FEATURE

John Morris and Tegwen Green
Office for National Statistics

Measuring the quality of the producer price index

SUMMARY

The calculation of standard errors for the output producer price index (PPI) has been investigated with the aim of measuring the quality of the growth rates of the published price indices. This article presents, for the first time, Office for National Statistics' (ONS) estimates of the standard errors for month-on-month and 12-month growth rates of the gross sector output PPI. It provides an account of the initial investigation of standard errors within the PPI context and explains: the PPI structure and describes the index types for which standard errors have been calculated; what standard errors are and how they can be interpreted; the new method of calculation of standard errors for the PPI; the main findings from the analysis within the context of the PPI structure; and the publication policy.

The output producer price index (PPI), produced by the Office for National Statistics (ONS), is a monthly index that measures the growth in UK factory gate prices. A new method for estimating standard errors of growth over any fixed period, for example, one month, three months and 12 months, has been developed. The overall standard error for the month-on-month growth rate of the gross sector output (GSO) PPI (including duty) is 0.2 percentage points, while, for the 12-month growth rate, the standard error is 0.7 percentage points.

This initial study focuses on the GSO all-manufacturing PPI, which measures the prices of products sold by UK manufacturers, irrespective of the classification of the customer who buys the product. Month-on-month and 12-month growth rates are the PPI First Release's main measures and these are the main components throughout the analysis.

What is the PPI?

The PPI measures the change in price of goods bought and sold by UK manufacturers. The indices are based on the estimation of average price movements for a fixed, representative sample of products. Prices are collected for these products on a monthly basis. Both input and output indices are produced. Input prices are the prices of goods bought by UK manufacturers for use in the manufacturing process and include prices for imported goods. Output prices relate to goods sold by UK manufacturers in the UK, that is, prices of exports are excluded. PPIs are also produced on both a gross and net sector basis. The net sector series exclude transactions between companies classified to the manufacturing sector, whereas intra-sector sales are included when calculating the gross sector series.

Structure of the PPI

The structure of the PPI is defined by the European Classification of Products by Activity (CPA) which is based on the standard European industrial classification NACE (Rev. 1). The CPA divides products into hierarchically numbered categories. The CPA's lowest level is the six-digit subcategory, which is the level at which data for the PPI are collected and the lowest level at which indices are calculated. The subcategory indices are aggregated to give four-digit class indices and these, in turn, are aggregated to give the two-digit division indices. The divisional indices are then aggregated to give the overall PPI.

The remaining paragraphs in this section provide a brief sketch of the construction of the PPI; for a fuller description, see Cope and Freeman (1998).

Each subcategory index is a weighted average of price relatives, where a price relative is a current price for an item divided by an average price for the same item in the designated base year (currently 2000). The weights are derived from data for the most recently available PRODucts of the European COMmunity (PRODCOM) survey. (The PRODCOM survey contains data on sales by UK-based manufacturers of the most commonly manufactured products

in the European Union). Each weight is proportional to the product of a sample weight and the relevant product sales from the PRODCOM survey. The sample weight is determined by the probabilities of selection for the PRODCOM sample and for the PPI sample, which is a sub-sample of the PRODCOM sample. To calculate indices at higher levels, subcategory indices are weighted together using weights based on estimates of product sales for domestic consumption. These estimates are derived from PRODCOM data for the base year 2000, after subtracting export sales, which are obtained using a combination of exports data from HM Revenue & Customs and from the ONS Monthly Production Inquiry.

Figure 1 illustrates the PPI index structure, using division 15 (Food products, beverages and tobacco) as an example.

There are four different sets of PPIs, all with the same hierarchical structure but with different weights and different price components. These relate to GSO, Net Sector Output (NSO), gross sector input and net sector input. The analysis in this article, as mentioned in the introduction, focuses on standard errors for the overall GSO PPI and for the component divisions.

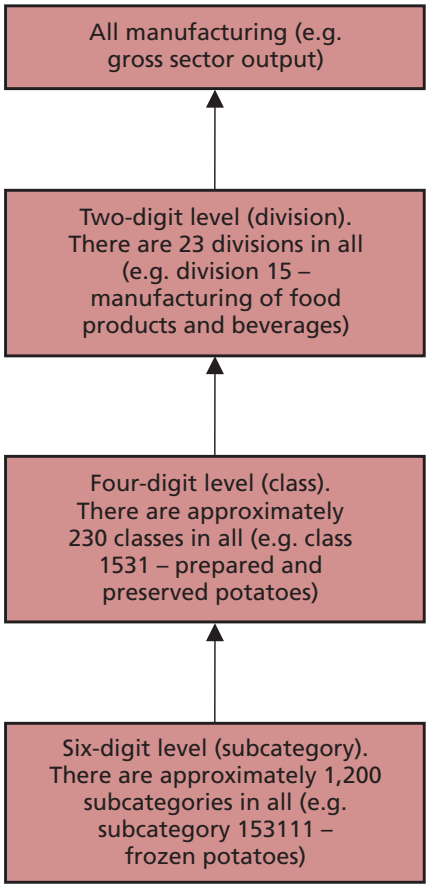
Estimating standard errors of movements in PPIs

ONS has recently devised a new method for estimating standard errors of movements in PPIs. The method is based on the concept that PPIs may be expressed as a function of monthly growth rates of price relatives. The means, variances and co-variances between these growth rates are modelled. Analysis of the data has highlighted that price movements for different items in the same subcategory and made by the same enterprise are positively correlated. Price movements for different items in different subcategories and made by the same enterprise have also been shown to be positively correlated, although to a lesser extent. The reasoning behind the correlations within and between subcategories for the same enterprise is that businesses tend to review prices for all their products at around the same time. It is assumed that there is no correlation of price movements between products made by different enterprises on the grounds that there should be no price-setting collusion between businesses. Estimates of standard errors for non-monthly growth rates, such as 12-month or three-month on three-month growth rates are based on the estimated variance-covariance matrix of monthly growth rates over the period required.

In some cases, the price collected is adjusted to account for a change in quality of the product. This is particularly prevalent in electrical and electronic products such as personal computers. The price is adjusted to ensure that price comparisons are on a like-for-like basis. The standard errors produced in this study are based on quality-adjusted data and no modelling error for the actual adjustment has been explicitly allowed for.

For a fuller description of the method of estimating standard errors, see Bucknall *et al* (2005) and Wood (2004).

Figure 1
Illustration of PPI index structure, using division 15



Analysis and results

The standard errors derived using the process described above are, like the indices they relate to, estimates and are also subject to estimation error. To reduce this estimation error, the standard errors presented here have been averaged over the 12-month period July 2005 to June 2006.

Table 1, Figure 2 and **Figure 3** present the overall GSO (including duty) PPI and the divisional PPI month-on-month percentage growth rates along with their standard errors.

The median divisional standard error of the month-on-month growth is 0.2 percentage points. It can be seen that divisions 23, 27, 30, and 37 have particularly large standard errors because of large differences in price movements within component subcategories.

It is worth noting that in Table 1, the all-manufacturing month-on-month growth rate is of the same order as the standard error, indicating that for this period

Box 1
What is a standard error?

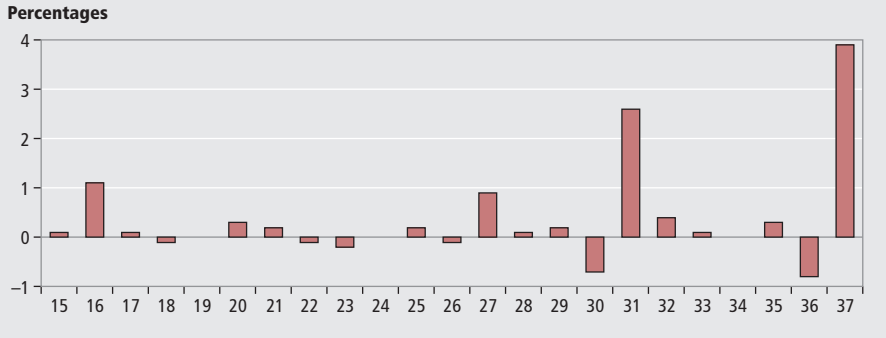
To calculate the PPI, it would be possible, in principle, to collect complete price information every month for all products from the whole population of businesses in the UK. The resultant index would be an exact measure of the average growth rate for prices in the UK. However, this would be extremely time-consuming and expensive and would impose an unacceptable burden on businesses. So, the PPI is based on a sample of price quotes from businesses and provides an estimate of the average growth rate for the population. If a different sample were selected, it would produce a different estimate of the same population growth rate. The difference between an estimate and its true population value is known as the sampling error. The actual sampling error for any estimate is unknown, but from the sample used, one can estimate a typical error, known as the standard error.

The standard error of the mean is a measure of the spread of possible estimates of the sample average likely to be obtained when taking a sample of a certain size. This provides a means of assessing the accuracy of the estimate: the lower the standard error, the more confident one can be that the estimate of average price growth is close to the true population value. Standard errors are often used to produce confidence intervals, but when doing so it is usual to assume that the data follow a normal distribution, that is, data are distributed symmetrically around the mean. However, as many prices for the PPI remain the same from month to month, the PPI growth rates show a large peak at 0 per cent and the assumption that the distribution of the data is normal is not valid. ONS therefore considers that it is inappropriate to quote confidence intervals for the PPI.

Table 1
Month-on-month growth rates and standard errors: by division

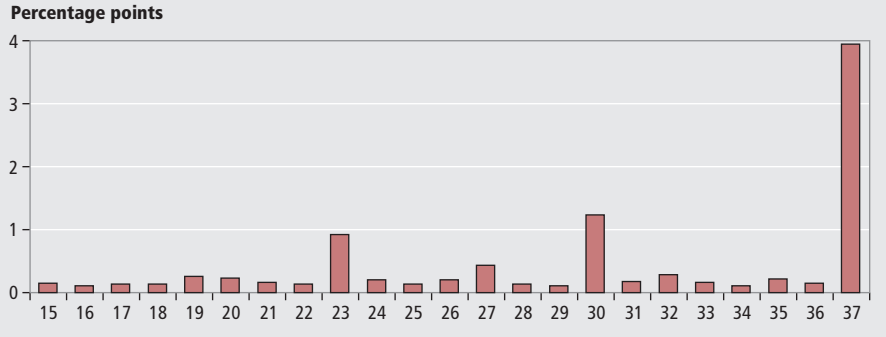
Two digit (division)	Division description	Month-on-month growth, June 2006 (percentages)	Standard error of the month-on-month growth, 12-month average, July 2005 to June 2006 (percentage points)
All manufacturing	Gross sector output including duty	*0.2*	0.2
15	Food products and beverages including duty	*0.1*	0.2
16	Tobacco products including duty	*1.1*	0.1
17	Textiles	*0.1*	0.1
18	Wearing apparel	*–0.1*	0.1
19	Leather and leather products	*0.0*	0.3
20	Wood and wood products	*0.3*	0.2
21	Pulp, paper and paper products	*0.2*	0.2
22	Printed matter and recorded media	*–0.1*	0.1
23	Petroleum products including duty	*–0.2*	0.9
24	Chemicals, chemical products and man-made fibres	*0.0*	0.2
25	Rubber and plastic products	*0.2*	0.1
26	Other non-metallic mineral products	*–0.1*	0.2
27	Base metals	*0.9*	0.4
28	Fabricated metal products, except machinery and equipment	*0.1*	0.1
29	Machinery and equipment not elsewhere classified	*0.2*	0.1
30	Office machinery and computers	*–0.7*	1.2
31	Electrical machinery and apparatus not elsewhere classified	*2.6*	0.2
32	Radio, television, and communication equipment and apparatus	*0.4*	0.3
33	Medical precision and optical instruments, watches and clocks	*0.1*	0.2
34	Motor vehicles, trailers and semi-trailers	*0.0*	0.1
35	Other transport	*0.3*	0.2
36	Furniture; other manufactured goods not elsewhere classified	*–0.8*	0.1
37	Recovered secondary raw materials	*3.9*	3.9

Figure 2
Month-on-month growth rates: by division, June 2006



Source: Office for National Statistics

Figure 3
Month-on-month standard errors: by division, July 2005 to June 2006[1]



Note:
1 12-month average.

Source: Office for National Statistics

it is impossible to distinguish any real movement from random noise. In Table 2, however, the all-manufacturing 12-month growth rate is six times the standard error, indicating that there is some distinguishable real movement. This demonstrates how much more reliable the annual movements are as indicators of the true inflation rate and highlights the importance of making due allowances for the inherent uncertainty in the estimates when making inferences from them.

Table 2, Figure 4 and **Figure 5** present the overall GSO (including duty) PPI and the divisional PPI 12-month percentage growth rates along with their standard errors.

The median divisional standard error of the 12-month growth rates is 0.6 percentage points. Again, divisions 23, 27, 30 and 37 have particularly large standard errors. Twelve-month growth rate standard errors are broadly in line with what would be expected from the equivalent month-on-month values.

A summary of the divisions with the largest standard errors is presented in **Table 3.**

Division 37 (recovered secondary raw materials) has a large standard error, because prices for copper and aluminium behave very differently from those of steel, and they are all included in the same subcategory. Division 30 is made up of office machinery and computers. There are large price movements for computers, as this is a fast-moving industry, and the changes in computer specifications and upgrades add to the disparities in price movements within this division. Division 27 (base metals) and division 23 (petroleum products) each have three subcategories with wide disparities in price movements. Petroleum and base metal prices are also highly variable, being influenced by worldwide trade markets and demand. This in turn affects the standard errors at the division level.

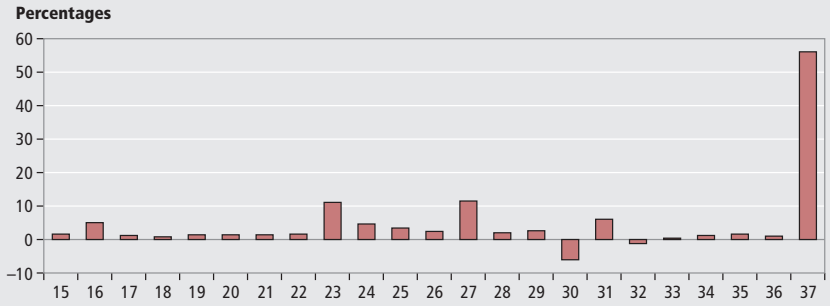
Net sector output

The same basic price information is used to feed into each of the PPI series. The difference between the various indices is the weights that are applied to combine the low-level series to form the higher-level indices. Indices from product level to divisional level are produced on a gross sector basis. Each division is then assigned two different weights (gross sector and net sector) and it is these weighting structures that define the different PPI series. The overall standard error for the month-on-month growth

Table 2
12-month growth rates and standard errors: by division

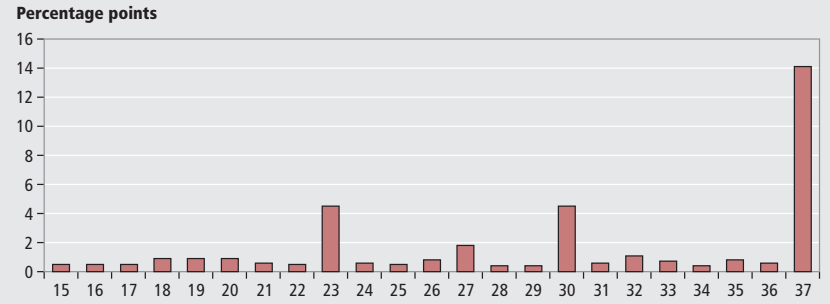
Two digit (division)	Division description	12-month growth, June 2006 (percentages)	Standard error of the 12-month growth, 12-month average, July 2005 to June 2006 (percentage points)
All manufacturing	Gross sector output including duty	*4.3*	0.7
15	Food products and beverages including duty	*1.6*	0.5
16	Tobacco products including duty	*5.1*	0.5
17	Textiles	*1.3*	0.5
18	Wearing apparel	*0.8*	0.9
19	Leather and leather products	*1.5*	0.9
20	Wood and wood products	*1.5*	0.9
21	Pulp, paper and paper products	*1.4*	0.6
22	Printed matter and recorded media	*1.8*	0.5
23	Petroleum products including duty	*11.2*	4.5
24	Chemicals, chemical products and man-made fibres	*4.7*	0.6
25	Rubber and plastic products	*3.5*	0.5
26	Other non-metallic mineral products	*2.6*	0.8
27	Base metals	*11.6*	1.8
28	Fabricated metal products, except machinery and equipment	*2.2*	0.4
29	Machinery and equipment not elsewhere classified	*2.7*	0.4
30	Office machinery and computers	*–6.0*	4.5
31	Electrical machinery and apparatus not elsewhere classified	*6.2*	0.6
32	Radio, television, and communication equipment and apparatus	*–1.2*	1.1
33	Medical precision and optical instruments, watches and clocks	*0.4*	0.7
34	Motor vehicles, trailers and semi-trailers	*1.2*	0.4
35	Other transport	*1.7*	0.8
36	Furniture; other manufactured goods not elsewhere classified	*1.0*	0.6
37	Recovered secondary raw materials	*56.2*	14.1

Figure 4
12-month growth rates: by division, June 2006



Source: Office for National Statistics

Figure 5
12-month standard errors: by division, July 2005 to June 2006[1]



Note:
1 12-month average.

Source: Office for National Statistics

rate of the NSO PPI (including duty) is 0.1 percentage points, while, for the 12-month growth rate, the standard error is 0.5 percentage points. These are lower than the respective GSO standard errors (0.2 and 0.7, respectively) as the PPI sample is designed to minimise the standard error of the top-level NSO PPI. The sample tends to be large where NSO weights are large, helping to keep the top-level standard error small. Conversely, the PPI sample tends to be small where the NSO weights are small, because these divisions have little effect on the top-level standard error. Consequently, where GSO weights are large relative to NSO weights, the effect of the relatively small sample sizes is magnified. This causes the standard error of the top-level GSO PPI to be larger than that for the NSO PPI.

Publication policy

The standard errors for the PPI month-on-month and 12-month growth will be calculated and updated annually in the spring. Details of the publication policy are given below. On 12 November 2007:

- the standard errors of growth for the following three key PPI indicators (NSO) will be published in a table in the background notes of the PPI First Release:
  - output of manufactured goods.
  - all manufacturing excluding duty
  - all manufacturing excluding food, beverages, petroleum and tobacco
- the standard errors for the all-manufacturing GSO (including duty) and for each component division will be published in the Summary Quality Report for the PPI at www.statistics.gov.uk/about/data/methodology/quality/information_business_statistics.asp
- the standard errors at class and subcategory level will be published in Excel spreadsheets on the National Statistics website

Table 3
Growth rates and standard errors across selected divisions

Two digit (division)	Division description	Month-on-month growth, June 2006 (percentages)	Standard error of the month-on-month growth, 12-month average, July 2005 to June 2006 (percentage points)	12-month growth, June 2006 (percentages)	Standard error of the 12-month growth, 12-month average, July 2005 to June 2006 (percentage points)
23	Petroleum products including duty	*–0.2*	0.9	*11.2*	4.5
27	Base metals	*0.9*	0.4	*11.6*	1.8
30	Office machinery and computers	*–0.7*	1.2	*-6.0*	4.5
37	Recovered secondary raw materials	*3.9*	3.9	*56.2*	14.1

CONTACT

elmr@ons.gsi.gov.uk

REFERENCES

Bucknall R, Sova M and Wood J (2005): Estimating Standard Errors of movements in Producer Price Indices. Proceedings of the GSS Methodology Conference 2005, ONS, London at www.statistics.gov.uk/events/gss2005/agenda.asp

Cope I and Freeman D (1998) 'Improving the Quality of the Producer Price Index', *Economic Trends* 541, pp 63–74.

Wood J (2004) *New Method for Estimating PPI Standard Errors*. Internal ONS paper.

Wood J (2005): Optimising Sample Allocation and Sample Selection for Business Price Indices. Proceedings of the GSS Methodology Conference 2005, ONS, London at www.statistics.gov.uk/events/gss2005/agenda.asp