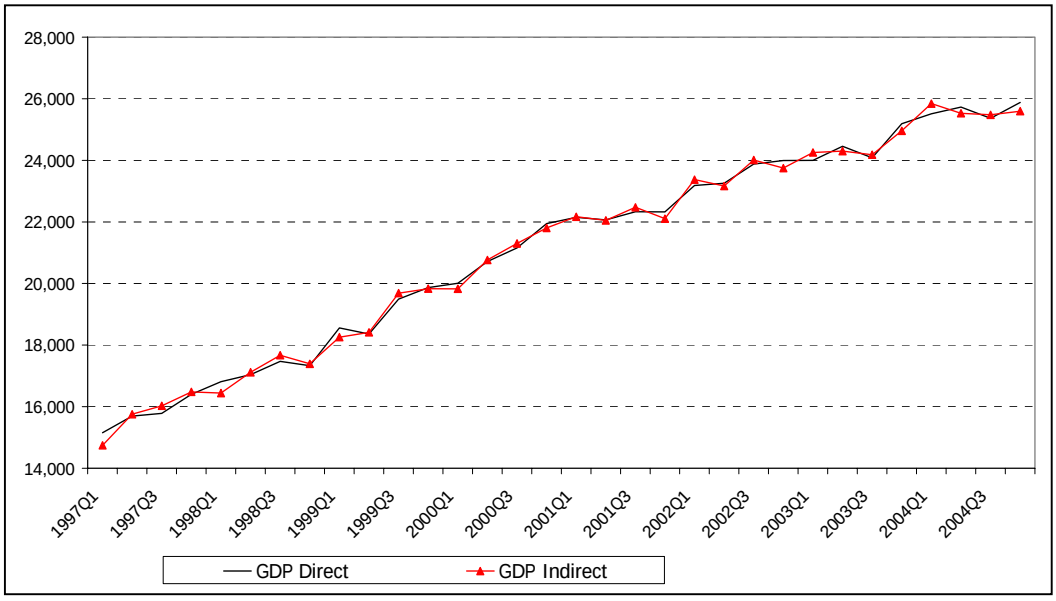
As with the quarterly macro aggregates, the CSO also uses the direct method for monthly series such as the Retail Sales Index and the Industrial Production Index. The construction of these aggregates is more complex than is the case with the national accounts, but it appears that direct and indirect seasonal adjustment methods also give materially different answers, in some cases, for these important monthly data.

For the national accounts, and also for retail sales and industrial production, it is clear that the sub-aggregates do not share what Planas and Campolongo call 'similar patterns'. While it is not possible to argue that the Irish CSO's use of the direct method will be inferior in all cases, the technical literature supports a presumption that this will be the case, and we conclude that consideration should be given to a change of methodology for the seasonal adjustment of the key aggregate series.

2. Quarterly National Accounts

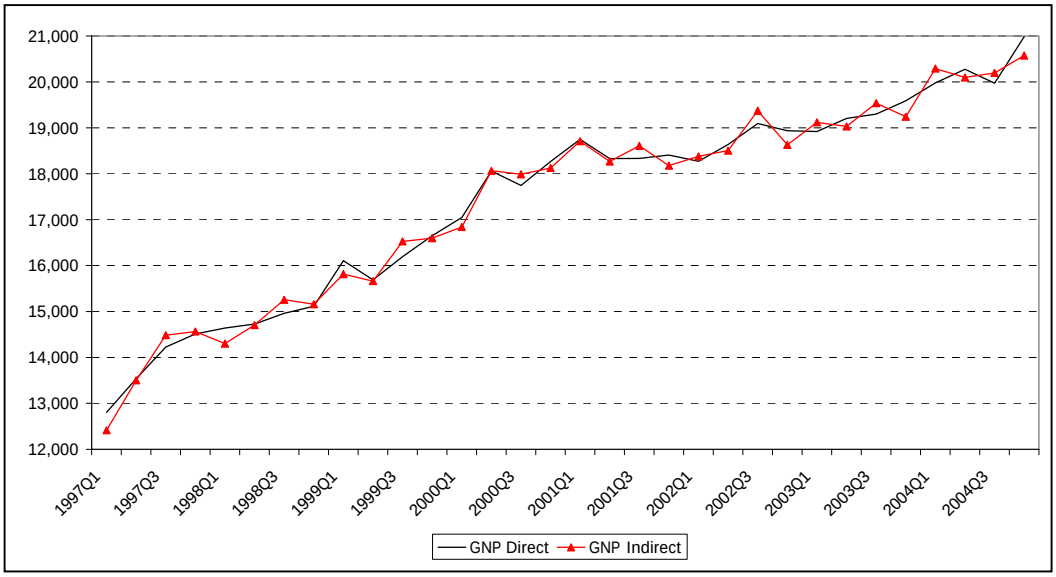
The quarterly National Income and Expenditure data for Ireland is still quite a short series, commencing in Q1 1997. In this paper, we have studied the data up to Q4 2004 (32 observations). Because of the short data-run, the CSO re-estimates the SA factors with each new observation. Appendix A sets out the SA data per the CSO.[1] The following charts show the figures under the direct and indirect approaches graphically.

Figure 1: GDP SA Direct Versus Indirect Approach



[1] A complication with calculating GDP/GNP SA under the indirect approach is the treatment of the statistical discrepancy, which arises from the difference in GDP calculated using the output and expenditure methods, and is one of the components of aggregate GDP in the nsa series. The CSO does not report a SA statistical discrepancy, and it is not necessary using the direct method. The series can be tested for a seasonal pattern, and if it has one it should be included in our indirect aggregation. Otherwise, it should be included unadjusted. X12 ARIMA, a development of the X11 ARIMA package used by the CSO, finds a seasonal pattern in the statistical discrepancy series to Q4 2004 and thus we include this series SA in our aggregation.

Figure 2: GNP SA Direct Versus Indirect Approach



The two alternative estimates of both the GDP and GNP series clearly differ. There are cases, which we consider below, where one approach shows an increase in quarterly GDP/GNP while the other shows a decrease. Table 1 sets out the quarterly percentage changes in the SA GDP and GNP figures, and the difference between the two approaches. This is the statistic of most interest when the series are released, and which attracts the greatest attention from analysts and commentators. We calculate the average of the absolute quarterly percentage change under each approach. The results indicate:

1. The absolute average difference in the SA quarterly growth rate between the two approaches is no less than 2.08 per cent (per quarter, 8.6 per cent annualised) for the GNP series, and 1.43 per cent (5.9 per cent annualised) for the GDP series.
2. For GNP, 28 out of 31 cases show a difference of greater than 1 per cent in the quarter-on-quarter growth rate (corresponding to over 4 per cent annualised); for GDP the same is true in 22 out of 31 cases.
3. The difference between the direct and indirect approaches is greater for GNP than for GDP.[2]

[2] This ranking is not stable as new data are added. Carrying out the exercise on seasonally adjusted data to Q2 2004 (just two observations less than used here) gave greater differences in the GDP series. Note that the CSO re-estimate the entire SA series with each new observation.

4. There are 9 quarters out of 31 where the GNP figure rose under one approach but fell under the other; for GDP there are 6 such cases.

Table 1: Quarterly Percentage Changes in SA GDP and GNP

	GDP			GNP		
	Direct	Indirect	Difference in Percentage Points	Direct	Indirect	Difference in Percentage Points
	%	%	%	%	%	%
1997Q2	3.59	6.85	3.25	5.70	8.76	3.06
1997Q3	0.58	1.74	1.16	5.10	7.30	2.19
1997Q4	3.91	2.82	-1.09	2.00	0.55	-1.45
1998Q1	2.50	-0.24	-2.74	0.89	-1.81	-2.70
1998Q2	1.36	4.11	2.75	0.59	2.83	2.24
1998Q3	2.52	3.24	0.72	1.59	3.75	2.16
1998Q4	-0.81	-1.59	-0.78	1.04	-0.65	-1.68
1999Q1	7.11	5.00	-2.11	6.55	4.32	-2.23
1999Q2	-1.09	0.85	1.93	-2.59	-0.94	1.64
1999Q3	6.16	6.93	0.78	3.24	5.50	2.26
1999Q4	1.93	0.71	-1.22	2.79	0.44	-2.35
2000Q1	0.71	-0.02	-0.72	2.40	1.46	-0.95
2000Q2	3.53	4.72	1.19	5.93	7.27	1.35
2000Q3	2.14	2.59	0.44	-1.75	-0.42	1.32
2000Q4	3.73	2.37	-1.36	2.94	0.77	-2.17
2001Q1	0.92	1.67	0.74	2.66	3.21	0.55
2001Q2	-0.36	-0.53	-0.17	-2.24	-2.37	-0.13
2001Q3	1.18	1.93	0.74	0.03	1.88	1.85
2001Q4	-0.04	-1.64	-1.60	0.39	-2.32	-2.71
2002Q1	3.87	5.73	1.87	-0.75	1.11	1.86
2002Q2	0.32	-0.89	-1.21	2.01	0.68	-1.34
2002Q3	2.68	3.64	0.96	2.45	4.70	2.26
2002Q4	0.46	-1.09	-1.55	-0.82	-3.83	-3.01
2003Q1	0.04	2.13	2.09	-0.09	2.63	2.72
2003Q2	1.90	0.19	-1.71	1.51	-0.48	-1.99
2003Q3	-1.52	-0.48	1.03	0.50	2.68	2.18
2003Q4	4.58	3.21	-1.37	1.49	-1.52	-3.01
2004Q1	1.28	3.55	2.26	1.99	5.44	3.45
2004Q2	0.87	-1.21	-2.08	1.48	-0.95	-2.44
2004Q3	-1.41	-0.21	1.20	-1.49	0.50	1.99
2004Q4	2.01	0.47	-1.54	5.07	1.87	-3.19
Average Absolute	**2.10**	**2.33**	**1.43**	**2.26**	**2.68**	**2.08**
Volatility Measure	**2.94**	**3.30**		**2.48**	**4.42**	

The direct and indirect methods give, in summary, dramatically different estimates, and the choice between them is material for these data. The difference arises because different seasonal patterns apply to the various component series making up GDP/GNP. We estimate, using X-12 ARIMA, that Personal Consumption, Government Consumption and Imports have linear seasonal patterns but with differing lag lengths in the moving averages chosen, while Fixed Capital Formation and Exports have multiplicative patterns.

The volatility measure shown is the mean of the sequential absolute difference in the growth rates. For both GDP and GNP the indirect approach *increases* the volatility of these quarterly growth rates. The Irish macro aggregates, seasonally adjusted as per the CSO's existing (direct) methodology, appear to be noticeably volatile anyway, see McCarthy (2004). If the indirect approach is to be preferred, this problem is even greater. For real GNP, the quarterly (sequential) growth rate (computed via the indirect method) differs an absolute 4.42 per cent on average from the figure a quarter earlier.

A "good" seasonal adjustment procedure should yield a series with no substantial remaining seasonality. We ran the alternative SA GDP and GNP figures from CSO through the X-12 ARIMA and Tramo-Seats packages, to see whether there was any discernible seasonal pattern left in the numbers. One would not expect any in the directly seasonally adjusted series, since these were arrived at by simply seasonally adjusting the aggregate NSA series. Some pattern might remain in the indirect seasonally adjusted series.

X-12 ARIMA found no remaining seasonality in the directly adjusted series, not surprising since this is the package used by CSO, but did find it in both indirectly adjusted series. Tramo-Seats found residual seasonality in the GDP direct and indirect series, but did not find it in either version of the GNP series. This suggests that the CSO's current choice of seasonal adjustment factors for the macro components could perhaps be improved on, although it must be recalled that the data series is short. The results of this exercise are given graphically in Appendix B.

The results also illustrate that X-11/X-12 and Tramo-Seats sometimes give different seasonal factors. This can be demonstrated further by estimating the SA GDP and GNP by Tramo-Seats, and comparing the results with the figures estimated by the CSO (using X-11 ARIMA). The results are given graphically in Appendix C. As can be seen, the results are very close when seasonally adjusting GDP and GNP directly, but substantial differences arise when using the indirect approach.

3. The Retail Sales Index

The aggregation of the RSI, from 15 constituent business sectors, is more complicated than that for GDP/GNP. Starting with the actual turnover in each business sector, a number of steps are followed:

1. Trading Day and Trading Week: Sales in each month vary with the number of trading days and weeks. The CSO generates "Standardised months", which have the same number of weeks, and the same number of Mondays, Tuesdays, etc.
2. The RSI turnover index is calculated using a modified Laspèyres index based on a set of fixed seasonal weights. The relative weight of each sector varies from month to month, and a set of current weights is used ("updated values"), based on the change in turnover in each sector in the last twelve months.

The formulae for the individual business sectors and aggregate RSIs are:

Individual RSI = $[W_{m-1}(T_m/T_{m-1})/ W_0] \times 100$

Aggregate RSI = $[\Sigma(W_{m-1}(T_m/T_{m-1}))/ \Sigma W_0] \times 100$

Where

W_0 and W_{m-1} are the base weights and updated weights ("updated values") respectively, and

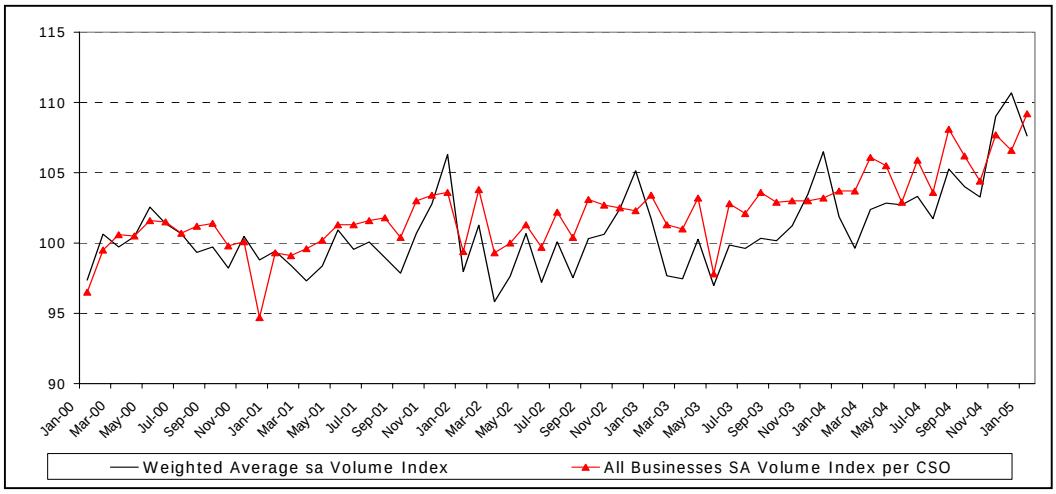
T_m and T_{m-1} are turnover values for the current and last period respectively.

0 = Base period (i.e. equivalent month in the base year 2000)
m = current month
m-1 = same month last year.

3. The turnover index is converted to a volume index using indices for each business sector derived from the CPI.
4. The series are then seasonally adjusted, with the SA factors updated twice-yearly. The set of factors used here is based on the seasonal pattern from January 1999 to April 2004.

Because of the method of calculation, it is not straightforward to compare the SA aggregate series generated by the direct and indirect approaches. We have taken a simple approach of calculating the average of the individual SA volume indices, weighted by the base weights, and comparing the monthly change in the resultant average with the monthly change in the aggregate SA volume index as calculated by the CSO. This should identify inconsistencies between the direct and indirect approaches to estimating the aggregate SA volume index. Figure 3 below shows the two series graphically.

Figure 3: Weighted Average of SA Volume Indices Versus Aggregate SA Volume Index per CSO



The CSO series is on average a higher number than the series we calculated, which is to be expected, as the CSO series would give greater weight to the sectors with higher sales over time, thus boosting growth in the index.

Table 2 overleaf sets out the monthly percentage changes in the two series since 2000. We calculate (1) the average of the absolute monthly changes, and (2) the average of the absolute differences between the two approaches. The results indicate that there is slightly more variability in the series we have calculated, and the average absolute difference in the growth rates in the two series is 1.55 per cent.

Comparing the two series also highlights a number of cases where the weighted average of the individual series indicates a reduction in overall retail volumes, while the aggregate series per the CSO indicate an increase, or vice versa. This occurs in no less than 16 cases out of 60.

We also carried out an exercise running the two series through X-12 ARIMA and Tramo-Seats, to see whether there was any discernible seasonal pattern left in the numbers. One would not expect any remaining SA pattern in the directly seasonally adjusted series, since this was arrived at by simply seasonally adjusting the aggregate nsa series. Some pattern might remain in the series generated indirectly, and X-12 found that seasonality was "probably present" in this series; Tramo-Seats found some surviving seasonality in both series. The results are summarised graphically in Appendix D.

Table 2: Monthly Percentage Changes in SA RSI

Month	DKM Series	CSO Series	Difference in Percentage Points	Month	DKM Series	CSO Series	Difference in Percentage Points
	%	%	%		%	%	%
Feb-00	3.40	3.10	0.30	Aug-02	-2.60	-1.80	-0.80
Mar-00	-0.90	1.10	-2.00	Sep-02	2.80	2.70	0.20
Apr-00	0.70	-0.10	0.80	Oct-02	0.30	-0.40	0.70
May-00	2.10	1.10	1.00	Nov-02	1.80	-0.20	2.00
Jun-00	-1.10	-0.10	-1.00	Dec-02	2.70	-0.20	2.90
Jul-00	-0.70	-0.80	0.10	Jan-03	-3.20	1.10	-4.30
Aug-00	-1.30	0.50	-1.80	Feb-03	-4.00	-2.00	-2.00
Sep-00	0.40	0.20	0.20	Mar-03	-0.20	-0.30	0.10
Oct-00	-1.50	-1.60	0.10	Apr-03	2.90	2.20	0.70
Nov-00	2.30	0.30	2.00	May-03	-3.30	-5.20	1.90
Dec-00	-1.70	-5.40	3.70	Jun-03	3.00	5.10	-2.10
Jan-01	0.60	4.90	-4.20	Jul-03	-0.20	-0.70	0.40
Feb-01	-1.00	-0.20	-0.80	Aug-03	0.70	1.50	-0.70
Mar-01	-1.10	0.50	-1.60	Sep-03	-0.20	-0.70	0.50
Apr-01	1.10	0.60	0.50	Oct-03	1.10	0.10	1.00
May-01	2.60	1.10	1.50	Nov-03	2.20	0.00	2.20
Jun-01	-1.40	0.00	-1.40	Dec-03	2.90	0.20	2.70
Jul-01	0.50	0.30	0.20	Jan-04	-4.30	0.50	-4.80
Aug-01	-1.10	0.20	-1.30	Feb-04	-2.20	0.00	-2.20
Sep-01	-1.10	-1.40	0.30	Mar-04	2.80	2.30	0.40
Oct-01	2.90	2.60	0.30	Apr-04	0.40	-0.60	1.00
Nov-01	2.10	0.40	1.70	May-04	-0.10	-2.50	2.30
Dec-01	3.40	0.20	3.20	Jun-04	0.60	2.90	-2.30
Jan-02	-7.80	-4.10	-3.80	Jul-04	-1.50	-2.20	0.60
Feb-02	3.40	4.40	-1.10	Aug-04	3.50	4.30	-0.90
Mar-02	-5.40	-4.30	-1.00	Sep-04	-1.20	-1.80	0.60
Apr-02	1.90	0.70	1.20	Oct-04	-0.70	-1.70	1.00
May-02	3.10	1.30	1.80	Nov-04	5.60	3.20	2.40
Jun-02	-3.50	-1.60	-1.90	Dec-04	1.50	-1.00	2.60
Jul-02	3.00	2.50	0.50	Jan-05	-2.80	2.40	-5.20
Average Absolute Difference					**2.08**	**1.58**	**1.55**

These results are suggestive rather than definitive, since there may be superior methods of creating an indirect series than the one we have employed. However, it would appear that the divergences between the direct and indirect methodologies are substantial for Retail Sales, one of the key short-term economic indicators in Ireland.

4. The Industrial Production Index

The CSO produces a monthly Industrial Production Index (IPI) for Ireland. Individual sub-indices are compiled for each industrial sector, based on the detailed NACE classification. The sub-indices are aggregated at several levels, using a weighted average approach, the weights being based on the Gross Value Added (GVA) at factor cost in each sector, per the 2000 Census of Industrial Production (CIP). The CSO also produces seasonally adjusted sub-indices and aggregate indices, using the direct approach for the latter.

We have generated an alternative SA IPI for manufacturing industry, using the indirect approach, by calculating a weighted average of the SA versions of the individual indices, using the weights from the 2000 CIP. The following chart shows the index, using the direct and indirect approaches, for 2000 to date.

Figure 4: Manufacturing Industry IPI SA Direct Versus Indirect Approach

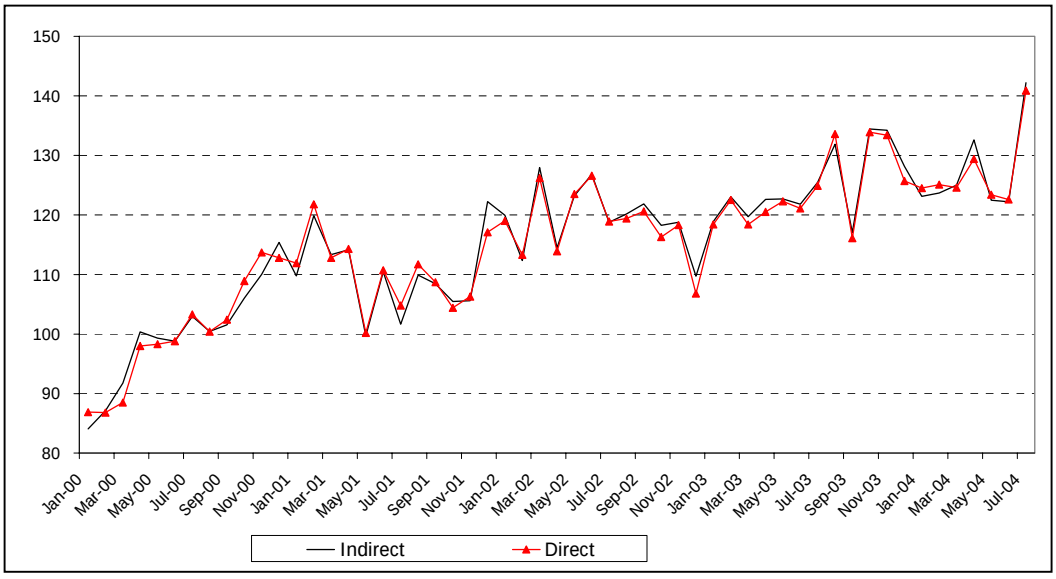


Table 3 overleaf sets out the monthly percentage changes in the SA IPI figures since 2000 using the direct and indirect approaches, and the difference between the two. We calculate (1) the average of the absolute monthly changes, and (2) the average of the absolute differences between the two approaches. The results indicate that there is slightly more variability in the series calculated using the indirect approach, and the average absolute difference in the growth rates in the two series is 1.4 per cent.

It is clear that the choice of seasonal adjustment procedure makes a big difference with the industrial production numbers. In 14 out of 60 cases, the absolute differences in the monthly growth rates exceed 2 per cent.

Table 3: Monthly Percentage Changes in SA Manufacturing Industry IPI

Month	Indirect	Direct	Difference in Percentage Points	Month	Indirect	Direct	Difference in Percentage Points
	%	%	%		%	%	%
Feb-00	3.60	-0.10	3.70	Aug-02	1.20	0.40	0.80
Mar-00	5.30	2.00	3.30	Sep-02	1.40	1.00	0.40
Apr-00	9.40	10.70	-1.40	Oct-02	-3.00	-3.60	0.60
May-00	-1.00	0.30	-1.40	Nov-02	0.40	1.70	-1.30
Jun-00	-0.50	0.50	-1.00	Dec-02	-7.60	-9.70	2.10
Jul-00	4.20	4.60	-0.30	Jan-03	8.40	10.90	-2.50
Aug-00	-2.50	-2.80	0.30	Feb-03	3.50	3.50	0.00
Sep-00	1.10	2.00	-0.90	Mar-03	-2.70	-3.30	0.70
Oct-00	4.40	6.30	-2.00	Apr-03	2.40	1.80	0.60
Nov-00	3.80	4.40	-0.60	May-03	0.10	1.50	-1.40
Dec-00	4.90	-0.80	5.70	Jun-03	-0.70	-1.00	0.30
Jan-01	-4.90	-0.80	-4.10	Jul-03	3.00	3.10	-0.10
Feb-01	9.20	8.80	0.40	Aug-03	5.10	7.00	-1.80
Mar-01	-5.50	-7.40	1.90	Sep-03	-11.30	-13.10	1.80
Apr-01	0.70	1.30	-0.60	Oct-03	14.90	15.30	-0.40
May-01	-12.70	-12.30	-0.30	Nov-03	-0.20	-0.40	0.20
Jun-01	10.80	10.50	0.30	Dec-03	-4.50	-5.80	1.20
Jul-01	-7.90	-5.30	-2.60	Jan-04	-3.90	-1.00	-3.00
Aug-01	8.10	6.60	1.50	Feb-04	0.50	0.50	0.00
Sep-01	-1.30	-2.70	1.40	Mar-04	1.10	-0.40	1.50
Oct-01	-2.80	-4.00	1.20	Apr-04	6.10	3.90	2.30
Nov-01	0.10	1.80	-1.70	May-04	-7.70	-4.60	-3.00
Dec-01	15.70	10.20	5.60	Jun-04	-0.20	-0.60	0.40
Jan-02	-1.90	1.60	-3.50	Jul-04	16.40	14.90	1.40
Feb-02	-6.30	-4.80	-1.60	Aug-04	-19.50	-18.70	-0.80
Mar-02	13.90	11.40	2.50	Sep-04	6.90	5.20	1.70
Apr-02	-10.50	-9.70	-0.80	Oct-04	2.10	2.10	0.00
May-02	7.70	8.40	-0.80	Nov-04	-2.60	-2.10	-0.50
Jun-02	2.90	2.50	0.40	Dec-04	3.80	3.60	0.20
Jul-02	-6.40	-6.10	-0.30	Jan-05	2.20	4.30	-2.10
Average Absolute Difference					**5.22**	**4.93**	**1.42**

We also carried out an exercise running the two SA IPI series through X-12 ARIMA and Tramo-Seats, to see whether there was any discernible seasonal pattern left in the numbers. We considered the two series from January 1996 to date, and did not test for trading day or other factors. One would not expect any remaining SA pattern in the directly seasonally adjusted series, since these were arrived at by simply seasonally adjusting the aggregate nsa series. Some pattern might remain in the indirect seasonally adjusted series. Neither X-12 nor Tram-Seats found any remaining seasonality in the

direct series, but Tramo-Seats found seasonality in the indirect series (see Appendix E).

5. Discussion of Results and Conclusions

We have compared direct and indirect approaches to the seasonal adjustment of Irish macroeconomic series published by the CSO. The presumption in the literature is that the indirect method is likely to be preferred in most real-world situations, but it is an empirical question whether it makes any great practical difference. Our results indicate that it makes a very big difference indeed, with one-period growth rates frequently changing sign, for example. It is clear that the component series have markedly differing seasonal patterns, and that this is contributing to the large differences between the two approaches. These are the circumstances in which the indirect method is likely to give a better adjustment.

However the indirect estimates have problems too, including residual seasonality in some cases. There are also trends to be noted in the relationship between the direct and indirect adjustments. For example, with the macro aggregates (and this is true for both GDP and GNP), the gap between the two drifts steadily upwards for the Q1 factors, compensated by a steady downtrend for Q2. With short series, there can always be problems with end-points, and the differences between the two approaches tended to be larger for some quarters in 2004, the final year of the sample. Formal diagnostic tests for seasonal adjustment of aggregated series are discussed in Hood and Findley (2004).

But the fact that the indirect estimation of seasonal factors does not purge the Irish macro data of apparently extreme volatility does not count against the approach; rather it suggests that the source of the extreme volatility lies elsewhere. Given the big differences between direct and indirect estimates our conclusion is that it is desirable to take a fresh look at alternative seasonal adjustment procedures for the key aggregate macro series.

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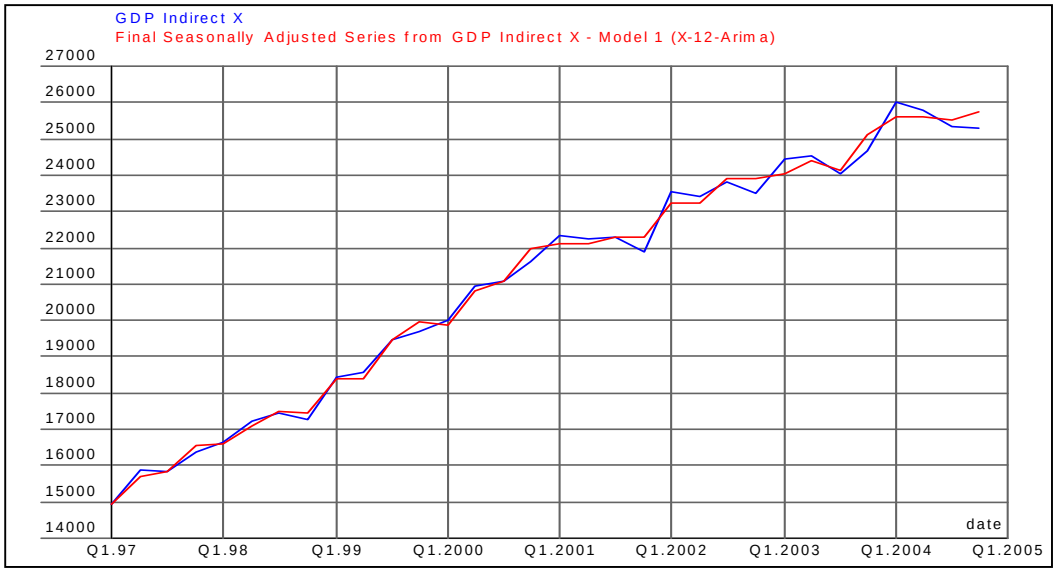
Appendix A: CSO SA Components of GDP/GNP (Constant 1995 € Million)

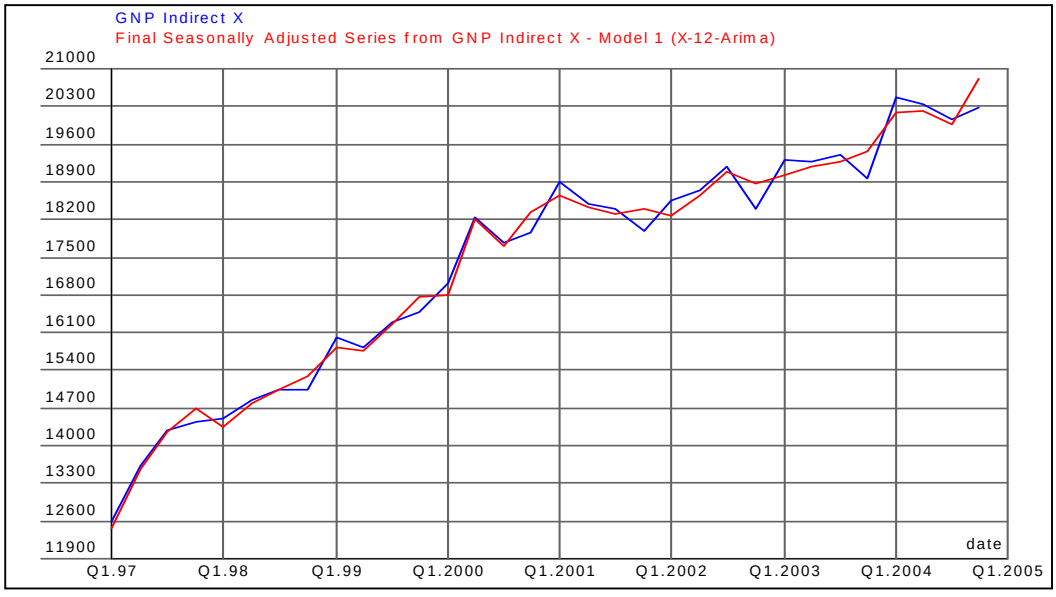
											Indirect Measures		Direct minus Indirect	
	Pers. Cons.	Govt Cons	Fixed K Form.	Chg Stocks	Exports	Imports	Stat. Discrep.	GDP (Direct)	Net Factor Inc	GNP (Direct)	GDP	GNP	GDP	GNP
1997Q1	8,001	2,077	2,848	284	12,170	-10,488	-148	15,149	-2,330	12,804	14,743	12,414	-406	-390
1997Q2	8,170	2,196	3,185	297	13,206	-11,104	-196	15,694	-2,252	13,534	15,753	13,501	59	-33
1997Q3	8,335	2,144	3,053	234	13,691	-11,510	80	15,785	-1,541	14,224	16,027	14,486	242	261
1997Q4	8,811	2,118	3,671	107	13,913	-11,814	-327	16,402	-1,913	14,509	16,478	14,565	77	56
1998Q1	8,643	2,225	3,613	399	15,418	-13,754	-105	16,812	-2,137	14,638	16,439	14,301	-373	-337
1998Q2	8,850	2,237	3,641	356	15,781	-13,541	-210	17,040	-2,409	14,725	17,115	14,705	74	-19
1998Q3	9,042	2,254	3,578	455	16,533	-14,212	20	17,471	-2,413	14,959	17,670	15,257	199	297
1998Q4	9,186	2,300	3,998	17	16,915	-15,124	96	17,329	-2,231	15,114	17,389	15,158	60	44
1999Q1	9,448	2,342	4,038	141	17,213	-14,647	-279	18,561	-2,444	16,105	18,258	15,814	-303	-291
1999Q2	9,408	2,398	4,189	-49	18,043	-15,446	-130	18,360	-2,748	15,688	18,413	15,664	53	-24
1999Q3	10,002	2,440	4,649	-63	19,097	-16,316	-119	19,490	-3,164	16,196	19,690	16,526	200	330
1999Q4	9,992	2,501	4,248	260	20,092	-17,075	-189	19,866	-3,231	16,649	19,830	16,599	-36	-49
2000Q1	10,342	2,495	4,472	17	20,508	-17,652	-356	20,007	-2,986	17,048	19,827	16,841	-180	-207
2000Q2	10,564	2,590	4,704	136	21,817	-18,771	-277	20,713	-2,698	18,059	20,763	18,066	50	7
2000Q3	10,639	2,629	4,745	259	22,990	-19,717	-244	21,157	-3,311	17,743	21,300	17,989	143	246
2000Q4	10,808	2,739	4,418	340	24,292	-20,844	54	21,946	-3,678	18,265	21,805	18,127	-141	-138
2001Q1	10,930	2,782	4,849	229	24,942	-21,703	141	22,149	-3,460	18,751	22,169	18,710	20	-41
2001Q2	11,156	2,829	4,537	-397	24,155	-20,059	-167	22,070	-3,785	18,331	22,053	18,267	-17	-64
2001Q3	11,168	2,967	4,328	394	24,166	-20,058	-488	22,331	-3,867	18,337	22,477	18,610	147	274
2001Q4	11,425	3,013	4,281	66	23,981	-20,303	-354	22,322	-3,931	18,408	22,109	18,178	-214	-230
2002Q1	11,345	3,089	4,701	-224	26,760	-22,096	-198	23,185	-4,997	18,270	23,376	18,379	191	109
2002Q2	11,356	3,146	4,592	51	25,974	-22,183	232	23,259	-4,665	18,638	23,168	18,503	-91	-135
2002Q3	11,638	3,191	4,696	73	25,710	-21,042	-254	23,882	-4,638	19,094	24,011	19,374	129	280
2002Q4	11,581	3,167	4,552	202	24,351	-19,575	-526	23,993	-5,120	18,937	23,751	18,631	-242	-306
2003Q1	11,700	3,206	4,373	200	24,618	-19,551	-292	24,002	-5,135	18,919	24,256	19,121	254	202
2003Q2	11,747	3,204	4,550	243	25,207	-20,276	-374	24,458	-5,272	19,205	24,301	19,029	-157	-176
2003Q3	11,795	3,253	4,853	130	25,597	-21,320	-123	24,086	-4,644	19,302	24,183	19,539	97	237
2003Q4	11,870	3,247	5,409	-46	26,464	-21,791	-193	25,190	-5,718	19,590	24,960	19,242	-230	-348
2004Q1	12,020	3,283	4,906	101	25,721	-19,791	-395	25,513	-5,556	19,980	25,845	20,289	332	309
2004Q2	12,114	3,305	5,302	83	26,730	-21,535	-469	25,734	-5,437	20,276	25,532	20,095	-202	-180
2004Q3	12,254	3,325	5,254	-125	26,547	-21,412	-363	25,370	-5,283	19,972	25,478	20,195	108	223
2004Q4	12,240	3,370	5,492	11	27,344	-22,392	-468	25,881	-5,024	20,985	25,598	20,574	-283	-411

Note: The seasonally adjusted statistical discrepancy is generated by DKM using X-12 ARIMA.
Source: CSO *Quarterly National Accounts*.

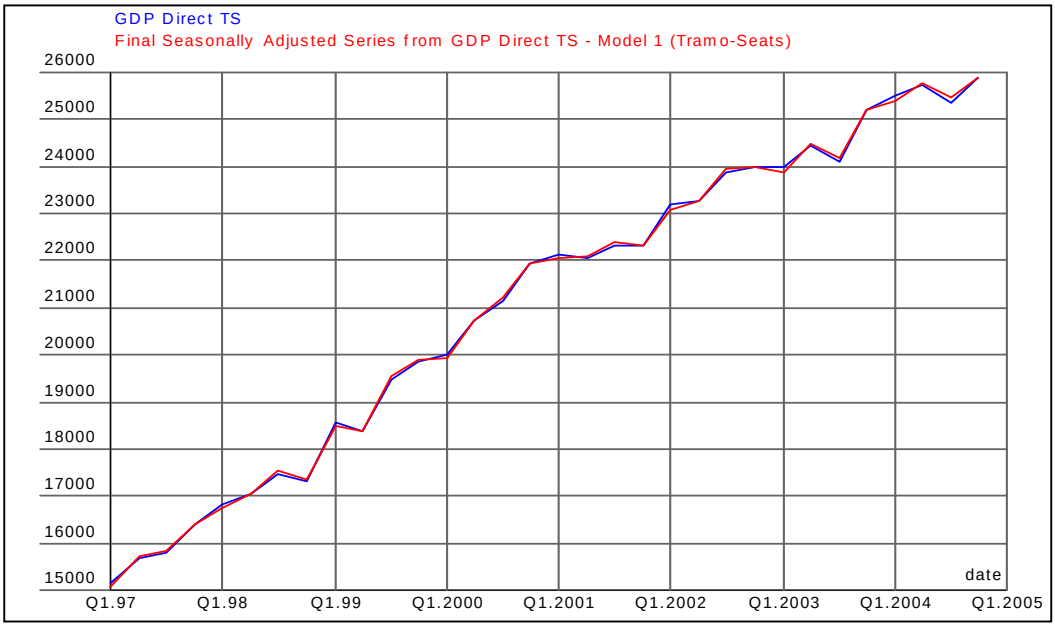
Appendix B: Results of Testing for Remaining Seasonality in GDP and GNP Direct and Indirect Series

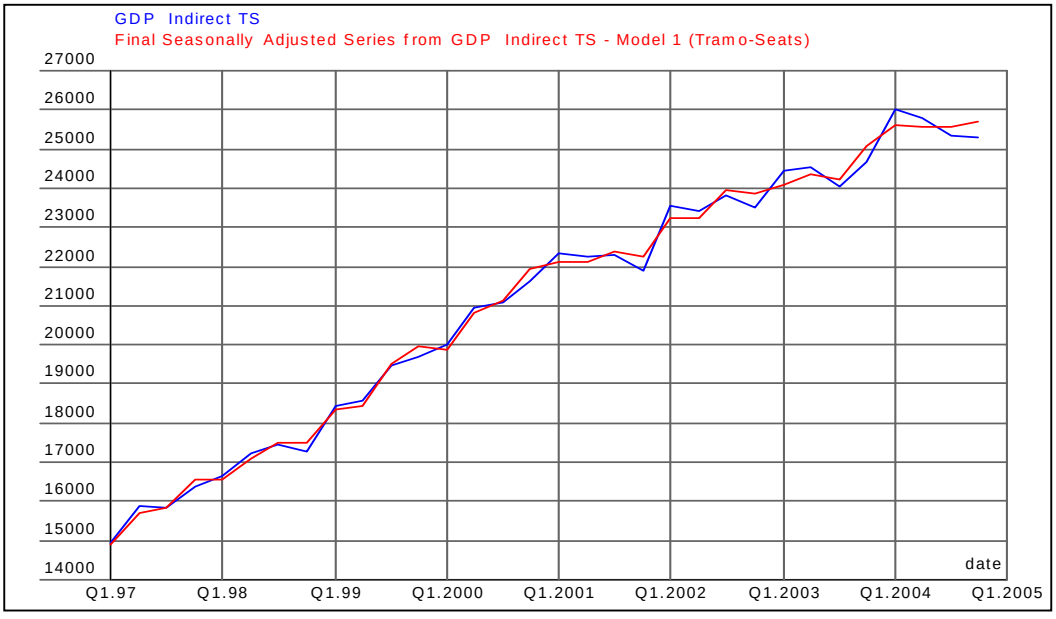
X-12 ARIMA Results





Tramo-Seats Results

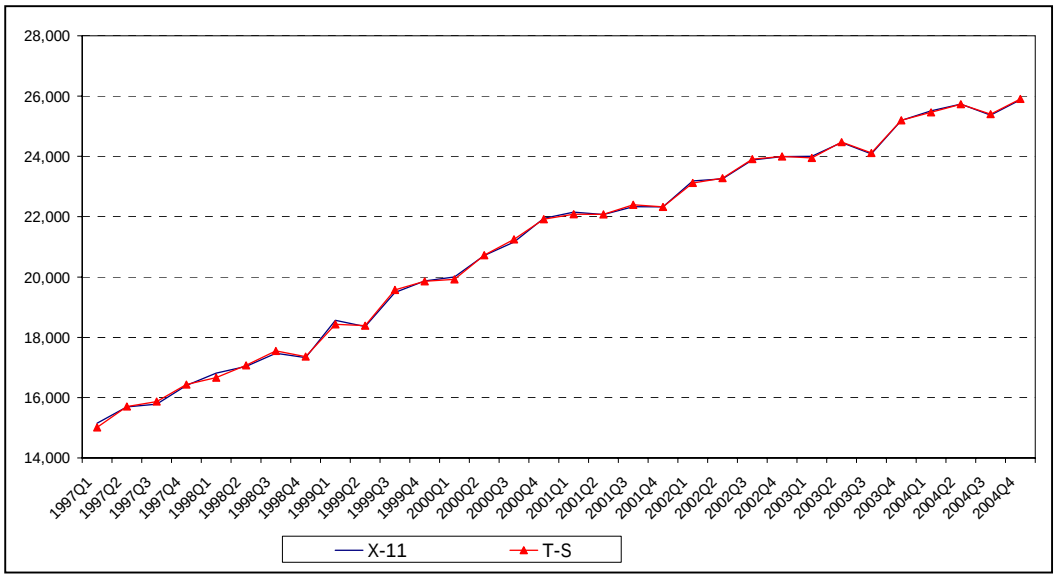




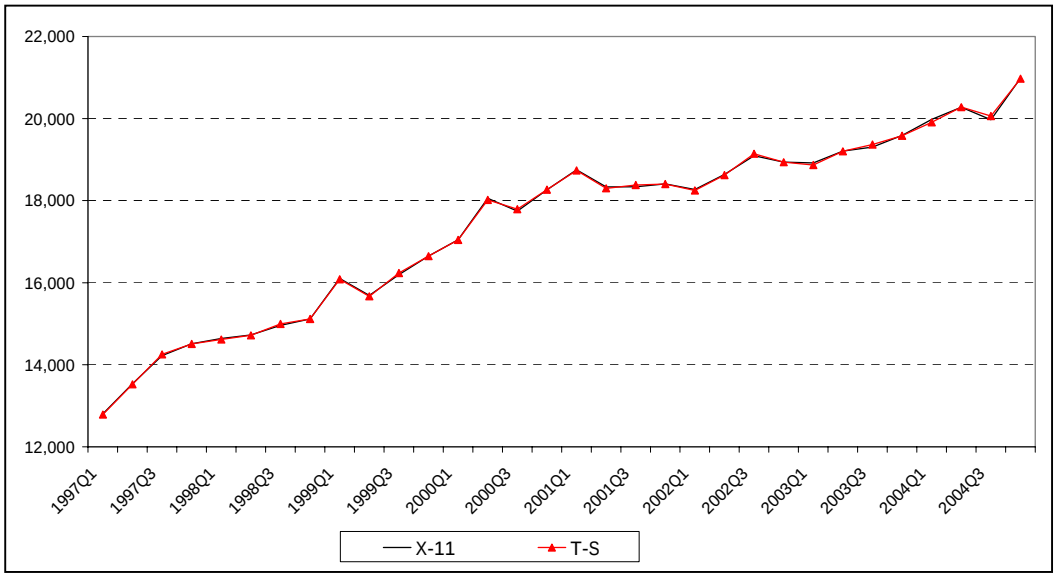
Appendix C: Comparing GDP and GNP SA Direct and Indirect Estimates using X-11 ARIMA and Tramo-Seats

Direct Estimate

GDP

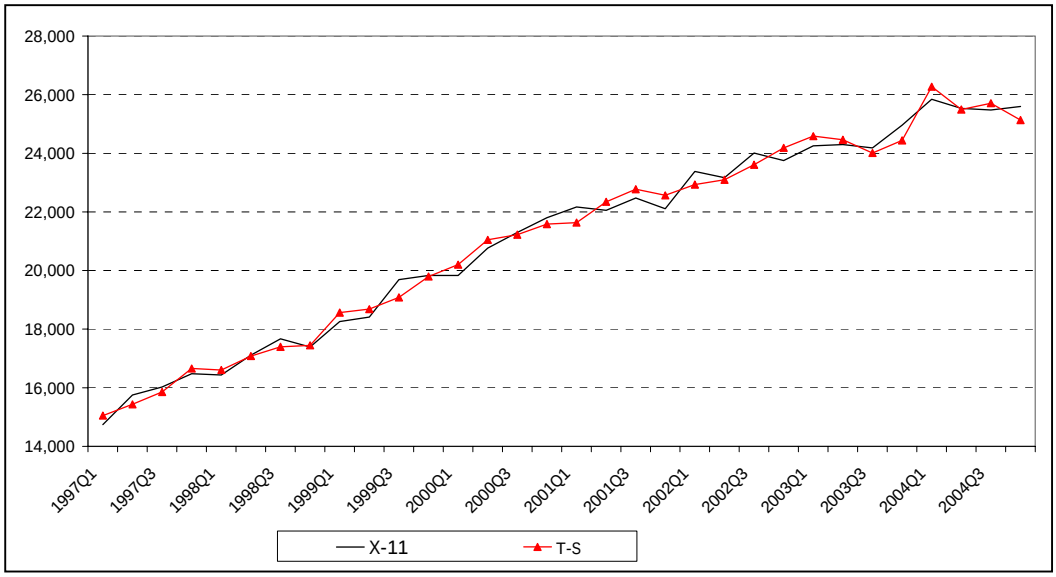


GNP

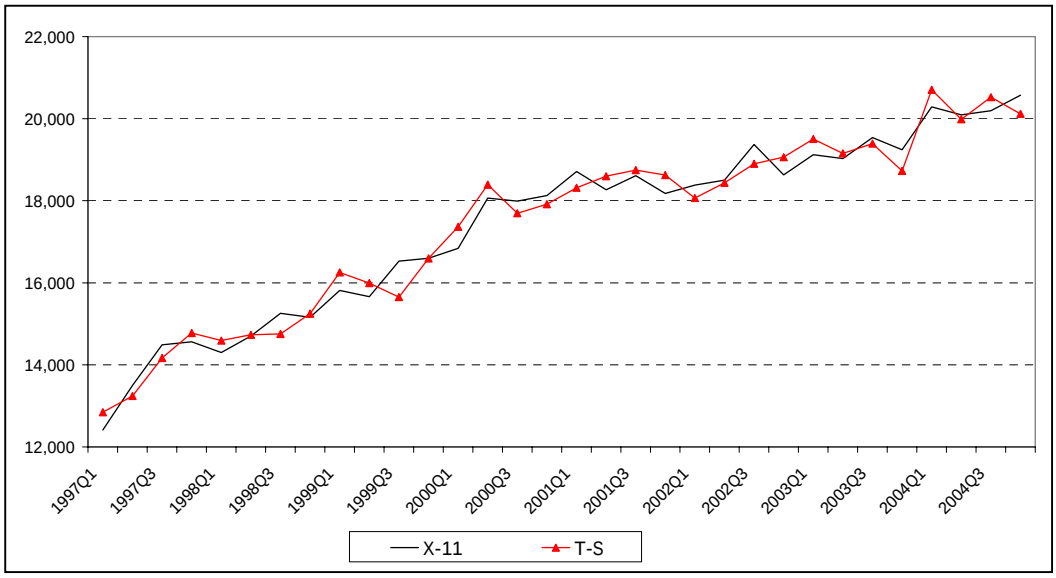


Indirect Estimate

GDP

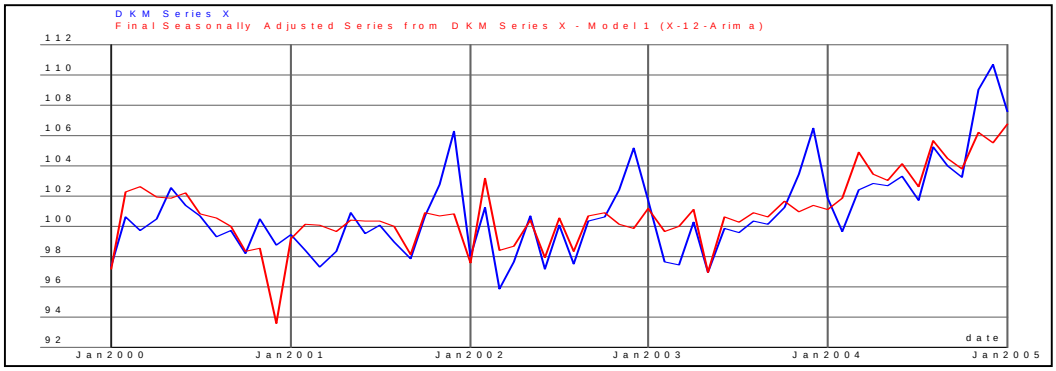


GNP

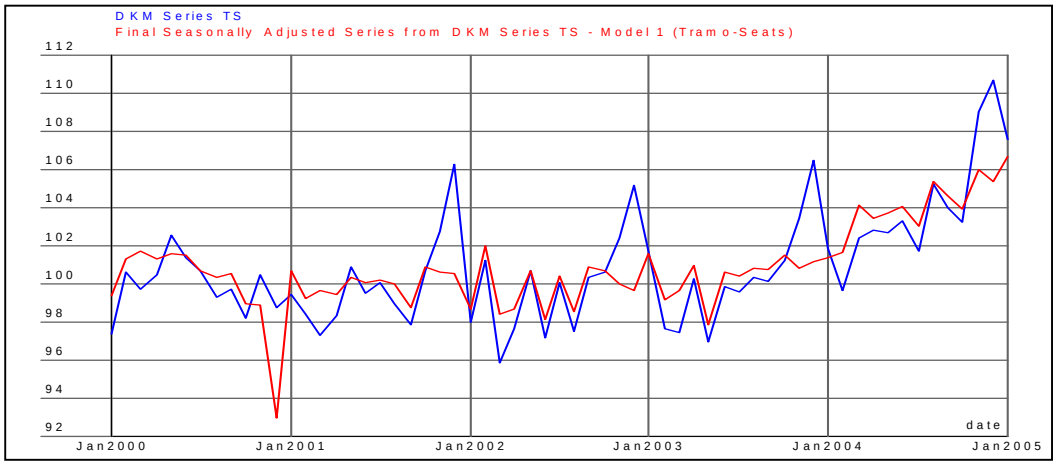


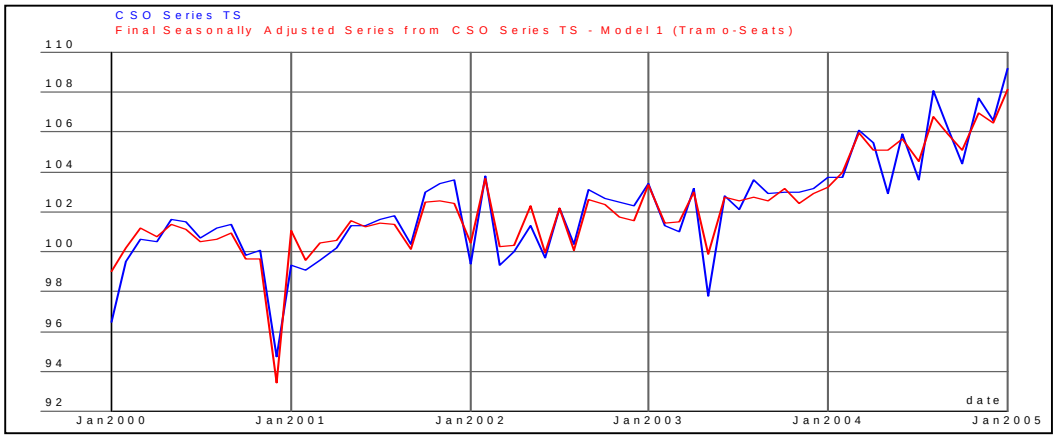
Appendix D: Results of Testing for Remaining Seasonality in RSI Direct and Indirect Series

X-12 Results



Tramo-Seats Results





Appendix E: Results of Testing for Remaining Seasonality in Industrial Production Index Direct and Indirect Series

Tramo-Seats Results