Measurement Issues and International Comparisons of Output and Productivity Growth

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ABSTRACT

Since the mid-1990s the average growth rates of real GDP and labour productivity in the European Union have fallen behind those in the United States. This development has led to questions about the potential contribution of the differences in measurement methodologies to GDP and productivity growth between the EU and the US. This paper outlines the issues regarding one of the measurement differences between the US and EU, that of using quality-adjusted or hedonic price indices for high-technology sectors. We also estimate their contribution to the observed output and productivity differentials.

We find that differences in measurement of high technology sectors cannot account for the widening productivity growth difference between the EU and the US. These measurement differences are estimated to have contributed between one and three tenths of a percentage point to differences in growth rates. Ireland proves to be an exception from this general finding however. The application of hedonic price indices for Ireland resulted in an increase of approximately 1.3 per cent in the growth rates of both GDP and labour productivity. This can be explained by the much higher relative importance of high-technology sectors in the Irish economy relative to the rest of the EU. Adjustments to the measurement of these sectors therefore have a larger effect on economy-wide measures of output and productivity.

1. Introduction

In order to compare living standards across countries and over time, economists and statisticians have developed measures of economic performance. The most common of these is *real* Gross Domestic Product (GDP), which provides information on the quantity of goods and services produced in the economy in any given period. In contrast, *nominal* GDP measures the current cash value of the goods and services produced. The key difference between the two measures is that real GDP removes any increase in expenditure due purely to inflation, thereby allowing us to make volume comparisons over time.

The process of measuring output to generate real GDP statistics has become more complex as the economy becomes more sophisticated. When the concept of GDP was first adopted as the primary measure of economic performance, attention was

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focused more on measures of agricultural and industrial output. For these items, obtaining a useful measure of real output was straightforward. In sectors where the goods produced are relatively uniform, such as energy production or primary commodities, there are few difficulties in quantifying total output, for example tonnes of wheat or steel. However, as economies have become more technologically advanced and the service sector has grown, it has become increasingly difficult to measure the real output of many sectors of the economy. This also impacts the accuracy of measures of productivity for these sectors, as productivity is typically calculated as output per employee or alternatively as output per hour worked.

This paper looks at one of the difficulties that have arisen in relation to measuring the output of high-technology sectors– goods such as computers and communications equipment– where quality changes occur particularly rapidly. While nominal expenditures on computers may be easy to measure, it is far more difficult to construct a meaningful measure of the price index for computers, given the speed at which quality changes have tended to occur. Such a price index is crucial in order to estimate the real or quality-adjusted output of these sectors.

To address this issue, statisticians and economists have constructed special *quality-adjusted* price indices for high-technology goods. Most prominently, these measures have been employed in the measurement of real GDP in the US. A number of other countries are considering the adoption of this approach, and some (notably France and Germany) have begun to use a similar method, although they have applied it to fewer sectors than in the US. As some countries are using this method, while others are not, this has complicated international comparisons of economic growth in recent years. For instance, the difference in approaches to the measurement of high-technology output has led to questions being raised about the extent to which it may have affected comparisons of overall GDP and productivity growth rates between the EU and the US. This is a particularly relevant issue because the average growth rates of real GDP and labour productivity in the European Union have fallen behind those in the United States since the mid-1990s. A change in the methodology used to measure prices of high-technology goods would also have particular implications for Ireland, given the relatively large share of output accounted for by these sectors.

This paper presents calculations that illustrate how the application of quality-adjusted price indices for high-technology sectors may affect real GDP growth for European Union countries. A consistent dataset of output and prices compiled by the Groningen Growth and Development Centre is used to calculate real growth rates for the EU and a small number of other countries from 1979 to 2002. Price deflators for two high-technology sectors are replaced with quality-adjusted prices from US data, and real GDP is then re-calculated on a consistent basis for each of these countries. This gives us an estimate of the impact that the adoption of quality-adjusted price deflators for high-tech sectors would have on real GDP growth across our sample of countries. The overall result for the EU-15 shows that the change in measurement has very little effect on real growth: The difference between the two methods is approximately one-tenth of a percentage point. This is also the case for most of the individual EU-15 economies, with one exception. Irish growth rates in the period 1995-2002 were substantially increased, by over one per cent per annum, when the quality-adjusted prices were used.

The outline of the paper is as follows: Section 2 provides a more detailed description of the quality-adjustment methodology and the motivation for its use in high-technology sectors. Section 3 introduces the data used in this study. Section 4 presents calculations, comparing growth rates based on the national deflators of the countries in the data with those generated by substituting the US-style price deflators. Section 5 looks at the impact of changing methodology for Ireland. Section 6 concludes.

2. Quality Changes and Price Measurement

Changes in the quality of goods and services are not always captured by traditional methods of price measurement. This failure to allow for improvements in quality can result in an overestimation of the price trend and an underestimation of output in real terms. This issue is of particular importance for goods characterised by rapid technological change, most specifically in the Information and Communications Technology (ICT) sectors.

To illustrate the issues related to measurement of real output in the context of rapid technological change, consider the following stylised example.

Table 1: Computer Quality and Pricing Example

	Period 1	Period 2
Computer 1 —100Mhz	€100	N/A
Computer 2 —200Mhz	€200	€120
Computer 3 —300Mhz	N/A	€180
Average Computer Price	€150	€150
Cost of 1Mhz	€1	€0.60
Real Output (Based on Average Computer Price)	€300	€300
Real Output (Based on Price Per Mhz)	€300	€500

Table 1 presents a hypothetical market for computers over two periods. In Period 1, two computers are available; computer 1 has a processor speed of 100Mhz and is priced at €100, while computer 2 has a 200Mhz processor and costs €200. In period 2, the first computer has become obsolete and is no longer available. Technological developments have led to the introduction of computer 3, which has a more powerful processor at 300Mhz and costs €180. The price of computer 2 has fallen to €120 in the second period. For simplicity, we assume that the market shares of the computers are equal in both periods and that the number of Mhz is the only distinguishing quality characteristic.

The first point to note about this example is that the average price paid for a computer does not change over the two periods, being €150 in both. If just one of each computer available was sold in each period, then there has also been no change in nominal spending on computers of €300. In this example, traditional measures —based only on the transaction prices of the computers —would show no change in prices or output in this market.

However, there have clearly been developments in the quality of the computers available and in the prices of the individual computers on the market, and these developments are being missed by the traditional measure. Looking at each period, we see that the computer with more Mhz commands a higher price. This tells us that the relevant *economic* concept here relates to the speed of the computer: purchasers place a clear value on the speed at which the computer can operate. In the example, the cost of obtaining a fixed amount of computer speed has declined, and the average quantity of the computing power produced has increased.

These developments can be measured in two ways. Firstly, we can follow the price of an individual model that is available in both periods. In this case, we can see that computer 2 has fallen in price from €200 to €120. Alternatively, instead of measuring the price of the computer, we could focus on the price of a unit of computing power and by doing this we find that the cost of 1Mhz has dropped from 1 Euro to 60 cents. Both of these quality-adjusted methods point to a price fall. Real computer output, measured in quality-adjusted terms as output of Mhz, has increased by two-thirds. In period 1, the total output of computer power was 300Mhz (= 100Mhz + 200Mhz), while in period 2 it rose to 500Mhz (= 200Mhz + 300Mhz).

Examples like this illustrate why the quality adjustment approach has generally gained acceptance as the best way to measure real output in industries undergoing technological change. In practice, however, the measurement of quality-adjusted price indices is somewhat more complicated than in this stylised example. The first method mentioned above, that of following the price of an individual item whose quality does not change over time, e.g. the price of the 200Mhz machine, is not easy to implement because of the difficulty of finding exactly comparable models over time in a market with rapid quality changes. The method more generally used is to explicitly estimate the value of various features. This method produces what is known as a "hedonic" price index for the good. This is closer to the idea of pricing the value of a Mhz in our example, although in reality consumers value a wide range of features, which all need to be taken into account if an accurate price index is to be constructed.

Quality-adjusted or hedonic price indices are used to account for changes in prices due to changes in a product's characteristics. In the case of computers for example, a hedonic price index would be estimated to take account of characteristics such as processor speed and memory amongst others. There are a number of methods used to construct a hedonic price index. The basic assumption is that the observed price of a good is a function of its characteristics. The US Bureau of Economic Analysis uses a method of imputing prices that compares new and old models of the same product and attributes price changes to changes in the characteristics. The value of each characteristic is estimated and the difference in the amount of the characteristic between the new and old models observed. The value of the additional characteristic can then be compared to the actual change in price.

When these hedonic indices are used in sectors with rapid technical progress and quality changes, significant price declines have been estimated. In the case of personal computers, nominal prices have not changed a great deal over the past few years, despite continuous improvement in product characteristics. This is equivalent to a price fall of the various product characteristics, as consumers get more computing power, for example, for the same money.

3. Data on Output and Prices

The data used in our calculations were initially compiled by the Groningen Growth and Development Centre (O'Mahony and Van Ark, 2003). Specifically, the Groningen Centre has produced an *Industry Labour Productivity Database,* which attempts to overcome the measurement differences outlined in the previous section. This new database allows cross-country productivity comparisons of economic growth to be made in a more consistent manner than was previously possible. The database contains information for a range of countries on output and labour input (employees and hours worked) for fifty-six disaggregated sectors of the economy. By aggregating across these sectors, the database allows researchers to calculate consistent measures across countries of both GDP and measures of labour productivity such as GDP per worker.

The Groningen data allow researchers to address the issue of differences in measurement of high technology sectors by applying the detailed US price indices for the computer and electronic industries to all other countries. This is done by applying US deflators for two high-technology sectors to the EU data, with a correction for the effect that the general price level may have had for these sectors in each country. The sectors in question are defined by the Groningen Centre as Office Machinery and Electronic Valves and Tubes (which includes items such as semi-conductors). This application of adjusted deflators results in significant changes in the estimates of real high-tech output in each country (apart, of course, from the US). However, it turns out that for most economies, the impact of this adjustment on the overall economy of each country is relatively small.

Table 2: Average Annual Change in Price 1995-2002

Office Machinery and Electronics

	Hedonic Deflator	National Accounts
EU-15	–33%	–7%
Austria	–36%	–2%
Belgium	–36%	–3%
Denmark	–33%	–4%
Spain	–31%	1%
Finland	–34%	–8%
France	–34%	–15%
Germany	–34%	–4%
Greece	–33%	2%
Ireland	–31%	3%
Italy	–34%	1%
Luxembourg	–29%	–1%
Netherlands	–30%	1%
Portugal	–35%	1%
Sweden	–28%	14%
UK	–31%	–11%

In order to give an idea of scale of the difference between price indices that do and do not adopt the quality-adjustment approach, Table 2 presents the average percentage changes annually over the period 1995 to 2002 for each country. Sharp declines in prices for the high technology sectors when the hedonic methodology is used are immediately evident, with the price index falling by in excess of thirty per cent per annum on average. The variations in these figures for individual countries primarily reflect different contributions of the two sub-sectors combined to generate these figures for high technology output. In contrast, the average price change in the national accounts of the EU-15 is a much slower decline of seven per cent. There is considerable country heterogeneity in the measurement of high technology sectors within the EU. This ranges from average price declines of 15 per cent in France (which applies a hedonic approach to measuring computer prices) to price increases in a number of countries, the largest increases being measured in Sweden. The variance shown in this table indicates that the issue of measuring prices in high technology sectors has implications for intra-EU comparisons as well as for comparisons with the US.

Another source of methodological difference across countries is the formula used to combine the real outputs of different sectors. The issue of how to combine the real outputs of a number of different sectors into a measure of total real GDP is essentially the question of how to add apples and oranges. Many EU countries use a fixed-base index, which weights the real outputs of the various sectors according to some fixed set of prices from an arbitrary base year. In contrast, Eurostat now a so-called "chained" index, where more recent prices are used to calculate the growth rate of real GDP each period.

The approach taken in the calculations presented here is to use a common aggregation methodology for each country. This allows us to highlight more precisely the contribution of the measurement of real GDP in high-tech sectors to economic growth in the various countries. Specifically, we use the chain-Laspeyres aggregation, which is the exact chain-index approach recommended by Eurostat, and which most EU countries have recently adopted.[1]

4. Comparison of Quality-Adjusted and Unadjusted Output

4.1 Some Caveats

Before presenting the comparison of the growth rates obtained using the national deflators and the US-type hedonic deflators, some limitations of the estimations should be noted. First, it is important to note that in these calculations, the deflators used are derived from hedonic price indices for the US and then applied to the data for other countries. Therefore, they may not be an entirely accurate reflection of price trends in each individual country and should be interpreted carefully. On a more general note, the accuracy of US hedonic prices has been questioned. We have already noted the difficulties in measuring all the characteristics valued by consumers and in incorporating completely new features and products. Recent research from the Federal Reserve Bank of New York has also suggested that falling prices of individual computer products may be partially explained by manufacturers with some market power setting initially high prices in order to obtain maximum rents from early adopters of new technologies before lowering the price to expand market share (Hobijn, 2001). Standard methods,

1 Other chain index approaches can be adopted. Our calculations showed that the differences in the figures produced by the various "chain" indices are usually quite small, so the choice of the specific chain index does not have any great impact on the final results.

however, have difficulty handling the implicit price increase associated with the introduction of the new high mark-up technologies.

4.2 Comparisons of Growth and Productivity

Table 3: Growth Rates for Real GDP

	1979-1990		1990-1995		1995-2002	
	Hedonic Deflators	National Deflators	Hedonic Deflators	National Deflators	Hedonic Deflators	National Deflators
Ireland	3.42	3.05	5.82	5.29	10.29	8.95
US	2.91	2.91	2.01	2.01	3.45	3.45
EU-15	2.32	2.24	1.87	1.80	2.47	2.38
Austria	2.23	2.19	2.95	2.88	2.37	2.25
Belgium	2.14	2.11	1.98	1.93	1.95	1.90
Denmark	1.67	1.61	1.38	1.33	2.38	2.33
Finland	3.65	3.61	–0.38	–0.46	4.23	4.15
France	2.35	2.24	1.15	1.09	2.20	2.12
Germany	2.11	2.00	2.77	2.67	1.76	1.65
Greece	1.96	1.96	0.87	0.86	3.41	3.41
Italy	2.41	2.36	1.48	1.42	1.84	1.75
Luxembourg	4.69	4.68	4.68	4.68	4.62	4.61
Netherlands	2.36	2.31	2.24	2.20	2.94	2.88
Portugal	2.91	2.85	1.95	1.88	3.20	3.11
Spain	2.81	2.75	1.59	1.52	3.27	3.18
Sweden	2.35	2.23	1.00	0.94	2.09	2.03
UK	2.25	2.12	1.68	1.55	3.02	2.87
Australia	3.67	3.63	2.67	2.63	3.90	3.83
Canada	2.95	2.92	1.53	1.51	3.77	3.68
Japan	4.51	4.37	2.67	2.34	1.43	0.92
Korea	8.43	8.31	8.37	7.92	4.95	4.27
Norway	3.10	3.06	3.37	3.32	2.95	2.93
Taiwan	8.67	8.46	7.61	6.95	6.18	4.74

These caveats noted, Table 3 reports comparisons of real GDP growth rates using both the hedonic price methodology and the unadjusted national price deflators over three sub-periods. The first result to note from these tables is that the growth rates of real GDP and labour productivity for the EU-15 are slightly higher when the hedonic methods are used, but the effect is very small. Thus, it appears that the differences between US and European methodologies for measuring the high-tech sector do not explain the recent divergence in labour productivity performance. In the period 1995-2002, the average growth rate using the national deflators for the EU-15 was 2.38 per cent, while with the hedonic deflators it was 2.47 per cent. Similar positive but small changes in growth rates are observed for most of the individual EU-15 members, and also for Australia, Canada and Norway.

The results in Table 4, which compare growth rates of real GDP per hour using the different deflators, paint a similar picture to those for total GDP growth. The application of the hedonic price deflator has a small upward impact on the estimates of GDP per hour growth in the EU-15 in all periods. The broader picture of a slowdown in labour productivity growth rates relative to the US from the late nineties is unchanged. Labour productivity grew at an average rate of 2.26 per cent in the US over the 1995-2002 period, compared to a rate of 1.54 per cent in the EU-15 if we use the national deflator or 1.63 per cent using the hedonic methodology. Moreover, whichever methodology is being used, it is clear that Europe has gone from having faster productivity growth than the US to having slower productivity growth.

Table 4: Productivity (Real GDP Per Hour) Growth Rates

	1979-1990		1990-1995		1995-2002	
	Hedonic Deflators	National Deflators	Hedonic Deflators	National Deflators	Hedonic Deflators	National Deflators
Ireland	4.30	3.92	3.98	3.46	6.79	5.49
US	1.25	1.25	0.95	0.95	2.26	2.26
EU-15	2.35	2.27	2.30	2.23	1.63	1.54
Austria	2.63	2.59	3.89	3.82	2.32	2.21
Belgium	3.03	3.00	2.50	2.45	0.85	0.79
Denmark	2.16	2.10	2.00	1.96	1.31	1.26
Finland	3.14	3.10	3.07	3.00	2.57	2.49
France	3.01	2.90	1.74	1.68	1.91	1.83
Germany	1.93	1.82	2.81	2.71	1.91	1.80
Greece	1.38	1.38	0.15	0.15	3.00	2.99
Italy	2.14	2.09	2.07	2.02	0.68	0.60
Luxembourg	3.91	3.89	2.31	2.30	0.48	0.47
Netherlands	2.46	2.42	1.41	1.37	1.24	1.18
Portugal	3.30	3.24	2.47	2.40	2.52	2.44
Spain	2.96	2.90	1.30	1.24	0.62	0.54
Sweden	1.39	1.27	2.09	2.03	1.67	1.62
UK	2.18	2.05	2.76	2.63	2.14	1.99
Australia	1.44	1.41	1.63	1.59	2.50	2.43
Canada	0.94	0.92	1.32	1.30	1.83	1.74
Japan	3.74	3.60	3.33	3.00	2.42	1.91
Korea	5.72	5.61	6.38	5.93	4.46	3.79
Norway	2.70	2.66	3.34	3.29	2.32	2.30
Taiwan	6.83	6.62	6.44	5.78	6.47	5.03

Amongst the individual EU countries, the effect of changing to a hedonic price deflator is small, varying from 0.01 per cent for Greece and Luxembourg to 0.15 per cent for the UK. The non-EU economies of Australia, Canada and Norway have similarly small differences between the two methodologies.

4.3 An Alternative Calculation

The calculations that we have reported so far have illustrated how the figures for GDP growth for European countries would change if they adopted the US hedonic price indices for high-tech sectors. These calculations show that this change would close only about one-tenth of a percentage point per year of the gap between productivity growth in the EU and the US that has opened up since the mid-1990s. However, there is another calculation that is also worth reporting: how much lower would US productivity growth have been if they had not adopted the hedonic index method for high-tech goods?

Table 5: Real GDP per Hour Growth Rates

	1990-1995			1995-2002		
	Separate National Deflators	Both use Hedonic Deflators	Both use Non-Hedonic Deflators	Separate National Deflators	Both use Hedonic Deflators	Both use Non-Hedonic Deflators
EU-15	2.23	2.30	2.23	1.54	1.63	1.54
US	0.95	0.95	0.79	2.26	2.26	1.99
Difference	1.28	1.35	1.44	–0.72	–0.63	–0.45

Hedonic deflator measures based on US deflators for Office Machinery & Electronic Valves
Non-hedonic deflator measures based on EU-15 deflators for same sectors

Table 5 reports these calculations. Replacing the US high-tech price indices with their EU-15 equivalent, US productivity growth over the period 1995-2002 falls to 1.99 per cent per year rather than the 2.26 per cent that is obtained when hedonic indices are used; in this case the gap between productivity growth rates falls to 0.45 percentage point. In other words, by this calculation, hedonic indices can account for 0.27 percentage point of the 0.72 percentage point gap between US and EU productivity growth over this period. Of course, the measurement differences do not eliminate the gap in productivity growth rates. In addition, there are strong reasons for adopting hedonic price indices as the best measures of real output, which means our best estimate of the productivity growth gap is still 0.63 percentage point.

5. Implications for Ireland

5.1 Real GDP

The results just presented do not imply that the adoption of quality-adjusted methods for high-tech industry must *necessarily* have a small effect on real GDP growth. In fact, Table 3 shows that for Ireland and Taiwan (and to a lesser extent Japan and Korea) the effect of applying the hedonic price methodology is quite substantial. The average growth rate of real GDP in Ireland from 1979 to 1990 was 3.05 per cent using the Irish national price deflators. However, applying the hedonic deflators increases the growth rate by 0.37 per cent to 3.42. In the period 1995-2002, the effect is even larger. Irish real GDP growth is 8.95 per cent when measured with the national deflators, but the estimate using the hedonic deflators revises this upwards to 10.29 per cent.

The same picture is evident in Table 4, where the figures for Irish labour productivity growth in the first period, 1979-1990, was 3.92 per cent using national deflators and 4.3 per cent using the hedonic methodology, giving an upward revision of four-tenths of a percentage point. The difference between the methodologies becomes even stronger by 1995-2002. In this period, using the national deflators results in a real GDP per hour growth rate of 5.49 per cent, whereas the hedonic methodology estimates this rate as 6.79 per cent.

The hedonic price adjustment has a greater effect for Ireland than for the rest of the EU-15 for two reasons. The first is that some degree of hedonic pricing is already being made in certain EU countries, whereas in Ireland these sectors had been measured as having price increases (see Table 2). The second reason is the size of the sectors in question, as is clear from Table 6, which shows the share of total value-added affected by the measurement change. The sectors to which the quality adjustment was applied account for only 0.3 per cent of value-added in the EU-15, so it would be surprising if even quite large price adjustments in these narrowly defined sectors fed through to the measurement of the economy's total value-added. In Ireland, on the other hand, the sectors involved make up a much larger share of the overall economy, almost 3.5 per cent in 2002, so any change in how they are measured is more likely to be seen in the aggregate figures. The increasing share of the relevant sectors in the overall economy also explains why the effect of applying the hedonic methodology to Ireland is larger in the 1995-2002 period than it was in the earlier periods. The same is true for Taiwan, Korea and Japan, all countries with significant high-technology sectors.

Table 6: Share of Office Machinery and Electronics Sectors in Total Value Added

	1979	1985	1990	1995	2002
Ireland	0.78	2.13	2.33	4.02	3.47
US	0.73	0.84	0.87	1.03	0.63
EU-15	0.44	0.49	0.42	0.37	0.30
Austria	0.28	0.31	0.34	0.27	0.34
Belgium	0.18	0.15	0.21	0.15	0.18
Denmark	0.23	0.25	0.25	0.17	0.16
Finland	0.10	0.34	0.24	0.32	0.24
France	0.67	0.63	0.53	0.47	0.36
Germany	0.52	0.62	0.54	0.34	0.33
Greece	0.02	0.02	0.02	0.01	0.01
Italy	0.26	0.30	0.27	0.30	0.25
Luxembourg	0.04	0.04	0.02	0.03	0.03
Netherlands	0.23	0.21	0.19	0.20	0.13
Portugal	0.32	0.54	0.24	0.26	0.21
Spain	0.22	0.38	0.27	0.28	0.20
Sweden	0.55	0.59	0.28	0.25	0.16
UK	0.59	0.83	0.76	0.82	0.43
Australia	0.24	0.23	0.15	0.25	0.14
Canada	0.20	0.25	0.20	0.21	0.24
Japan	0.83	1.43	1.65	1.77	1.47
Korea	0.77	0.91	1.64	3.03	3.15
Norway	0.14	0.22	0.14	0.08	0.08
Taiwan	0.88	1.66	2.53	3.44	4.86

5.2 Inflation

We have seen that the application of hedonic methods raises Irish *real* GDP growth by 1.3% per year over 1995-2002. What effect does this have on other variables? Firstly, it must be noted that this has no implications for *nominal* GDP over this period. Therefore there are no implications for any economic variables that depend only on nominal GDP; for instance there should be no implications for forecasting tax revenues. Looking at the adjustment from the point of view of Irish firms, there are no changes in revenue or export earnings; measured productivity is higher but this is offset by lower prices of the high technology products.

Because nominal GDP is unaffected, these calculations show that if hedonic methods were applied, GDP price *inflation* would be 1.3% per year lower over this period. It should be stressed, however, that the impact on consumer inflation is much smaller, because high-technology goods play a much less important role in Irish consumption than they do in terms of our produced output. Applying a similar methodology to that used for the production sectors described above, we applied US price indices for personal computers and consumer electronics to the equivalent products in the Irish Harmonised Index of Consumer Prices (HICP). The data for these calculations come from the Bureau of Labor Statistics for the US and the Central Statistics Office for Ireland. The difference between the hedonic and non-hedonic methods for consumer price inflation is 0.03 per cent per annum over the period 2001-2005. This small difference reflects the fact that the weight of the products the hedonic adjustment was applied to make up just 0.65 per cent of the basket of goods on which inflation is based.

Table 7: Methodology Comparison for Ireland

Average Annual Changes

	Hedonic Deflator	Non-Hedonic Deflator
GDP Price Inflation (1995-2002)	3.05%	4.32%
Consumer Inflation (HICP) (2001-2005)	2.97%	3.00%

Source: Authors own calculations from GGDC and CSO data.

6. Conclusions

Productivity growth in the EU has fallen behind that of the US since the mid-1990s, a development that has been of substantial concern to European policy-makers. The extent to which this gap may be due to differences in the methodology used to measure the output of high-technology sectors, and also to differences in aggregation methodology, has made it difficult to make consistent international comparisons. This paper has reviewed these methodological differences and presented calculations estimating the contribution of measurement to differences in international GDP and labour productivity growth rates.

The main result of the paper is that differences in the measurement of the high-tech sectors cannot account for the widening productivity growth differential between the EU-15 and the US. These measurement differences are estimated to explain a relatively small fraction of the EU-US productivity growth gap. However, this is not to say that the issue of measurement differences in high technology sectors is always unimportant. As we have seen, for countries with a large enough share of GDP coming from these sectors, the impact of a change in methodology is more significant. This is illustrated by the Irish case, where the application of the hedonic price deflator resulted in an increase of approximately 1.3 per cent in the growth rates of both GDP and labour productivity. Similar findings were made for Taiwan and Korea, indicating that the impact of the hedonic methods applies in general to countries with large high-technology sectors.

While this paper has applied a consistent methodology across countries in relation to measurement of high-technology sectors and a consistent aggregation method, there remain a number of other measurement issues that may hamper international comparisons of economic data. The problems of defining and measuring the output and productivity of many services sectors is one example where finding a consistent and comparable method is of growing importance, as services constitute an ever larger proportion of GDP in many economies. The availability of an internationally comparable dataset such as the one used here can potentially also be employed for other calculations to assess the impact of measurement error, or of adopting improved statistical techniques for other countries.

References

Hobijn, Bart (2001) "Is Equipment Price Deflation a Statistical Artifact?" *Federal Reserve Bank of New York, Staff Report* No. 139.

O'Mahony, Mary and Bart van Ark (2003), "EU productivity and competitiveness: An industry perspective. Can Europe resume the catching-up process?" European Commission, Brussels.