

# News Release



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## National Accounts

### Seasonally adjusted GDP 2000-2005

At the National Statistics Office, most time series observations are made at equidistant time points: annually, biannually, quarterly, or monthly. When the period is shorter than a year, the series often exhibits a seasonal pattern, this component being called seasonal variation. The variance component posed by the seasonality problem has traditionally been regarded by economic analysts as a nuisance. This is because it makes it harder to compare consecutive periods and to distinguish economically important components, like the long-term trend and the business cycle. In many countries, the most important economic quarterly time series, the Gross Domestic Product (GDP), is seasonally adjusted.

#### Methods for isolating the seasonal effect: historical and technical background

As a first attempt to get rid of the seasonal component, it was assumed that it was periodic up to a random component that was assumed to be normally and independently distributed with mean zero and constant variance. This was a crude assumption that may have offered some relief if the data covered a very short period, say 2-3 years. But it was useless when it was applied for longer time series where the seasonal profile changed over time.

Computers opened the way for more data-intensive methods. Whilst several rather elaborated methods were already in use before 1967, these were then abandoned in favour of a more powerful method initiated at the US Bureau of Census, in the form of the X11-program (which is still applied). The program was based on moving average filters, such as Henderson's trend filter and a seasonal filter. Whilst the X11-program used fairly primitive methods (the Box-Jenkins model had not yet made its appearance at the time), according to the empirical standards of the time it was fairly advanced – for example it incorporated a way of handling outliers. The X11 suffered from two disadvantages: one was a lack of transparency, since it lacked an appropriate statistical model to support the method, thus making it difficult to evaluate on sound theoretical grounds. The other disadvantage was the poor accuracy of the forecasts that are necessary in order for the adjustment to reach the ends of the time series, especially the recent and most exciting observations. Although the trends were stochastic, the forecasts being used in X11 were based on deterministic trends. In 1988, Box-Jenkins model forecasts were incorporated through the introduction of a new version called X11-ARIMA. But the adjustment method was not changed and the filters were not based on maximum likelihood estimations of stochastic model parameters (methods like the X-11 were henceforth referred to as "Empirically-Based", contrary to strict "Model-Based" approaches).

Whilst a system like X11 (or X12, see below) is a standardised tool that works quite well for many time series, a model-based method that uses time series analysis to find the optimal method by maximum likelihood estimation is a better approach, since this model determines a filter that is particularly designed for that individual time series. Hence, a seasonal adjustment that is based on statistical theory is preferred to a method that lacks such foundations. The utilisation of new models for filtering time series, notably the seasonal component, (incorporating the pioneering work on time series analysis by the researchers Box and Jenkins in 1970) progressed steadily, culminating in the introduction in the UK of the first computer program of ARIMA-Model-Based-decomposition.

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**Theme:**  
**Economy and Finance**

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The program was called SEATS (**S**ignal **E**xtraction in **A**RIMA **T**ime **S**eries), which still survives today as the decomposition program in TRAMO/SEATS. First an adequate ARIMA model is specified, and then, by allocating different frequencies to different components, a decomposition of the series is obtained. The other model-based method (Structural Time Series), based on the work of Engle, whilst being made available through the program package STAMP (**S**tructural **T**ime **S**eries **A**nalyser, **M**odeller and **P**redictor), has not yet been properly developed into a user-friendly mass production software.

During the 1990s, the major improvement was the development of efficient preadjustment of time series, preceding actual decomposition. The computer software was given the name TRAMO (**T**ime **S**eries **R**egression with **A**RIMA **N**oise **M**issing **O**bservations, and **O**utliers), and this constitutes the other half of the current TRAMO/SEATS program package (Gómez and Maravell 1996). The combination of TRAMO with SEATS signified the emergence of the first practical tool for seasonal adjustment using model-based decomposition. The advantages of this new seasonal adjustment method (which eventually became a viable challenger to the old empirical methods) were: maximum likelihood estimation of calendar effects, an automatic outlier detection and correction procedure based on sound statistical grounds, automatic specification of an ARIMA model and a model-based decomposition using maximum likelihood parameter estimates and optimal signal extraction.

During this time the US Bureau of Census developed the program X12 (X-12-ARIMA), which is an extension of X11 with ARIMA forecasts. But X12, whilst incorporating the useful feature of a regression program (REGARIMA, which is used before the actual decomposition) is still empirically based; the purpose of this program is similar to that of TRAMO, and has extensive diagnostics, which makes it useful when working with time series.

During the last few years, there has been a convergence of TRAMO/SEATS and X12. Eurostat has developed the software DEMETRA that implements these two methods in a single interface.

#### **Demetra modules for seasonal adjustment and trend estimation**

The main task of DEMETRA is to mimic the usual work of seasonal adjustment by a producer of statistics. Hence, DEMETRA contains two main modules:

- (1) An automated module designed for fully automatic seasonal adjustment and trend estimation of lists from one up to a huge amount of time series, and
- (2) A detailed analysis module which allows in-depth examinations of the seasonal behaviour of single time series, and is a useful tool for analyzing very difficult time series.

In both cases DEMETRA will:

- Get the time series stored in a database,
- Apply to each series a given set of parameters that is consistent with what was done before, or apply customised or default parameters for a new automatic adjustment,
- Run the seasonal adjustment for the whole set of series,
- Test if the results are satisfactory and automatically detects difficult time series,
- Store the satisfactory results in the database,
- Provide a complete table listing all time series with the results obtained (models, statistics and diagnostics, error messages).

For a series wherein some difficulties are encountered, a thorough assisted examination is then provided, using alternative methods and graphs ■

**The scope of this news release is to familiarise users with the concept of seasonal adjustments as applied to the GDP expenditure approach components at current and constant prices. The figures should be interpreted with caution, since the seasonally-adjusted GDP level varies depending on the number of observations and the detail in the GDP components. This release is technical in nature and is therefore primarily intended for econometricians and statisticians. It contains information on the models used and on the resulting diagnostics. The figures in this release are based on the official GDP figures published on the 9th June in news release number 125/2005.**

**Table 1. Original data at current prices**

		Lm'000						
Period		Consumption	Government Expenditure	Gross Capital Formation	Exports	Imports	GDP	% change (Q <sub>t</sub> /Q <sub>t-1</sub> )
2000	Q1	252,834	82,395	89,425	335,428	379,734	<b>380,348</b>	
	Q2	263,098	80,692	125,211	396,469	446,044	<b>419,426</b>	10.27
	Q3	274,420	78,865	95,649	431,898	439,456	<b>441,376</b>	5.23
	Q4	283,008	81,878	125,601	409,028	474,865	<b>424,650</b>	-3.79
2001	Q1	248,854	83,691	96,823	340,784	381,958	<b>388,194</b>	-8.58
	Q2	266,996	88,554	77,182	367,871	372,125	<b>428,478</b>	10.38
	Q3	284,927	85,266	63,402	372,404	358,564	<b>447,435</b>	4.42
	Q4	292,356	96,677	72,036	338,771	374,986	<b>424,854</b>	-5.05
2002	Q1	263,912	91,964	64,423	316,198	331,365	<b>405,132</b>	-4.64
	Q2	272,978	99,779	63,548	388,825	387,858	<b>437,272</b>	7.93
	Q3	286,191	91,025	41,440	412,315	370,002	<b>460,969</b>	5.42
	Q4	277,219	90,682	77,903	375,260	384,383	<b>436,681</b>	-5.27
2003	Q1	264,881	103,604	98,310	310,951	363,861	<b>413,885</b>	-5.22
	Q2	275,845	101,210	98,756	362,128	387,962	<b>449,977</b>	8.72
	Q3	295,506	93,066	83,549	384,932	386,386	<b>470,667</b>	4.60
	Q4	294,423	95,110	87,334	361,554	379,674	<b>458,747</b>	-2.53
2004	Q1	266,671	103,946	82,642	327,351	343,274	<b>437,336</b>	-4.67
	Q2	286,500	102,480	97,911	358,636	394,000	<b>451,527</b>	3.24
	Q3	315,623	98,405	74,087	378,268	383,650	<b>482,733</b>	6.91
	Q4	308,331	103,289	151,735	344,543	432,303	<b>475,595</b>	-1.48
2005	Q1	273,979	97,707	131,126	285,278	346,405	<b>441,685</b>	-7.13

**Table 2. Final seasonally adjusted series at current prices**

		Lm'000						
Period		Consumption	Government Expenditure	Gross Capital Formation	Exports	Imports	GDP	% change (Q <sub>t</sub> /Q <sub>t-1</sub> )
2000	Q1	270,277	79,864	87,249	379,756	412,708	<b>404,437</b>	
	Q2	268,225	79,485	118,004	388,670	436,659	<b>417,725</b>	3.29
	Q3	267,601	82,154	120,125	397,762	439,516	<b>428,126</b>	2.49
	Q4	268,513	82,480	112,372	404,641	448,605	<b>419,401</b>	-2.04
2001	Q1	267,707	81,121	94,464	385,818	415,122	<b>413,989</b>	-1.29
	Q2	272,283	87,220	72,741	360,634	364,295	<b>428,583</b>	3.53
	Q3	275,374	88,839	79,629	342,972	358,614	<b>428,200</b>	-0.09
	Q4	277,246	97,404	64,448	335,140	354,254	<b>419,985</b>	-1.92
2002	Q1	281,020	94,547	62,850	357,984	360,134	<b>436,267</b>	3.88
	Q2	278,875	92,604	59,892	381,175	379,693	<b>432,853</b>	-0.78
	Q3	275,390	94,844	52,049	379,726	370,052	<b>431,956</b>	-0.21
	Q4	265,723	91,431	69,697	371,237	363,135	<b>434,953</b>	0.69
2003	Q1	283,341	100,346	95,908	352,044	395,452	<b>436,186</b>	0.28
	Q2	282,507	99,636	93,073	355,007	379,793	<b>450,430</b>	3.27
	Q3	282,425	96,969	104,939	354,508	386,437	<b>452,404</b>	0.44
	Q4	283,471	95,917	78,133	357,675	358,685	<b>456,511</b>	0.91
2004	Q1	286,393	100,697	80,624	370,609	373,081	<b>465,242</b>	1.91
	Q2	293,283	100,877	92,278	351,585	385,704	<b>452,319</b>	-2.78
	Q3	298,251	102,517	93,057	348,370	383,701	<b>458,494</b>	1.37
	Q4	295,932	104,143	135,744	340,845	408,400	<b>468,264</b>	2.13
2005	Q1	295,715	100,471	127,923	322,977	376,487	<b>470,599</b>	0.50

**Table 3. Information on models at current prices**

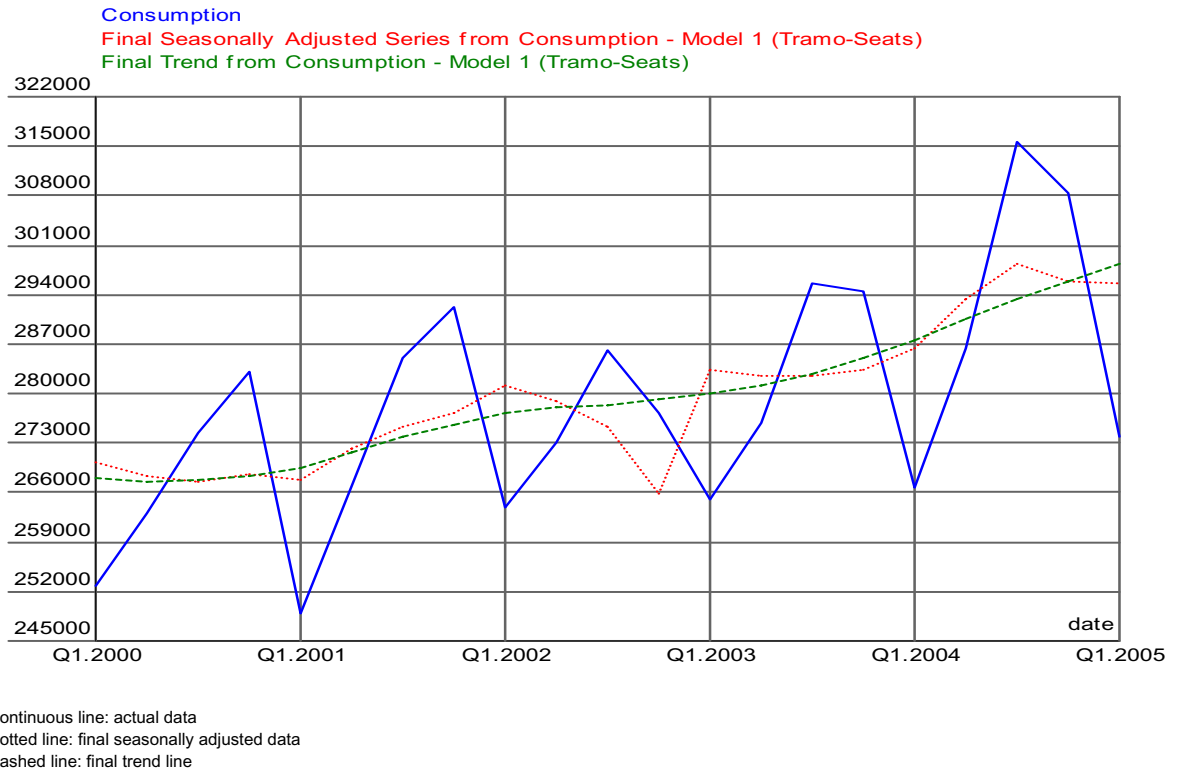
Variable	Status of adjustment	Time span (n° of obs.)	Arima model	Transformation	Mean correction	Outliers	ARIMA decomposition	Seasonality
Consumption	Accepted	Q1.2000 - Q1.2005 (21)	(3 1 0)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC; 1: AO Q4.2002,	Exact	Seasonal model used
Government Expenditure	Accepted	Q1.2000 - Q1.2005 (21)	(0 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used
Gross Capital Formation	Accepted	Q1.2000 - Q1.2005 (21)	(0 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used
Exports	Accepted	Q1.2000 - Q1.2005 (21)	(0 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used
Imports	Accepted	Q1.2000 - Q1.2005 (21)	(0 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used

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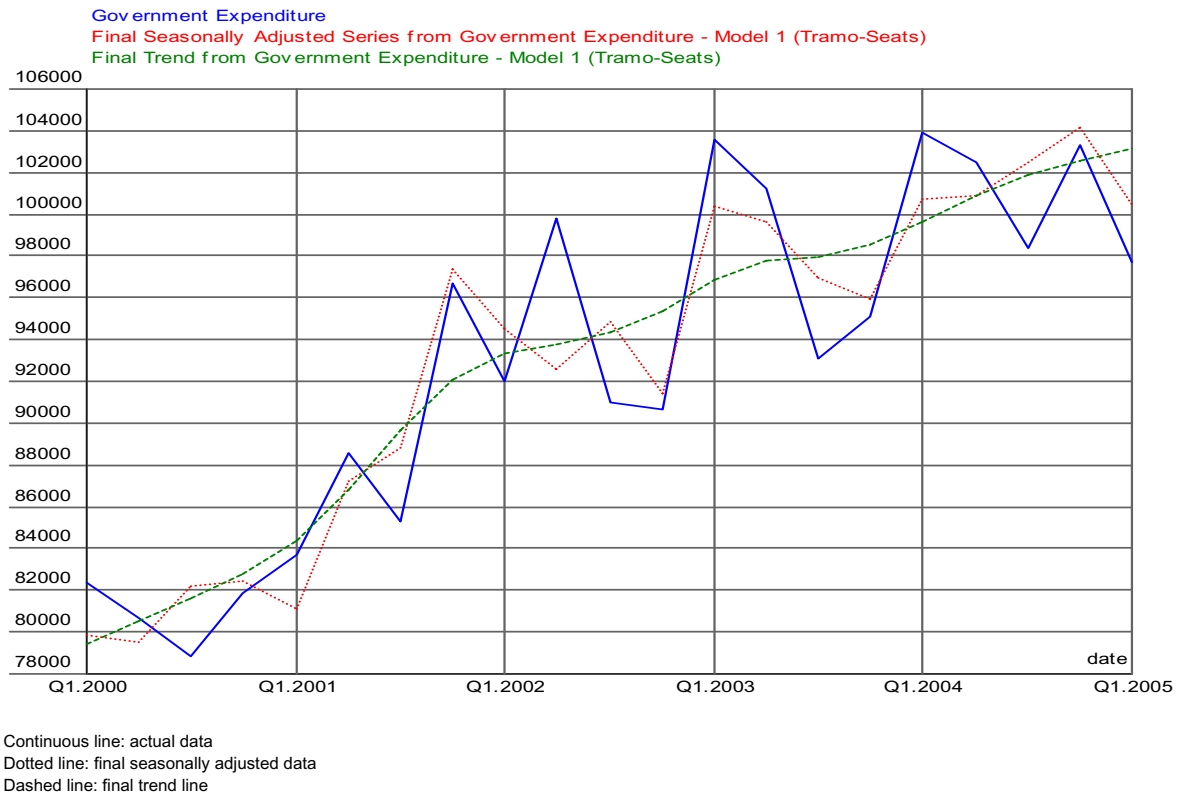
**Table 4. Information on diagnostics at current prices**

Variable	Ljung-Box on residuals	Ljung-Box on squared residuals	Box-Pierce on residuals	Box-Pierce on squared residuals	Normality	Skewness	Kurtosis	Percentage of outliers
Consumption	2.91 [0, 15.50] 5%	3.50 [0, 15.50] 5%	0.35 [0, 5.99] 5%	1.44 [0, 5.99] 5%	0.91 [0, 5.99] 5%	0.31 [-1.24, 1.24] 5%	1.97 [0.52, 5.48] 5%	4.76% [0%, 5.0%] ad-hoc
Government Expenditure	2.97 [0, 18.30] 5%	4.30 [0, 18.30] 5%	4.27 [0, 5.99] 5%	0.86 [0, 5.99] 5%	0.07 [0, 5.99] 5%	0.12 [-1.24, 1.24] 5%	2.77 [0.52, 5.48] 5%	0.00% [0%, 5.0%] ad-hoc
Gross Capital Formation	4.43 [0, 18.30] 5%	3.52 [0, 18.30] 5%	3.58 [0, 5.99] 5%	0.46 [0, 5.99] 5%	0.13 [0, 5.99] 5%	0.10 [-1.20, 1.20] 5%	2.60 [0.60, 5.40] 5%	0.00% [0%, 5.0%] ad-hoc
Exports	7.13 [0, 18.30] 5%	5.46 [0, 18.30] 5%	3.88 [0, 5.99] 5%	0.74 [0, 5.99] 5%	0.46 [0, 5.99] 5%	0.31 [-1.20, 1.20] 5%	2.45 [0.60, 5.40] 5%	0.00% [0%, 5.0%] ad-hoc
Imports	2.92 [0, 18.30] 5%	5.46 [0, 18.30] 5%	0.53 [0, 5.99] 5%	0.86 [0, 5.99] 5%	0.47 [0, 5.99] 5%	-0.36 [-1.20, 1.20] 5%	2.56 [0.60, 5.40] 5%	0.00% [0%, 5.0%] ad-hoc

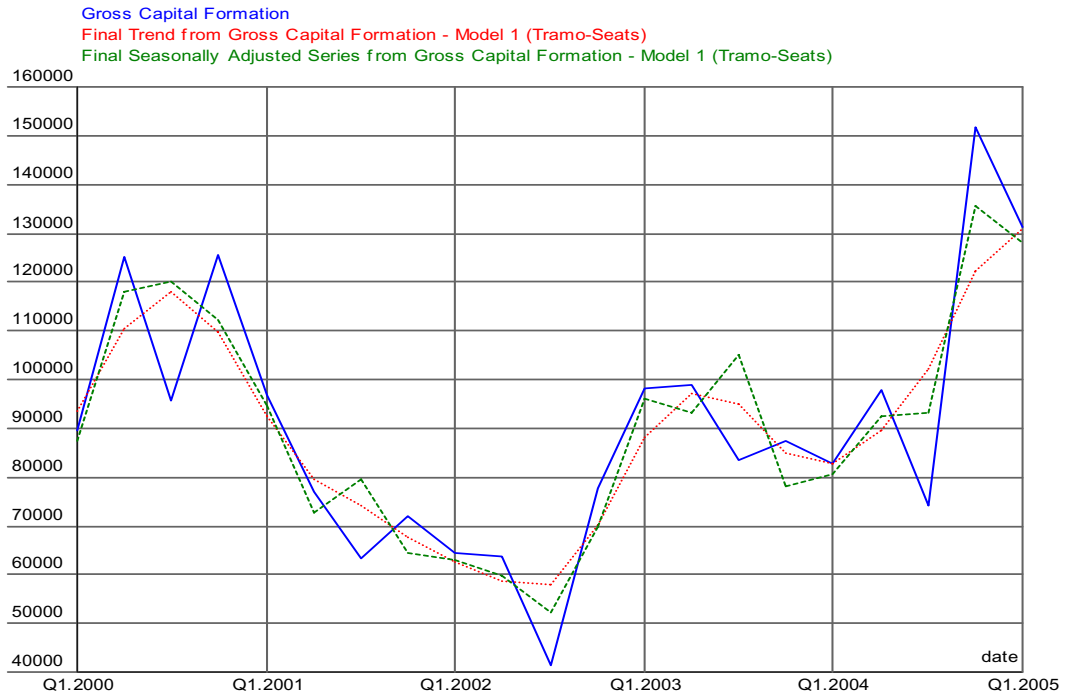
**Figure 1. Consumption at current prices**



**Figure 2. Government consumption expenditure at current prices**

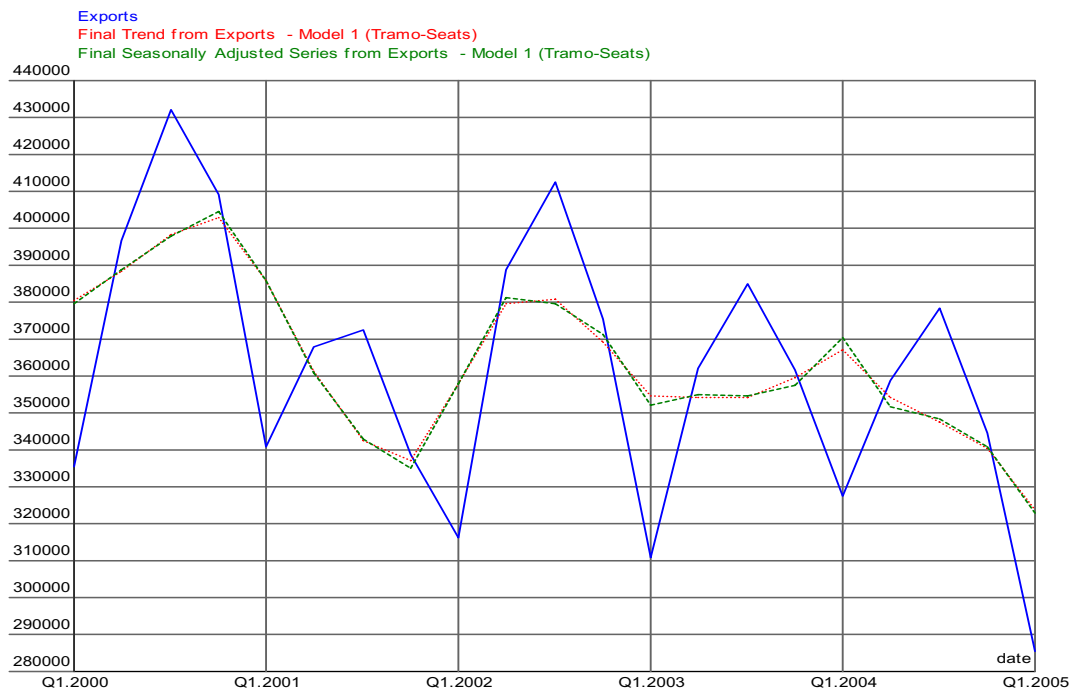


**Figure 3. Gross Capital Formation at current prices**



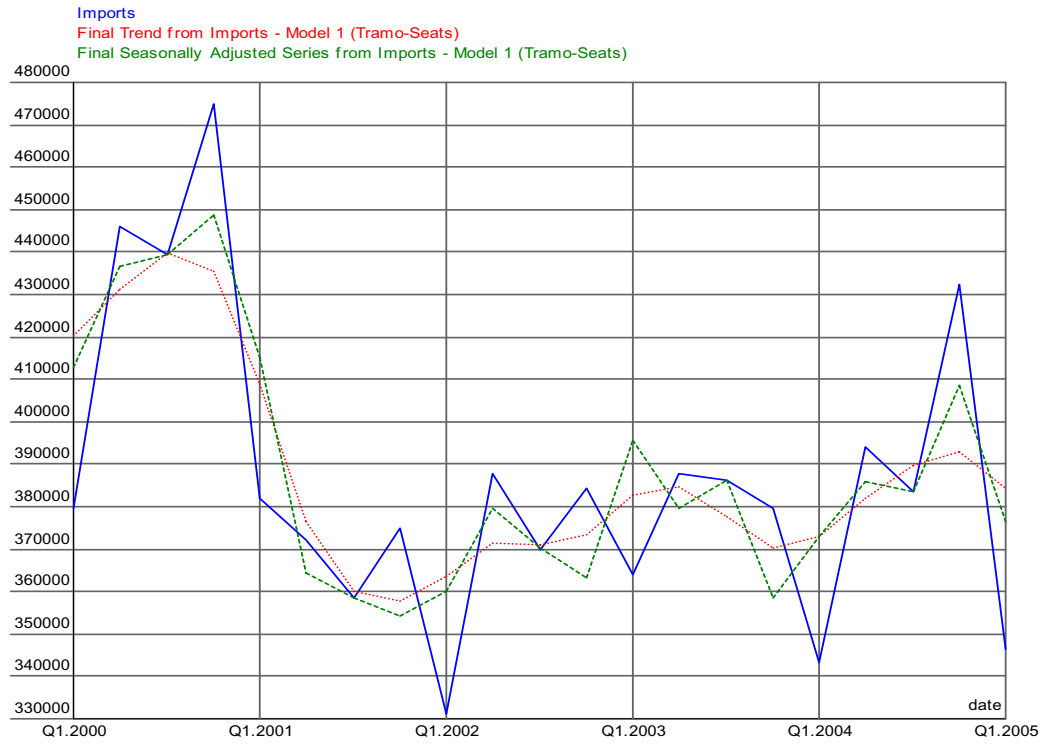
Continuous line: actual data  
 Dotted line: final trend line  
 Dashed line: final seasonally adjusted data

**Figure 4. Exports of Goods and Services at current prices**



Continuous line: actual data  
 Dotted line: final trend line  
 Dashed line: final seasonally adjusted data

**Figure 5. Imports of Goods and Services at current prices**



Continuous line: actual data  
 Dotted line: final trend line  
 Dashed line: final seasonally adjusted data

Table 5. Original data at constant prices

							Lm'000	
Period	Consumption	Government Expenditure	Gross Capital Formation	Exports	Imports	GDP	% change (Q <sub>t</sub> /Q <sub>t-1</sub> )	
2000	Q1	252,834	82,395	89,424	335,428	379,734	<b>380,347</b>	
	Q2	263,098	80,692	125,212	396,469	446,044	<b>419,427</b>	10.27
	Q3	274,420	78,865	95,648	431,898	439,456	<b>441,375</b>	5.23
	Q4	283,008	81,878	125,601	409,028	474,865	<b>424,650</b>	-3.79
2001	Q1	249,044	77,072	93,782	379,982	403,650	<b>396,230</b>	-6.69
	Q2	261,627	80,948	74,459	402,932	396,578	<b>423,388</b>	6.85
	Q3	277,802	77,540	61,153	398,563	387,096	<b>427,962</b>	1.08
	Q4	287,061	88,723	69,527	368,995	403,039	<b>411,267</b>	-3.90
2002	Q1	259,791	83,212	59,087	340,480	347,348	<b>395,222</b>	-3.90
	Q2	265,513	90,426	61,074	415,726	411,183	<b>421,556</b>	6.66
	Q3	274,556	81,715	38,957	436,471	391,378	<b>440,321</b>	4.45
	Q4	265,851	81,545	71,953	402,542	403,096	<b>418,795</b>	-4.89
2003	Q1	257,839	92,348	90,974	343,447	399,143	<b>385,465</b>	-7.96
	Q2	265,414	89,228	91,301	388,404	427,059	<b>407,288</b>	5.66
	Q3	282,759	81,533	77,485	407,839	421,620	<b>427,996</b>	5.08
	Q4	281,026	83,439	80,947	392,301	414,190	<b>423,523</b>	-1.05
2004	Q1	254,042	88,554	75,840	365,618	387,425	<b>396,629</b>	-6.35
	Q2	265,033	87,835	89,595	398,949	436,144	<b>405,268</b>	2.18
	Q3	291,640	83,937	68,044	416,042	430,136	<b>429,527</b>	5.99
	Q4	284,214	88,436	138,368	401,115	482,557	<b>429,576</b>	0.01
2005	Q1	251,725	83,576	118,584	313,937	371,432	<b>396,390</b>	-7.73

Table 6. Final seasonally adjusted series at constant prices

							Lm'000	
Period	Consumption	Government Expenditure	Gross Capital Formation	Exports	Imports	GDP	% change (Q <sub>t</sub> /Q <sub>t-1</sub> )	
2000	Q1	268,124	81,665	88,539	372,930	426,245	<b>385,014</b>	
	Q2	268,132	78,579	113,703	385,874	430,976	<b>415,314</b>	7.87
	Q3	268,789	82,067	121,364	402,019	437,727	<b>436,513</b>	5.10
	Q4	269,872	81,617	112,278	412,585	444,284	<b>432,067</b>	-1.02
2001	Q1	268,160	76,400	88,905	419,555	447,381	<b>405,639</b>	-6.12
	Q2	269,423	78,824	72,362	394,166	380,689	<b>434,086</b>	7.01
	Q3	270,041	80,686	73,663	372,117	384,552	<b>411,955</b>	-5.10
	Q4	269,021	88,435	63,991	368,147	384,053	<b>405,542</b>	-1.56
2002	Q1	270,642	82,497	58,259	380,598	381,857	<b>410,139</b>	1.13
	Q2	270,777	88,048	56,418	404,320	385,463	<b>434,100</b>	5.84
	Q3	269,172	85,028	51,325	409,686	388,360	<b>426,851</b>	-1.67
	Q4	256,706	81,278	65,070	397,836	396,551	<b>404,339</b>	-5.27
2003	Q1	272,594	91,565	85,360	384,525	412,102	<b>421,942</b>	4.35
	Q2	271,540	86,877	88,745	381,343	413,945	<b>414,561</b>	-1.75
	Q3	271,553	84,836	91,387	380,158	416,858	<b>411,076</b>	-0.84
	Q4	271,600	83,161	75,215	387,904	418,278	<b>399,602</b>	-2.79
2004	Q1	271,713	87,816	75,341	407,333	425,827	<b>416,377</b>	4.20
	Q2	272,139	85,517	84,190	393,979	430,581	<b>405,244</b>	-2.67
	Q3	273,681	87,335	92,532	391,850	437,020	<b>408,378</b>	0.77
	Q4	273,084	88,136	119,784	386,311	441,969	<b>425,346</b>	4.15
2005	Q1	272,928	82,891	118,936	358,330	432,675	<b>400,411</b>	-5.86



**Table 7. Information on models at constant prices**

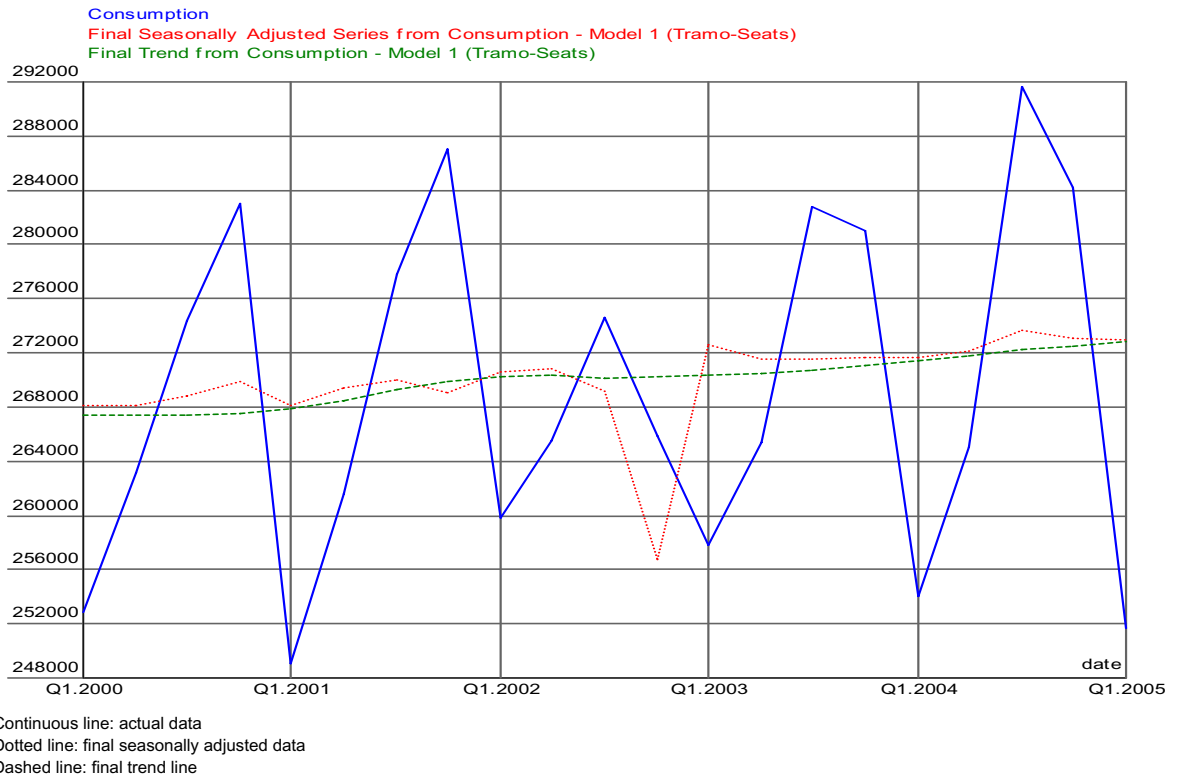
Variable	Status of adjustment	Time span (n° of obs.)	Arima model	Transformation	Mean correction	Outliers	ARIMA decomposition	Seasonality
Consumption	Accepted	Q1.2000 - Q1.2005 (21)	(2 1 1)(0 1 0)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC; 1: AO Q4.2002,	Exact	Seasonal model used
Government Expenditure	Accepted	Q1.2000 - Q1.2005 (21)	(1 1 1)(0 1 1)	Logarithm	Yes	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used
Gross Capital Formation	Accepted	Q1.2000 - Q1.2005 (21)	(3 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used
Exports	Accepted	Q1.2000 - Q1.2005 (21)	(3 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC	Exact	Seasonal model used
Imports	Accepted	Q1.2000 - Q1.2005 (21)	(3 1 1)(0 1 1)	Logarithm	None	Autom.(t-value>2.80):AO,LS,TC; 1: LS Q2.2001,	Exact	Seasonal model used

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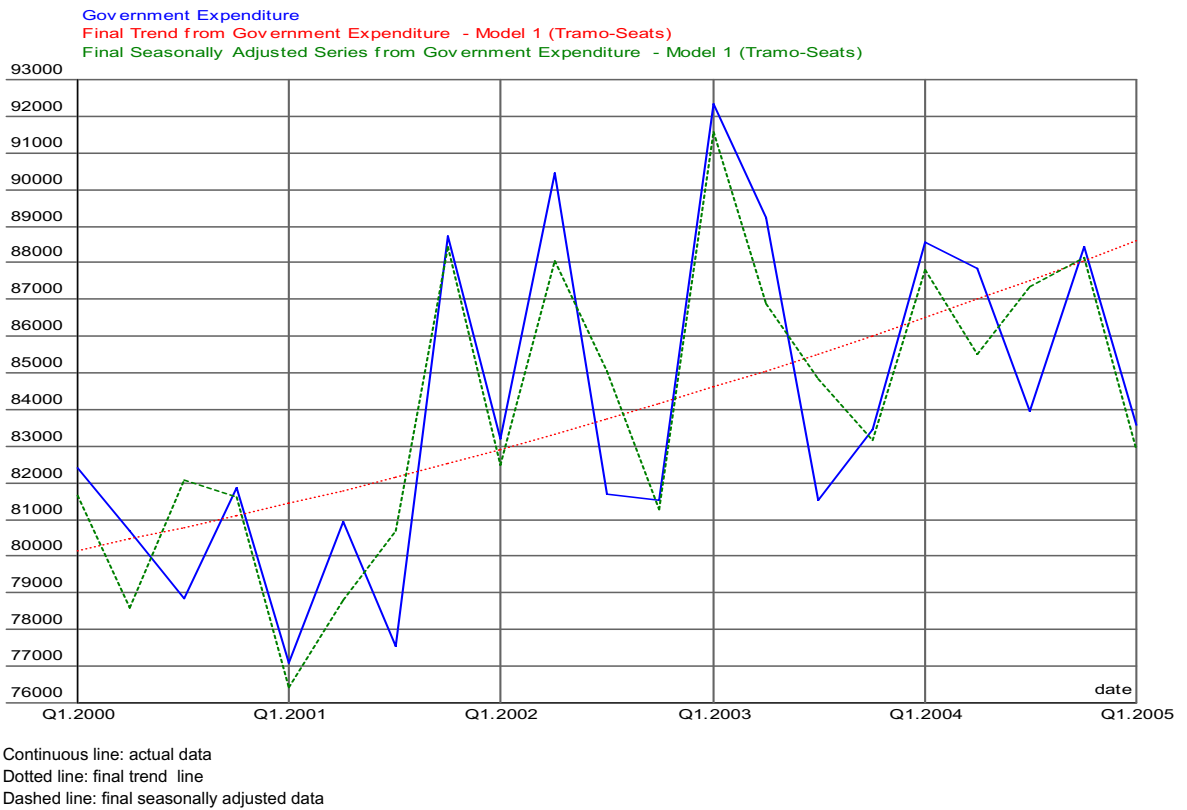
**Table 8. Information on diagnostics at constant prices**

Variable	Ljung-Box on residuals	Ljung-Box on squared residuals	Box-Pierce on residuals	Box-Pierce on squared residuals	Normality	Skewness	Kurtosis	Percentage of outliers
Consumption	7.40 [0, 16.90] 5%	4.62 [0, 16.90] 5%	0.69 [0, 5.99] 5%	0.82 [0, 5.99] 5%	1.62 [0, 5.99] 5%	0.75 [-1.24, 1.24] 5%	2.43 [0.52, 5.48] 5%	4.76% [0%, 5.0%] ad-hoc
Government Expenditure	1.05 [0, 16.90] 5%	2.46 [0, 16.90] 5%	4.73 [0, 5.99] 5%	0.31 [0, 5.99] 5%	0.48 [0, 5.99] 5%	0.10 [-1.24, 1.24] 5%	2.15 [0.52, 5.48] 5%	0.00% [0%, 5.0%] ad-hoc
Gross Capital Formation	5.52 [0, 14.10] 5%	4.29 [0, 14.10] 5%	3.71 [0, 5.99] 5%	1.49 [0, 5.99] 5%	0.18 [0, 5.99] 5%	0.12 [-1.20, 1.20] 5%	2.53 [0.60, 5.40] 5%	0.00% [0%, 5.0%] ad-hoc
Exports	1.85 [0, 14.10] 5%	0.69 [0, 14.10] 5%	0.50 [0, 5.99] 5%	0.35 [0, 5.99] 5%	5.15 [0, 5.99] 5%	-1.19 [-1.20, 1.20] 5%	4.43 [0.60, 5.40] 5%	0.00% [0%, 5.0%] ad-hoc
Imports	1.17 [0, 14.10] 5%	7.73 [0, 14.10] 5%	2.50 [0, 5.99] 5%	4.50 [0, 5.99] 5%	2.90 [0, 5.99] 5%	1.07 [-1.24, 1.24] 5%	3.13 [0.52, 5.48] 5%	4.76% [0%, 5.0%] ad-hoc

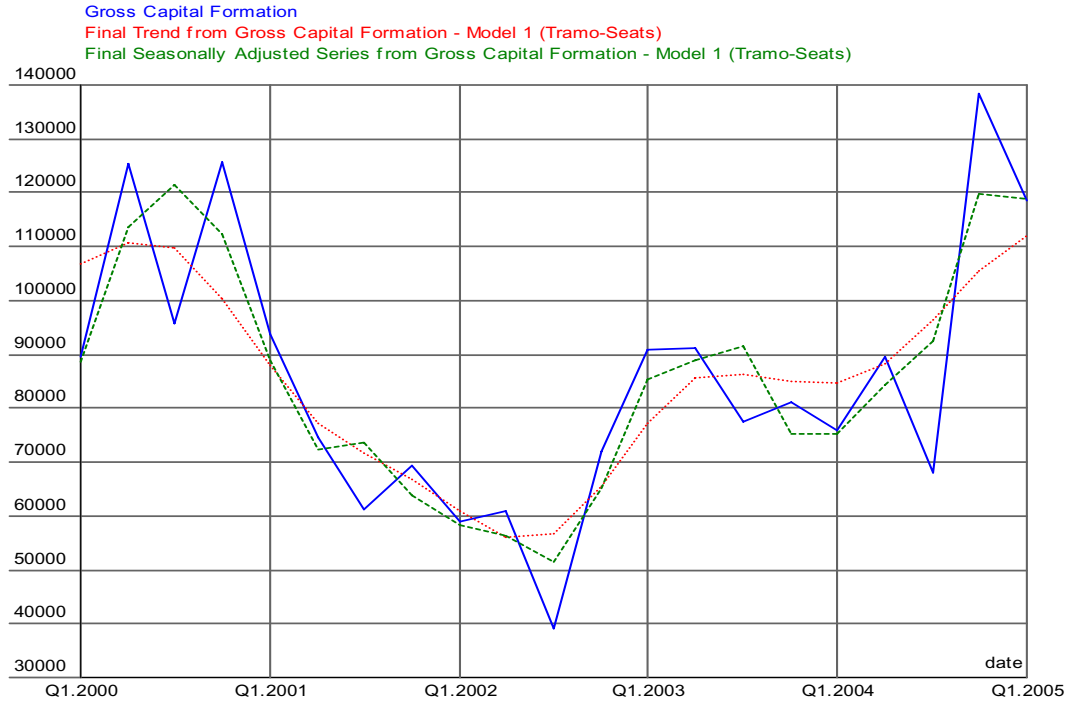
**Figure 6. Consumption at constant prices**



**Figure 7. Government consumption expenditure at constant prices**

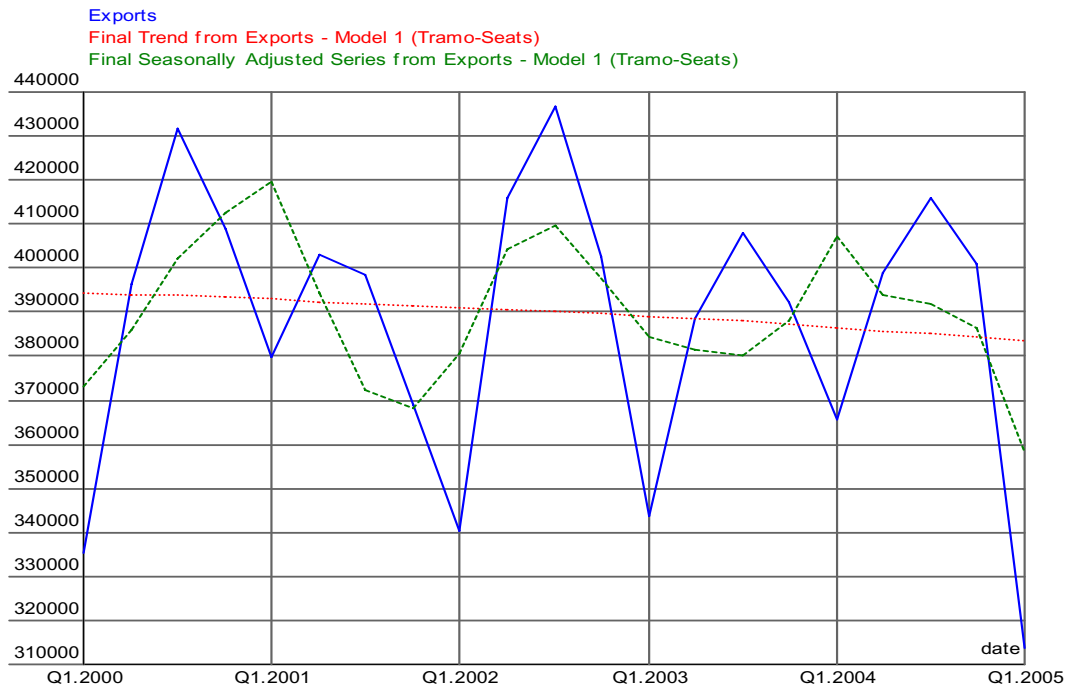


**Figure 8. Gross Capital Formation at constant prices**



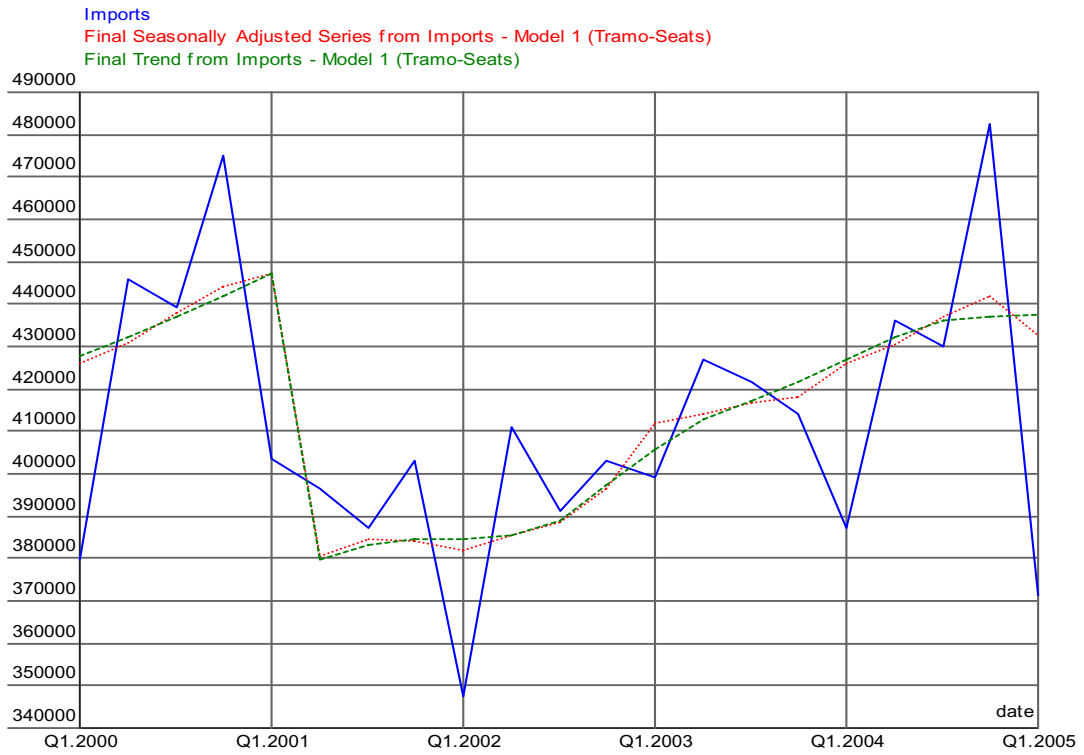
Continuous line: actual data  
 Dotted line: final trend line  
 Dashed line: final seasonally adjusted data

**Figure 9. Exports of Goods and Services at constant prices**



Continuous line: actual data  
 Dotted line: final trend line  
 Dashed line: final seasonally adjusted data

**Figure 10. Imports of Goods and Services at constant prices**



Continuous line: actual data  
Dotted line: final seasonally adjusted data  
Dashed line: final trend line