

Adjusting national income for quality changes

When comparing GDP over time a fundamental problem is the changing nature of goods. Over time technological advancement has meant that the quality, or the functional capabilities of goods, has improved substantially. At any point in time we'd expect higher quality goods to cost more than those of a lower quality. However, in making comparisons over time the reality is that many goods have not only improved in quality but also fallen in price.

Electrical and new technological products are a clear example. But even goods that have risen in price have also improved in terms of quality, such as automobiles. This raises a question as to how GDP measures should be adjusted to represent the improving quality of goods.

Nominal GDP simply measures the market value of total output at a given point in time. Real GDP though adjusts nominal measures by a price deflator to represent the changing cost of goods over time. Therefore, if prices are falling the deflator will also fall and real measures would be higher.

The purpose of a deflator is to adjust nominal (current price) data into real (constant price) data. Therefore, a deflator is essentially an index which describes the change in the price of a good or service over time. Constructing deflators for goods where the specifications change quickly though is difficult. Here the observed price change consists of a pure price change and a quality change. For the purpose of deflation it is only the pure price change that is required, but this is an unobserved variable.

Measured price change = Quality change + Pure price change

Failing to extract the quality change from measured prices would lead to nominal output being over-deflated, and hence real output is underestimated. This is particularly relevant in the ICT (Information and Communications Technology) sector of the economy, where there have been remarkable and rapid advances in the capabilities and characteristics of goods. Traditional price indexes are well adapted to measuring standardised products but encounter problems when there is a quick turnover of vintages.

Computer Hardware

The recent advances in information technology have been remarkable, and nowhere is this more evident than in computer hardware. Computers have consistently exhibited rapid change. Michael Holdway (Quality-adjusting computer prices in the producer price index, 1999, Bureau of Labor Statistics) notes that between 1993 and 1998 observed prices were fairly stable for desktop computers, but during this time CPU speed (MHz) jumped 1263% (which is in fact an under estimate), system memory increased by 1500%, hard drive capacity by 3700% and monitor size by 13%. Although observed prices were relatively constant over this period, pure prices adjusted for quality changes undoubtedly fell.

In the subsequent period, there have been further advances in the quality of computer hardware and also a tendency for market prices to fall. Even so, the rate of deflation would be underestimated without deducting the value of quality improvements.

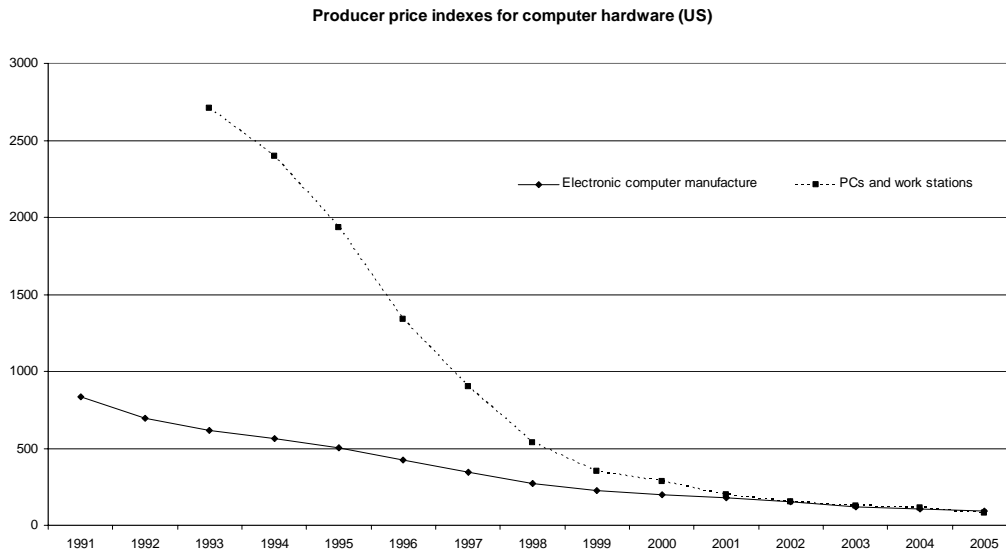


Figure 1: Source BLS

Figure 1 plots quality adjusted producer price indexes for computers and more specifically PCs and work stations in the US. It is clear that deflation has been rapid since the beginning of the 1990s.

This has been recognised by many statistical organisations around the world and it is fairly common practice to adjust the price of computer hardware for quality changes. There are several techniques which can be used to achieve this, but perhaps the most common is to use a hedonic regression method.

Hedonics Regressions

A hedonic function relates the price of a good to a set of characteristics. For example, two characteristics which are widely acknowledged as being important determinants of price are processor speeds and memory size, but there are a wide variety of others such as monitor size, DVD player, sound card etc. Taking a cross-section of prices (P) and characteristics (X) a hedonic function can be expressed in the following general form.

$$P_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \dots + \varepsilon_t$$

This can be estimated econometrically and the coefficients used to price the various characteristics of the good. Holdway (1999) presents an example of this approach for desktop PCs in 1999 in table 1.

Table 1: Hedonic Regression results for personal desktop computers- June 1999 (685 Observations)

Constant	619.925
CPU per MHz	3.533
Celeron CPU*	-277.538
SDRAM/MB	1.686
HD/MB	0.02
100MB ZIP*	96.702
DVD (4.6/6.0)*	95.459
Video/MB	5.076
Sound card and 2 Speakers*	24.184
Speakers and Sub*	77.246
56.6 Fax Modem	27.919
10/100Mbps NIC*	49.287
Monitor, 15 inch*	246.919
Monitor 17 inch*	296.941
Monitor 17 inch Trinitron	370.599
Software office suite*	62.568
MS office suite SBE*	228.988
3-year on-site warranty	155.622
Company A	257.225
Company B	139.632
Company C	-121.727

* Dummy variable

A dummy variable can be used where the characteristic is discrete. These are 1-0 variables which will take the value of '1' if the PC has that characteristic or '0' if not.

Having estimated the hedonics regression the parameters can be used to measure the value of quality changes. For example, suppose that a new vintage of PC arrived on the market priced at \$1500. This is the same price as the older vintage which has been withdrawn but the system memory has increased from 32MB to 64MB. A simple price index would find no price change, but obviously quality has changed which will have implications for the pure price change.

According to the above hedonic regression each MB of system memory is worth \$1.686, so the extra 32 MB in the new vintage would be worth $32 * 1.686 = \$53.95$. Hence the quality adjusted price change is $(1500 - 53.95 - (1500)) / 1500 = -3.6\%$.