1. INTRODUCTION

The Consumer Price Index (CPI) is the most widely used inflation indicator. The CPI measures the dynamic behaviour of the purchase cost of a pre-determined basket of goods. Its major convenience is its simple calculation, since the determination of the nominal cost of a fixed basket of goods at each moment is quite simple.

Nevertheless, this simplicity also constitutes a serious drawback. Over time, relative prices change, new goods enter the market, the features of the formerly existing goods are altered, and new distribution schemes of consumption goods emerge — as hypermarkets, or electronic shopping. These modifications yield changes in the pattern of households’ consumption and purchasing which are not reflected in the calculation of the CPI.[1]

Therefore, a range of factors limit the utilisation of the CPI as an indicator of the dynamic behaviour of the true cost-of-living according to consumer theory. This paper estimates the magnitude of the across-strata substitution bias of the Portuguese CPI. International evidence (described in section 3) suggests that the bias is centred between 0.05 and 0.2 percentage points per year, which constitutes a small part in the overall bias of the CPI. In fact, four factors[2] account for the CPI mis-measurement of the cost of living:

Substitution bias

At the same time the general level of prices rises, relative prices also change. Consumers tend to substitute goods and services which become relatively more expensive for those becoming comparatively cheaper. As a result, the consumption basket is altered. Since the CPI is calculated by measuring the cost of a fixed bundle of goods, changes in the pattern of consumption triggered by changes in good’s relative prices are overlooked. Therefore, the CPI overestimates the income compensation that would be required if consumers’ welfare were to remain constant. This overestimation constitutes the CPI substitution bias.

Quality change bias

The characteristics of some goods and services included in the CPI are subject to significant changes, reflecting quality changes. The evolution of computer hardware, automobiles and most household electrical appliances are examples of quality improvements, whereas the increase in the time of delivery of normal mail can be interpreted as quality worsening. Under these circumstances it becomes important to distinguish price changes reflecting changes in the good or service characteristics from those corresponding to changes in the general level of prices. However, only the latter should be considered as reflecting price increases, since the former result in changes in consumers’ welfare.
New-items bias

The entrance of new goods and services in the market also contribute towards the upward bias of CPI; for methodological reasons new goods and services only can be included in the reference basket when the base period basket is changed. The dynamic behaviour of prices of new items is often different from that of the remainder goods and services. Prices start by being quite high, entering a stage of more or less rapid decrease afterwards, and reaching maturity by the end — when the behaviour finally follows the overall pattern. Calculators, video recorders, hi-fis, or more recently cellular phones illustrate this behaviour. Whenever prices of these goods and services do in fact behave quite differently from those included in the reference bundle, the CPI necessarily provides an upward-biased estimate of the cost of living.

New-outlets bias

Just like the composition of baskets purchased by consumers changes, also purchasing sites and schemes change strikingly. This issue is particularly important as regards the Portuguese case, given the significant innovations recorded in the distribution of goods. Consumers will tend to alter their purchase sites in favour of outlets yielding a better quality-price relationship. This phenomenon may be significant in Portugal over the course of the last ten years, given that consumers shifted their usual market sites towards the hypermarkets. From this change in consumption habits results that the CPI is an inappropriate indicator of the cost of living.

Although the CPI is vulnerable to various biases posting distinct signs and sizes, empirical evidence shows that in general the total effect of these factors makes that the CPI overestimates the changes in the cost of living. The magnitude of this bias has arouse increasing interest by economists. Recently, in December 1996 the Boskin Report was released (3). This study estimates that the USA consumer price index overstates increases in the cost of living by about 1.1 percentage points (4). Since some budgetary items are indexed to the CPI, this bias triggers effects on public finances. The estimate presented in Boskin (1996) suggests that a 0.5 per cent adjustment (reduction) in the USA inflation rate in the period 1996 to 2000 would allow for a reduction in the projected value for public deficit by more than 10 per cent of its value in the year 2000.

In addition to the Boskin Report, many other recent papers in economic literature have dealt with this issue — for instance, Moulton (1996) and Shapiro and Wilcox (1996), but also some studies by Central Banks, as is the case of Lebow et al. (1993), Crawford (1993) and Cunningham (1996). Table 1 exhibits a summary of the estimates for the CPI bias in the USA, United Kingdom and Canada (5). Regarding the latter two countries, avail-

### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lebow, Roberts e Stockton (1992)</td>
<td>USA</td>
<td>1.0</td>
</tr>
<tr>
<td>Relatório Boskin (1996)</td>
<td>USA</td>
<td>1.1</td>
</tr>
<tr>
<td>Shapiro e Wilcox (1996)</td>
<td>USA</td>
<td>0.6-1.5</td>
</tr>
<tr>
<td>Fortin (1990)</td>
<td>Canada</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>Crawford (1993)</td>
<td>Canada</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Cunningham (1996)</td>
<td>United Kingdom</td>
<td>0.35-0.8</td>
</tr>
</tbody>
</table>

(3) Professor Michael J. Boskin headed a working group established by the USA Senate Finance Committee to quantify the USA CPI bias, to analyse the respective consequences and to propose recommendations to the Bureau of Labour Statistics, responsible for the production of the CPI. This working group was also composed by Professors Ellen Dulberger, Robert Gordon, Zvi Griliches and Dale Jorgenson. The final report presented by this working group is named “Toward a More Accurate Measure of the Cost of Living, Final Report to the Senate Finance Committee”, Senate Finance Committee, December. This report became known as the “Boskin Report”, which is the designation hereafter used in the text.

(4) This report indicates that the true cost of living is overestimated between 0.8 and 1.6 p.p.. 0.2 p.p. should be added to this estimate in years up to 1996, due to the existence of a problem known as the formula bias. See Boskin Report.

(5) A wide range of other studies (not presented in table 1) deal with the USA case. See Moulton (1996) Pg. 160 for a more complete reference list.
able evidence points towards a slightly lower bias than that estimated for the USA.

Similar researches were also developed in Portugal. Santos (1997) and Santos and Coimbra (1995) are the main references. The latter analyses the CPI bias resulting of the change in automobile quality, estimating that a bias averaging 0.2 to 0.3 percentage points is caused in 1992 and 1993 by car quality improvement, although becoming negligible in 1994.

The present study aims at estimating the substitution bias component of the CPI, further referred to as the across-strata substitution. Section 2 explains the nature of the substitution bias and proposes methods to approach the true cost of living, based on the consumer theory. In section 3 the results obtained for Portugal are presented and some international comparisons are drawn. Finally, section 4 presents the major conclusions.

2. THE SUBSTITUTION BIAS OF THE CPI

This section is divided into five subsections: a brief presentation of the CPI and of the characteristics of the Laspeyres and Paasche indices; differences between the CPI and a cost-of-living index; alternative procedures in drawing out the substitutions bias of the CPI; determinants of the magnitude of the substitutions bias; finally, the distinctions between the within-strata and the across-strata substitution.

a) The Consumer Price Index

The CPI is a Laspeyres price index, defined as follows:

\[
L_{t,0}^p = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} = \frac{\sum_{i=1}^{n} p_i^0 q_i^0 \left( \frac{p_i^t}{p_i^0} \right)}{\sum_{i=1}^{n} p_i^0 q_i^0} = \sum_{i=1}^{n} w_i^0 \left( \frac{p_i^t}{p_i^0} \right)
\]

Where \(q_i^0\) with \(i = 1, ..., n\) is the base period basket, \(q_i^0\) and \(q_i^t\) are respectively the prices in the base period and in \(t\), and \(w_i^0\) stands for the weight of expenditure on good \(i\) in the base period total expenditure.

To illustrate the overestimation of the change in the cost of living, we present the following example drawn from the Boskin Report. Consider a consumer who consumes two goods only: beef and poultry. In period 0, the price of both goods equals 1; the consumer consumes one unit of each good, so total expenditure equals 2. In period 1, the price of beef doubles that of poultry (1.6 and 0.8 respectively). The change in relative prices leads the consumer to consume 0.8 units of beef and 2 units of poultry, corresponding to a total expenditure of 2.88. Table 2 summarises the situation.

<table>
<thead>
<tr>
<th></th>
<th>Prices period 0</th>
<th>Quantities period 0</th>
<th>Prices period 1</th>
<th>Quantities period 1</th>
<th>Relative prices</th>
<th>Relative shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>1</td>
<td>1</td>
<td>1.6</td>
<td>0.8</td>
<td>1.6</td>
<td>0.63</td>
</tr>
<tr>
<td>Poultry</td>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>2</td>
<td>0.8</td>
<td>1.25</td>
</tr>
</tbody>
</table>

The Laspeyres index indicates the growth in expenditure necessary to consume the period 0 bundle at period 1 prices. It therefore indicates the increase in expenditure that must occur so that one unit of beef and one unit of poultry are consumed at prices equalling 1.6 and 0.8 respectively. According to the Laspeyres price index, prices increased by 20 per cent in period 1. This value overstates the growth in the cost of living. In fact, it results from the assumption of no substitution of goods that meanwhile became more expensive by those which became cheaper.

The Paasche price index \(P_{t,0}^p\) is an alternative to the Laspeyres index. The former compares the expenditure which would be necessary to purchase...
the base period bundles if prices were those of the final moment, with the actual expenditure in the final moment. In the example above, prices grew by only 3 per cent according to the Paasche price index. This figure underestimates the increase in the cost of living.

b) Cost-of-living indices

Two exact cost-of-living indices exist, and are based upon the consumer theory: the compensation index and the equivalent index. The former calculates the increase in nominal expenditure that would be necessary to maintain the same level of welfare prior to the price changes. The latter indicates the reduction in income which is equivalent to the growth of prices, i.e., the decrease in nominal income that at initial prices leaves the consumer as well-off as after the price increase. Consider for instance \( e(p_0, U^0) \) and \( e(p_t, U^t) \) as being the expenditure levels necessary to reach the level of welfare \( U^0 \) at prices \( p_0 \) and \( p_t \) respectively. Similarly \( e(p_0, U^t) \) and \( e(p_t, U^t) \) can be defined as the expenditure levels needed to attain welfare \( U^t \) at prices \( p_0 \) and \( p_t \). The compensation and equivalent indices are written, respectively, as follows:

\[
C_{t,0} = \frac{e(p_t, U^t)}{e(p_0, U^0)} \quad E_{t,0} = \frac{e(p_t, U^t)}{e(p_0, U^t)}
\]

The Laspeyres and Paasche price indices are first order approximations to the exact indices \( C_{t,0} \) and \( E_{t,0} \) respectively, and do not reflect the substitution possibilities.

If a price increase takes place, the indices are ordered as follows:

\[
P_{t,0} \leq E_{t,0} \leq C_{t,0} \leq L_{t,0}
\]

c) Procedures for estimating the substitution bias

The substitution bias can be estimated by following three alternative procedures: the estimation through a complete system of demand functions, application of the revealed preferences theory, or the calculation of superlative indices. The usage of a complete system of demand functions — derived from a primal or dual representation of consumers’ preferences — to estimate the exact cost-of-living index is the procedure chosen by Braithwait (1980) and Fry and Pashardes (1989).

Manser and McDonald (1988) resort to the second and third methods. In what concerns the revealed preferences theory, the first step consists of checking if consumers’ choices are compatible with homothetic preferences. After this property has been guaranteed, the method makes use of some results of the revealed preferences theory to determine upper and lower boundaries for the substitution effect, hence defining an interval for the substitution bias.

Using superlative indices is a somewhat simpler procedure, having Manser and McDonald (1988) pioneered its application.

Superlative indices are second-order approximations to the exact cost-of-living index. Among these notice should be made of the Fisher and Tornqvist indices, defined as:

\[
F_{t,0} = \left[ \sum_{i=1}^{n} w_i^0 \left( \frac{p_i^t}{p_i^0} \right)^{\gamma} \right]^{\frac{1}{\gamma}} \left[ \sum_{i=1}^{n} w_i^t \left( \frac{p_i^t}{p_i^0} \right)^{-\frac{1}{\gamma}} \right]^{-\frac{1}{\gamma}} = \sqrt{L_{t,0}P_{t,0}}
\]

and

\[
T_{t,0} = \prod_{i=1}^{n} \left( \frac{p_i^t}{p_i^0} \right)^{\gamma w_i} \neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\neg\n
(7) This subsection utilises some results of the consumer theory. It should be mentioned, however, that whilst valid for a given consumer, these relationships do not hold necessarily for aggregated data. See Deaton and Muellbauer (1980).

(8) This relationship holds only if preferences are homothetic. See Deaton and Muellbauer (1980).

(9) See Diewert (1976).
tion when consumers’ preferences are represented by a homogeneous quadratic utility function, while the Tornqvist price index constitutes an exact approximation when preferences are bound to be represented by the translogarithmic indirect utility function\(^{(10)}\).

d) Determinants of the magnitude of the substitution bias\(^{(11)}\)

The magnitude of the substitution bias depends on a fairly wide range of factors: the frequency of revisions to the reference basket, the considered breakdown of the CPI, the magnitude of compensated demand elasticities and the size of changes in relative prices.

The Consumer Price Index is calculated upon a bundle of goods and services determined for a reference year. The procedures vary widely from one country to another. In the United Kingdom and in France the reference bundle is re-defined every year; in Germany, Netherlands and Japan, the bundle is revised every five years; in other countries (e.g., Italy, Belgium, Spain and Denmark) this revision is less regular; finally in the USA the reference bundle has been revised more or less every ten years\(^{(12)}\). In Portugal the actualisation of the reference basket has been carried out irregularly. The Household Budget Surveys dated of 1973-1974, 1980-81 and 1989-90 led to the calculation of the CPI with 1976, 1983 and 1991 as its base periods. The CPI were published respectively for periods 1977-87, 1988-91 and 1991-97. In Portugal, surveys to households’ budgets shall be carried out every five years, to allow for the calculation of the weights of the CPI. This is a requirement of the process of harmonisation between consumer price indices in the European Union.

The greater the time span between two consecutive revisions of the reference bundle, and the greater the time span between the moment consumers’ expenditure is observed and the respective base period of the CPI, the greater will be the substitution bias. Furthermore, for a given base of the CPI, the substitution effect increases with the number of years after the last revision of the CPI. This means that, ceteris paribus, the substitution bias of the Portuguese CPI (in its current base) must be higher in 1977 than in 1992, for instance.

The estimated substitution bias also depends on the level of breakdown used in its determination, i.e., the number of elementary strata of the CPI, considered in its calculation. Hence, if we aggregated up to one consumption good alone, the estimate for the substitution bias would equal zero. Manser and McDonald (1988) compared price indices at different aggregations of the USA CPI (6, 58 and 101 consumption strata, respectively). The estimates for the substitutions bias calculated for the period 1959 to 1985 more than multiplied threefold when aggregation went from 6 to 58 goods, and increased by about one third when aggregation went from 58 to 101 goods. This result suggests that further disaggregations would yield increasingly smaller additions to the estimated substitutions bias. These results indicate that the higher the breakdown, the more accurate estimates for the substitution bias will be — i.e., the lesser will be the underestimation of the size of the substitution bias.

The size of the substitution bias also depends on changes in relative prices. The greater are changes in relative prices the greater is the substitution bias\(^{(13)}\). Grier and Perry (1996) show that international empirical evidence suggests a positive correlation between the level of inflation and the dispersion of relative prices. Coimbra and Neves (1997) show that the Portuguese disinflation process was linked to a reduction in the dispersion of price changes of items included in the CPI over the 1990’s — thus suggesting smaller changes in relative prices. These relationships suggest that the substitution bias is smaller in lower inflation periods.

Lastly, the size of the substitution bias also depends on compensated demand-price elasticities\(^{(14)}\). In

\(^{(10)}\)See Pollak (1983) and Diewert (1983) for a demonstration of these results.

\(^{(11)}\)This subsection is chiefly based upon Crawford (1993).

\(^{(12)}\)The weights of the USA CPI reflect expenditure patterns obtained for the period 1982-1984. The following revision of the reference consumption bundle is projected for 1998, reflecting the expenditure pattern in period 1993-1995.

\(^{(13)}\)See Braithwait (1980) and Shapiro and Wilcox (1996) for a definition of statistical indicators to quantify changes in relative prices.

\(^{(14)}\)See Braithwait (1980).
case these elasticities are nil\(^{(15)}\), the substitution effect is nil and the Laspeyres Index equals the cost-of-living index. In this situation, the substitution bias is nil too. No extensive empirical evidence exists on the magnitude of compensated demand-price elasticities for Portugal\(^{(16)}\), for a relatively disaggregated classification of consumption strata. Therefore it is hard to assess as to what extent this factor contributed to the substitution bias over the course of the period under analysis.

(e) Two kinds of substitution bias: across-strata and within-strata of CPI

Two kinds of substitutions bias in the CPI may be considered. The within strata bias is due to the fact that the CPI is a Laspeyres price index where goods and services (in the 1991 base) are aggregated to 99 elementary strata, monthly published by the INE. The change in relative prices leads consumers, in their expenditure minimisation problem subject to a given level of utility, to change the optimal composition of their bundles. This kind of bias is the only one that can in fact be calculated on the data released by the Instituto Nacional de Estatística.

The second type of substitution bias results from the fact that the CPI considers prices of about 30,000\(^{(17)}\) different goods and services to obtain the 99 elementary CPI indices. Fixed weights for each good and service within a stratum are taken in building each elementary index. The change in relative prices within every stratum will also yield a substitution bias\(^{(18)}\). However, the data that would allow the estimation of this bias is not published.

The Boskin Report presents an estimate for the total substitution bias centred on 0.4 p.p. per year. This value reflects a 0.15 p.p. across-strata substitution bias and a 0.25 p.p. within-strata substitution bias\(^{(19)}\).

3. RESULTS FOR PORTUGAL AND INTERNATIONAL COMPARISONS

This section presents the estimates for the substitution bias in the Portuguese CPI. Results refer to the 1976 and 1983 base-periods of the CPI, and to the values of the indices published for the periods 1976 to 1983 and 1983 to 1991. Since more recent weights of consumers’ expenditure are not available, we were not able to estimate a substitution bias for the period following 1991.

Using the data published by the Instituto Nacional de Estatística, we calculated the Laspeyres, Paasche, Fisher and Tornqvist indices for the periods 1976 to 1983 and 1983 to 1991. The expenditure weights considered for 1976, 1983 and 1991 were those utilised in calculating the CPI, for each of the base-periods. The released information on the 1976 base only considered 66 expenditure strata in the CPI. This number rose to 91 and 99 in the 1983 base and 1991 base of the CPI, respectively. Therefore, to calculate the above mentioned indices some items of the 1983 and 1991 aggregations had to be rearranged. Regarding the calculation of the indices for 1976-1983, 1983-1991 and 1976-1991 according the 1976 aggregation, items were classified so as to use 66 basic strata, while in the 1983-1991 indices calculated according to the 1983 aggregation the number of elementary strata was increased to 91.

Table 3 exhibits the main results.

For the period 1983-1991, the Laspeyres index presents a growth of prices 2.0 and 2.2 p.p. higher than that delivered by the Tornqvist and Fisher indices, respectively. On its turn, the Paasche price index yields a growth in prices 2.4 and 2.2 p.p. below that indicated by the referred indices. In annual average terms, the substitution bias\(^{(20)}\) of the CPI in relation to the Fisher and Tornqvist indices

\(^{(15)}\)This case is known as the perfect complementary goods or Leontief preferences case.

\(^{(16)}\)See, however, Pessanha and Neves (1986) and Neves (1993) for relatively aggregated strata of goods and services.

\(^{(17)}\)Number of prices collected in the 1983 base index Índice de Preços no Consumidor, Série Estudos, no. 58, INE. In the publication “Índice de Preços no Consumidor 1991-Metodologia”, INE 1992, it is mentioned that in the 1983 base index 25,362 prices were collected; this number rose to 62,817 in the 1991 base index.

\(^{(18)}\)In the English literature, within- and across-strata biases are sometimes referred to as Lower and Upper Substitution Biases, respectively.

\(^{(19)}\)Note, however, that the methodology for calculating the USA Consumer Price Index implies that, in addition to the already mentioned substitution bias, a formula bias also exists. See for instance Moulton (1996) and Shapiro and Wilcox (1996).
amounted to 0.086 and 0.094 p.p. per year, respectively.

An alternative calculation also presented in Table 3, consists of using the 1976 base CPI, which would require some rearrangement in the classification of elementary items of the CPI in the period 1983-1991. As a matter of fact, for the 1976 base CPI the only available data refers to 66 elementary strata. In annual average terms, the substitution bias in the CPI vis-à-vis the Fisher and Tornqvist indices amounted to 0.545 and 0.568 p.p. per year in the period 1976-1983 and to 0.042 and 0.041 p.p. in the period 1983-1991.

These results illustrate some of the effects described in subsection 2c). Hence, the magnitude of the substitution bias in the CPI is higher in periods of higher inflation, as is illustrated by the estimate for the period 1976-1983 compared to that for the period 1983-1991. Secondly, the utilisation of a more aggregated classification of goods and services leads to an underestimation of the substitution bias of the CPI. In fact, if 66 strata are used instead of 91, the estimates for the substitution bias vis-à-vis the Fisher and Tornqvist indices are 0.052 and 0.045 p.p. lower, respectively.

Table 4 summarises the results regarding the across-strata substitutions bias available for other countries. Estimates for the USA and for Canada tend to fall in the 0.1-0.2 p.p. interval; the estimate for the United Kingdom is identical to that for Portugal. The estimated value for Portugal stands close to the lower limit of the interval for the presented estimates.

4. CONCLUSIONS

A range of factors limit the utilisation of the CPI as an indicator for the true cost of living according to the consumer theory: substitution bias,

\[
\frac{(IPC - F)}{n} \times 100
\]

Where \(n\) stands for the number of years running between the base-period and year \(t\). The average bias relative to index \((T)\) was calculated analogously.

Table 3

<table>
<thead>
<tr>
<th>Index</th>
<th>1983 aggregation 91 strat</th>
<th>1976 aggregation 66 strat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price indices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laspeyres (CPI)</td>
<td>293.628</td>
<td>414.479</td>
</tr>
<tr>
<td>Paasche (P)</td>
<td>289.258</td>
<td>384.742</td>
</tr>
<tr>
<td>Fisher (F)</td>
<td>291.435</td>
<td>399.334</td>
</tr>
<tr>
<td>Tornqvist (T)</td>
<td>291.619</td>
<td>398.726</td>
</tr>
<tr>
<td>Average inflation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laspeyres</td>
<td>14.413</td>
<td>22.522</td>
</tr>
<tr>
<td>Average bias in CPI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisher</td>
<td>0.094</td>
<td>0.545</td>
</tr>
<tr>
<td>Tornqvist</td>
<td>0.086</td>
<td>0.568</td>
</tr>
</tbody>
</table>
quality change bias, new-items bias and new-outlets bias. These factors generally account for the fact that the CPI tends to overestimate the dynamic behaviour of the cost of living.

Except for Santos and Coimbra (1995), which presents estimates for the CPI bias due to quality changes in cars, no other estimates for the magnitude of these biases are available regarding the Portuguese case. The current study presents an estimate for the across-strata substitution bias in the CPI, assessed through the utilisation of superlative indices. According to the results presented in section 3, the substitution bias recorded in period 1983-1991 is estimated to have reached circa 0.1 p.p. per year.

However the application of this estimation to present days is problematic. Nevertheless, the analysis of the determinants of the substitution bias may supply important indicators. Firstly, the inflation rate in 1997 stood quite below that recorded in the period 1983-1991, and so 0.1 p.p. must constitute an upper limit to that bias in 1997. Secondly, the consideration of 91 elementary strata may lead to some underestimation of the CPI substitution bias. This is suggested by the increase from 0.042 to 0.094 p.p. in the bias when 91 strata are used instead of 66 regarding the Fisher index. Lastly, the actual weights of the CPI are based on a consumption structure of households referring to 1990. Given that relative prices changed greatly since then — specially in what concerns the division between tradables and non-tradables — the quantities of the reference bundle are possibly dis-adjusted due to the substitution effect. Taking into consideration all these elements, the authors believe that the across-strata substitution bias is actually fixed between 0.05 and 0.1 percentage points per year.

Table 4
ACROSS-STRATA SUBSTITUTION BIAS IN THE CPI

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Method</th>
<th>Period</th>
<th>Bias</th>
</tr>
</thead>
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