WPS7105

Policy Research Working Paper 7105

Durable Goods and Poverty Measurement

Nicola Amendola
Giovanni Vecchi

WORLD BANK GROUP
Poverty Global Practice Group
November 2014

Policy Research Working Paper 7105

Abstract

The paper focuses on durable goods and their role in the measurement of living standards. The paper reviews the theoretical underpinnings of the methods available to estimate the value of the services flowing from consumer durable goods. It also provides a unified framework that encompasses the acquisition approach, the rental equivalent approach, and the user cost approach. The pros and cons of each method are discussed in the context of poverty and inequality analysis and it is argued that the user cost should receive the highest consideration.

This paper is a product of the Poverty Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at giovanni.vecchi@uniroma2.it.

Durable Goods and Poverty Measurement

Nicola Amendola[1] **and Giovanni Vecchi**[2][3]

JEL: C46, D31, I32, O15

Keywords: Measurement of poverty; Inequality; Consumption aggregate, Income Distribution

[1] University of Rome "Tor Vergata"

[2] University of Rome "Tor Vergata"

[3] We are grateful to Lidia Ceriani, Sergio Olivieri, Marco Ranzani, Carlos Felipe Balcazar and Nobuo Yoshida for the useful comments received.

1 Introduction

When it comes to measuring inequality and poverty, the choice and definition of an appropriate welfare indicator is not a straightforward task. A number of decisions must be made, many of which are controversial, and most often the decision making process is based on well-established practices rather than on theoretical arguments (Lanjouw, 2009; Deaton and Zaidi 2002). In this paper we focus on consumer durable goods and investigate their contribution to determining the living standard of the household.

In general, long-lived items such as automobiles, appliances and furniture have a positive and significant impact on living standards. Sometimes the outlay on durable goods only claims a small fraction of disposable income, but they most often change the lifestyle of the individuals, either by saving their time – as in the case of housework appliances – or by consuming their time, as with entertainment appliances (Offer 2005). Either way, consumer durable goods clearly matter to the wellbeing of individuals and there is an increasing consensus on the fact that any welfare measure should account for them (Slesnik, 2001, Deaton and Zaidi 2002, OECD 2013).

In the first part of this paper we review the theoretical underpinnings of the methods available to deal with durables. We outline the main alternatives found in the literature and discuss their advantages and disadvantages in the context of poverty and inequality analysis. We end up our review by arguing that the so-called "user cost approach" is well worth our recommendation (Diewert 2009). The underlying idea is that it is not the expenditures on consumer durables that should be included in the welfare aggregate. Rather, it is the flow of services from durables that must be valued and comprised in the welfare aggregate, and the user cost method estimates it simply by calculating the difference between the value of the durable at the beginning of analytical the period and its actual value at the end of the same period. While simple, this method is not naïve, and offers the further advantage (not shared by the rental equivalence approach) of being a viable solution given the information typically available in household budget surveys.

The second part of the paper is devoted to measurement issues. What is simple in theory can turn into a thorny problem in practice. In fact, the estimation of the user cost of durable goods is an exercise fraught with difficulties. Data limitation is probably the single most important obstacle to implementing the user cost method. We discuss how data limitations can be overcome, or at least dealt with, by overviewing the current practice for a number of countries all around the world.

PART I – THEORY

2 Concepts and definitions

What is a durable good and why durable goods require a special treatment? These are two focal questions that need to be addressed before outlining the theoretical approaches available to deal with consumer durable goods and their role in the measurement of living standards.

A durable good is a consumption good that can "deliver useful services to a consumer through repeated use over an extended period of time" (Diewert, 2009 p. 447). The main characteristic of a durable good does not depend on its *physical durability*, a property shared by many other consumption goods, but by the fact that, like capital goods, it is *productive for two or more periods*. According to the System of National Accounts (SNA) – the internationally agreed set of recommendations on how to compile measures of economic activity – "….the distinction is based on whether the goods can be used once only for purposes of production or consumption or whether they can be used repeatedly, or continuously. For example, coal is a highly durable good in a physical sense, but it can be burnt only once. A durable good is one that may be used repeatedly or continuously over a period of more than a year, assuming a normal or average rate of physical usage. A consumer durable is a good that may be used for purposes of consumption repeatedly or continuously over a period of a year or more." (SNA 2008: 184). Housing is clearly a durable good, arguably among the most important ones in most consumers' bundles. Due to its importance, however, the way rents and imputed rents are estimated for inclusion in the welfare aggregate is the object of a separate paper.[4] In this paper we focus on consumer durable goods other than housing[5].

The SNA definition helps to answer the second question, namely why durable goods require special treatment when measuring living standards. The essence of the problem lies in the inconsistency between the so-called *reference period* chosen for the welfare aggregate, and the period of time during which durable goods deliver their utility to the consumer. In theory, prior to the analysis, "we need to decide the reference period for welfare measurement, whether someone is poor if they go without adequate consumption or income for a week, a month, or a year" (Deaton 1997: 151). Once this choice is made, the same reference period must be applied to all the components of the welfare aggregate, no matter if it is pears or t-shirts, electric fans or cars. In practice, very rarely the reference period exceeds one year; most often, it coincides with the year[6]. If we assume that the reference period is one year (or less), then it is clear that durable goods, by their very

[4] This follows a well-established practice according to which, a welfare aggregate is constructed by putting together four building blocks, namely *(i)* food consumption, *(ii)* non-food consumption, *(iii)* durable goods and *(iv)* housing [Deaton and Zaidi 2002: 25].

[5] According to the Classification of individual consumption by purpose (COICOP) nomenclature, consumption goods are classified as non durable (ND), semi-durables (SD) and durable (D). The consumption goods classified as durable belong to the following categories: furniture, furnishings, carpets and other floor coverings, major household appliances, tools and equipment for house and garden, therapeutic appliances and equipment, vehicles, telephone and fax equipment, audiovisual, photographic and information processing equipment (except recording media), major durables for recreation, electrical appliances for personal care, jewelry, clocks and watches (ILO, 2004).

[6] In most LSMS questionnaires the recall period for nonfood items does not exceed one year.

definition, pose a problem: how to reconcile the fact that items whose economic life extends beyond the reference period of the welfare aggregate must be part of it?

The purchasing market price of a durable good is clearly an inadequate pricing concept. This is because the purchasing market price corresponds to the value of the durable good for its entire economic life, while what we need is the value of the use of durable goods for a shorter period, the reference period. Unfortunately, the value of the use of a durable that contributes to the welfare during the reference period is rarely, if ever, directly observed. This explains why durable goods require special treatment: the expression coined in the literature is that we need to estimate the *consumption flow* of durable goods, that is to estimate the benefit accruing to the household from the ownerships of durable goods, limited to the reference period of analysis.

The impact of using the consumption flow instead of the purchasing price of the durable depends on the purposes of the analysis. Let us start with the context of the system of national accounts (Moulton 2004; Young 2005). The value of expenditures on consumer durables tend to fluctuate widely over the business cycle, while the value of their services (the consumption flow) varies more smoothly. This suggests that the latter measure provides a better picture than the former of the changes of a nation's economic welfare over time and make international comparisons more meaningful Katz (1983: 406). While the 2008 SNA recognizes these advantages, in practice, "the SNA measures household consumption by expenditures and acquisitions only. The repeated use of durables by households could be recognized only by extending the production boundary by postulating that the durables are gradually used up in hypothetical production processes whose outputs consist of services. These services could then be recorded as being acquired by households over a succession of time periods. However, durables are not treated in this way in the SNA. A possible supplementary extension to the SNA to allow for such an extension of the production boundary could usefully take place in a satellite account." (SNA 2008: 184).

A similar issue arises in the construction of a consumer price index (CPI). As argued by Alchian and Klein (1973), any analytically correct measures of inflation should take account of changes in the price of durable goods. The point was, in fact, made by Irving

Fisher as far back as 1911, when he explained that to base a price index only on "services and immediately consumable goods would be illogical" (Fisher 1911: ch. 10, X.39). The claim that durable goods should be covered by the consumer price index has never been disputed from a theoretical standpoint. Yet, in practice, the task of incorporating the price dynamics of consumer durables is not straightforward. A special treatment of the prices of durables is often necessary in order to moderate the observed volatility in measures of inflation that incorporate changes in the price of assets (Goodhart, 2001). Even more relevant to the present context is the fact that if the CPI is to serve as a cost-of-living index, then the pricing concept should hinge on the cost of the use of the services of the durable good during the reference period rather than on its purchase price (Diewert 2004, 2009).

When it comes to measuring living standards, poverty and inequality, the estimation of the value of consumer durables is also crucial. The use of the purchase price instead of the consumption flow leads to overestimate the effect of economic cycle on the household welfare, to underestimate absolute poverty, and most likely to bias the poverty profile (Deaton and Zaidi 2002). A well-documented study on Russia, for instance, shows that the impact on inequality can be very large: the Gini index of expenditure increases from 32 percent to 44 percent when the full purchase value of durables is included instead of its use value (World Bank 2005: 9).

Irrespective of the angle that one may take, the estimation of the *consumption flow* from durable goods stands out as a complex task. The main reason is that the value of the flow of services of a durable depends on its *physical deterioration* rate but also on the (unobserved) *expected price* of the durable[7]. This imputation exercise can be interpreted as a special case of the classical problem of the measurement of capital, one of the oldest and most contentious areas of economic theory (Hicks 1955; Hulten 1990; Downs 1986).

[7] There are circumstances were the estimation of the consumption flow is a simple task. If the consumer purchases the services of durables – for instance renting a car – then the price that s/he pays does the job as it represents the consumption flow. Unfortunately, in most cases ownership is not separated from usage and analysts must deal with the imputation problem.

3 Main theoretical approaches for dealing with durables

In this section we discuss the main *theoretical* approaches to estimate the consumption flow from durable goods. We begin by introducing some notation. Consider a household in year *t,* owning a durable good manufactured in year (*t-v)* and purchased in year (*t–s),* where $0 \leq s \leq v$, and let $p_{v,t}^{s}$ denote the market price of the durable in period *t*, When $v = 0$, $p_{v,t}^{s}$ denotes the market price of a new durable; when $v > 0$, $p_{v,t}^{s}$ corresponds to the (second-hand) market value in period t of a *v*-year old durable good. The *consumption flow* CF_t of the durable in period *t* is defined as follows:

(1) $$CF_t = k_{v,t}^{s} \times p_{v,t}^{s}$$

where $k_{v,t}^{s} \in \mathbb{R}^{+}$. Equation (1) expresses the current value of the flow of services (CF_t) for a generic *v-year old* consumer durable purchased *s* years back in time, as a fraction ($k_{v,t}^{s}$) of the market price ($p_{v,t}^{s}$). The coefficient $k_{v,t}^{s}$ is typically less than one, but in principle can be greater than one.[8] The main theoretical approaches to dealing with durable goods can be described as different procedures for estimating the coefficient $k_{v,t}^{s}$. Following Diewert (2009), we distinguish between three alternatives: *(i)* the acquisition approach; *(ii)* the rental equivalence approach and *(iii)* the user cost approach. We depart from Diewert as the focus of our analysis is limited to consumer durable goods, and in particular we do not cover owner-occupied housing. Unlike Diewert, we are not much interested in consumer price indices but rather in constructing a household level welfare indicator and ultimately in evaluating the distributional impact of alternative measurement methodologies. Our attempt, in the rest of this section, is to develop a unified approach – here expressed in equation (1) – that encompasses the three approaches above.

[8] This is likely to be the case of, say, a Picasso painting or of a vintage car.

3.1 Acquisition approach

When a durable good is purchased by a household and its entire value is attributed to the household expenditure, we say that the durable good is treated according to the acquisition approach (also known as "net acquisition approach"). Looking at equation (1), this approach amounts to specifying the coefficient $k_{v,t}^{s}$ as follows:

(2) $$k_{v,t}^{s}(a) = \begin{cases} 1 & if\ s = 0 \\ 0 & if\ s > 0 \end{cases}$$

In equation (2), the argument "a" in $k_{v,t}^{s}(a)$ stands for "acquisition". According to the acquisition approach, $CF_t = 0$ if the household does not purchase the durable during the survey year *t* – eq. (2) says that $k_{v,t}^{s}(a) = 0$ for all items for which s>0, that is for items purchased prior to the current period *t.* Note that the definition does not contemplate *v,* that is, it does not matter if the durable is new or used. A positive consumption flow $CF_t = p_{v,t}^{0}$ is attributed to durable goods purchased by the household when *s=0*, that is during the survey year. Under the assumption that the market price $p_{v,t}^{0}$ captures the current value of all services provided by the durable over its entire economic life, then the net acquisition approach assigns the household the entire stream of current and future productive services of the durable in year *t* and zero for subsequent years.

The acquisition approach ignores the problem of distributing the initial cost of the durable over the useful life of the good and allocate the entire charge to the period of purchase [ILO 2003: 419]. Further, the acquisition approach is clearly distortionary: it underestimates the welfare of households that owns *used* durable goods with respect to households who happened to purchase durable goods in the current year. [9] When the net acquisition approach is used for the construction of the consumption aggregate, both the level and the

[9] It is certainly true that this distortionary effect is less important if we are interest in aggregated variables but we cannot say that it completely vanishes (see section 4).

budget shares of durables tend to mirror the business cycle. This is due to the fact that households tend to postpone the purchase of durables when the economy slows down, and to increase it when the economy boosts.

3.2 Rental equivalence

If rental or leasing markets for consumer durable goods exist, then the market rental prices can be used to estimating consumption flows from durable goods. This method is known as the rental equivalence approach [ILO 2003, Diewert 2009]. Suppose that in period *t* a competitive market exists, where households can purchase the *services* of *v*-year-old durable goods. Consumers can rent a car or a refrigerator, for example. Also assume that households own homogeneous durable goods, that is assume that all goods are of the same type and quality. Let $R_{v,t}$ denote the market rental value of the *v*-year-old durable good. If markets are competitive and the economy is in equilibrium, then the market rental value $R_{v,t}$ measures the consumption flow from the durable owned by the household.[10] Going back to equation (1), the rental equivalence approach specifies $k_{v,t}^{s}(r)$ as follows:

$$k_{v,t}^{s}(r) = \frac{R_{v,t}}{p_{v,t}^{s}} \qquad (3)$$

where $R_{v,t}\ /p_{v,t}^{s}$ is the rental ratio with respect to the market value of the durable owned by the household, also known as the *capitalization rate*. In equation (3), the argument “r” in $k_{v,t}^{s}(r)$ stands for “rental”. If we substitute (3) in (1) we obtain $CF_t = R_{v,t}$.

In the rental equivalence approach, a pivotal role is clearly played by the market prices for the services of durable goods. However, three restrictions must be introduced in order to make the approach fully consistent: *(a)* one must assume the existence of a complete set of

[10] We also do not consider here taxes and transaction costs.

markets for the *services* of the durables owned by the household; *(b)* markets must be competitive and *(c)* the economy must be in equilibrium. If assumption *(a)* does not hold we cannot apply the method and if one of the other two assumptions is violated the market rental value does not reflect necessarily the household welfare gain from using the durable in period *t*.

An additional concern with the rental equivalence approach has an empirical nature. The estimate of $k_{v,t}^{s}(r)$ in equation (3) requires the availability of market rental prices in period *t* for services of vintage-*v* durable goods. Even if, according to assumption *(a),* such a market exists, this does not necessarily imply that actual transactions are available in the sample. When markets are thin, 1) it can be very difficult to observe rental prices for all the durables owned by the households, and 2) prices are likely to suffer from heterogeneity[11]. The first condition is well-known and well documented in the literature that deals with the measurement of the cost of shelter for homeowners (see, among the others, Gillingham 1983). One solution for determining rental price equivalents for consumer durables is to ask households what they think their durables would rent for. Perception, however, does not always and necessarily matches with reality. Households might have imperfect information on current market prices especially with regard to consumption goods purchased or sold infrequently (or never purchased or sold).

3.3 User cost

The user cost approach is based on a concept first introduced by Keynes (1936, chapter 6, p. 53) and successively reformulated by Jorgenson (1963). The idea behind the approach is highly intuitive: the user cost approach calculates the cost of purchasing the durable at the beginning of the period, using the services of the durable during the period and then netting

[11] Note that this should not happen if markets were perfectly competitive. Hence, the empirical relevance of point 2) may indicate a violation of the perfect competition assumption.

off from these costs the benefit that could be obtained by selling the durable at the end of the period (ILO 2003: 422)[12].

Let $p_{v,t}^{s}$ denote the market price of a durable produced in year *t-v*, but purchased in year *t-s*. We assume here that the purchase took place at the beginning of period *t.* Similarly, let $p_{v+1,t}^{s+1}$ denote the market price of the same durable at the end of period *t*. This notation (both indices are now *v+1* and *s+1*) reflects the fact that at the end of the period *t* both the vintage of the good (*v*) and its purchase date have increased by one unit. The user cost evaluated at the end of period *t* can be defined as follows:

(4)
$$UC_t = (1 + i_t)p_{v,t}^{s} - p_{v+1,t}^{s+1}$$

where i_t is the nominal interest rate in period *t*.

The user cost can be interpreted as the *opportunity cost* of owning for one period the durable instead of selling the durable at the beginning of period *t*. Equation (4) can be manipulated to show that the user cost UC_t equals the sum of the net return of the durable (in equilibrium, the net return corresponds to what the consumer would obtain by *not* purchasing the asset and investing an equivalent amount of money on a competitive financial market) plus a possible *capital gain*:

(5)
$$UC_t = \underbrace{i_t p_{v,t}^{s}}_{returns} + \underbrace{\left(p_{v,t}^{s} - p_{v+1,t}^{s+1}\right)}_{capital\ gains}$$

Equation (5) shows that the user cost depends on the current price of the durable $p_{v,t}^{s}$, on the current nominal interest rate i_t, but also on *expected* capital gains, that is on the

[12] Alternatively, the user cost can be derived by equating the price of a durable to the discounted value of the net benefits that it is expected to generate in the future. See Jorgenson (1963) and OECD (2009).

expected price of the durable at the end of period t. Thus, the user cost can be interpreted as an ex-ante measure of the consumption flow. In equation (5), and in the rest of this section, however, we do not distinguish between expected and actual prices. This amounts to assuming that the economy is in equilibrium and that the user cost is at the same time an ex ante and an ex post measure of the consumption flow.

In equation (5), capital gains (or losses) depend on the *economic depreciation* of the durable and on the monetary price dynamics of durable goods. Economic depreciation is an expression used to describe the loss in monetary value that most capital goods experience with age [Hulten and Wykoff 1981]. Due to *economic depreciation*, one unit of the consumer durable of vintage v at the beginning of period t corresponds to $(1-\delta_t)$ units of a durable of vintage v+1 at the beginning of the period t, where $\delta_t \epsilon (0,1)$ is usually referred to as the net *depreciation rate*.[13] At the same time, the price of one unit of a consumption durable of age v at the end of period t is equal to $(1+\pi_t)p^s_{v,t}$, where π_t measures the durable-specific *inflation rate* in period t. It follows that $p^{s+1}_{v+1,t} = (1-\delta_t)(1+\pi_t)p^s_{v,t}$. Substituting in equation (5) we obtain:

$$UC_t = [i_t + 1 - (1-\delta_t)(1+\pi_t)]p^s_{v,t} \tag{6}$$

If we assume $\pi_t \delta_t \simeq 0$, equation (6) simplifies to:

[13] Hulten and Wykoff (1995) distinguish between "deterioration" and "depreciation". The former is a quantity concept while the latter refers to a financial value. Deaton and Zaidi (2002: 14) prefer to use the concept, and discuss a model for the "deterioration rate" based on the assumption that "the quantity of the good is subject to "radioactive decay", so that if the household starts off the year with the amount S_t, it will have an amount $(1-\delta_t)S_t$ to sell back at the end of the year". This model corresponds to the geometric depreciation model that we introduce in section 5.4.1. Hulten and Wykoff (1995), however observe that under the depreciation model the two concepts coincide. See also Koumanakos and Hwang (1988)

(7) $$UC_t = (r_t + \delta_t)p^s_{v,t}$$

where $r_t = i_t - \pi_t$ is the Fisherian real interest rate. Equation (7) states that the user cost can be obtained by applying the sum of the real interest rate and the economic depreciation rate to the market price of an *v*-year old consumer durable in period *t*. Hence, according to the user cost approach, the coefficient $k^s_{v,t}(u)$ is simply:

(8) $$k^s_{v,t}(u) = r_t + \delta_t$$

where the argument "u" in $k^s_{v,t}(u)$ stands for "user cost". Equation (8) helps clarify the relationship between the *user cost* and the *rent equivalent* approaches. The two approaches produce the same estimate of the consumption flow if and only if $k^s_{v,t}(u) = k^s_{v,t}(r)$, i.e. if and only if:

(9) $$R_t = [r_t + \delta_t]p^s_{v,t}$$

Equation (9) states that the market rental value of the durable in a single period must be equal to the real rate of return that can be obtained by selling the durable and investing it on the capital market net of the depreciation rate of the durable. This is clearly an arbitrage condition that is only satisfied in equilibrium and in absence of any market friction [Jorgenson 1963, Deaton and Muellbauer, 1980][14].

[14] Garner and Verbrugge (2007) find evidence on the empirical divergence between the two measures.

4 Discussion

There are clear conceptual and theoretical differences between the three approaches reviewed in the previous section. The net acquisition approach is a *stock approach*, while the rental equivalence and the user cost approaches are *flow approaches*. If we interpret the consumer durable as a capital asset, the net acquisition approach consists in valuing both the present and future productive services of new "capital" by means of the purchasing market price of the durable. One advantage of this method is that it treats durable goods symmetrically with non-durable consumption goods. The approach is also conceptually simple, easy to communicate and parsimonious in terms of data requirement (Diewert, 2004, 2009): its implementation only requires the market value of the durables purchased by the household in the survey period. A further advantage is its consistency with the prescriptions of SNA 2008 (SNA 2008). For all these reasons, most statisticians engaged in constructing consumer price indices adopt the acquisition approach for all durable goods (with the exception of housing) [ILO 2003: 419].

There are, however, theoretical drawbacks that cannot be ignored. While the adoption of the acquisition approach might have a relatively little impact on the SNA, especially if the economy is on a steady state growth pattern[15], the same is not true for micro-level analyses. By imputing the entire value of the durable to the initial (acquisition) period the analyst clearly misrepresents the time pattern of the welfare accruing to the household that owns durable goods. The acquisition approach systematically overestimates the living standards of households who decide to invest on new consumer durables, and underestimate it for

[15] Diewert, (2004, 2002) prove that, in a long run equilibrium, the ratio between the value of the consumption flow estimated according to the user cost approach and the value estimated following the acquisition approach is constant and is, in general, larger than one. The ratio approximate the unity in a steady state growth pattern Jorgenson and Lanfeld (2006) note, however, that the distortion induced by the acquisition approach could also involve the aggregated level analysis. In a boost phase of the business cycle households tend to postpone investments on durables and the opposite is true in boom phases. Hence, the acquisition approach emphasizes the cycle giving a large weight to the more volatile component (sensitive to expectation) of households' consumption expenditure

households who decide to postpone this decision or have taken this decision in the past. While it is not easy to identify the direction and the magnitude of the bias, poverty and inequality estimates are certainly biased in the presence of durable goods imputed by means of the acquisition approach.

The above discussion lead us to prefer the rental equivalence and the user cost approaches to the acquisition approach, at least in the context of welfare analysis. This is in line with the conclusions reached by Deaton and Zaidi (2002: 35), Diewert (2004, 2009), and more recently by the OECD Expert Group on Micro-statistics on Household Income, Consumption and Wealth (OECD, 2013).

As shown in equation (9), in an equilibrium position, the rental equivalence and the user cost approach are theoretically consistent. The rental equivalence approach uses the market evaluation (observed paid rent) as an (ex ante) estimate of the user cost. If expectations are fulfilled, market rents can be considered as a good approximation of the user cost. There are however two problems. Firstly, if there is uncertainty, the hypothesis of perfect foresight may not be a plausible one[16]. In most situations, the rental equivalence approach is unlikely to converge to the user cost, due to departures from the theoretical conditions that must hold in order for equation (9) to hold true. Market rental prices for durables are often sensitive to expectations and other cyclical factors. Secondly, we should consider certain data issues. For most *v*-year old durable goods, the availability of actual market rental prices is the exception rather then the rule. In most developing countries, markets for durable *services* are thin or even non existent and this makes the hypothesis of perfect foresight discussed *sub* 1) untenable. As appealing as the solution of asking households a self-assessment of durable rental prices might seem, the absence of reliable market data would not allow to test the reliability of the answers.

[16] The question has been clearly pointed out, even if in a different context, by Hulten and Wykoff (1995): "The rental price, on the other hand, is the ex ante cost of acquiring the right to use the capital good for a stipulated period of time. Under perfect foresight with full utilization the two concepts will tend to converge. With uncertainty, they may not"

A combination of theoretical and data-related arguments leads us to express a preference for the user cost approach. Further, questionnaires used in many household budget surveys around the world contain useful information for implementing the user cost approach, irrespective of the choice of the welfare aggregate (in particular, whether income- or expenditure based). All in all, the user cost provides the best balance between theoretical consistency and data requirement to properly account for durable goods in measuring welfare at the household level.

PART II – PRACTICE

In this section we focus on implementation issues, and in particular on how to estimate the consumption flow of consumer durable goods according to the user cost approach. The discussion covers both data issues and estimation methods available to estimate the consumption flow as expressed in equation (7). We start off with an overview of how consumer durables are accounted for in living standard assessment reports around the world (section 5). Next we focus on the practicalities of how the consumption flow from durables can be estimated starting from the user cost approach (section 6).

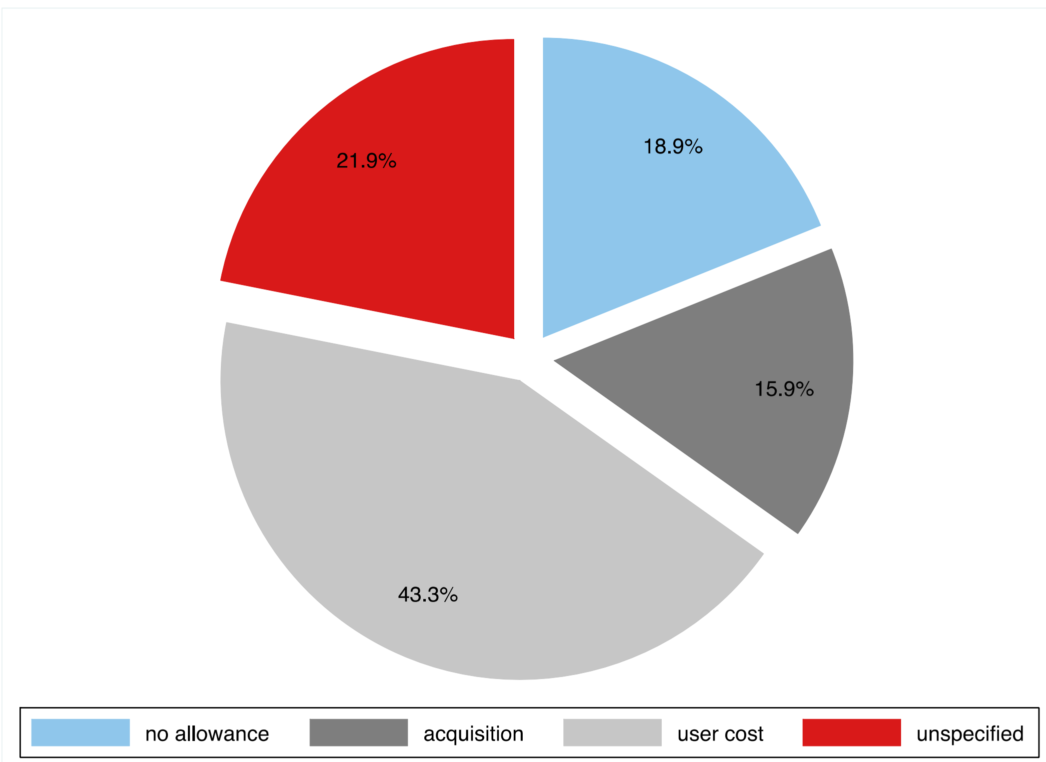
5 A bird's eye view of current practices

We begin our review by summarizing the solutions adopted in selected World Bank Poverty Assessment Reports. We examined a sample comprising 95 reports published between 1996 and 2014, covering 61 countries.[17] We find that 43 percent of the reports fail

[17] We excluded from the sample another 20 reports in which it was not possible figure out – with the due detail – the definition of the welfare aggregate. In most cases, our understanding is that durables were not accounted for.

to account for durable goods in the construction of the welfare aggregate: consumer durable goods are simply ignored and excluded from the welfare aggregate, no matter whether income- or expenditure based (Figure 1). The reason underlying the exclusion of consumer durables is not necessarily a choice of the analyst. Oftentimes exclusion is a consequence of data limitation: not all questionnaires collect suitable information on consumer durables and their ownership. In other circumstances, durables are excluded due to the analyst's concern for making *consistent* intertemporal comparisons. This is the case, for instance, of Turkey in 2005 or of Egypt in 2011. Among the reports that do include consumer durables, almost one out of four follows the acquisition approach (Section 3.1).

Figure 1 – Durable goods in World Bank's selected poverty assessment reports



Source: Authors' elaboration

Regional practices matter. The choice of the method to deal with consumer durables tend to be common to countries belonging to the same region. The regions in which durable goods have been included in the welfare aggregate more frequently are Central Asia and Latin America (60%). In the MENA region, one out of two reports does account for durable goods, and does so by means of the acquisition approach. In contrast, in Central Asia and Latin America and Caribbean the user cost approach is the most popular method (more than 70% of considered reports). The user approach is also popular in East and South Asia (2 out of 3 reports account for durables), but almost 6 out of 10 directly exclude durables from the welfare aggregate. Data constraints are particularly binding in Sub-Saharan Africa: only few reports include durables.

Recently, an OECD expert group, chaired by Bob McCall from the Australian Bureau of Statistics, has released a report, part of a project launch in 2011, aimed at improving the measurement of living standards at the micro level, i.e. at the level of individuals and households. The new framework, named "Framework for Statistics on the Distribution of Household Income, Consumption and Wealth" (ICW Framework), takes advantage of the result obtained by a previous work, the *Canberra Group Handbook on Household Income Statistics* [Canberra Group, 2011], suggests a number of methodological innovations and does so by giving durable goods the due attention.

According to the OECD report, consumer durables are to be accounted irrespective of whether using income or expenditure as a welfare measure. Beginning from income-based measures, the advocacy for including an estimated value of the flow of services of durables is clearly stated: "As with owner-occupied housing, household consumer durables normally provide their owner with services over a number of years. The economic resource flowing to the owner is notionally the rental value of the durables less the costs such as maintenance expenses, depreciation and interest on any loan used to purchase the items. While similar in nature to the net value of owner-occupied housing, it is separated out because it is much more difficult to obtain relevant data, and because on average it is likely to have less impact on the micro data, although it may be significant for some sub-population analysis". [OECD 2013: 46] Later on in the report, the estimated consumption flow from durables is clearly listed among the components of income (code I3.3, “Net value of services from household consumer durables”) [OECD 2013: table 4.1, p. 83].

Similarly, the concept of consumption expenditure developed within the ICW framework recognizes the need to account for durable goods: “When a household purchases a dwelling or consumer durables, it does not normally consume them immediately. Rather, the household can be viewed as a producing entity that invests in those items as capital expenditure and provides a flow of services to itself as a consuming entity. In the ICW Framework, that flow of services is included as consumption expenditure, rather than the initial purchase of the capital items. Two such service flows are included in the detailed framework: i) the value of housing services provided by owner-occupied housing and ii) the value of services from household consumer durables” [OECD 2013: 105]. It is worth noting, however, that “Any consumer durables (…) provided in kind to households as a return for labour or for the use of the household’s property are included in income but not in consumption expenditure” [OECD 2013: 106].

The country-level experience is variegated. We did not undertake an exhaustive review of the common practice in all countries, a task that goes beyond our scope here, but we chose a few countries, much depending on the accessibility of the websites where methodological notes are stored. Following no special order, here is a schematic account of our findings:

- In the US, consumer durable goods do not seem to receive any specific attention. The issue is mentioned in Citro and Michael (1995: 245), but only in passim. As a matter of fact, the consumption flow from durables is not part of the method used to estimate official poverty in the US.
- In Canada, there is no official government definition and therefore, measure, for poverty. The point is clearly stated in Fellegi (1997): “Once governments establish a definition, Statistics Canada will endeavour to estimate the number of people who are poor according to that definition. Certainly that is a task in line with its mandate and its objective approach. In the meantime, Statistics Canada does not and cannot measure the level of “poverty” in Canada.” That said, Murphy et al. (2010, 2012) do not mention any special treatment reserved to consumer durables, and our understanding is that, de

facto, consumer durables do not enter the definition of total income used to measure poverty.

- In Australia, the income aggregate does not include any estimates of the service from consumer durables (Australian Bureau of Statistics, 2013). With regards to the expenditure based welfare aggregate, the Australian practice has primarily hinged on the acquisition approach (Australian Bureau of Statistics, 2012: 18-20).
- In the UK, the income-based welfare aggregate does not include the consumption from durables [Department for Work and Pensions, 2013].
- In India, durables are included in the welfare aggregate according to the acquisition approach (Government of India, 2007).

Overall, in most countries, the current practice does not seem to be consistent with the lessons stemming from Part I of this paper, where it was argued that the user cost approach deserves the highest consideration as a way of including consumer durables in the welfare aggregate. The recent OECD publication goes in the right direction in that it endorses the need of estimating the consumption flow of durables by means of a flow-based depreciation method.

6 The estimation of the consumption flow

We begin from equation (7), which we rewrite as follows:

(10) $$UC_t = (i_t - \pi_t + \delta_t)p_{v,t}^s$$

Equation (10) contains four variables that must be estimated:

1) i_t, the nominal interest rate;

2) π_t, the durable-specific yearly inflation rate. Note that i_t and π_t jointly determine the real interest rate, $r_t = i_t - \pi_t$.
3) $p^s_{v,t}$, the current market value of the v-year old durable;
4) δ_t, the economic depreciation rate.

In the rest of this section we discuss the information required to estimate each variable separately. This will bridge the gap between theory (eq. 10) and practice.

6.1 The nominal interest rate

The nominal interest rate is determined in the capital market and is intended to measure the monetary financial opportunity cost of a household who decides to purchase (or not to sell) a durable good. In an economy with competitive markets there are many reference interest rates. Moreover, financial assets may have different maturities and different degrees of risk. The equilibrium interest rates reflect all this complexity and even more[18]. Which one, among the many available rates, should the welfare analyst choose?

There are many defensible answers and the final choice depends on the ultimate aim of the analysis, as well as on the institutional context. If one is willing to assume that risk aversion and wealth are negatively correlated[19], then a good choice is the average interest rate on safe assets, *e.g.* the yields of government bonds. This type of information is typically available in most countries, and regularly published either by the national statistical office or by the central bank. A second possibility is to use the interest rates on loans, and specifically the borrowing rate on consumer durable goods like cars or other major durables[20].

[18] For instance, also the heterogeneity in agents' expectations should be taken into account. Also, if one allows for imperfections in financial markets, different individuals might face different interest rates on loans.

[19] Arrow (1971) was the first one who argued that absolute risk aversion decreases as wealth increases.

[20] See Katz (1983) and Diewert (2009).

Concerning the time horizon there are two possibilities: 1) to adopt the same reference period of the estimated consumption flow (typically, one year); 2) to cover the average economic life of the durable good considered. Under the first alternative short period interest rates are considered, while in the second alternative use is made of long-term rates. The second option is probably to be preferred to the first one, as it implies a lower volatility typically associated to long-term rates. Further, long-term rates allow to mitigate the effects of pure monetary fluctuations on inequality and poverty trends.

6.2 The inflation rate

The second variable in equation (10) is the annual rate of change of monetary price of the durable for which we want to measure the real financial opportunity cost. In theory, we are interested in a price index specific to each and every durable good acquired by the household. In practice, no such an index is likely to exist. Instead, it is common practice for analysts to rely on the general consumer price index (CPI)[21]. Accordingly, we can assume:

$$\pi_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \qquad (11)$$

Equation (11) implies that a CPI for the at least two years is available in order to identify the real interest rate in equation (10).

[21] To the extent that the analysis is focused on poverty issues, it is advisable to refer to a cost of living index specific to poor households, that is, an index based on the consumption pattern of households belonging to the bottom deciles of the distribution of income and or expenditure.

6.3 The market values of durable goods

As discussed in Section 3, irrespective of the approach that we adopt, the consumption flow can be expressed as a fraction of the current market value of the durable $p_{v,t}^{s}$. The monetary value $p_{v,t}^{s}$ reflects the specific features of the durable good and the market conditions faced by the household who owns the durable. Unfortunately, most household budget surveys do not provide adequate information on $p_{v,t}^{s}$. In this sense, it is useful to distinguish between the case when $s = 0$ (the durable good has been purchased by the household during the survey year) and $s > 0$ (the durable has been purchased prior to the survey year). Typically, household budget surveys only record the price paid by the household to purchase a new durable good (no matter if purchased on the second hand market)[22], which is information that can be consistently used to estimate the market prices $p_{v,t}^{0}$. The survey questionnaire does not always report the market values of the durables purchased prior to the survey year. When this is the case, we must rely on *indirect* estimation methods for the market value $p_{v,t}^{s}$ based on the price paid by the household, on price changes between t and t-s, and on estimates of the specific consumption durable depreciation rate.

Households are often asked to report the historical price paid s years before the survey year for the purchase of the durable, which we denote with $p_{v-s,t-s}^{s}$. Let $\bar{\pi}$ denote the yearly durable specific inflation rate between $t - s$ and t. The rate $\bar{\pi}$ can be calculated by solving the equation $\prod_{i=0}^{s}(1+\pi_{t-s+i}) = (1+\bar{\pi})^{s}$. By keeping constant the age of the durable, we can write:

$$p_{v-s,t}^{s} = (1+\bar{\pi})^{s} p_{v-s,t-s}^{s} \tag{12}$$

22 Sometimes only the price paid for the durable good purchased more recently is reported.

The implementation of equation (12) requires the availability of the time series of some sort of price index CPI_T for *T=t-s-1,…,t*. If, for instance, the durable good was purchased 10 years prior to the survey year (s = *10*), the analyst needs the price indices for the past 11 years. Secondly, equation (12) provides an estimate of $p^s_{v-s,t}$, that is, of the current value of a *(v–s)*-year old durable. However, the durable owned by the household is a *v*-year old durable. To estimate $p^s_{v,t}$ we need to know the average yearly economic depreciation rate between age $v - s$ and *v*. This is what we discuss in the next section.

6.4 The depreciation rate

The depreciation rate measures the loss (or gain) in value that durable goods experience with age due to their physical deterioration and market value change. The depreciation pattern of a durable good can be represented in a general way. In order to simplify our discussion, we shall omit the index s, *i.e.* we will ignore the purchasing date of the durable[23]. Thus, we can write:

(13) $$p_{1,t} = (1 - \delta_1)\, p_{0,t}$$

where $p_{0,t}$ is the market value of a new durable in *t* and $p_{1,t}$ is the market value of a 1-year old durable in *t*. The value $\delta_1 \leq 1$ is the deterioration rate for the first year of life of the durable. Following the same notation, and with the same interpretation, we can also write:

(14) $$p_{2,t} = (1 - \delta_2)\, p_{1,t}$$

[23] In the rest of this section we also assume that delta is unique, for each good, at the national level. In principle, one can explore the use of different deltas for different regions or population subgroups. To the best of our knowledge, these possibilities have not been discussed in the literature.

Equation (14) expresses the price of the durable good when it turns 2-year old, that is at the end of the second year, as a fraction of its value when it was 1-year old. Substituting equation (13) in equation (14) we obtain:

(15) $$p_{2,t} = (1 - \delta_2)(1 - \delta_1)\, p_{0,t}$$

Proceeding iteratively one obtains:

(16) $$p_{v,t} = \prod_{i=1}^{v} (1 - \delta_i)\; p_{0,t}$$

According to equation (16) the entire depreciation pattern of the durable good between *t–v* and *t* is described by the sequence $\{\delta_i\}_{i=1}^{v}$. There are, obviously, many ways of characterizing this depreciation sequence and they all require different pieces of information to be implemented. We will here discuss the three most common models that are found in the literature[24]: 1) the geometric depreciation model; 2) the straight line depreciation and 3) the "light bulb" depreciation. Further, we will suggest a fourth depreciation model, a mixture of methods 1) and 3), which has the advantage of being parsimonious in terms of information requirement, and therefore potentially widely applicable.

6.4.1 The geometric depreciation model

Under the geometric model the depreciation rate is assumed to be constant over time. In other words, a constant fraction of the value of the durable is lost every year. In equation (16) this implies that $\delta_i = \delta$ for every *i*:

[24] See Hulten and Wykoff (1981, 1996) and Diewert (2003, 2004, 2009).

(17) $$p_{v,t} = (1-\delta)^v \, p_{0,t}$$

Equation (17) can be solved with respect to the (unique) depreciation rate δ:

(18) $$\delta = 1 - \left(\frac{p_{v,t}}{p_{0,t}}\right)^{\frac{1}{v}}$$

In equation (18) the estimation of the depreciation rate only requires information on the market values of homogeneous durable goods of different age. Due to its analytical simplicity and its empirical robustness, the geometric model is one of the most popular models[25].

6.4.2 The straight line depreciation model

The straight line depreciation model assumes that the economic life of the durable is finite and that its value follows a linear pattern of depreciation. Let us denote with T the economic life of the durable: after T years its consumption flow equals zero. According to the linear depreciation model we have:

(19) $$\frac{p_{v,t}}{p_{0,t}} = \begin{cases} \dfrac{T-v}{T} & if\ v \leq T \\ 0 & otherwise \end{cases}$$

[25] See Hulten and Wykoff (1981, 1996) Jorgenson (1996) and Fraumeni (1997). The general conclusion of the empirical literature on the capital depreciation rate is that the geometric pattern is closer to the actual pattern than the patterns implied by the straight line and the light bulb depreciation model

Hence, it is straightforward to show that:

(20)
$$\delta_i = \begin{cases} \frac{1}{T-i} & if\ i < T \\ 1 & otherwise \end{cases}$$

where δ_i is the depreciation rate for the year *i* of the economic life of the durable good.

Equation (20) shows that, unlike in the geometric depreciation method, the depreciation rate here is not constant over time. This implies that in order to implement the user cost formula we need to calculate a vintage-specific depreciation rate[26]. Also note that the implementation of the straight line depreciation model requires the knowledge of T, which requires an estimate of the economic life for each and every durable good owned by the households.

Deaton and Zaidi (2002) assume that the age of the durable goods is uniformly distributed. Accordingly, $2\bar{T}$ is an estimator of the maximum economic life of the durable, where $\bar{T}$ is the average life of the durable calculated form the data recorded in the survey. An alternative consists in using some outlier-resistant statistics computed over the set of the most long-lived goods in the sample: one possibility, for instance, is the 95th percentile of the sample distribution of the ages of the durable good.

6.4.3 The light bulb depreciation model

The light bulb depreciation model, also known as the "one-hoss shay" model, is the simplest among the depreciation models. The idea is that the durable maintains its efficiency and value along all its economic life and ceases to work, like a bulb, after T years. Accordingly, the consumption flow, as measured by the user cost, is constant over

[26] For an application of the linear depreciation model see Diewert (2003).

the entire economic life of the durable. Let us define $U_t = UC_t/(1+i_t)$ as the user cost of the durable evaluated at the beginning of period *t*. Equation (4) allows us to write:

$$U_t = p^s_{v,t} + \frac{(1+\pi_t)}{(1+i_t)} p^s_{v+1,t} \quad (21)$$

If $U_t = \overline{U}$ is a constant for $v < T$, then equation (21) can be rewritten as follows:

$$p^s_{v,t} = \overline{U} + \gamma_t p^s_{v+1,t} \quad (22)$$

where $\gamma_t = \frac{(1+\pi_t)}{(1+i_t)}$. We also assume $\gamma_t < 1$, i.e. that the real interest rate is always strictly positive.

Each durable goods maintains its efficiency for *T* periods and then ceases to function. Precisely at that time, $p^s_{T,t} = 0$. Substituting iteratively the RHS term in equation (22) we obtain:

$$p^s_{v,t} = \overline{U}[1 + \gamma_t + {\gamma_t}^2 \ldots + {\gamma_t}^{T-1-v}] = \overline{U}\left[\frac{1 - {\gamma_t}^{T-v}}{1 - \gamma_t}\right] \quad (23)$$

By using equation (18) we obtain the final formula for the "light bulb" depreciation rates:

$$\delta^t_v = 1 - \left[\frac{1 - {\gamma_t}^{T-1-v}}{1 - {\gamma_t}^{T-v}}\right] \quad (23)$$

It should be observed that in order to estimate the depreciation rate for the user cost formula we need to know the "duration" *T* of the durable, *i.e.* its economic life, and the parameter

γ_t that depends on the period t asset specific inflation rate π_t and on the nominal interest rate i_t. If we assume that γ_t is constant over time the depreciation rate only varies with v, *i.e.* with the vintage of the durable[27].

6.4.4 A mixture depreciation model

In this section we introduce a depreciation model that can be obtained as a mixture of the geometric and light bulb depreciation models. The pure geometric depreciation model assumes that the value of the durable depreciates at a fixed rate δ, but the economic life of the durable never ends. In the new model, the key assumption is that durable goods depreciate at a constant rate δ, but the rate goes to one when $v > T$, where T denotes the maximum economic life of the durable.

The question then is how to determine the scrap value of the durable, *i.e.* the value of the durable at $v = T$. One solution consists in assuming that the scrap value $p_{T,t}$ is a fraction $\alpha < 1$ of the initial value $p_{0,t}$.

$$p_{T,t} = \alpha p_{0,t} \tag{24}$$

The new parameter α can be interpreted as a measure of the transaction cost for the durable; α is assumed here to be proportional to the initial value of the durable. The idea is that at the end of the economic life of the durable good the transaction costs absorb all the value of the durable. As a consequence, after T years the durable cannot be sold on the market without incurring into a loss[28]. Substituting in equation (17) we obtain:

---

[27] The pattern of the value of the durable can be easily calculated is given by $p_{v,t} = (1 - {\gamma_t}^{T-v}/1 - {\gamma_t}^{T})p_{0,t}$.

[28] The actualized value of the residual consumption flows from the durable good (the reservation price) is less than the transacion cost that must be paid to purchase the durable.

(25) $$\alpha p_{0,t} = (1-\delta)^T \, p_{0,t}$$

and solving with respect to δ we can write:

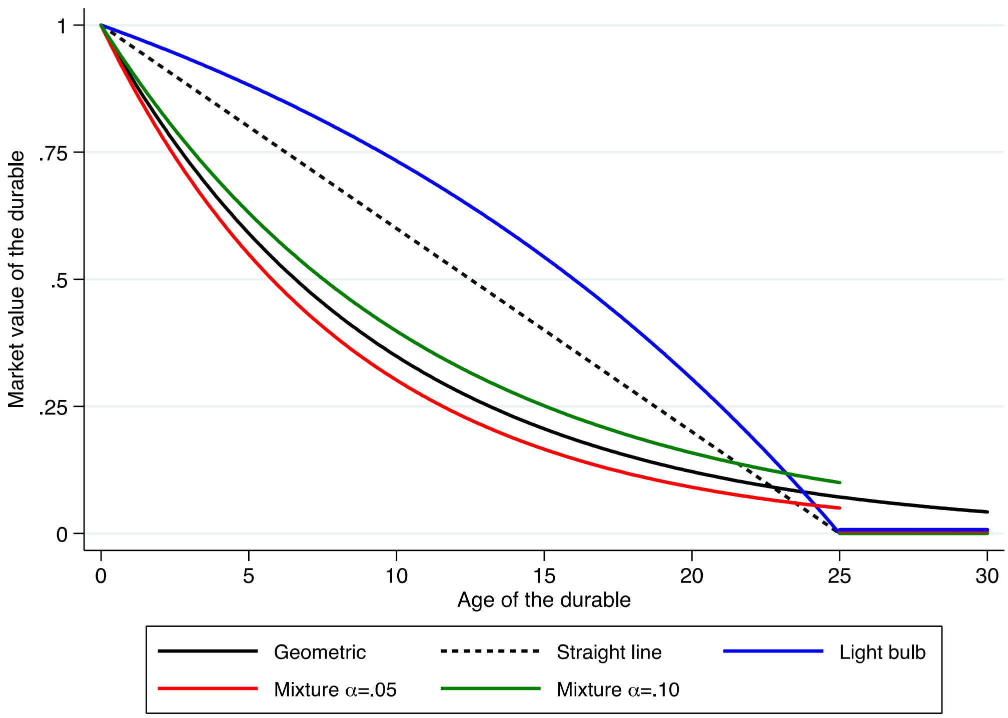
(26) $$\delta = 1 - \alpha^{\frac{1}{T}}$$

Equation (26) compares with equation (18). The advantage of equation (26) is that it does not require information on the current market prices of durable goods with different manufacturing years. This facilitates tremendously its implementation, both when data are relatively abundant, and even more so when the survey only provides an inventory of the durable goods owned by the households. A drawback is that the estimate of the depreciation rate δ depends on the parameter α, which is arbitrarily chosen by the analyst. In fact, it can be shown that the consumption flow from the durable is quite insensitive to choice of alpha. Equation (26) can be substituted in equation (10) and the elasticity of the consumption flow with respect to alpha $\eta_{CF/\alpha}$ can be easily calculated:

(27) $$\eta_{CF_t/\alpha} = \frac{1}{T}\left[\frac{r_t + 1 - 2\alpha^{\frac{1}{T}}}{r_t + 1 - \alpha^{\frac{1}{T}}}\right] = \frac{1}{T} h(\alpha)$$

where $h(\alpha)$ is always less than one and is a decreasing function of α. Hence the elasticity of the consumption flow with respect to α is always less than one and tends to zero as the age of the durable tends to infinity. To get a sense of the magnitude of $\eta_{CF/\alpha}$, assume a conservative scenario where $T = 2$, $\alpha = 0.10$ and $r_t = 0.05$; under this assumption the elasticity $\eta_{CF/\alpha} = 0.28$, that is a one percent increase in α is associated with a 0.28 percent increase in the consumption flow. *Ceteris paribus*, if $T = 25$, $\eta_{CF/\alpha} = -0.22$. Again, the consumption flow is anelastic to α.

Figure 2 – Depreciation models compared



Source: our elaboration.

Figure 2 compares the four depreciation models described in this section. On the vertical axis, the initial value of the durable good is normalized to one. We assume that the geometric depreciation rate is 10% and that the economic life T is equal to 25 years (empirically, these are reasonable assumptions for many consumer durables). The dashed line describes the pattern of the straight line model, while the blue line describes the pattern of the bulb light model. The geometric depreciation pattern is represented by the black solid line. The green and the red lines describe the mixture model under the assumption that $\alpha = 5\%$ and $\alpha = 10\%$, respectively.

6.4.5 Econometric models

A depreciation rate gives the percentage change of the market value of a durable good between two subsequent years. In principle, depreciation rates can be calculated directly from the empirical age-price curves for each durable good. In practice, however, lack of adequate data prevent the analyst from drawing complete age profiles for most durable goods and, as a consequence, to estimate the required depreciation rates[29]. It is then necessary to estimate the age-price profile by using an econometric model.

Studying the economic depreciation of capital assets Hulten and Whykoff (1981) introduced an econometric model that encompasses all the theoretical depreciation models described in sections 6.4.1-6.4.3[30]. Let p_i be the observed market price of an asset of age v_i in year t_i. Then, the Box-Cox model for the used asset price is:

$$\hat{p}_i = \propto + \beta \hat{v}_i + \gamma \hat{t}_i + u_i \tag{28}$$

where

$$\hat{p}_i = \frac{{p_i}^{\theta_1} - 1}{\theta_1};\ \hat{v}_i = \frac{{v_i}^{\theta_2} - 1}{\theta_2};\ \hat{t}_i = \frac{{t_i}^{\theta_3} - 1}{\theta_3}$$

[29] As observed by Hulten and Wykoff (1981a, 1981b), there is also a problem of *censoring*. The used price sample contains only the price of the "survived" durables and they provide a biased estimate of the average value of a specific vintage. A possible correction for censoring consists in multiplying the prices of surviving assets of each vintage by the age dependent probabilities of survival. Jorgenson (1996) shows that this correction has a relevant impact on depreciation rate estimates. Another possible source of bias depends on the fact that the equilibrium prices in second hand markets might be largely affected by adverse selection phenomena (Akerlof, 1970).

[30] An alternative econometric model was proposed by Oliner (1993) who augmented the standard linear regression model with polynomial components for v_i and t_i. Micro-Economic Analysis Division of Canada (2007) has carried out a variety of other estimation exercises based on survival econometric models.

and $u_i \sim N(0,\sigma^2)$. The parameter vector $\boldsymbol{\theta} = (\theta_1, \theta_2, \theta_3)$ identifies the specific functional form of the Box-Cox power transformation that corresponds to the theoretical depreciation models discussed above. In particular, for $\boldsymbol{\theta} = (0,1,1)$ equation (28) takes the semi-log form that corresponds to the geometric depreciation pattern[31]. When $\boldsymbol{\theta} = (1,1,1)$ we obtain the linear depreciation pattern, while $\boldsymbol{\theta} = (1,3,1)$ identifies the light bulb model.

In the absence of reliable data on used asset prices, the assumption of a geometric depreciation pattern can be used to derive an alternative estimation procedure:

(29) $$\delta = \frac{p_v - p_{v+1}}{p_v}; \qquad v = 0,1,\ldots\ldots,T-1$$

where p_v is the vintage *v* asset price (we omit here the temporal index *t*) and *T* is the expected economic life of the asset. From equation (29) we derive:

(30) $$T\delta = \sum_{v=0}^{T-1} \frac{p_v - p_{v+1}}{p_v}$$

Equation (30) can be rewritten as follows:

(31) $$\delta = \left[\sum_{v=0}^{T-1} \frac{p_v - p_{v+1}}{p_v}\right] \Big/ T = \frac{DBR}{T}$$

where DBR is known in the literature as the "declining balance rate". The larger is the expected service life *T* of the durable, the higher must be the declining balance rate

[31] See also Jorgenson (1996)

consistent with a given geometric depreciation rate[32]. The idea of the method is that of estimating directly DBR for all the assets for which there are reliable information on prices and then to use these estimates to calculate, by means of eq. (31), the depreciation rate for which there are only information about the expected economic life of the asset. This "second best" estimation procedure that was firstly proposed by Hulten and Wykoff (1981a, 1981b, 1996) is the one mainly adopted by the Bureau of Economic Analysis to produce its official comprehensive table of depreciation rates[33] (Fraumeni, 1997, BEA, 2003).

7 Conclusions

The estimation of the value of the flow of services from durable goods is a relevant issue in many areas of economic analysis, from national accounting to price index theory, as well as in welfare analysis. In this paper the focus has been on the treatment that consumer durable goods must receive in the process of constructing a welfare aggregate. The economic literature is relatively abundant in theoretical studies focused on the economic depreciation of assets. The single most debated issue refers to the measurement of capital and investment decisions. In contrast, the questions of economic depreciation of consumer durable goods and the impact that different approaches have on the measurement of welfare at the individual- or household-level have remained largely unexplored issues.

A general conclusion of the literature is that the user cost approach (section 3.3) is the most appropriate pricing concept to evaluate the flow of services from durable assets. We also found a broad consensus on the fact that the geometric depreciation model (section 6.4.1) is the most empirically robust as well as theoretically consistent depreciation model for

[32] Equation (31) is clearly an approximated formula. In the geometric depreciation model there is no ending date for the capital asset.

[33] According to the most recent BEA estimates, the DBR values range from 0.89 to 2.27 (www.bea.gov/national/pdf/BEA_depreciation_rates.pdf).

capital assets. Our analysis supports the fact that most of the advantages that hold true for capital goods, broadly defined, also hold true for consumer durable goods. Alternative approaches, like the acquisition approach or the rental equivalence approach, imply a higher risk of affecting in undesired ways the distribution of the welfare aggregate, and more generally welfare comparisons.

The second finding, relating to the advantages of the geometric depreciation model, is more controversial for two reasons. The empirical evidence in favor of the geometric model is based on capital assets and not on consumer durables. Extending the same line of argument to consumer durables is not straightforward. Secondly, the lack of adequate data is often responsible for insurmountable difficulties that prevent the analyst from estimating the geometric depreciation rate for consumer durable goods. We suggested a new depreciation model that preserves the basic structure of the geometric model, but relies on a more parsimonious set of statistical information.

The main deficiency in the literature reviewed in this paper is that it fails to assess the impact of the consumption flow from durable goods on the measurement of welfare and its distribution. We are not aware of studies that come up with an evaluation of the impact on poverty and inequality measures of including (excluding) the consumption flow in (from) the welfare aggregate. Nor are we aware of studies that report the sensitivity of the welfare distribution to different estimation methods of estimating the consumption flow. This adds uncertainty when it comes to advising on the “best method” to use in practice, and to designing guidelines for the construction of the welfare aggregate. Further research is badly needed in this area.

References

Akerlof, G. (1970), The Market for Lemons, *Quarterly Journal of Economics*, 488-500

Alchian, A. and B. Klein, (1973) On a Correct Measure of Inflation, *Journal of Money Credit and Banking*, Vol. 5, 173-191.

Amendola, N. and G. Vecchi (2010), "Setting a Poverty Line for Iraq", in *Confronting Poverty in Iraq: an Analytical Report on the Living Standard of the Iraqi Population*, The World Bank.

Arrow, K. J. (1971) *Essays on the Theory of Risk Bearing*. Chicago: Markham Publishing.

Australian Bureau of Statistics (2012), *Household Expenditure Survey and Survey of Income and Housing, User Guide, Australia 2009–10*, ABS, Canberra.

Australian Bureau of Statistics (2013), *Household Income and Income Distribution, Australia, 2011-12*. ABS, Canberra.

Bureau of Economic Analysis (BEA), (2003), *Fixed Assets and Consumer Durable Goods in the United States, 1925-97*, U.S. Department of Commerce

Citro, C.F. and R.T. Michael (eds.) (1995), *Measuring Poverty. A New Approach.* Washington DC: National Academy Press.

Deaton, A. (1997), *The Analysis of Household Surveys. A Microeconomateric Approach to Development Policy*. The John Hopkins University Press.

Deaton A. and J. Muellbauer (1980), *Economics and Consumer Behavior*, Cambridge University Press.

Deaton A. and S. Zaidi (2002), "Guidelines for Constructing Consumption Aggregates for Welfare Analysis." *Living Standards Measurement Study* Working Paper n. 135. The World Bank, Washington, DC.

Department for Work and Pensions (2013), *Households Below Average Income. An analysis of the income distribution 1994/95 – 2011/12*, June 2013 (United Kingdom)

Diewert, W. E. (2002) ‘‘Harmonized Indexes of Consumer Prices: Their Conceptual Foundations’’, in *Swiss Journal of Economics and Statistics*, Vol. 138, No. 4.

Diewert, W. E. (2003), "Measuring Capital", NBER Working Paper, n. 9526

Diewert, W. E. (2004), "Durables and User Costs" in ILO, *Consumer Price Index Manual: Theory and Practice*, chapter 23, ILO/IMF/OECD/UNECE/Eurostat/World Bank.

Diewert, W. E. (2009), "Durables and Owner-Occupied Housing in a Consumer Price Index" in W. E. Diewert , J.S. Greenlees and C.R. Hulten (eds.), *Price Index Concepts and Measurements*, University of Chicago Press.

Fellegi, I.P. (1997), “On poverty and low income”, available here: http://www.statcan.gc.ca/pub/13f0027x/13f0027x1999001-eng.htm.

Fisher, I (1911), *The purchasing power of money, Its Determination and Relation to Credit, Interest, and Crises*. New Yoor: The McMillan Co.

Fraumeni, B. (1997) ”Measurement of Depreciation in the US. National Income and Wealth Accounts.” *Survey of Current Business*. US, vol 77 (7), 7 – 23

Garner, T. and R. Verbrugge (2007), “The Puzzling Divergence of U.S. Rents and User Costs, 1980-2004: Summary and Extensions”, BLS Working Papers, WP n.409

Gillingham R. (1983), “Measuring the Cost of Shelter for Homeowners: Theoretical and Empirical Considerations”, *The Review of Economics and Statistics*, (65)2: 254-65.

Goodhart, C. (2001), “What Weight Should be given to Asset Price in Measurement of Inflation?”, *The Economic Journal*, Vol. 111, 335-356.

Government of India (2007) “Poverty Estimates for 2004-05”. New Delhi.

Hicks, J.R. (1955), *Capital and Growth*, Oxford Clarendon Press

Hulten, C. R. (1990), “The measurement of capital”. In *Fifty years of economic measurement*, ed. E. R. Berndt and J. E. Triplett, 119– 58. Chicago: University of Chicago Press.

Hulten, C. R. and F. Wykoff (1981), “The measurement of Economic Depreciation” in C. R. Hulten eds, *Inflation and Taxation of Income from Capital*, Washington DC

Hulten, C. R. and F. Wykoff (1996), “Issues in the Measurement of Economic Depreciation: Introductory Remarks”, *Economic Inquiry*, 34 (1): 10– 23.

ILO (2004), *Consumer price index manual: Theory and Practice*. Geneva, International Labour Office, 2004

Jalava, J and Kavonius, K (2009), “Measuring The Stock of Consumer Durables and its Implications for Euro Area Savings Ratios”, *Review of Income and Wealth*, 55, 1.

Jorgenson, D. W. (1963), “Capital Theory and Investment Behaviour”, *American Economic Review*, 53: 247-259.

Jorgenson, D. W. (1973), “The economic Theory of Replacement and Depreciation”. In *Econometrics and Economic Theory*, ed. W. Sellekaerts, 189– 221. New York: Macmillan.

Jorgenson D. W. and S. Lanfeld (2006) “Blueprint for Expanded and Integrated U.S. Accounts Review, Assessment, and Next Steps”, in *A New Architecture for the U.S. National Accounts*, Dale W. Jorgenson, J. Steven Landefeld, and William D. Nordhaus (eds.), The University of Chicago Press Chicago and

Koumanakos, P. and J.C. Hwang, (1988). *The Forms and Rates of Economic Depreciation, The Canadian Experience*. Presented at the 50th anniversary meeting of the Conference on Research in Income and Wealth, Washington, DC, May 1988.

Katz, A. J. (1983), "Valuing the services of consumer durables", *Review of Income and Wealth,* 29 (4): 405– 27.

Lanjouw, P (2009), "Constructing a Consumption Aggregate for the Purpose of Welfare Analysis: Principles, Issues and Recommendations Arising from the Case of Brazil".

Meyer, B. D. and J.X. Sullivan (2011), "Consumption and Income Poverty over the Business Cycle", NBER Working Paper No. 16751.

Micro-Economic Analysis Division (2007), "Depreciation Rates for the Productivity accounts", *The Canadian Productivity Review*.

Moulton, B.R. (2004), "The System of National Accountsfor the New Economy: What Should Change?", *Review of Income and Wealth*, 50 (2): 261-278.

Murphy, B., X. Zhang, and C. Dionne (2010), "Revising Statistics Canada's Low Income Measure (LIM)", Income Research Paper Series, Statistics Canada, Income Statistics Division.

Murphy, B., X. Zhang, and C. Dionne (2012), "Low Income in Canada: a Multi-line and Multi-index Perspective", Income Research Paper Series, Statistics Canada, Income Statistics Division.

OECD (2009), *Manual: Measuring Capital*, Second Edition OECD, Paris,

OECD (2013), OECD Framework for Statistics on the Distribution of Household Income, Consumption and Wealth, OECD Publishing.

Offer, A. (2005), *The Challenge of Affluence. Self-Control and Well-Being in the United States and Britain since 1950*. Oxford University Press.

Oliner, S. D. (1993) "Constant-Quality Price Change, Depreciation, and Retirement of Mainframe Computers," in Price Measurements and Their Uses, edited by M. F. Foss, M. E. Manser, and A. H. Young. Chicago: University of Chicago Press.

Slesnik, D.T. (2000), *Consumption and Social Welfare: Living Standards and Their Distribution in the United States*, Cambridge University Press.

System of National Accounts (2008), Commission of the European Communities, International Monetary Fund, United Nations, World Bank, Brussels/Luxembourg, New York, Paris, Washington, DC, 1993.

Young, A.S. (2005), "Some Uncertainties in Household Consumption Expenditure Statistics", mimeo (www.statssa.gov.za/commonwealth/presentations/Paper_young.pdf).