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by Diana Wyman

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.. not available for a specific reference period
... not applicable
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0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E} use with caution
F too unreliable to be published
* significantly different from reference category ($p < 0.05$)

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Seasonal adjustment and identifying economic trends

by Diana Wyman [1]

Overview

There has been heightened interest in understanding the movements in monthly and quarterly [2] economic data as a result of the recent economic downturn. This makes a review of the basics and the subtler aspects of seasonal adjustment both timely and relevant for analysts who are grappling with the repetitive ups and downs and added volatility of the unadjusted data. This article aims to explain seasonal adjustment and highlight how seasonally adjusted data help analysts hone in on the underlying economic trend.

The unadjusted data can be broken down into four elements: the long-term trend (T), the cyclical component (C), the irregular component (I) and the seasonal component (S). Of these, the cyclical component is the focus of analysis of the business cycle, as it is movements in this component that show whether the economy is contracting or expanding and at what rate. The long-term trend is a relatively stable component, changing gradually to reflect phenomenon such as demographic change. Because it has little effect on short-term movements, it is grouped with the cyclical component to form what is called the trend-cycle. The two remaining components are those which obscure the current status of the business cycle – the seasonal and irregular components.

The concept of "seasonality" is not limited to the effect of changing seasons. It encompasses any regularly recurring movements in the unadjusted data, namely the effect of average weather patterns, statutory holidays, industry norms (such as the holidays in the auto and construction industries every July), as well as the number and distribution of working days in a month or a quarter. As shown in Figure 1, the seasonal pattern is often the dominant feature of the monthly change in unadjusted data, masking the underlying trend. By removing seasonal effects, seasonally adjusted data allow analysts to focus more clearly on the underlying trend-cycle in as close to real-time as possible.

Seasonally adjusted data are the unadjusted (or 'raw' data in the lingo of statisticians) data with an estimate of these regularly recurring effects removed. This estimate is based on the patterns observed in the past. Retail sales are one example of a series that exhibits a clear seasonal pattern. In the unadjusted retail sales data shown in Figure 1, January sales fall nearly one-quarter on average after December and then drop a bit further to their yearly low in February. Retail sales then rise throughout the spring and summer as milder weather encourages shoppers and drivers to venture out. Sales dip as cool weather returns, before shooting upward in November and December when holiday shopping is in full swing.

The irregular component remains in seasonally adjusted data, at times obscuring the trend-cycle. The irregular component encompasses the random element introduced by unexpected events. Memorable examples of the irregular component include the ice storm in central Canada in winter 1998 and the electrical blackout in Ontario in August 2003, both of which severely disrupted production. More frequently, unscheduled maintenance, labour strikes, or atypical weather are reflected in this component.

The three components of seasonality

Seasonality captures more than changing weather. There are three parts to seasonal patterns: the climatic (weather-related) effect; the institutional component; and the calendar effect. [3] Only the first part, the

climatic effect, reflects the change in economic activity resulting from recurring weather changes of the four seasons; for example, the drop in agriculture following the autumn harvest.

The second part, the institutional component, refers to industry-specific norms, such as regular annual vacations and scheduled shutdowns, and statutory holidays. The impact of Christmas, which fuels retail sales through November and December, is one example.

The third part of seasonality, the calendar effect, relates to the composition of the calendar. The main calendar effect is the trading day effect, which refers to the variation in the number of days in a month (for example, unadjusted retail sales data are lower for February relative to the other months, which have 30 or 31 days) and the distribution of particular week days in a month. As retail sales are highest on Saturdays, [4] a month of unadjusted retail sales data with five Saturdays may be higher than another with four. However, this does not indicate that sales had fundamentally improved that month, only that sales received a boost from the extra Saturday.

The switching of Easter between March and April is another calendar effect, shifting sales and output between the two months. [5] Without accounting for the calendar effect, it is misleading to compare two months within the same year, or to compare a month with the same month one year earlier. [6]

Seasonal adjustment entails estimating the usual monthly seasonal pattern, which is reflected in the seasonal factor. The seasonal factor is expressed as a ratio [7] of the monthly seasonally adjusted data and the monthly unadjusted data for that month. Dividing the original series by this factor yields the seasonally adjusted series. [8] Seasonal factors for a given month can be greater or less than 1.0. As shown in Table 1, retail sales in December are typically 15% higher than those in an average month, as indicated by its seasonal factor of 1.15. January's sales are below average, as indicated by its seasonal factor of 0.82, which shows that sales are usually about 18% less than an average month.

As the same exercise was conducted for all prior months, the seasonally adjusted data for December can be compared with October and November data in order to get a sense of the underlying trend. A seasonally adjusted series makes December more comparable with other Decembers as well as with every other month of the year.

Shifting seasonality

Seasonal adjustment does not remove all seasonal effects but rather the 'average' seasonal pattern determined by observing the past. Shifting seasonality, which refers to the movement of a seasonal pattern into a new time period or a change in the magnitude of a seasonal pattern, is not addressed by seasonal adjustment. One reason for this is that a new seasonal pattern may not obviously be a pattern until it recurs several times. Until then, shifting seasonality is reflected in the irregular component.

In recent years, there have been several changes to seasonal patterns that are worth highlighting. These shifts relate to changes such as the proliferation of gift cards, the creation of cold-resistant concrete, and the introduction of Family Day in mid-February in several provinces starting in 2008.

With regard to gift cards, the usual shopping pattern during the 1990s was that retail sales peaked in November and December and then dropped sharply in January. Since the advent of gift cards, the fall in January has not been as severe, as the purchase of the gift card is included when the gift card is redeemed (and not when it is bought). [9] Prior to the introduction of gift cards, which shifted some shopping from December to January, the seasonal factor indicated that unadjusted retail sales in December were 20% higher than those in an average month. In recent years, December sales were only 15% higher, as sales shifted into the new year, when gift cards were redeemed.

Similar to the technological innovation of the gift card, cold-resistant concrete mix and the plastic covering of whole buildings have allowed the construction season to be prolonged and some construction to continue year-round. [10] Prior to their introduction, very little construction output occurred during the winter months. The proliferation of these new technologies changed the seasonal pattern in series such as housing

starts [11] and employment. The recent introduction of Family Day in several provinces is another example of changing seasonal patterns, as this meant one fewer working day in February.

Changing seasonal patterns tend to occur gradually. The growing popularity of gift cards after 2000 dampened December retail sales. The opposite was true for January as sales steadily rose in each January until about 2007, when the use of gift cards became available from nearly every major retailer and the new seasonal pattern stabilized.

Seasonal adjustment and volatility

While the seasonal component is the most consistent source of volatility in the unadjusted data, there is a common misunderstanding that data that are seasonally adjusted reflect only the underlying trend. Seasonal adjustment removes only predictable ups and downs in the data; not all weather-related changes are seasonal. For example, a prolonged heat wave may increase seasonally adjusted energy use as the seasonal factor reflects 'average' weather as determined by that observed in past years. Any divergence from this norm will remain in the seasonally adjusted data, as part of the irregular component.

The irregular component is always present in seasonally adjusted data and can produce a large amount of volatility in any given month. In the case of major events such as the Ontario electrical blackout and the ice storm mentioned earlier, the trend-cycle was overwhelmed by the monthly irregular component. The Toronto municipal strike in the summer of 2009 is another example. [12]

The magnitude of the irregular component varies among different economic series. This is demonstrated in Figures 2a and 2b, which show the unadjusted data for monthly retail sales and new vehicle sales and their breakdown into their seasonal, irregular and trend-cycle components. Monthly (or quarterly) movements in the irregular component can be large and even exceed changes in the trend-cycle (as in the case of new motor vehicles, partly due to the recurring use of rebates and other incentives to purchase). In comparison, the irregular component of retail sales is relatively small, and its trend-cycle is much smoother.

For both retail sales and housing starts, unadjusted January and February data are the yearly lows, posting very small values relative to those for the rest of the year. As a result, movements in the irregular component in January and February are amplified; this results in a higher variability in the seasonally adjusted data. [13] In these circumstances, it is up to the analyst to isolate the monthly movement of the trend-cycle from the irregular component.

When comparing the unadjusted and seasonally adjusted data in Figure 3, it is evident that with the seasonal pattern removed, the seasonally adjusted series is much more stable than the unadjusted data. In most months, the seasonally adjusted series is a good indicator of the movements in the trend-cycle. However, when there are large changes in the irregular component, as in June 2003 (after a case of mad cow disease led to a decline in demand for food products), and in August 2003 (during Ontario's electrical blackout), the seasonally adjusted series diverges from the trend-cycle. Analysis is straightforward when comparing months without large irregular components. However, if an irregular component is present, interpreting the seasonally adjusted data correctly is not a simple task. Shifting seasonality can further obscure the underlying trend.

In addition to the seasonal and irregular component creating challenges for analysts, the trend-cycle itself can be a source of volatility. Since the economy contracted sharply in late 2008, data users have keenly followed short-term changes in the economy and found themselves wading through many volatile datasets. For example, unadjusted retail sales in December 2008 were below those of May 2008, a rare shift from the normal pattern of December sales being above those of all other months of the year by a sizeable margin.

[14] One of the reasons for this volatility is that the seasonal pattern was overridden by the cyclical movement of a severe recession.

Seasonal patterns were overwhelmed by the recession in many other series. New motor vehicle sales normally rise rapidly in the spring, peak in May, and then decline sharply. In 2009, sales increased at a more gradual rate in the lead-up to May, before stabilizing into autumn. Manufacturing sales normally drop sharply in July as vacations and maintenance at auto plants mean fewer working hours. As a result of auto plant shutdowns that took place prior to July 2009 following unprecedented bankruptcy proceedings, the reduction in hours worked was no more pronounced in July 2009 than in May and June.

Seasonal patterns affect all of the major economic indicators. Because it removes recurring seasonal patterns, seasonal adjustment facilitates analysis by leaving only the irregular pattern to account for when focusing on the underlying cyclical trend. When the economy is steadily growing or contracting, seasonally adjusted data usually offer an easy-to-read update for analysts. Other times, such as when a major labour disruption occurs or a new holiday is instituted, there will be a large irregular component. Moreover, in turbulent economic times, there will be additional volatility in the trend-cycle, which requires analysts to be innovative.

Year-over-year changes

Analysts have always searched for ways to cope with the recurring ups and downs in the unadjusted data as a first step in isolating the trend-cycle. One commonly used method is the same-month year-ago percentage change, which compares the same two months one year apart.

Using unadjusted data is useful in several instances [15] such as when seasonally adjusted data are not yet released (one of the drawbacks of seasonally adjusted data is the time required to process and publish these estimates) but the unadjusted indicator is available early (such as daily or weekly changes in financial markets or company sales). Often, seasonally adjusted data are not available at all for the level of detail required, such as employment by occupation. Unadjusted data are also useful in trying to understand seasonal patterns: for example, when do retail sales peak so that a business can ensure adequate inventories?.

There are several weaknesses in using the year-over-year percentage change for unadjusted data. The main limitation is that the story it tells is an outdated one [16] , a weakness that is especially important now given the current focus on identifying the point at which the economy may have moved from contraction to recovery. By comparing the latest month to the same month one year ago, the year-over-year calculation is the sum of the twelve monthly changes during that year. For example, the economy in late 2008 and early 2009 contracted sharply. Since the spring of 2009, the economy has stabilized and begun improving, with moderate gains observed in most series. As a result, the same-month year-ago change throughout 2009 has been a mixture of two very different trends. [17]

Also, given that the central objective of most analysts is to identify the underlying trend-cycle, the year-over-year percentage change for unadjusted data does not perform well as an analytical tool. It does not account for the trading day effect, leaving the analyst wondering if the number or distribution of days is affecting the monthly or quarterly movement. Nor does it address the problem of an outlier month distorting the basis of comparison. Events such Ontario's electrical blackout (August 2003), and the Toronto municipal strike (summer 2009) are examples of outlier months as they created large irregular components, depressing production and building permits to unusually low levels. When calculating year-over-year changes for these months, the increase occurring twelve months after the outlier is exaggerated by the weakness in the base period of the comparison.

Seasonally adjusted data help address the problem of comparing with an outlier month. When comparing seasonally adjusted data, the analyst examines adjacent months. If there is an event in the previous month that created a large irregular movement, the analyst is more likely to observe this irregular component and discount it. If the size of the irregular component cannot be estimated, the outlier month can be ignored and the trend determined from comparing the current month with earlier months. [18]

When a year-over-year measure is discussed in Statistics Canada's main economic data releases, it usually compares two seasonally adjusted data points. While the year-over-year change still offers an outdated view of recent trends relative to the seasonally adjusted month-to-month change, it does provide context to the monthly analysis by comparing it with the longer-term trend. The year-over-year calculation using

seasonally adjusted data is preferable to the same-month year-ago change in unadjusted data, since the trading day adjustments are removed from the data prior to the calculation. As a result, the data are smoother and the trend is clearer, as the year-over-year change in the seasonally adjusted data is not obscured by the presence of trading day effects.

For example, in Figure 4 the decline in retail sales in late 2008 was revealed earlier in the seasonally adjusted year-over-year change and the decline is more gradual than in the unadjusted data. February 2009 was the weakest month for unadjusted retail sales, dropping 9%. In contrast, the year-over-year change in seasonally retail sales showed a decrease of 5% in February and the trend indicated that the rate of decline was slowing from its low of -7% in December 2008. The gradual improvement in year-over-year seasonally adjusted sales in January accords with the increase that began in monthly seasonally adjusted sales. The main reason for the larger decline in the unadjusted data was that 2008 was a leap year; moreover, this extra day was a Friday, which is the second busiest day of the week for retail sales. The seasonally adjusted data accounted for the effects of the leap year and the additional Friday as part of the overall calendar adjustment, which is why the largest drop in the year-over-year seasonally adjusted retail sales occurred in December 2008, not February 2009.

Conclusion

This paper shows that given the magnitude of seasonal swings in the unadjusted data, the underlying trend-cycle is difficult to distinguish. Same-month-year-ago calculations may offer a rudimentary sense of the trend, but are limited by their inability to account for trading day effects, and the possibility of an outlier month distorting the comparison. In addition and most importantly, year-over-year changes fall prey to the problem of being outdated.

Many analysts have used seasonally adjusted data with only a cursory understanding of the basics of seasonal adjustment, in some cases inferring that seasonality refers solely to weather-related patterns in the data. While living with Canada’s four distinct seasons and highly variable weather does ensure that seasonality is a preoccupation among analysts, the effects of industry norms and statutory holidays and the arrangement of the calendar are responsible for many of the monthly (or quarterly) seasonal swings throughout the year.

After accounting for repetitive seasonal swings by using seasonally adjusted data, analysts still face the challenge of identifying the unexpected ups-and-downs from the irregular component, comprised of random events and emerging seasonal patterns, in order to isolate the trend-cycle. In times of boom or bust, such as the recent downturn in late 2008, there is additional volatility in the trend-cycle, as opposed to the gradual rise, decline, or flat trend to which analysts are accustomed. It requires good analysis, a familiarity with the subject matter, and attentiveness to current events and industry developments in order to screen out these effects and isolate changes in the underlying trend-cycle.

Notes

1. Current Analysis Group (613-951-4886)
2. Monthly and quarterly data (or sub-annual data) are affected by seasonal patterns and require seasonal adjustment. Annual data are not affected by the seasonal pattern that occurs within a year. However, annual totals of seasonally adjusted monthly or quarterly series are affected by shifting seasonal patterns and extra trading days, and may not equal the unadjusted annual total unless it has been specified in the seasonal adjustment program to impose it on the seasonally adjusted data.
3. According to the "Statistics Canada Quality Guidelines", Statistics Canada Catalogue no. 12-539, October 2009, (available at /pub/12-539-x/12-539-x2009001-eng.pdf, page 63), climatic and institutional effects are seasonal effects while trading day effects and the movement of Easter between March and April are calendar effects. Together, the seasonal and calendar effects form the combined seasonal effect. In order to avoid confusion in this paper, the climatic and institutional effects are discussed separately, and all references to seasonal factors, seasonal effects, seasonality, seasonal patterns, and seasonal adjustment throughout the paper refer to the combined seasonal effect.
4. The most important days of the week vary from series to series. In the international merchandise trade import data, Mondays are the busiest days. An additional charge is applied to goods processed by customs on Saturdays and Sundays, which leads some importers to hold their goods until Monday and thus creates a queue.
5. The Easter effect increases retail sales in the month in which it occurs but reduces the work week (and therefore has a dampening effect) for most other series. Easter in early April also affects retail sales late in March.
6. The calendar effect tends to be much greater in series such as retail sales and merchandise trade than in labour force survey (LFS) and consumer price index (CPI) data. The LFS and CPI data are collected over a scheduled period each month and do not have a trading day adjustment but rather a reference period adjustment that accounts for holidays in the period in which the data are collected. As a result, the difference between the unadjusted and seasonally adjusted LFS and CPI data is much less than these other series.
7. This is the case only for series for which a multiplicative model of seasonal adjustment, the most common, applies. An additive model is used for series such as the change in inventories where negative numbers occur.
8. The seasonal adjustment package that Statistics Canada uses is X-12-ARIMA. This package can be downloaded without charge from the US Census Bureau website.
9. Yiling Zhang. "Consumer Holiday Shopping Patterns." Analysis in Brief. December 2004.
10. Katherine Marshall. "Seasonality in employment." Perspectives on Labour and Income. Statistics Canada Catalogue no. 75-001-XPE, Spring 1999.
11. This shifting seasonality occurred in various construction-related series such as residential construction, building permits, and housing starts.
12. During the Toronto municipal strike in 2009, the stoppage in the approval of building permits led to a large decline in the number of permits issued in July and a subsequent recovery in the autumn as the city caught up with the backlog of applications.
13. The variability in January and February as measured by the standard deviation of growth in these months, was 1.8 and 1.3, respectively, compared with a standard deviation of 1.1 for the entire series.
14. On average, between 2004 and 2007, retail sales were 13% higher in December than in May.
15. Some data are not adjusted for seasonality, either because the irregular pattern is so large that it overwhelms the seasonal pattern, which consequently cannot be identified, or because there is no seasonal pattern to that particular economic activity. For example, for the Industrial Product Price Index (IPPI), many industries raise prices once a year and leave them unchanged for the rest of the year. Seasonally adjusting the series would only pro-rate this once-a-year price increase over the twelve months, which is analytically meaningless and therefore is not undertaken.
16. See Benoit Quenneville, "Gain and phase shift of the Annual Difference Operator," Statistics Canada, Working Paper of the Methodology Branch (forthcoming) which demonstrates that the trend of the

year-over-year calculation is dominated by what happened, on average, six months earlier rather than what is taking place in the current month.

17. When using unadjusted data, it is more useful to analyze the change in the year-over-year calculation (that is, the difference in the growth between January 2008 and January 2009 and the growth between February 2008 and February 2009) than to focus only on the same-month year-ago percentage change calculation in isolation.

18. The 'cash for clunkers' program in the US, which allowed households with older cars to receive money toward a new vehicle purchased in July and August 2009, is one example of how the issue of an outlier month is partially addressed by using seasonally adjusted data. Some analysts speculated that sales would spike during the 'cash for clunkers' program and then sharply retreat as demand dried up. However, after a small dip in September, sales followed their pre-clunkers trajectory and by late in 2009 had grown above the pre-'clunkers' level. Ignoring July, August, and September therefore reveals the underlying trend of the seasonally adjusted series.

Chart 3.1
Retail sales, seasonally adjusted and unadjusted

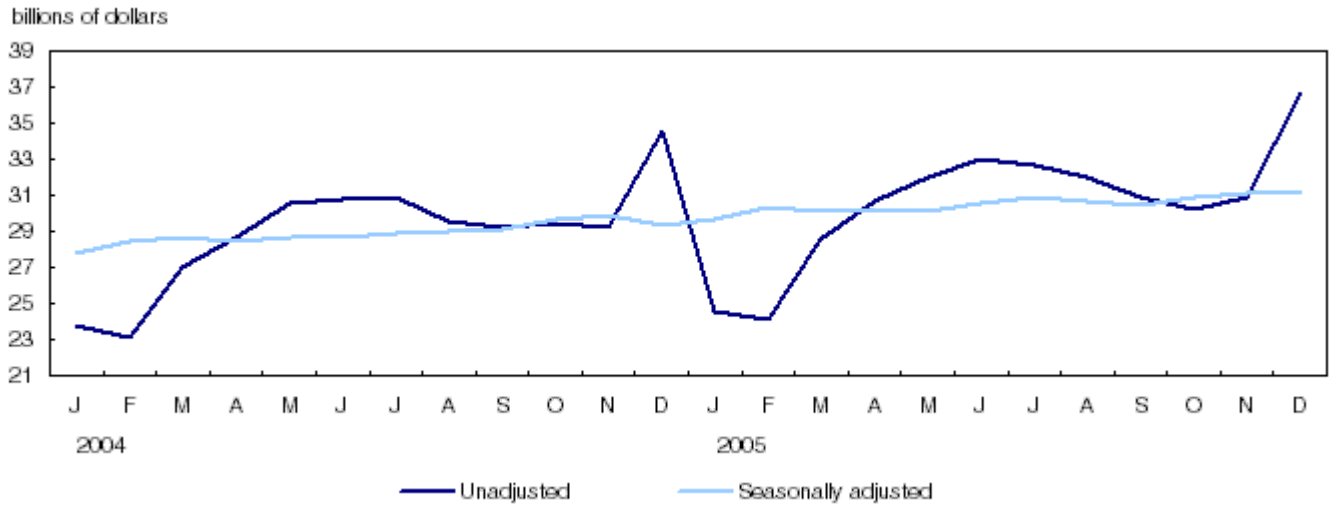


Chart 3.2
Retail sales, components of unadjusted data

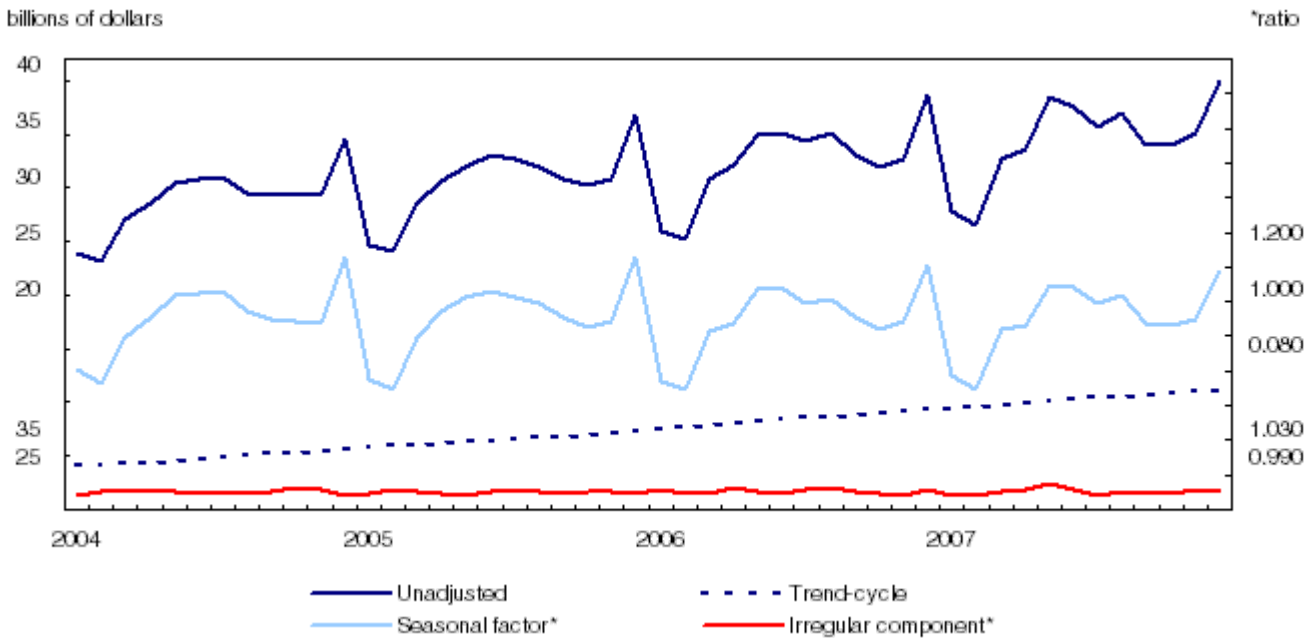


Chart 3.3
New vehicle sales, components of unadjusted data

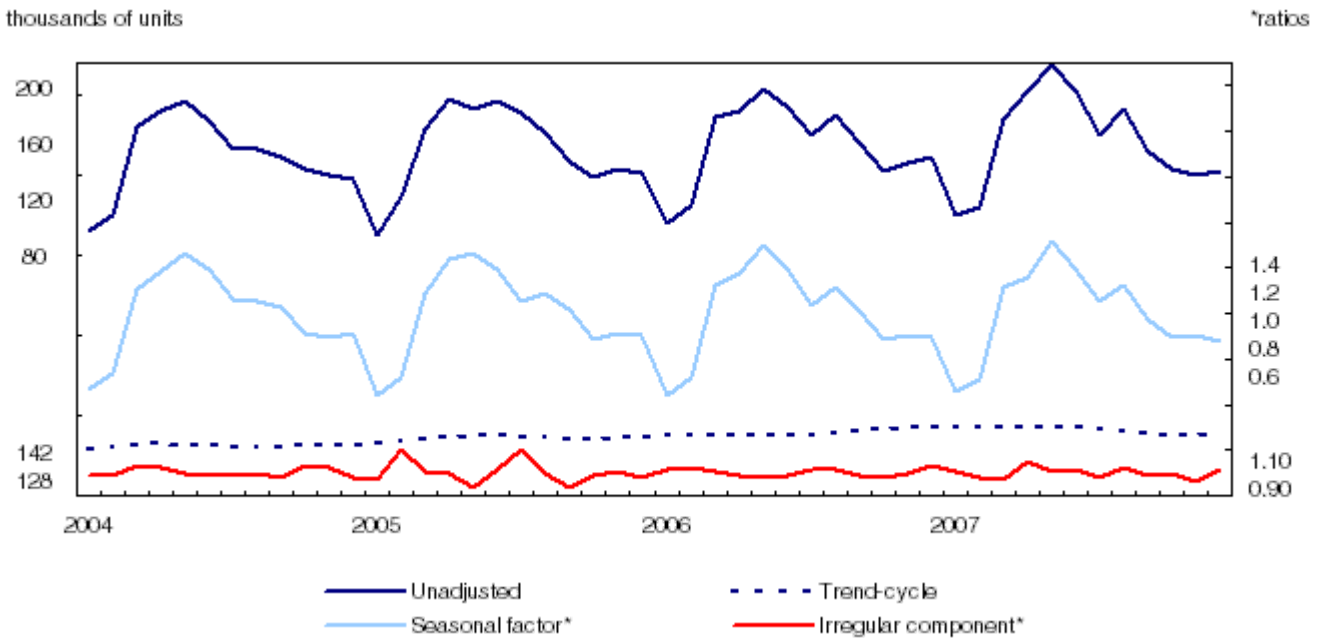


Chart 3.4
Manufacturing sales

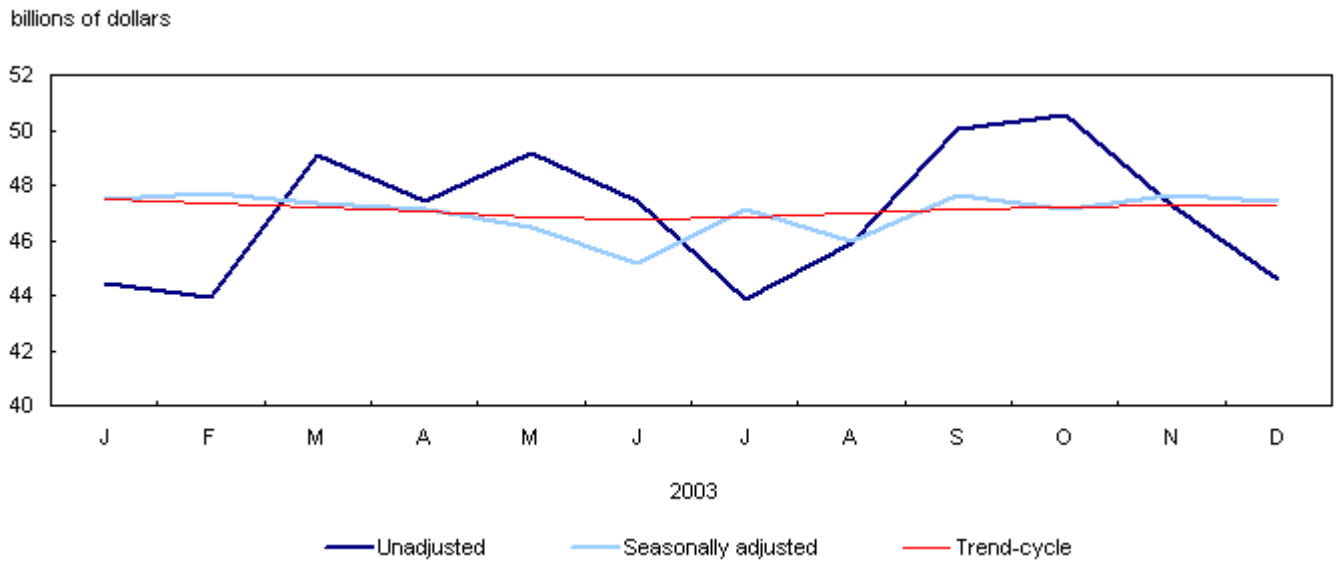
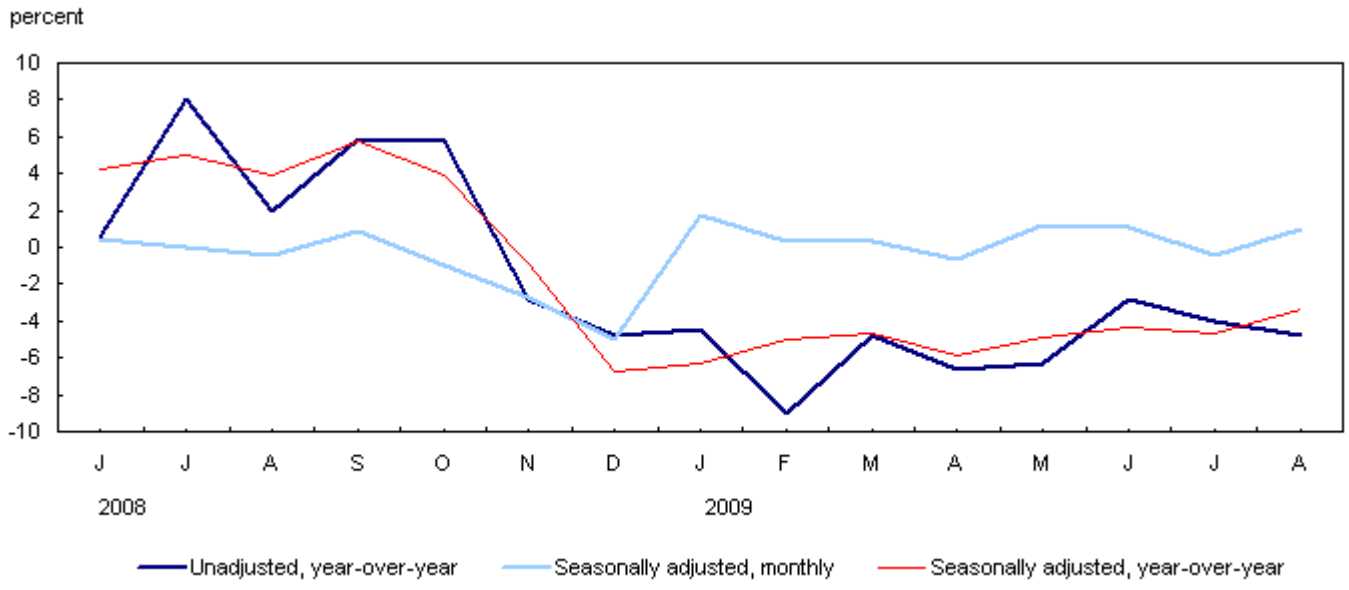


Chart 3.5
Retail sales, year-over-year and monthly percentage change



Text table 3.1
Seasonally adjusting retail sales

	Original series $ millions	Seasonal factor number	Seasonally adjusted series $ millions
January 2006	26,021	0.822	31,656
February 2006	25,171	0.794	31,702
March 2006	30,732	0.965	31,847
April 2006	32,117	0.989	32,474
May 2006	34,928	1.088	32,103
June 2006	35,056	1.087	32,250
July 2006	34,370	1.044	32,921
August 2006	35,010	1.061	32,997
September 2006	32,995	1.014	32,539
October 2006	31,858	0.973	32,742
November 2006	32,677	0.998	32,742
December 2006	38,551	1.151	33,493
January 2007	27,768	0.838	33,136

Note(s): The figures in this table may not exactly match those in CANSIM as a result of revisions that have taken place since the publication of this paper.