Measurement bias in the HICP:

What do we know, and what do we need to know?[1]

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Measurement bias in the HICP: What do we know, and what do we need to know?

Mark A. Wynne and Diego Rodriguez Palenzuela

Abstract: The Harmonized Index of Consumer Prices (HICP) is the primary measure of inflation in the euro area, and plays a central role in the policy deliberations of the European Central Bank (ECB). The ECB defines its Treaty mandate of price stability as "…a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2% …to be maintained over the medium term." Among the rationales given for defining price stability as prevailing at some positive measured inflation rate is the possibility that the HICP as published incorporates measurement errors of one sort or another that may cause it to systematically overstate the true rate of inflation in the euro area. The purpose of this paper is to review what is known about the scope of measurement error in the HICP. We conclude that given the scant research on price measurement issues in the EU and the ongoing improvements in the HICP, there is almost no scientific basis at this time for a point (or even an interval) estimate of a positive bias in the HICP.

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1. Introduction

Fifteen or twenty years ago, few economists outside the community of scholars specialising in these matters were interested in the question of how well national statistical agencies measure inflation. At that time inflation in most countries was still running at rates that clearly could not be attributed to measurement error, but rather to errors on the part of economic and monetary policy makers. Since then, a number of (not completely unrelated) developments have moved the question of measurement to centre stage. The first was the remarkable success of central banks in all of the industrialised countries in bringing inflation rates down to levels not seen in decades. The transition to a low inflation environment, one in which measurement error could possibly account for a significant fraction of observed inflation, once again made the question of how well inflation statistics measure what they are supposed to measure of central importance.[2] The second key development was the shift of many central banks around the world towards inflation targeting as a strategy or framework for monetary policy. Inflation targeting shifts the question of inflation measurement to centre stage in the formulation of monetary policy. Indeed, some central banks have eschewed the adoption of formal inflation targets because of the difficulty of accurately measuring inflation in a dynamic economy.[3] The third development was the remarkable rate of productivity growth in the

[2] It is probably no accident that prior to the appointment of the Boskin Commission in 1995, the last time the problem of price measurement had attracted the attention of lawmakers in the US was at the end of the 1950s, a period of low inflation comparable to what the US experienced in the late 1990s. The Price Statistics Review Committee was created in July 1959 and issued its report in 1960. The report and a series of staff studies was published as Stigler (1961).

[3] See in particular Greenspan (2001b) who noted that "When industrial product was the centrepiece of the economy during the first two-thirds of the twentieth century, our overall price indexes served us well….But in our new century, the simple notion of price has turned decidedly ambiguous…how will we measure inflation….in the twenty-first century when our data -- using current techniques -- could become increasingly less adequate for tracing price trends over time?…For all these conceptual uncertainties and measurement problems, a specific numerical inflation target would represent an unhelpful and false sense of precision."

manufacture of computers and related high-tech equipment, and the extraordinary rate of improvement in the quality of the output of this and related sectors. The rapid rate of improvement in the performance of computers and other IT equipment raised the question of how well statistical agencies dealt with quality change in measuring inflation. In some countries (in particular the US) the decision was made to make greater use of hedonic methods to try to control for these quality improvements to ensure that the raw data used to construct aggregate price statistics were capturing pure price changes. And the dramatic changes in quality-adjusted prices that hedonic methods revealed lead to renewed concerns about the possibility of significant substitution bias in traditional fixed-weight Laspeyres type measures of prices and output, and ultimately to a major overhaul of the US national accounts with the fixed-weight Laspeyres measures of output being replaced by chain-weighted Fisher measures.[4] Recently the failure to account fully for quality improvements in high-tech equipment has been advanced as a possible explanation of sluggish investment growth in some European countries.[5] Finally, there has been technical progress in the measurement of inflation itself. This includes the emergence of large scale price-scanner databases, the drastic reduction in computing costs facilitating the implementation of hedonic methods and analytical advancements in the economic theory of price indices, like the derivation of exact index numbers under decreasingly restrictive assumptions[6].

[4] The change is explained in Landefeld and Parker (1995). Triplett (1992) and Young (1992) provide background.
[5] See in particular the June 2000 *OECD Economic Outlook*, the August 2000 *Monthly Bulletin* of Deutsche Bundesbank, the December 2000 issue of Sveriges Riksbank's *Inflation Report* and the July 2001 *Monthly Bulletin* of the European Central Bank.
[6] Diewert (2001) gives a historical overview of the link between theory and practice of price measurement issues. He concludes that the challenges to inflation measurement will only increase in the future, as technological change will make inflation measurement increasingly complex. He lists current analytical developments that should facilitate meeting those challenges in the future.

Our purpose in this paper is to assess the state of play on price measurement in Europe. In particular we want to pose and start answering the question of whether the Harmonized Index of Consumer Prices (HICP), which is central to the monetary policy deliberations of the European Central Bank (ECB), overstates (or understates) the rate of inflation in the euro area.[7] The ECB has defined its mandate of price stability as "…a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2% … to be maintained over the medium term." Among the rationales given for defining price stability as prevailing at some positive measured rate of inflation is the possibility that the HICP as published incorporates measurement errors of one sort or another that may cause it to systematically overstate the true rate of inflation in the euro area.[8] After the appearance of the Boskin Report in the US, several studies were conducted for European countries to assess the extent of mismeasurement in national CPIs. These studies reached different conclusions, but there is a vague consensus among economists and policy makers that inflation statistics persistently overstate the true rate of inflation by an unspecified amount.

In this paper we want to do two things. First, we want to review the current state of knowledge about measurement biases in consumer price inflation statistics in the EU, and specifically the HICP. Second, we want to give our impression of what the research priorities should be for future research on HICP measurement bias. We will start by briefly summarising the conceptual framework of the HICP and then sketch the two broad strategies that have been implemented for assessing the extent of measurement

[7] It is worth noting that in the press release announcing its strategy for monetary policy, no mention is made of the possibility of a measurement bias in the HICP, and the only feature of the HICP that the ECB cited as justifying the choice of this index for defining price stability was the fact that it was (and remains) the

bias. We will review the studies that were done for various European countries following the publication of the Boskin Report in the US, and review the work that has been done since. We will conclude by outlining our view of the research priorities.

Any attempt to assess the extent of measurement bias in a price index inherently entails some attempt to hit a moving target. The practices of statistical agencies may deliver better or worse results at different points in time depending on economic conditions. For example, substitution bias is less of a problem when relative prices are less volatile, which in turn depends in part on the level of inflation.[9] Measurement problems are also likely to be more severe during episodes of rapid technological change. Even in an economy that was not continually changing, the scope for measurement error varies over time as statistical agencies learn of problems and move to correct them. These considerations apply with even greater force to any attempt to assess measurement bias in the HICP. In many ways, the HICP is a work in progress.

2. The Harmonized Index of Consumer Prices (HICP)

The Harmonized Index of Consumer Prices (HICP) has its origin in the requirement of Article 109j of the Treaty on European Union (the Maastricht Treaty) that "a high degree of price stability" be among the criteria to be used in assessing whether Member States had achieved the necessary high degree of sustainable convergence criterion prior to the launch of EMU.[10] Protocol No. 6 of the Treaty further clarified the price stability criterion, stipulating that convergence consisted of having an inflation rate

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only price index that was sufficiently harmonised across the euro area at the launch of EMU. See European Central Bank (1998) and (2001).

[8] See for example European Central Bank (2001) p.39.

[9] See for example Balke and Wynne (2000) and Silver and Ioannidis (2001).

[10] Article 121 of the Consolidated Version of the Treaty on European Union (Amsterdam Treaty).

that "…does not exceed by more than 1½ percentage points that of, at most, the three best performing Member States in terms of price stability." Furthermore, Protocol No. 6 required that "Inflation shall be measured by means of the consumer price index on a *comparable* basis, taking into account differences in national definitions" (emphasis added). It was this requirement that inflation be measured on a comparable basis that led to the development of the HICP programme. The consumer price indexes of the Member States differ greatly in terms of their coverage and even in terms of their conceptual frameworks.

As described in Commission of the European Communities (2000) the HICP is "…a Laspeyres-type price index that is based on the prices of goods and services available for purchase in the economic territory of the Member State for the purpose of directly satisfying consumer needs." (p.13, emphasis in original) Given this pricing concept, the coverage of the HICP is defined as "household final monetary consumption expenditure." Commission of the European Communities (2000) further explains "The HICP is not a cost of living index. That is, it is not a measure of the change in the minimum cost for achieving the same 'standard of living' (i.e. constant utility) from two different consumption patterns realised in the two periods compared and where factors other than pure price changes may enter the index" (p.13, emphasis in original).[11] The weights used to calculate the HICP may relate to a reference period that is up to seven years prior to the current year, but must be updated each year for "…especially large changes in the expenditure pattern" (p. 14). The HICP was first published in March 1997

[11] There is a potential inconsistency here with how the HICP treats quality change. In the same document the Commission notes ' "Quality change" occurs whenever …a change in [product] specification has resulted in a significant difference in *utility* to the consumer between a new variety or model of a good or

and is published each month about two weeks after the end of the month to which it refers. Since November 2001, Eurostat has released a "flash" estimate of the HICP shortly (a couple of days) after the end of the reference month.

As already noted, the HICP is defined as a Laspeyres-type index. Thus for a country j the HICP in month t is defined as

$$HICP_{j,t} = \sum_i w_{i,j,b} \left(\frac{p_{i,j,t}}{p_{i,j,r}} \right) \quad (1)$$

where $p_{i,j,t}$ is the price of the i'th commodity in country j in the comparison month t, $p_{i,j,r}$ is the price in the reference month r, and $w_{i,j,b}$ is the weight assigned to the i'th commodity based on expenditure shares in the expenditure base period b. As already noted, the weights used to aggregate the elementary aggregates can be based on expenditure patterns up to seven years prior to the year for which the HICP is being compiled, although some countries update the weights annually. The reference period for the HICP sub indexes is 1996=100; for the new sub-indexes introduced in January 2000, the reference period is December 1999=100.

The elementary aggregate indexes, the individual $p_{i,j,t}$, or price relatives $(p_{i,j,t} / p_{i,j,b})$ are calculated as either arithmetic or geometric means. Specifically, the price relatives should be calculated as $(p_{i,j,t} / p_{i,j,b}) = (\frac{1}{n}) \sum_k p_{i,k,j,t} / (\frac{1}{n}) \sum_k p_{i,k,j,t}$ or $(p_{i,j,t} / p_{i,j,b}) = \left(\prod_k (p_{i,k,j,t} / p_{i,k,j,b}) \right)^{(1/n)}$. HICP regulations allow the use of arithmetic

service and a good or service previously selected for pricing in the HICP for which it is substituted.' (Commission of the European Communities, 2000, p. 62, emphasis added)

means of price relatives under special circumstances.[12] Note that one of the Boskin Commission's recommendations was that the US Bureau of Labor Statistics switch to the use of geometric means at the elementary aggregate level to eliminate the problem of formula or lower level substitution bias, which they estimated as contributing as much as 0.25 percentage points to the overstatement of inflation in the US. However, Triplett (1998) argues that the undesirable properties of the arithmetic mean of price relatives that led to its being banned in the computation of elementary aggregates in the HICP are not necessarily eliminated by the geometric mean.

The classification of goods and services in the HICP is based on the classification of consumer expenditures devised for the 1993 System of National Accounts. The COICOP/HICP (Classification of Individual Consumption by Purpose adapted for the HICPs) omits some COICOP categories (e.g. narcotics, prostitution, imputed rentals for owner-occupied housing) and combines others to ensure that the weight of each category exceeds 0.001 in most of the member states. It is worth noting here that Triplett (forthcoming) has criticised the adoption of the COICOP for classifying the components of consumer price indexes as "wholly inappropriate" because it is not rooted in economic theory.

As noted earlier the HICP plays a central role in the policy deliberations of the ECB. The Monetary Union Index of Consumer Prices (MUICP) is used to assess inflation developments within the euro area. The MUICP is a simple weighted average of the HICPs of the Member States participating in EMU, with country weights equal to the country's share of household final monetary consumption. The MUICP is calculated as

[12] Commission of the European Communities, 2000, p.52.

an annual chain index with country weights $w_{j,t}$ for country j at date t defined as the share of the country's household final monetary consumption expenditure in the EMU total:

$$MUICP_t = \sum_{j \in MU} w_{j,t} HICP_{j,t} \qquad (2)$$

For example, the country weights used in 2000 are derived from national accounts data for 1998, price updated to December 1999.[13]

Compilation of the HICP remains a highly decentralised affair, with responsibility for compiling national HICPs resting with national statistical agencies. At the time of writing, detailed information on the methods and practices of the various national statistical institutes does not appear to be readily available. While the harmonization programme has been very successful at dramatically increasing the degree of comparability of consumer price indices across EU countries and has sought moreover to achieve harmonization on best practice in most areas, there is very little documentation currently available to outsiders explaining the details of how national HICPs are constructed. The two reports of the Commission on the harmonization process (Commission of the European Communities 1998 and 2000) are valuable resources but incomplete in important respects. In this regard, Eurostat's plan to make available a Handbook and a more comprehensive compendium of HICP regulations is a positive development, which should be further complemented with additional releases of documents and information on current practices to implement the HICP in member

[13] Commission of the European Communities, 2000, p.14.

countries.[14] Appendix A of this paper lists the currently available information on the compilation of national CPIs in the member states.

3. What do we know about bias in measures of consumer price inflation in Europe?

Lets start with the question of what we currently know about the accuracy of measures of consumer price inflation in the EU. The answer is: Very little. To date there have been a number of attempts to assess the accuracy of the national CPIs in individual member states using the direct or "brute force" approach of looking at components of the indexes and then aggregating to obtain an estimate of the overall bias. This was the approach of the high-profile Boskin Commission in the US, and in some circles remains the preferred approach to studying measurement problems. A drawback of this approach is that it can be difficult to be sure that all potential biases have been found. There is the risk of paying too much attention to narrow categories of goods or services where there may have been a tendency to overstate inflation, and neglect broader categories of goods and services where there may be a tendency to understate inflation. An alternative, indirect, approach is to try to assess the extent of measurement bias indirectly by comparing measured consumer price inflation with either survey data of one sort or another, or by trying to estimate quality or other types of bias using alternative data on consumer spending patterns. The main studies in this category are those of Nordhaus (1998), Krueger and Siskind (1998), Hamilton (2001) and Bils and Klenow (2001), all of which refer to the US. The drawback of the indirect approaches to assessing the extent of measurement error is that we usually need to make a variety of strong assumptions to draw inferences about measurement bias, although it is a matter of debate whether these

[14] See Astin (1999).

assumptions are any stronger than those needed to implement the ground up direct approach.

The reference period for almost all of the existing studies preceded the launch of the HICP, so they typically did not consider the extent to which their conclusions applied to the HICPs of the member states. The principle of harmonisation on best practice that was and continues to be a guiding principle of the HICP program suggests that the results of these studies may be of limited applicability to the HICP, although this will vary from country to country to the extent that some countries were already employing best practice and to the extent that the differences between national CPIs and HICPs are not all that great for some countries. Table 1 gives some sense of the degree of overlap between national CPIs and national HICPs. Note that for some countries the coverage of the two is almost identical, which would in principle allow us to directly infer from estimates of bias in the national CPI the magnitude of the likely bias in the HICP. There does not appear to have been any attempt to perform a comprehensive audit of the CPI or HICP in any of the member states comparable to the audits of the US CPI carried out by the Stigler (1961) and Boskin (1996) Commissions[15]. Indeed many of the studies of bias in European CPIs seem to have been prompted by the Boskin Commission report rather than undertaken independently. Nor do there appear to have been any independent attempts to carry out a review of possible measurement problems comparable to Gordon's (1990) study of the measurement of durable goods prices. In assessing the state of knowledge, we can draw a distinction between the surveys that were prepared around

[15] The Stigler Commission reviewed all of the major price indexes published by the US government, not just the CPI.

the same time as the publication of the Boskin report in the US, and the work that has been done since.

3.1 Post-Boskin reviews.

Germany. Of the studies to date, the most comprehensive by far, and a model for what is needed for other countries, is that by Hoffman (1998) for Germany. In addition to pulling together existing studies of potential problems in the German CPI, Hoffman carried out a number of new studies, significantly adding to the body of knowledge on the potential for quality bias in the German CPI. However, Hoffman notes in his conclusions that the paucity of detailed case studies of mismeasurement of individual prices severely limits the ability to come up with a reliable estimate of the overall bias.[16] The number he provides as an estimate of the bias is 0.75 per cent a year, but he notes that the bias may well be larger in certain circumstances, especially during periods of falling prices.

France. Lequiller (1997) provides an overview of the measurement problems in the French CPI. Taking the Boskin Commission report as his point of departure, he notes that some of the Commission's suggestions for improvements in the US CPI were already in place in France, reducing the potential for substitution bias. On the subject of new goods and quality change, he notes the paucity of studies on which to base a firm conclusion. He cites one study of PC prices in France that shows a discrepancy of as much as 4.4 percentage points a year between the official index for PCs and a quality-adjusted index based on hedonic methods.[17] His bottom line, however is that there is

[16] The vast majority of the some 160+ references in Hoffman's paper were to studies for other countries or general problems of index number construction.
[17] See Moreau (1996).

simply not enough evidence to warrant a strong conclusion about the extent of the overall bias.

UK. Two studies have looked at the possibility of measurement error in the UK Retail Price Index (RPI). Oulton (1995) reviews the traditional sources of bias and concludes that "…substitution and outlet bias are probably not significant sources of error in the UK. The two other sources of bias [quality change and new goods] most probably do lead to significant overstatement, but the size of the upward bias cannot at the moment be quantified." Oulton does not cite any studies using UK data to justify his conclusions about the unimportance of substitution bias or outlet substitution bias, so arguably *none* of the biases can be quantified.[18] Again, the vast majority of the references in his paper (ten of fifty six, and the bulk of these are to publications describing the construction of the RPI rather than independent studies of the accuracy of its components) are to studies that have been done using US data. Cunningham (1996) guesstimates that the extent of the bias in the RPI is 0.35 to 0.8 percent a year, although again almost exclusively on the basis of studies for the US.

Netherlands. The only other study of the overall bias in national CPIs for Europe of which we are aware is that by Folkertsma (1998) for the Netherlands, which concludes that "…the CPI in the Netherlands is probably biased but because of the lack of empirical research in this area the size of the measurement bias cannot be assessed." Once again the bulk of the references in Folkertsma's study (twelve of sixteen) are to studies of US data.

Table 2 summarises the findings of these surveys. The coverage of the studies is about half of the EU or EMU. Crudely adding the estimates together, we would conclude

[18] Although he does present some data on retail trends in the UK to support his claim about outlet substitution bias.

that bias in the HICP for the EU might be of the order of magnitude of 0.28 to 0.37 percentage points per annum, or 0.28 to 0.30 percentage points per annum for the MU. These estimates are based on the assumptions that nothing has been done to correct the problems identified by these studies, and that the bias in all of the other member states of the EU or MU is zero. We believe that both of these assumptions are too strong to allow us to place much confidence in these numbers.

3.2 Ongoing research.

It is important to note that since the appearance of these initial surveys of measurement problems, there has been further work done in some EU countries on some of the measurement problems. By contrast to most of the studies reviewed in the previous sections, the more recent studies have in general not aimed at providing estimates of the total bias in overall inflation. Instead, recent work has been focused in assessing as well as understanding the nature of the biases in key sub-indices of the national CPIs or the HICPs. In particular, a number of the recent papers have been geared towards the contribution of methodological innovations (in terms of sampling as well as computation of price indices) that could overcome the problems that gave rise to measurement biases. In this sense the more recent contributions, while remaining fairly limited in number, might be seen as setting the basis for future progress in the accuracy of the HICP, in that they identify items where the bulk of the bias is likely to be found and moreover point to new methods that could succeed at reducing those biases.

Regarding sectoral aspect of price measurement, the bulk of the more recent work has tended to be concentrated in the areas of high tech goods like PCs, where the

problems of quality bias are believed to be particularly acute while remaining a small fraction of overall inflation, housing services, which represent a substantial part of the HICP while featuring limited technological change, and private transportation, which is an intermediate case in both regards. As regards data and methodological issues in the more recent work, increasing attention is being paid to the potential for scanner data and complementary data sources like household surveys and databases provided by manufacturers' and consumers' associations to alleviate some of the well-known problems in price measurement.[19] In addition, new alternatives to conventional hedonic methods have been proposed for estimating quality-adjusted prices.

Germany. Following up on his overview of potential measurement error in the German CPI, Hoffmann (1998) provided further evidence of the potential for quality bias in the German CPI. Citing his own earlier work and research by Harhoff (1999) he suggested that given the rules employed by the German Federal Statistical Office to make quality adjustments, the potential for upward bias increases at lower inflation rates and as of 1998 was around 0.25 percent per annum.

Hoffmann and Kurz (2001) explore the potential for measurement error in the CPI for rental housing services for West Germany. Their results suggest that the year to year rate of increase in this component of the CPI for West Germany could be reflecting a *downside* bias of 0.5 percentage points since approximately 1992 (i.e. coinciding with German re-unification). This result is based in the comparison of the official CPI information with an index of rental housing services derived from an alternative survey-based data base, the German socio-economic panel (GSOEP), for the period 1985-1998.

[19] See Feenstra and Shapiro (forthcoming). De Haan (2001) reports that scanner data will be used in the compilation of the CPI for the Netherlands from May 2001.

Although the exact nature of their estimate of the bias in the CPI is difficult to pin down, the discussion in Hoffmann and Kurz (2001) suggests that the downside bias could be related to the fact that that the German CPI sub-index for rental housing services is a matched-models index (i.e., the sample of rents results from following dwellings, and not households, over time). They show in particular that rent adjustments in dwellings tend to occur upon tenant turnover. Since overall tenant turnover in the former West Germany increased after German re-unification, a possible explanation of the emergence of a bias in the official series since re-unification is that the German CPI sub-index for rental housing services under-represents tenant turnover in the underlying sample.

France. Poinat (1997) examines the potential for bias in the French CPI due to annual chain linking of December indexes. Bascher and Lacroix (1998) report estimates of hedonic models for dishwashers and apparel (women's suits and men's shirts) in the French CPI. Unfortunately they do not compare the results of quality adjustment using their hedonic models with traditional methods. However, their hedonic model has been used since September 1997 to make quality adjustments to dishwashers. Figure 1 shows the annual rate of change on the relative price of dishwashers in France over the course of the 1990s. Note that since the introduction of the hedonic index, the rate of change of the dishwashers index increased.

Netherlands. Bode and van Dalen (2001) report the results of estimating hedonic regressions for new cars in the Netherlands under a user-cost approach[20] and compare the effects of quality adjustments based on these regressions with the published indexes for new cars. Over the 1990-1999 sample period they find that while the official CPI for new

cars increased 11.2 percent over this period, the hedonic indexes show that quality adjusted prices were roughly constant, recording changes of between 0.1 percent and –3.6 percent depending on specification and implying a cumulative upward bias in the CPI of between 11.1 and 14.8 percentage points.

UK. Blow and Crawford (1999) use nonparametric methods to examine the problems of substitution bias, new goods bias and quality bias in the UK RPI. They conclude that substitution bias in the RPI caused it to overstate the increase in the true cost of living by up to 3.2% over the period 1976-1997.[21] They also look at quality change in the audio-visual equipment component of the RPI and find that failure to make appropriate adjustments for quality change in this category caused the RPI to overstate inflation by about 1% over the period 1974-1996, or about 0.05% per annum. Finally, they estimate that the gain in welfare associated with the introduction of a single new good (the UK National Lottery) reduced the measured rate of inflation from 2.14 percent per annum to 1.97 percent[22]. Of particular note for the debate over research priorities in the area of price measurement is their concluding observation that

> "The bounds on the biases caused by a *single* instance of a new good and quality change in *one* section of the RPI are comparable to the *overall* bias caused by commodity substitution. We therefore conclude that, although substitution bias in the RPI formula is significant, it is likely to be much smaller than the biases

[20] This is particularly relevant for the case of the CPI in the Netherlands, which follows into the Cost of Living methodology. The user-cost approach aims at measuring the total cost per unit of service from a commodity to its owner.

[21] They note that the RPI is not designed to be a cost of living index, but argue that given that the many uses to which the RPI is put require that it be interpreted as a cost of living index it is legitimate to ask how well it approximates this theoretical ideal.

[22] Blow and Crawford (2001b) revisit this question using further methodological innovations based on non-parametric methods. The size of the bias from excluding the National Lottery as a new good is increased somewhat in this case, when the Törnqvist index is used to compare the change in prices under inclusion and exclusion of the new good.

that can be caused by continual product innovation in the form of new goods and quality change." (Blow and Crawford 1999, p. xii, emphasis added)]

Silver and Heravi (2001) explore the potential bias arising under the matched-models approach to quality adjustment. They conclude that unless the matched-models approach is used in a context of frequently updated sampling and is implemented as a relatively high frequency chained index, it will be subject to important biases, particularly in settings with rapid quality change. Specifically, comparing a hedonic-based quality adjusted index based on scanner data for washing machines retailing in the UK in 1998 (which virtually reflects the universe of transactions in that year) with a quality adjusted index based on the matching-models method, they find that the latter suffers from a *downside* bias of 3.2 percentage points per year. Silver and Heravi (2001) provide a comprehensive argument as of how the matching-models method is likely to induce a bias in consumer price indices. Specifically, the matching-models approach tends to introduce a sample selection bias in the price index. Requiring that a given item should be present in the sample both in the former and the latter period when the price comparison is made implies two cases of sample selection. *New* models that are present in the latter but not in the former period, as well as *old* items that are present in the former but not in the latter, are more frequently dropped out of the sample. Then, if the pricing of old and new products is systematically different than pricing of matched models (as it is frequently the case since product prices tend to change along the product life cycle) then the matching-models method introduces a sample selection bias in price measurement. Silver and Heravi (2001) conclude that, although increasing chaining and sampling frequency alleviates the sample selection bias of the matched-models method, sectors

with rapid technological and quality change may call for the combined use of scanner data and hedonic-based quality adjustment.

Spain. The recent series of papers by Ruiz-Castillo, Ley and Izquierdo (1999, 2000a, 2000b) address some distributional issues that arise in the measurement of inflation. It is not obvious to us that a central bank ought to be concerned about the potential for plutocratic bias (which Ruiz-Castillo et. al. (1999) defined as the difference between inflation as measured by the (plutocratic) official CPI (which implicitly weights households by their expenditures) and inflation as measured by an index in which all households get an equal weight). Ruiz-Castillo et. al. (2000b) examine the distributional consequences of quality change bias in the Spanish CPI. Importantly, they do not have independent evidence of the extent of the quality bias in the Spanish CPI, but rather rely on the figures arrived at by the Boskin Commission, suitably adjusted for Spain. It is really only the third of the three papers that addresses a source of bias that might be of more interest to monetary policy makers. This is the bias that arises when statistical agencies fail to allow for price changes that occur between the period when household consumption patterns are investigated to obtain the weights to be used to aggregate prices and the reference period for the price index. Ruiz-Castillo et. al. term this the Laspeyres bias, and (interestingly enough) show that it was *negative* on average over their sample period.[23]

More recently, a number of sectoral studies on price measurement issues have been undertaken by Banco de España, focusing on owner housing prices, automobiles and personal computers. Bover and Velilla (2001) apply panel data methods to analyse

[23] This appears to be essentially the same bias that the Boskin Commission termed lower-level substitution bias.

prices of dwellings in a sample of newly constructed multi-unit sites for the period 1993-1997. They compare price increases in dwellings based on a number of quality adjustment methods with those from a naïve indicator[24], which only takes into account the size of the dwelling. The latter might be seen as a proxy for an owner occupied house prices index that follows a cost-of-acquisition approach and that does not introduce adjustment for quality change. The comparison of the best quality-adjusted specification with the naïve indicator reveals that the latter suffers an upside bias from quality adjustment in the range of 0.75 to 1.2 percentage points per year. An important contribution of Bover and Velilla (2001) is that they show that panel data methods can be used to construct parsimonious quality adjusted prices of dwellings. These can be derived from a sample that includes information only about the price, the size (i.e. number of square meters) of the dwelling, and a site indicator where the dwelling belongs. Specifically, Bover and Velilla (2001) show that their parsimonious quality-adjusted prices turn out to be very similar to those derived from a conventional hedonic regression which takes into account a large number of individual characteristics of the dwellings.

As regards quality adjustment for prices of cars in Spain, Licandro, Izquierdo and Maydeu (2001) exploit a very detailed database of sold cars' prices and characteristics provided by a manufacturers association for the period 1997-2000. Building on these data, they construct a price index comparable to the one provided by the Spanish National Statistics Institute (SMSI) and compare it to their own hedonic-type of quality adjusted indicator. Their results indicate that the average difference (in percentage rates of

[24] They also compare their quality-adjusted series to the National Accounts deflator for residential constructor. This comparison suggests that the latter features a significant downside bias of 3.5 percentage points per year. However, the new residential house deflator is constructed as an index of the costs of the

increase) between the indicator constructed to follow the official one and indicator that they propose is 3.5 percentage points per year. The estimator of quality adjusted car prices of Licandro, Izquierdo and Maydeu (2001) is based on a two-stage extension of the conventional hedonic methodology. In a first stage, car characteristics are divided in a number of groups, each of them is then aggregated into a "quality characteristic" of the car. This reduction in the dimension of the space of characteristics is based on the use of principal-components techniques. Once the quality characteristics of the cars have been constructed, they are used as input in the conventional hedonic regression (i.e. instead of directly using the raw characteristics in the right-hand-side of the hedonic regression). However, Licandro, Izquierdo and Maydeu (2001) do not provide an assessment of the costs and benefits of this two-stage procedure, relative to conventional hedonic regressions, either in the context of their sample, or in more general theoretical terms.

Izquierdo and Matea (2001) exploit a database on desktop and laptop personal computers' prices and characteristics for the period 1990-2000 to come up with an estimate of the measurement bias in the Spanish price sub-index for information processing equipment.[25] Their quality-adjusted estimates based on the standard hedonic method point to the possibility of a substantial upside bias the official measure. While the latter reports an average decrease of 9 percent per year in information processing equipment prices, their estimates indicate an average price decline of 35 percent per year, i.e. a bias of 26 percentage points on average per year. At the same time, their results should be interpreted with caution, since certain important quality characteristics of PCs, like the type of microprocessor and weight, are missing from the sample.

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construction inputs. The discrepancy reflects partly a potential bias from insufficient quality adjustment together with declining profit margins for residential house developers.

Portugal. Neves and Sarmento (1997) report estimates of the size of the substitution bias in the Portuguese CPI of between 0.05 and 0.1 percentage points a year. Santos and Coimbra (1995) present estimates of bias due to the failure to fully account for quality improvements in cars. More recently, Covas and Silva (2001) revisit the issue of estimating the outlet substitution bias in the Portuguese CPI. They make use of data from the Portuguese household budget surveys to complement the sample on which the CPI is based. Allegedly, the latter may have failed to take into account the rapid expansion of large retailers in the 1990s. They conclude that the outlet substitution bias in the Portuguese CPI may have been close to 0.5 percentage points per year, i.e. larger than reported in earlier studies. They indicate however that the outlet substitution bias is likely to have decreased to about 0.25 percentage points per year in the later years, although the size of the bias in the later years is particularly difficult to gauge.

Ireland. Research on price measurement problem in Ireland in recent years has tended to concentrate on the problems of accurately measuring house prices due to the extraordinary increases in real estate values associated with the rapid growth the country has experienced over the past decade. Conniffe and Duffy (1999) review some of this research, which has tended to focus on the problems of correcting for differences in the characteristics of different houses to compute an index of average house prices. Since the Irish CPI measures the costs of owner-occupied housing using mortgage interest costs, and the HICP does not yet include the costs of owner-occupied housing, the results of this research are of limited applicability for our purposes.

[25] About 90% of which corresponds to personal computers.

3.3 Indirect approaches to inferring measurement error

An alternative to the direct approach to estimating the overall bias in the HICP is to try to infer it indirectly using alternative data. One ingenious suggestion put forward by Nordhaus (1998) involves comparing median household income deflated by some measure of consumer prices with self-reported measures of well being. Taking data from the University of Michigan Household Survey (specifically the response to the question asking how the household's financial situation had changed over the past year) and regressing it on the change in median household income deflated by the CPI allows one to back out an estimate of the bias in the CPI. For example, a finding that more households reported their financial situation as having improved over the past year than report it as having deteriorated, at a time when a CPI deflated measure of median household income shows no change, suggests that the deflator used to deflate income may be over stating the inflation experienced by the average household. Figure 2 replicates Nordhaus' scatter plot.

A simple regression of the form

$$y_t = a((v_t - p_t) - b) + e_t$$

where y_t is the percentage of survey respondents reporting themselves as being better off less the percentage of respondents reporting themselves as being worse off than they were 12 months ago, v_t is the growth of median household income over the past year, and p_t is measured inflation, allows one to estimate the extent of bias in the CPI.[26] If the CPI correctly measures inflation, then the estimated parameter b should be zero. The

[26] The precision of this approach may be enhanced if the distribution of responses (instead of the summary statistic "% better off - % worse off") is made available by the statistical agency and if this distribution can be compared with the distribution household incomes deflated by the CPI.

simple regression line shows that on average equal numbers of people report themselves as being better of as report themselves as being worse off when median household income deflated with the All Items CPI-U was declining at 1.1 percent a year.[27]

A comparable exercise at the EU or MU level is not feasible. While the European Commission's monthly Harmonized Consumer Survey does provide usable measures of households self assessed well being similar to those in the Michigan Survey (specifically question 1 "How does the financial situation of your household now compare with what it was 12 months ago?"), we do not have EU or MU-wide data on income distribution or median household income. There are very limited time series data available at the level of the individual member states that would allow us to employ this approach to the problem of bias estimation: we were only able to obtain data for the UK, Sweden, France and Italy. Statistics Sweden reports data on median income from work for persons employed full time over full year on an annual basis form 1990 through 1998.[28] However, the European Commission Harmonised Consumer Survey for Sweden only begins in 1995, the date of Sweden's accession to the EU, leaving little in the way of usable data. We have not been able to find a comparable survey of household well being that could be used instead. For the UK we are able to obtain a long time series (1961-1998) on median household income drawn from the Family Resources Survey and the Family Expenditure Survey.[29] For Italy, Brandolini (1999) reports various measures of income distribution.

Figures 3-5 show scatter plots of growth in real median household income against the balance statistic from the European Commission's monthly survey for the UK, France and Italy. What is striking is that on average more households report themselves as being

[27] Nordhaus' estimate is 1.5 percent but we were unable to replicate his results exactly.
[28] At http://www.scb.se/eng/befovalfard/inkomster/hink/hinktab2.asp

worse off than as being better off in every single year of the sample in both France and Italy. This despite the fact that real median income appears to be growing in most years. Crude application of Nordhaus' methodology to these data would suggest that far from overstating inflation at the consumer level in these countries, the national CPIs drastically *understate* it!

While Nordhaus' simple approach to estimating the CPI bias yielded results that were remarkably close to the conclusions of the Boskin Commission, Krueger and Siskind (1998) using more detailed data on income distribution from the Panel Study on Income Dynamics (PSID) find that the CPI may in fact provide an accurate measure of changes in the cost of living. Krueger and Siskind motivate their study by pointing out that Nordhaus' approach is only valid if the entire distribution of income moves with the median income.[30] There are a significant number of panel studies in Europe, and we are currently investigating the feasibility of employing the Krueger-Siskind approach to bias estimation using these datasets.

Two other recent creative uses of alternative data sources to estimate biases in the US CPI are Hamilton (2001), and Bils and Klenow (2001). Hamilton uses the PSID to estimate Engel curves for food which are then used to derive an estimate of CPI bias. If the demand function is properly specified, tastes are stable and there are no systematic errors in variables, the estimated Engel curves should be stable over time. Instead,

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[29] We thank Tom Clark of the UK's Institute of Fiscal Studies for helping us track down this data.

[30] Consider a population consisting of five households. Suppose that over the course of a year, the poorest of the five households experiences a decline in its (correctly measured) real income, the next two richest households experience no change, while the richest two households experience real income growth. Under these circumstances, median household income remains unchanged. However, 40 percent of households have experienced income gains, while only 20 percent have experienced income losses. A survey of households would find more reporting themselves as being better of than reporting themselves as being worse off, at the same time as real median household income is unchanged. In this situation it would be incorrect to infer that there was an upward bias in the deflator used to construct real income.

Hamilton finds that they shift to the left, meaning that a given share of food in overall household expenditures is associated with lower levels of CPI deflated household income. Hamilton attributes this pattern to an upward bias in the CPI, which he puts at 2.5 percent per annum during the period 1974-81, and slightly less than 1.0 percent per annum during the period 1981-1991. The latter figure is remarkably close to the estimate of the Boskin Commission.

Bils and Klenow (2001) use data from the U.S. Consumer Expenditure Survey for 1980 to 1996 to estimate quality Engel curves for a range of consumer durables. Unlike the standard Engel curve that relates (nominal) expenditure on a product to income, the quality Engel curve expresses unit price as a function of income. (The traditional Engel curve is then simply the product of the quality Engel curve and a quantity Engel curve.) The essence of Bils and Klenow's approach can be stated as follows. The unit price paid by household h for product i at date t, x_{iht}, is simply the product of the common quality-adjusted price for product i faced by all households at date t, z_{it}, and the quality of product i purchased by household h at date t, q_{iht}: $x_{iht} = z_{it}q_{iht}$. Log differencing and averaging across households, we obtain $\Delta x_i = \Delta q_i + \Delta z_i$. The measured rate of change of the price of good i, Δp_i, is equal to the rate of change of the quality-adjusted price of i, Δz_i, plus some possibly unaccounted for quality change, Δq_i: $\Delta p_i = \Delta z_i + m\Delta q_i$. Combining the two equations allows us to write $\Delta p_i = m\Delta x_i + (1 - m)\Delta z_i$. A simple regression of Δp_i on Δx_i (using instrumental variables to take care of the correlation between Δx_i and Δz_i) allows one to estimate the proportion of quality growth, m, that goes unmeasured. Bils and Klenow estimate

that the BLS miss about 60 percent of the improvement in the quality of durable goods over time, imparting an upward bias to the CPI of about 0.8 percent per annum over 1980-1996.

We are currently investigating the possibility of using these approaches to bias estimation on data for individual EU countries.

4. What do we need to know?

Two important prerequisites need to be addressed before attempting to provide a comprehensive answer to the question of whether the HICP overstates the true rate of inflation in the euro area. The crucial first step is to define what the true rate of inflation is.[31] The second is to understand in detail how exactly the HICP is computed on a month-to-month basis.

The mainstream approach to evaluating measures of consumer price inflation involves comparing official measures with the cost-of-living index of economic theory. If, as Eurostat has stated on numerous occasions, the HICP is not based on the theory of the cost of living index, we need to know what theory it is based on, and whether, how and to what extent this theory differs from the theory of the cost of living index. Is it possible to put the HICP on as rigorous a choice-theoretic foundation as that on which the cost of living index rests?

One key difference between the HICP and the cost of living index has to do with the appropriate treatment of durable goods. In the cost of living framework it is the service flow yielded by durable goods that ought to be priced, and not the purchase price

of the good. (Although in reality this principle only seems to be followed when it comes to pricing owner occupied housing). However, the situation is exactly the reverse under the HICP concept. Some of these issues are clarified in the recent working paper by Diewert (2000). Is the price concept that forms the basis of the HICP the right one for a measure of inflation for monetary policy? On the face of it, the concept of household final monetary consumption expenditures that forms the basis of the HICP is appealing from the stand point of monetary policy. The biggest drawback of this concept is that the measure of inflation that it gives rise to does not have a rigorous foundation in economic theory. This is in stark contrast to the cost of living concept, which is familiar to anyone who has ever studied intermediate microeconomics.[32] Some detailed analysis of the differences between the two measures is also probably warranted. Under what circumstances would the different treatment of durable goods in the two indexes cause them to diverge?[33] For example, would a revised HICP that included the net acquisition cost of owner occupied homes be more sensitive to housing market booms than a cost of living index? Is this desirable from the perspective of monetary policymakers?

At present the HICP does not include the costs of owner-occupied housing. Eurostat is working towards the inclusion of housing prices using a net acquisition cost approach (for the time being on an experimental basis, later as part of the index). How

[31] Commission of the European Communities (1998) notes that "The HICPs can all be said to meet their purposes of 'measuring inflation by consumers' to a degree which is unknown (and perhaps unknowable) because there is no reference by which to determine the extent of any bias." (p.11)
[32] There is a curious inconsistency in the position of advocates of the cost of living approach. They argue that the service flow of durables should be priced because consumers acquire durables with a view to enjoying their services over several years. However, the standard theory of choice that underlies the construction of the traditional cost of living index ignores the fact that consumers maximise not just current utility but also expected future utility. Ideally we should then focus on an intertemporal cost of living index as advocated by Alchian and Klein (1973) and Pollak (1983), and operationalized by Shibuya (1992). However, this raises a whole new set of intractable issues.
[33] Diewert (2000) reports some illustrative calculations along these lines.

this will be done in practice remains to be seen, but will raise a whole new set of questions. For example, how will changes in the quality of houses be handled?[34] Is sample representivity a problem (in smaller countries the number of new houses on sale each month available to the price surveyor may be quite limited)? More generally, the rationale for excluding the options of imputed rental value and user cost were ruled out on the ground that those payments depend directly on interest rates. But interest rates (through the cost of mortgages) may have sizeable effects also on the net acquisition value. How large are those effects precisely and do they pose problems for the HICP as an indicator for monetary policy?

The second crucial issue that needs to be addressed is the paucity of information available to outsiders about how the HICP is constructed. There is a very limited amount of documentation available about the construction of national CPIs, and in those cases where it is available it is only in the language of the state concerned. It would be extremely useful to researchers working on measurement issues related to the HICP to have, as early as possible, documentation available for all countries in English. Note that Eurostat has made available a significant amount of extremely useful information about the HICP program through their reports to the Council (See Commission of the European Communities (1998, 2000)). However, it is still rather difficult to get a good sense of how the different national statistical agencies go about compiling the raw data that go into the HICP. For example, to what extent do national statistical agencies rely on sampling of goods and outlets when deciding what to price and where? When identical new model year cars are being priced for the HICP, are they adjusted for quality exactly the same

[34] Recall that failure to properly account for quality change in the stock of owner occupied housing in the US prior to 1978, specifically , deterioration in quality due to depreciation, imparted a downward bias to

way in all countries in which they are priced?[35] Knowing what the practices of the statistical agencies are would greatly help in setting priorities for future research. For example, if we were reasonably confident that statistical agencies followed best practice when it came to making quality adjustments, but followed more informal procedures as regards outlet selection, it would make more sense to devote more resources to figuring out the potential for outlet substitution bias than to second guessing the agencies' quality adjustments.

The problems that arise in accurately measuring inflation are usually grouped under three headings. The first type of problem relates to the sampling procedure (including the choice of when to sample products) used to select the goods in the consumption basket, as well as to record their price and quality characteristics. The second broad class of problems arises due to substitution on the part of consumers away from relatively expensive products toward relatively cheaper products. These substitution problems arise as a result of the choice of index number formula and weighting scheme. We can also include in this category the problem of outlet substitution as consumers shift their spending from traditional retail outlets to newer discount stores. The third broad class of problems arises due to changes in the quality of goods and services, and the arrival of new goods.

The limited availability documentation on the implementation of the HICPs at national level makes it difficult to assess the extent to which potential heterogeneity in sampling timing and methods (including the frequency with which weights are updated and the basis on which the updating in weights is made –i.e., whether weights are updated

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the US CPI for a long time. See Randolph (1978).

[35] Commission of the European Communities (2000) suggests not.

on the basis of new consumers' survey or just on changed prices) gives rise to measurement bias. We include under this heading the issue of list versus transactions prices. For almost all uses to which a price index is put, it is important that, to the extent that is feasible, the prices that enter into the index are those at which actual transactions take place, and not list prices at which relatively few transactions occur.[36] [37]The two reports from the Commission to the Council on the HICP do not appear to address the issue of transactions versus list prices explicitly, although the guidelines on the treatment of sales prices or price reductions are relevant.

Arguably, substitution bias in the traditional sense is *by definition*[38] not a problem in the HICP. The coverage of the HICP is defined as "final monetary consumption expenditures of households" and the HICP is intended to measure the average price change experienced by households attempting to maintain a given pattern of these final monetary consumption expenditures. As we have noted above, Eurostat states explicitly that the HICP is not intended as a cost of living index. Given that discussions of substitution bias are based on a comparison of a calculated index with a theoretical ideal of a cost of living index based on household expenditure functions, any discussion of the substitution bias in the HICP seems moot. However, this simply brings us back to the question of what is the theoretical basis for the HICP. The household final monetary consumption expenditure concept has a certain intuitive appeal, but it would be helpful if it could be put on a more formal basis.

[36] Lequiller (1997) acknowledges that the French CPI may have overstated inflation during the 1993 recession by failing to take full account of retailers greater use of unadvertised discounts during this period.
[37] Note that Hoven (1999) states explicitly that list prices are used for the compilation of the CPI for new cars in the Netherlands
[38] In the sense that "substitution" captures an aspect of economic behaviour that cannot be accounted for by a purely statistical index. In practice, National Statistical Institutes routinely take into account the issue of

Even if we were to take the theory of the cost of living index as the appropriate benchmark for the HICP, there are other reasons to believe that there may be relatively little substitution bias in the HICP. At the highest levels of aggregation, this reflects the fact that the weights are updated annually (albeit on the basis of "price updating" rather than annual consumer expenditure surveys, which in turn raises interesting questions) rather than being held fixed for long periods of time. At the lower level it appears that the lower-level substitution bias that was of such concern to the Boskin Commission is probably not a major issue in the HICP because of widespread use of geometric means.

As for outlet substitution bias, there does not seem to be much to go on. Hoffman (1998) notes that traditional high-cost outlets are probably over represented in the German CPI, but concludes that based on observed trends in market shares outlet substitution bias is unlikely to amount to more than 0.1 percent annually. We would be surprised if outlet substitution bias turned out to be a major source of bias in the HICP, since the retail sector in many (but not all) European countries seems to be a lot more regulated than the retail sector in the US.[39] Arguably in the presence of such regulation, it may make little difference where the statistical agencies collect their raw data. More importantly this example illustrates the need for input at the national level, and more

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substitution bias through the update of the relevant basket whenever the effect of the update amounts at least to 0.1% of the index.

[39] The US-based retailer Wal-Mart entered the German market in 1998, opening a chain of superstores similar to those it operates in the US offering a range of discount department store goods and groceries. In May 2000, it lowered its prices on a number of staples below their purchase cost in an attempt to gain market share. The Aldi and Lidl chains followed suit, prompting the German Cartel Office to open an investigation under Section 20(IV)(2) of the Act Against Restraints of Competition (Gesetz gegen Wettbewerbsbeschränkungen) which prohibits businesses with superior market power from pricing below cost (except in very limited circumstances). In September 2000, the Cartel Office found that all three retailers were indeed engaging in illegal price cutting, and ordered all three to raise prices. See, for example, the Associated Press story by Stephen Graham of September 9, 2000.

specifically the need for a long-run project assessing bias in the HICP to develop from the ground up.

For these reasons, traditional substitution bias is probably the lowest priority for a long-term research project. To begin with, as noted above, given that the HICP does not take the theory of the cost of living index as its theoretical concept, the issue of traditional substitution bias, which only has meaning with reference to a true cost of living index, is moot. Second, given the frequency with which the weights are adjusted (in principle if not in practice) any substitution bias is likely to be small. And finally, of all the potential problems with the HICP, this one is the easiest to get a handle on and so should be the lowest priority.

The big unanswered questions have to do with quality change and the introduction of new goods. There is some reason to believe that the rules put in place governing the treatment of new goods are such that this is might be less of a problem with the HICP than has been the case with some national CPIs. The HICP program requires that new goods be included when they achieve a sales volume of over one part per thousand of consumers spending. As noted above, to date there have been remarkably few studies of the problem of quality change in European price statistics. Many of the existing estimates of the extent of measurement bias in national CPIs rely heavily on studies for the United States. For example, Hoffmann (1998) notes that, at the time he was writing, there were only three studies of the quality problem for Germany. At the outset we cannot rule out the possibility that the paucity of studies of quality change in Europe reflects fundamental differences between Europe and the US, specifically a less innovative environment and a slower pace of product innovation and technical change. We are inclined to discount this

possibility. It seems to us that the electronic goods purchased by European households, to take but one example, have experienced improvements in quality over the past two decades at a rate comparable to the US. By way of illustration, Figure 6 shows the recent behaviour of computer prices in the US CPI and the HICP for the EU (EICP). Note that the US series, which has been quality adjusted using a hedonic model since January 1998, shows a much more rapid rate of decline (an average of -29.4 percent per annum) than the EU series (an average of –13.5 percent per annum). We also caution against a presumption that the methods employed by national statistical agencies to make quality adjustments are inherently susceptible to producing an upward bias in a measure of consumer prices. It has long been argued by practitioners that the difficulty of disentangling changes in "fashion" from changes in quality in the apparel component of a consumer price index make it as likely that the consumer price index understates inflation as overstates inflation. Wynne and Sigalla (1996) cite an example pointed out by Jack Triplett in an unpublished conference paper wherein he noted that the infant's and toddler's component of the US CPI (which was presumably less influenced by fashions cycles) showed a much more rapid rate of increase than the men's or women's components. [40]

The classification of goods and services in the HICP does not distinguish between men's, women's and children's apparel, but it does distinguish between "clothing materials" (COICCOP/HICP code 03.1.1), "garments" (COICOP/HICP code 03.1.2) and "other articles of clothing/clothing accessory" (COICOP/HICP code 03.1.3). Figure 7 shows the rate of change of these three components of the HICP over the past five years.

[40] See also Astin (1999) and Gordon (2001).

We see that the rate of change of the garments component of the index (which we would expect to be the most susceptible to a fashion cycle induced understatement of inflation) does indeed grow at a slower rate than the other components. And as Astin (1999) points out, the weight of apparel in the HICP is on the order of 25 times the weight of personal computers and other high tech goods where quality change is commonly thought to impart an upward bias to the price index. Some additional, albeit more ambiguous, evidence is presented in Table 3, which reports the rate of change of detailed components of the French CPI.

For the purposes of assessing the extent of potential bias due to, for example, inadequate quality adjustment we would ideally want to obtain the exact specifications of the products priced by the agencies and then construct an alternative price index based on, say, hedonic quality adjustment. In reality, however, this is likely to be infeasible for a variety of reasons (either the agencies do not have the necessary detailed product descriptions or they cannot release them due to confidentiality requirements).

Alternatively we could gather price information and product specifications from technical publications, mail order catalogues, consumer magazines and the like, and use these data to construct alternative quality adjusted price indexes. This is the strategy adopted by Gordon (1990) in his monumental study of the prices of producers' durable equipment in the United States. The primary drawback of this approach is that the data used to construct the alternative series may not be representative or strictly comparable to the data used by the national statistical agency. A discrepancy between the two series could be due to the methods of quality adjustment or the use of different data (which may be more or less representative of the prices paid by households). More importantly from

the perspective of obtaining a quick answer to the question of how well the HICP measures inflation, the resources and time needed to produce a scholarly study such as Gordon's should not be underestimated.

It may therefore be useful to explore alternative indirect strategies for estimating the extent of quality bias in the HICP other than by estimating hedonic price indexes. In particular the approach developed by Bils and Klenow (2000) based on quality Engel curves may have some potential. The revealed preference approach of Blow and Crawford (1999) may also hold some promise in this regard, as may the statistical approach of Lichtenberg and Griliches (1989). What we do know is that within the realm of traditional (non-hedonic) methods to account for quality change that are used in member countries, there is great variety in outcomes (mainly, markedly different patterns of price decrease in high-tech sectors).

On the issue of new goods, we note that the rule that new goods be included in the HICP once they achieve a sales importance of 1/1000 may help alleviate the potential for an upward bias from this source. However, it is still an open question as to how well the 1/1000 rule does in capturing the gains on consumer surplus from the introduction of new goods? At this point it would appear that all we can do is some suggestive numerical exercises. It probably won't be until after a major new product has arrived and appeared to have been overlooked by the HICP that we will be able to do more. However, under this heading we might also want to include expanded product variety. Some of the products suggested by national statistical agencies as new goods (lamb, discos) have been around for a while, but are only now becoming significant at the level of some member states. Included under this heading are the greater variety of products that are available in

many categories of goods. Here the work of Hausman (1997, 1999) provides a useful starting point, and a reminder that greater variety is widespread in all categories of spending.

5. Concluding observations.

In this paper, we have attempted to summarise the current state of knowledge about the potential for measurement bias or error in the HICP. This question is important to the European Central Bank, as it has noted that the possible presence of measurement error in the HICP justifies a definition of price stability as prevailing at small positive rates of measured inflation. We believe that at this point in time there is very little scientific basis for putting a point estimate on the likely magnitude of the overall bias in the HICP. There are two reasons for this. First the HICP is still an evolving measure of inflation. Practices are being refined and improved on an ongoing basis. Second, assessing the potential for bias requires a detailed knowledge of how the HICP is actually constructed. The various Council Regulations set certain standards, but at this time we do not have a definitive handbook of HICP methods documenting actual (as opposed to aspired to practices) that can be studied to see whether there is room for improvement.

Of the problems that are typically thought to affect measures of consumer price inflation, we believe that those of quality change and new goods require the most urgent attention vis-à-vis the HICP. We also think that meaningful discussions about the accuracy of the HICP can only take place after its theoretical framework has been more fully elaborated.

Appendix A

In the recent *Report from the Commission to the Council on the Harmonization of Consumer Price Indexes in the European Union* Eurostat noted that only six EU countries (Belgium, Finland, France, Greece, Spain and the UK) published manuals detailing the methods used to calculate the HICP or CPI. The specific references are:

- **Belgium** – *L'Indice des Prix à la Consommation, Base 1996*, Ministère des Affaires Économiques, Administration de la Politique commerciale, Service de l'Indice, Dépôt légal: D/1999/2295/20.
- **Finland** – *The consumer price index 1995=100, Handbook for Users*, Statistics Finland, October 1998.
- **France** – *Pour comprendre l'indice des prix*, Institut national de la statistique et des études économique (INSEE), edition 1998.
- **Greece** – *Revised Consumer Price Index, Base Year 1994=100,0*, Statistics Greece.
- **Spain** – *Indice de Precios de Consumo. Base 1992. Metodología*. Instituto Nacional de Estadística, Madrid, January 1994.
- **UK** – *The Retail Prices Index, Technical Manual*. Office for National Statistics (ONS), 1998.

Only three of these manuals (those for Finland, Greece and the UK) are reported as being available in English. The IMF Dissemination Standards Bulletin Board (DSBB) (see http://dsbb.imf.org/category/cpictys.htm) provides a limited amount of information about current practices as regards consumer price measurement in thirteen EU countries (no information is reported as being available for Greece or Luxembourg). In addition to the documentation (in French) for the French CPI/HICP that Eurostat reports as being available, DSBB reports that methodological information is also available for France in English (in *A Presentation of the French Consumer Price Index* published in September 1998). DSBB also reports the availability of information for

- **Austria** - *Verbraucherpreisindex, Revision 1986, Beiträge zur österreichischen Statistik 853*.
- **Denmark** - *Indeksberegninger i Danmarks Statistik (1985*).
- **Germany** - in the form of various articles in *Wirtschaft und Statistik.*
- **Ireland** - in the June 1997 issue of the quarterly CSO *Statistical Bulletin*.
- **Italy** - *Metodi e Normi (Series A)* available from ISTAT.
- **Netherlands** - in *Monthly Bulletin of Price Statistics*, April 1993, pp. 10-19.
- **Portugal** - *Índice de Preços no Consumidor, Base 97 – Metodologia.*
- **Sweden** - in the annual publication *Statistika meddelanden series P 15* and on the Statistics Sweden website.

Note that some of the information on the DSBB website has not been updated since 1999. However, if the information on the DSBB website is correct, it would appear that there is a significant amount of information on current practices available in one form or another. The only EU country for which there does not appear to be any

information available is Luxembourg. Supplementing these official publications, a number of papers presented to meetings of the Ottawa Group over the years provide additional information on the practices of national statistical offices. See in particular Hoven (1999) on quality adjustment in the Netherlands, Hoffman (1999) on quality adjustment in Germany

While we have not had time to read these documents, we can set out a list of questions that we might reasonably expect any description of methods to address. A useful (but by no means the only) model for the kind of information that should be available is the chapter on the Consumer Price Index in the *BLS Handbook of Methods* published by the US Department of Labor (see http://www.bls.gov/opub/hom/pdf/homch17.pdf; see also U.S. Department of Labor, *BLS Handbook of Methods*, April 1997 Washington DC: US Government Printing Office.)[41] The US Bureau of Labor Statistics also publishes articles about changes in the US CPI in its monthly periodical, *Monthly Labor Review*. The following list of questions is intended as a guide only. We will use the generic term "item" to refer to both goods and services.

1. Where (i.e. in what geographic areas) are prices collected? How are these areas selected? Are price quotes collected only in major urban areas or in both urban and rural areas? Do the areas in which price quotes are collected change as the distribution of the population changes? For example the reference population groups for the US CPI are urban consumers, so prices are collected in some 85 urban areas across the US. However, the reference populations for the HICP are the entire population. What practices ensure that the areas in which prices are collected reflect the distribution of the population?

2. How frequently are prices collected? Are all items priced at all outlets in all areas every month? For example, according to the *BLS Handbook of Methods* only food, fuels and a few other items are priced monthly in all 85 urban areas in which prices are collected. Most other goods are priced monthly only in the five largest urban areas, and bimonthly in the remaining areas.

3. How are items selected for pricing within an outlet? On the basis of sales? Shelf space? Other criteria? For example, BLS field representatives select items for pricing in selected outlets using a multistage probability selection technique that makes the probability of an item being selected proportional to sales of the item.

4. How are the outlets at which prices are collected selected? Is there systematic rotation of the outlets from which price quotes are collected? For example, in the US the Continuing Point-of-Purchase Survey (CPOPS) collects data on retail outlets frequented by urban households in the US, an d this survey is the basis of the sampling frame of outlets for most commodities in the US CPI. Each year new item and outlet samples are selected for 20 percent of the Primary Sampling Units (PSUs) (or geographic areas) in the US CPI.

[41] This document is also sometimes referenced as U.S. Department of Labor Bulletin 2490.

5. What happens when an item selected for pricing is no longer available? Is it simply dropped from the survey, or is a comparable item selected for pricing? If the latter, how is this item selected? What criteria are used to determine comparability of items? For example, the US BLS has tried to reduce the number of item substitutions in the apparel category that are deemed non-comparable by providing field agents with collection documents containing more detailed lists of price-determining characteristics of apparel.

6. What happens when an outlet from which price quotes are collected disappears? Are prices collected from a comparable outlet in the same area? How is comparability of outlets assessed?

7. How do the agencies ensure that they are collecting transactions rather than list prices? For example, the price quotes used in the US CPI are adjusted to reflect bonus merchandise offers, manufacturers rebates, cents-off coupons that are attached to products for immediate redemption, and utility refunds. The US CPI also makes adjustments to allow for the fact that new cars and trucks rarely sell for the manufacturer's suggested retail price.

8. How are prices collected? By visits? By telephone surveys? For example, in the US data are collected through both visits and telephone calls.

9. How frequently is quality adjustment needed? How is the need for quality adjustment determined? Is it determined by the field agent collecting the price quote or by the central office? What methods are used to adjust for quality changes? For example, what is the relative importance of adjustments based on manufacturers costs, adjustment based on class mean imputation and other methods of quality adjustment?

10. How are the raw price quotes from different outlets and different areas combined to arrive an intermediate aggregates?

As we have already noted, some or all of these questions may be addressed in the documents on methodology that Eurostat is aware of, or the documents referred to on the DSBB website. It might be useful to study these documents before making a formal approach to Eurostat for assistance with obtaining information on current practices in the national statistical agencies.

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Table 1 Coverage of HICP and CPI (percent)		
	Expenditure covered by HICP but excluded from CPI	Expenditure covered by CPI but excluded from HICP
Belgium	0.0	1.1
Denmark	8.2	11.4
Germany	2.0	11.4
Greece	6.9	0.0
Spain	0.0	0.5
France	8.7	0.0
Ireland		
Italy	0.0	4.8
Luxembourg		
Netherlands	8.4	17.3
Austria	13.2	8.3
Portugal	0.0	7.7
Finland	0.0	0.0
Sweden	0.0	16.5
UK	12.4	9.6

Notes to Table: Source: Commission of the European Communities (1998).

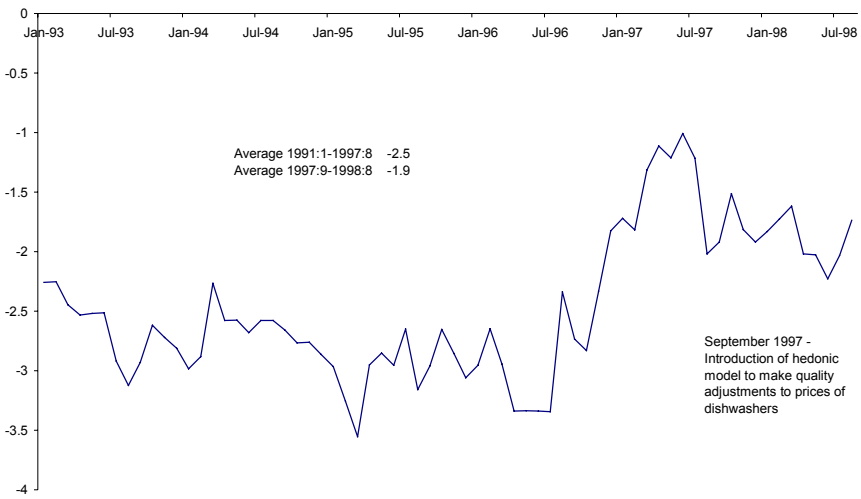
Table 2 Summary of existing surveys of measurement error			
	Germany (Hoffman, 1998)	France Lequiller (1997)	UK Cunningham (1996)
Substitution bias -Upper level - Lower level	< 0.1	0.05 - 0.10	0.05 – 0.1
Outlet substitution bias	< 0.1	0.05 - 0.15	0.1 – 0.25
Quality change	< 0.5	?	0.2 – 0.3
New goods	< 0.1	?	0.0 – 0.15
Total	≈ 0.75	> 0.1 - 0.25 ?	0.35 - 0.8
Expenditure covered by CPI but excluded from HICP	11.4	0.0	9.6
Share of - EICP - MUICP	 27.149 34.651	 16.380 20.907	 16.34 NA
Implied bias in - EICP - MUICP	 ≈ 0.20 ≈ 0.26	 > 0.02 - 0.04 ? > 0.02 – 0.04	 0.06 – 0.13 NA

Notes to Table: Source: Hoffman (1998), Lequiller (1997), Cunningham (1996). Shares of EICP and MUICP are country weights for 2000, price updated to December 1999 weights, from Commission of the European Communities (2000).

Table 3 Rate of change of selected components of French CPI 1991-1998			
	Men's	Women's	Children's
Coats & jackets	0.8	1.0	0.5
Pants	0.9	0.7	0.0
Casual attire	0.1	0.4	0.8
Dress shoes	1.0	0.7	1.9

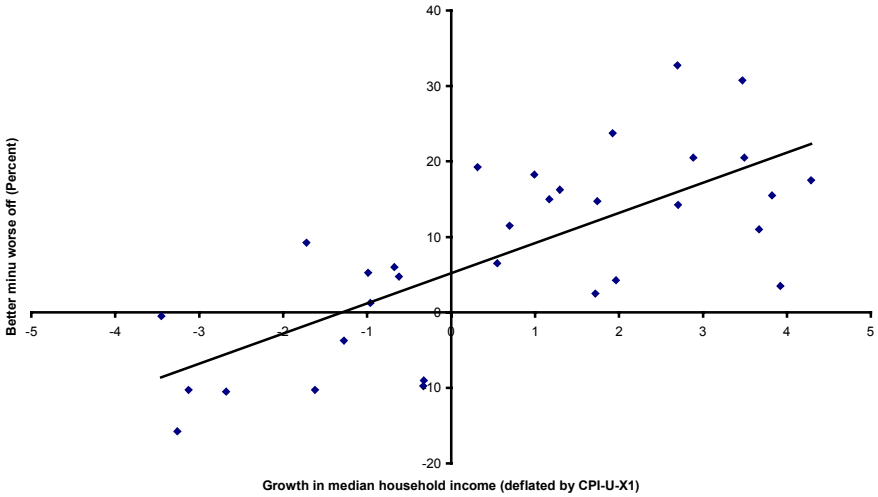
Notes to Table: Source INSEE.

Figure 1
Change in relative price of dishwashers
France 1993-1998

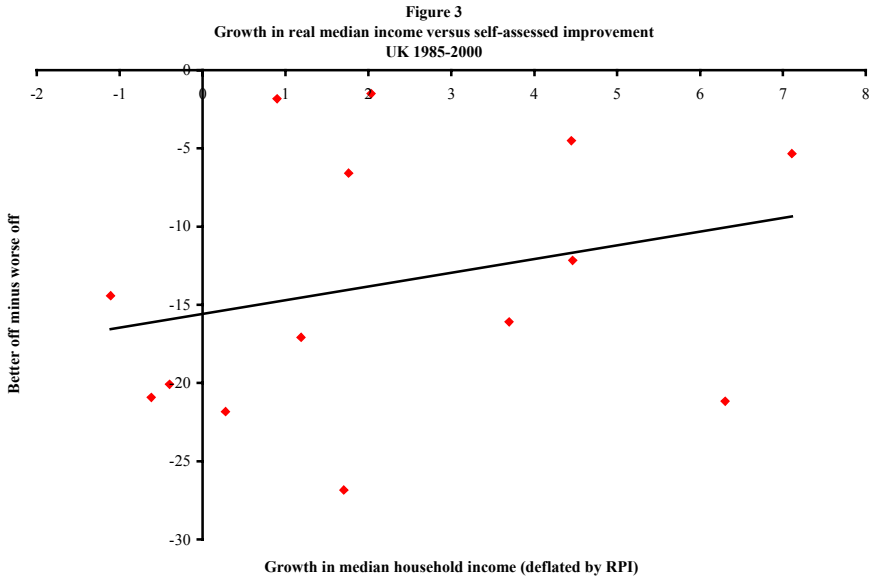


Notes to Figure 1: Source: INSEE. Annual change in CPI series "Lave-vaisselle" 4315 divided by CPI..

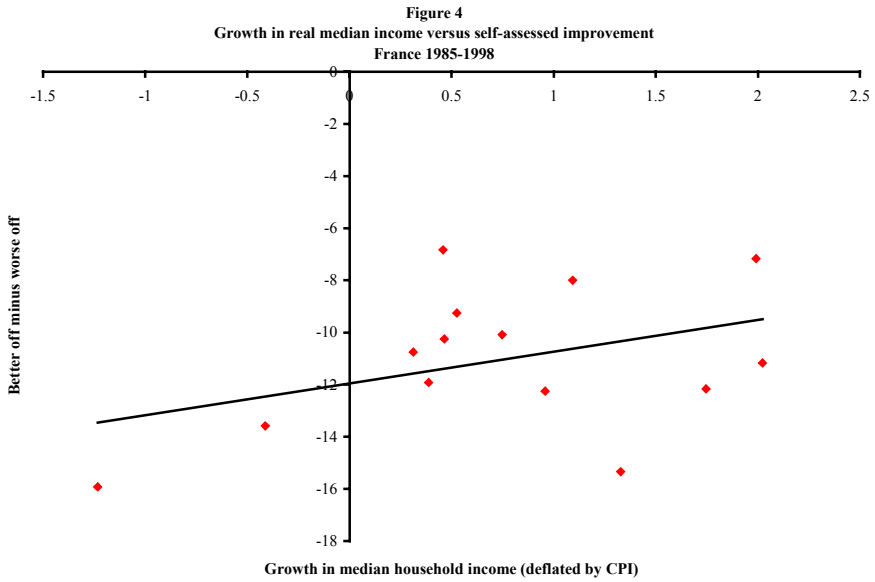
Figure 2
Growth in real median income versus self-assessed improvement
US data 1967-1998



Notes to Figure 2: Scatter plot of growth in real median income against change in self assessed well being. Real median household income is defined as Nominal median household income from Table A-1 of U.S. Census Bureau (2001) deflated by the CPI-U-X1 research series. The measure of self-assessed well being is from the University of Michigan's monthly Survey of Consumers. Question A2 of the Survey asks: "We are interested in how people are getting along financially these days. Would you say that you (and your family living there) are better off or worse of financially than you were a year ago?" We used the responses to this question (reported in Table 4 of the monthly reports) to calculate a balance statistic (i.e. percent reporting themselves better off minus those reporting themselves worse off). The Figure shows the average over the course of the year of the quarterly balances.

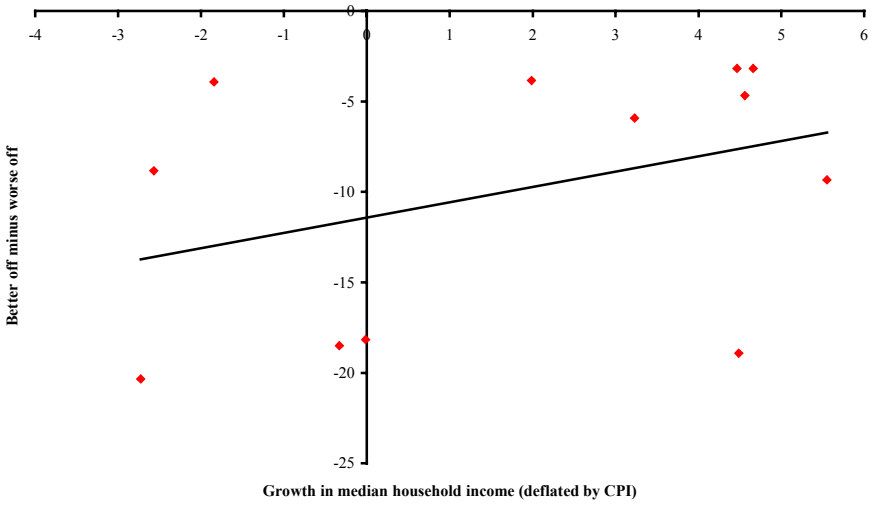


Notes to Figure 3: Balance statistic from the European Commission's Harmonized Consumer Survey. Median income from Institute for Fiscal Studies. RPI from Haver Analytics.



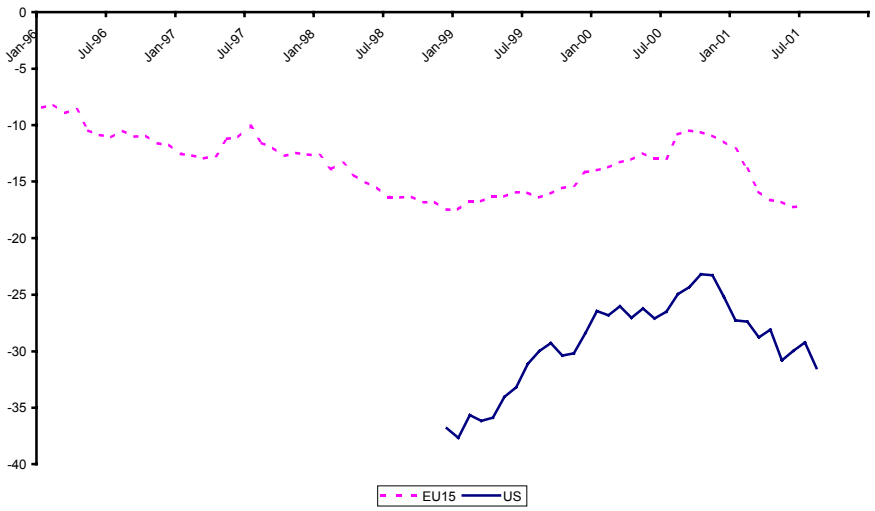
Notes to Figure 4: Data on median household income from INSEE. Balance statistic from the European Commission's Harmonized Consumer Survey. CPI data from Haver Analytics.

Figure 5
Growth in real median household income versus self-assessed improvement
Italy 1985-1996



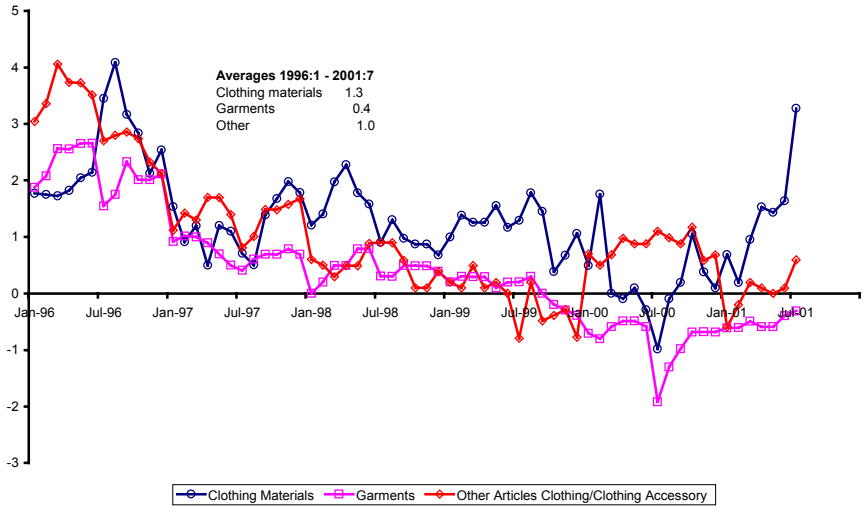
Notes to Figure 5: Data on median household income from Brandolini (1999). Balance statistic from European Commission's Harmonized Consumer Survey. CPI for Italy from Haver Analytics.

Figure 6
Information processing equipment
EU15 and US



Notes to Figure 6: Annual change in relative prices of personal computers. The US series is the CPI for Personal computers and peripheral equipment divided by the All Items CPI-U. The EU15 series is the HICP for Information processing equipment (COICOP/HICP code 09.1.3) divided by the EICP. Information processing equipment had a weight of 0.32 percent in the EICP in 2000. The US CPI series for personal computers has been quality adjusted using hedonic methods since January 1998, and had a relative importance of 0.079 percent in the CPI-U as of December 2000. Source: Haver Analytics.

Figure 7
Components of apparel inflation
EU15 level



Notes to Figure 7: Source: Haver Analytics.