



Methodological issues on the analysis of consumer
demand patterns over time and across countries

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Working paper No 9

February 2004

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DEMPATEM working papers are published on behalf of the Dempatem research project by the project coordinators, Wiemer Salverda and Ronald Schettkat.

The Dempatem working papers are available online as PDF-files at <http://www.uva-aias.net/lower.asp?id=186>; exceptionally paper copies will be made available on request (see address below). The Dempatem working papers are intended to make the results of the Dempatem-research available to all persons interested. They aim to stimulate discussion. Comments are welcome.

The Dempatem research project (2001-2004) addressed *Demand Patterns and Employment Growth: Consumption and Services in France, Germany, the Netherlands, Spain, the United Kingdom and the United States*. It was a joint undertaking of the Universities of Amsterdam, Utrecht, Oxford and Paris-I Sorbonne, and the University Carlos III in Madrid, University College London and 17th Street Economics, Washington DC. The Socio-economic Key Action of the Fifth Framework Programme of the European Commission (HPSE-CT-2001-00089) financially supported the project. List of the full project membership and all working papers can be found at the end of the paper.

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I INTRODUCTION

The consumption-team of the DEMPATEM project examines household expenditure patterns over the last two decades. The countries under investigation are France, Germany, Netherlands, Spain, United Kingdom and United States. In particular, this project examines changes in the demand for service related commodities and possible explanations for these changes. The empirical exercise consists of three steps. In the first step, a complete picture of demand changes is provided. In the second step, explanations suggested in the literature for the rise in households' demand for services are examined. In the third step, the differences between the European countries and the United States are examined. This study is solely concerned with the methodology used in the second and third step.

Several explanations for the changes in household expenditure patterns over the last few decades have been put forward in the economic literature.¹ The explanations of interest in this study are those that have testable implications from the empirical point of view when using consumer budget surveys. The four explanations that meet this criterion and are examined in this study can be formulated as follows:

- (1) Household compositional effects. Changes in households' demographic composition and employment structure may have affected the allocation of expenditures among the different commodities. It is hypothesized that these changes caused an increase in the demand for services related commodities.
- (2) Income effects. Most developed countries have experienced real income growth. The way the demand for a commodity is affected by income growth depends on whether this is a luxury, necessity or an inferior commodity. Under the assumption that services related commodities are a luxury, their budget share will have increased over the last decades (Clark, 1951).
- (3) Price effect. Baumol's cost disease stipulates that certain sectors, such as the service sector, experience relatively lower productivity growth and, consequently, face relatively higher increasing costs (Baumol, 1967). This translates into relatively higher

prices of the commodities produced in these sectors. Consequently, in the case demand is price inelastic the budget shares of these commodities increase. The change in the budget share due to a change in relative prices holding quantities constant is referred to in this study as price effect. Demand will most likely respond to relative price changes and this is part of Explanation (4) underneath.

- (4) Preference changes and substitution effects due to changes in relative prices. These two effects cannot be separately identified in this study. In particular insufficient price variability precludes the identification of price elasticities (substitution effects). This explanation is a residual explanation and amounts to the part that cannot be explained with the explanations (1)-(3) formulated above.

This study describes in detail how these four explanations are analysed in this project using household budget survey data and price index information. The outline is as follows. Section 2 deals with the computation of budget shares in current and constant prices. Section 3 describes the Engel curve estimations and the decomposition of changes over time in demographic, employment, and expenditure effects (Explanations 1-2). Section 4 introduces the Price effect (Explanation 3). Section 5 discusses the comparison with the US. Details are relegated to Appendices A, B, C and D.

¹ See Schettkat (2003) for an overview.

2 THE BUDGET SHARES IN CURRENT AND CONSTANT PRICES

The starting point is the availability of consumer expenditures on different commodities. The commodities used in the empirical analysis are summarized in Appendix A. This Section deals with definitional issues and the construction of budget shares in current and constant prices.

A budget survey consists of H_t households, indexed by h , and for each household the expenditures on K commodities are observed, indexed by k . The budget survey is available for two years, $t \in \{1,2\}$. The quantity demanded of commodity k by household h in year t is denoted by $q_{k,h}^t$. The corresponding price, which is assumed to be the same for all households, is p_k^t . Quantities and prices are not separately observed in available household budget surveys.

What is observed are the expenditures on commodities, defined as:

$$x_{k,h}^t = p_k^t q_{k,h}^t, \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (1)$$

Household total expenditures, the budget, is the sum over all expenditures:

$$x_h^t = \sum_k x_{k,h}^t = \sum_k p_k^t q_{k,h}^t, \quad t \in \{1,2\}. \quad (2)$$

The budget share of commodity k of household h in year t in current prices is denoted by $w_{k,h}^t$:

$$w_{k,h}^t = \frac{p_k^t q_{k,h}^t}{\sum_k p_k^t q_{k,h}^t}. \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (3)$$

The budget share in current prices is computed using the observed expenditures:

$$w_{k,h}^t = \frac{x_{k,h}^t}{x_h^t}, \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (4)$$

The budget share in constant prices is defined as:

$$\tilde{w}_{k,h}^t = \frac{\tilde{p}_k q_{k,h}^t}{\sum_k \tilde{p}_k q_{k,h}^t}, \quad t \in \{1,2\}, k \in \{1,\dots,K\}, \quad (5)$$

where \tilde{p}_k is the reference price of commodity k . Budget shares in constant prices are not directly observed, and are computed using the observed expenditures, $x_{k,h}^t$'s, as well as the price index information commonly available from official statistics. The official price indexes are of the following form:

$$\frac{p_k^t}{p_k^0}, \quad t \in \{1,2\}, k \in \{1,\dots,K\},$$

where p_k^0 is the price of commodity k in the base period of the consumer price index system.

Using these price indexes, the relative prices needed in the sequel are obtained as follows:

$$\frac{p_k^t}{\tilde{p}_k} = \frac{\left(\frac{p_k^t}{p_k^0}\right)}{\left(\frac{\tilde{p}_k}{p_k^0}\right)}, \quad t \in \{1,2\}, k \in \{1,\dots,K\}.$$

(6)

Using (6) the budget shares in constant prices, i.e. equation (5), are computed as follows:

$$\tilde{w}_{k,h}^t \equiv \frac{\tilde{p}_k q_{k,h}^t}{\sum_k \tilde{p}_k q_{k,h}^t} = \frac{\left(\frac{\tilde{p}_k}{p_k^t}\right) p_k^t q_{k,h}^t}{\sum_k \left(\frac{\tilde{p}_k}{p_k^t}\right) p_k^t q_{k,h}^t}, \quad t \in \{1,2\}, k \in \{1,\dots,K\}.$$

(7)

In terms of the observed commodity expenditures:

$$\tilde{w}_{k,h}^t = \frac{\left(\frac{\tilde{p}_k}{p_k^t}\right) x_{k,h}^t}{\sum_k \left(\frac{\tilde{p}_k}{p_k^t}\right) x_{k,h}^t}, \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (8)$$

3 THE SYSTEM OF ENGEL CURVES: SPECIFICATION AND ESTIMATION

The change investigated in the empirical analysis is the change in the average budget shares in current prices between two years, referred to as year 1 and year 2 from here onwards:

$$(w_k^2 - w_k^1) = \frac{1}{H_2} \sum_{h=1}^{H_2} w_{k,h}^2 - \frac{1}{H_1} \sum_{h=1}^{H_1} w_{k,h}^1, \quad k \in \{1, \dots, K\},$$

(9)

where the budget shares are as defined in equation (3). For simplicity, sample weights that make the sample representative for the population are ignored in the sequel.

This Section is concerned with the investigation to what extent the changes in the average budget share of commodity k over time, i.e. $(w_k^2 - w_k^1)$ in equation (9) can be attributed to household demographic changes, changes in household employment structure and changes in household total expenditures, i.e. Explanations (1)-(2) as formulated in Section 1.

The relationship between the share of expenditures on a certain commodity (the budget share) and household total expenditures (the budget) is commonly referred to as an Engel curve. The system of Engel curves for the K commodities forms the basis for the analysis of household expenditure patterns discussed in this section.

3.1 THE SYSTEM OF ENGEL CURVES

The dependent variable in each Engel curve is $w_{k,h}^t$ as defined by equation (3). A popular empirical specification relates each budget share to the logarithm of household total expenditures and other household characteristics (see Appendix C):

$$w_{k,h}^t = \alpha_k^t + \gamma_k^t z_h^t + \beta_k^t \ln(x_h^t) + \varepsilon_{k,h}^t, \quad h \in \{1, \dots, H_t\}, \quad t \in \{1, 2\}, \quad k \in \{1, \dots, K\},$$

(10)

where z_h^t is a vector containing demographic and employment variables (see Table A2, Appendix A), x_h^t is household total expenditures, α_k^t, γ_k^t and β_k^t are the parameters of interest of the budget share equation for commodity k in year t , and $\varepsilon_{k,h}^t$ is an idiosyncratic error term to control for issues such as measurement errors and unobserved explanatory variables. The

properties of this error term are discussed in Section 3.2. As mentioned above, within a period all households are assumed to face the same prices. Given that only two cross-sections of budget data are available, insufficient price variation makes it impossible to identify price-elasticities.

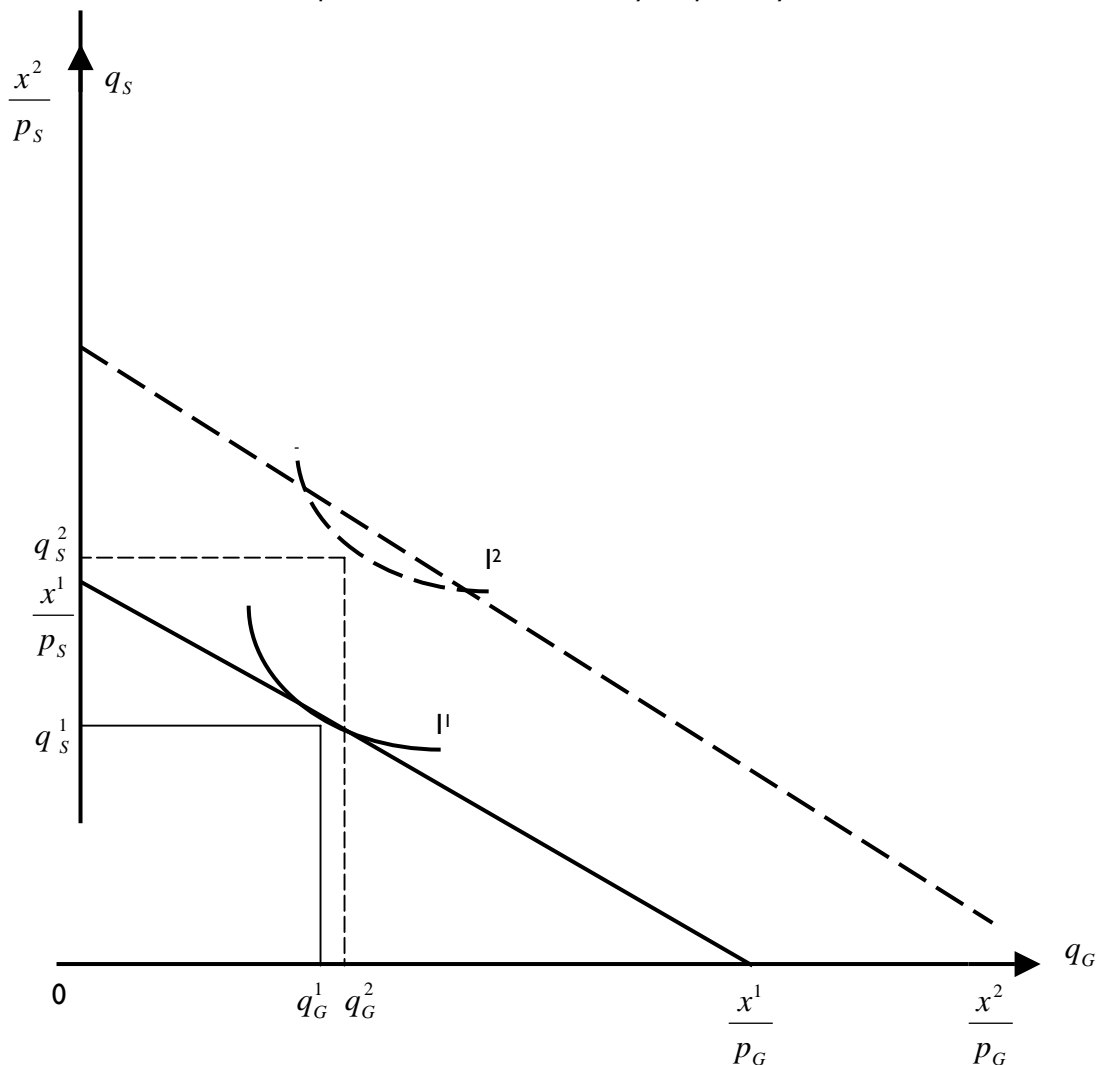
3.2 EMPIRICAL SPECIFICATION AND ESTIMATION

Equation (10) controls for the household budget and demographic and employment variables. As can be seen in equation (4), household total expenditures appears in the denominator of budget shares, so that if measurement error is present the error term will be correlated with household total expenditures, i.e. $E_t[\varepsilon_{k,h}^t | z_h^t, x_h^t] \neq 0$. For this reason equation (10) is estimated using Instrumental Variables (IV), taking into account possible measurement errors in total expenditures. Disposable household income (denoted by y_h^t) is used as an instrument for household total expenditures. One important condition for this procedure to yield consistent estimates is $E_t[\varepsilon_{k,h}^t | z_h^t, y_h^t] = 0$. The IV estimates of α_k^t , γ_k^t and β_k^t are denoted by, respectively, $\hat{\alpha}_k^t$, $\hat{\gamma}_k^t$ and $\hat{\beta}_k^t$.

Goodness-of-fit

The IV estimator employed is a one-step estimator. To assess the fit of the regression model a generalized R-squared is constructed based on two-step estimation: the predicted (ln-) expenditures of the first step are included in equation (10) instead of the observed (ln-) expenditures. The corresponding R-squared of this second step estimation (using Least Squares) can be considered a generalized R-squared, as a measure of the goodness of fit (Pesaran and Smith, 1994).

Figure 1: Budget effects: an increase in the budget from x^1 to x^2 . Services are assumed to be a luxury. The indifference curves in period 1 and 2 are denoted by, respectively, I^1 and I^2 .



3.3 THE BUDGET ELASTICITY

Figure 1 shows the budget effect in the case of a two commodities Services (S) and Goods (G). In this case the budget (household total expenditures) increases from x^1 to x^2 and depending on

the budget elasticity of each commodity the budget shares change. Here the budget elasticity of Services is defined as $\frac{\partial q_s^t}{\partial x^t} \frac{x^t}{q_s^t}$. Only in the case when the budget elasticity is equal to one the budget share remain unchanged. In Figure 1 Goods are assumed to be necessary commodities and the demanded quantity increases relatively less than the demanded quantity of Services, which is assumed to be a luxury. As a result the budget share of Goods decreases and that of Services increases due to an increase of the household budget.

Engel curves like equation (10) are commonly used to estimate the budget elasticities and classify commodities as inferior, a necessity or a luxury. The budget elasticity, denoted by ε_k^t , is defined as follows:

$$\varepsilon_k^t = \frac{\partial q_k^t}{\partial x^t} \frac{x^t}{q_k^t}, \quad t \in \{1, 2\}, k \in \{1, \dots, K\}.$$

In terms of estimates and observable budget shares the budget elasticity is calculated as follows:

$$\varepsilon_k^t = 1 + \frac{\beta_k^t}{w_k^t}, \quad t \in \{1, 2\}, k \in \{1, \dots, K\}.$$

(11)

Substituting the parameter estimate $\hat{\beta}_k^t$ in this equation yields the estimated budget elasticity $\hat{\varepsilon}_k^t$. The change in the budget share of commodity k due to a percentage change in the budget is equal to $\hat{\beta}_k^t$. Based on the estimated budget elasticity commodity k is categorized as in Table 1.

Table 1: The Budget Elasticity.

Estimated Budget Elasticity	Type of Commodity
$\hat{\varepsilon}_k^t \leq 0$	Inferior
$0 < \hat{\varepsilon}_k^t \leq 1$	Necessity
$\hat{\varepsilon}_k^t > 1$	Luxury

3.4 DECOMPOSITION OF CHANGES OVER TIME

The magnitude to be explained is the average change in budget share of commodity k , i.e. $(w_k^2 - w_k^1)$, equation (9). Given the properties of the IV estimator, the average predicted

difference (based on the parameter estimates) and the average observed difference are equal, $(w_k^2 - w_k^1) = P(w_k^2 - w_k^1)$. The predicted difference is written as follows:

$$P(w_k^2 - w_k^1) = (\hat{\alpha}_k^2 - \hat{\alpha}_k^1) + (\hat{\gamma}_k^2 z^2 - \hat{\gamma}_k^1 z^1) + (\hat{\beta}_k^2 \overline{\ln(x_h^2)} - \hat{\beta}_k^1 \overline{\ln(x_h^1)}),$$

$$k \in \{1, \dots, K\}$$

(12)

with

$$z^t = \frac{1}{H_t} \sum_h z_h^t, \quad \overline{\ln(x_h^t)} = \frac{1}{H_t} \sum_h \ln(x_h^t), \quad t \in \{1, 2\}.$$

The predicted (counterfactual) budget share using the estimates of year 1 and average characteristics of year 2 is given by $(\hat{\alpha}_k^1 + \hat{\gamma}_k^1 z^2 + \hat{\beta}_k^1 \overline{\ln(x_h^2)})$. This counterfactual is added and subtracted from equation (12) to obtain a decomposition of the predicted difference into a part due to a compositional changes and a part due to changes in parameter estimates:

$$P(w_k^2 - w_k^1) = \hat{\gamma}_k^1 (z^2 - z^1) + \hat{\beta}_k^1 (\overline{\ln(x_h^2)} - \overline{\ln(x_h^1)}) + R_k^{2,1},$$

(13)

with

$$R_k^{2,1} = \hat{w}_k^2 - (\hat{\alpha}_k^1 + \hat{\gamma}_k^1 z^2 + \hat{\beta}_k^1 \overline{\ln(x_h^2)}), \quad k \in \{1, \dots, K\}.$$

(14)

The first term at the RHS of equation (13) is the predicted change in the budget share due to a change in household composition, referred to as Explanation (1) in Section I. The second term at the RHS is the predicted change due to a change in household total expenditures, referred to as Explanation (2) in Section I. The third term, $R_k^{2,1}$, is the predicted change due to a change in the parameters, since it can also be written as $((\hat{\alpha}_k^2 - \hat{\alpha}_k^1) + z^2 (\hat{\gamma}_k^2 - \hat{\gamma}_k^1) + \overline{\ln(x_h^2)} (\hat{\beta}_k^2 - \hat{\beta}_k^1))$, and includes price effects, changes in preferences, and other unknown factors (Explanations (3) and (4), Section I).

An alternative decomposition is obtained if the counterfactual budget share using the estimates of year 2 and average characteristics of year 1, i.e. $(\hat{\alpha}_k^2 + \hat{\gamma}_k^2 z^1 + \hat{\beta}_k^2 \overline{\ln(x_h^1)})$, is added and subtracted from equation (12).

The first term at the RHS of equation (13) can be further decomposed into a demographic and an employment effect. Let $z_h^{d,t}$ denote the demographic variables with corresponding parameter vector $\gamma_k^{d,t}$, and let $z_h^{e,t}$ be the employment variables with corresponding parameter vector $\gamma_k^{e,t}$. Furthermore, the second term at the RHS of equation (13) can be further decomposed into an average budget effect and a distributional effect. To investigate this the following decomposition is exploited:

$$\overline{\ln(x_h^t)} = \ln(x^t) - \Gamma^t, \quad (15)$$

with

$$\ln(x^t) = \ln\left(\frac{1}{H_t} \sum_h x_h^t\right) \quad \text{and} \quad \Gamma^t = \frac{1}{H_t} \sum_h \ln\left(\frac{x_h^t}{x^t}\right),$$

$$t \in \{1, 2\}.$$

The first term at the RHS of equation (15) is the log- average expenditures and the second term on the RHS is the well-known (negative of the) Theil inequality index, denoted by Γ^t , (Theil, 1967). Substituting equation (15) in (13) and decomposing household composition effects into demographic and employment effects yields:

$$\begin{aligned} P(w_k^2 - w_k^1) &= \hat{\gamma}_k^{d,1} (z^{d,2} - z^{d,1}) + \hat{\gamma}_k^{e,1} (z^{e,2} - z^{e,1}) \\ &\quad + \hat{\beta}_k^1 (\ln(x^2) - \ln(x^1)) + \hat{\beta}_k^1 (-\Gamma^2 + \Gamma^1) \\ &\quad + R_k^{2,1}, \quad k \in \{1, \dots, K\}. \end{aligned} \quad (16)$$

with

$$z^{d,t} = \frac{1}{H_t} \sum_h z_h^{d,t}, \quad z^{e,t} = \frac{1}{H_t} \sum_h z_h^{e,t}, \quad t \in \{1, 2\}.$$

Equation (16) shows that an increase in average expenditures, i.e. $\ln(x^2) > \ln(x^1)$, yields an increase (decrease) in the average budget shares of a luxury (a necessity or an inferior commodity). An increase in inequality, i.e. $\Gamma^2 > \Gamma^1$, yields a decrease (increase) in the average budget shares of a luxury (a necessity or an inferior commodity).

The decomposition as outlined above computes the effects of compositional changes using period l parameters. An alternative decomposition (as mentioned above) can be obtained by

using period 2 parameters and this may yield different results, depending on the change in the parameter estimates over time.

4 CURRENT VERSUS CONSTANT PRICES: THE PRICE EFFECTS

As mentioned in the introduction, a relative increase in the price of a commodity due to Baumol's cost disease yields an increase in the budget share holding constant the quantities demanded, i.e. Explanation (3) in Section 1. The unexplained part in equation (16), the residual $R_k^{2,1}$ (Equation (14)), includes effects due to (relative) price changes, hence the Price effects are in essence part of this residual.

One way of examining the Price effect is decomposing the changes in budget shares (equation (9)) into changes in quantities holding prices constant and changes in prices holding quantities constant. More formally, for any commodity k and a reference price vector \tilde{p} , this decomposition can be written as follows (using sample averages):

$$(17) \quad (w_k^2 - w_k^1) = (w_k^2 - \tilde{w}_k^2) + (\tilde{w}_k^2 - \tilde{w}_k^1) + (\tilde{w}_k^1 - w_k^1), \quad k \in \{1, \dots, K\}.$$

The second term at the RHS is due to quantity changes, holding prices constant. These changes may occur for different reasons, included in what has been called Explanations (1)-(2) and (4) in Section 1 (see also Section 3). The first and third terms at the RHS are the changes in the budget share due solely to price changes and holding quantities constant. The sum of these changes relates to Baumol's cost disease, i.e. Explanation (3).

The reference period of the price indices may be conveniently chosen to be either year 2 or year 1. If the reference year is equal to year 2 then the first term at the RHS is equal to zero, and if the reference period is year 1 then the third term at the RHS is equal to zero. In the latter case, for example, equation (17) becomes:

$$(18) \quad w_k^2 - w_k^1 = (w_k^2 - \tilde{w}_k^2) + (\tilde{w}_k^2 - \tilde{w}_k^1), \quad k \in \{1, \dots, K\},$$

since $\tilde{w}_k^1 = w_k^1$ if $\tilde{p}_k = p_k^1$. The first term at the RHS, i.e. $(w_k^2 - \tilde{w}_k^2)$, is the average change in commodity k 's budget share due to what in this study is referred to as the "Price effect". In this case, this is the change in the budget share in year 2 due to a change in the relative prices from year 1 to year 2 and holding quantities constant. Appendix B discusses also the situation when year 2 is chosen as reference period, as well as the importance of using household specific price indexes in the construction of the Price effect.

One way of integrating Baumol's explanation into the more formal analysis of Section 3 is to rewrite the residual $R_k^{2,1}$, equation (14), by subtracting and adding the budget share in year 2 in constant price, i.e. \tilde{w}_k^2 , and use $\hat{w}_k^2 = w_k^2$:

$$R_k^{2,1} = (w_k^2 - \tilde{w}_k^2) + \tilde{R}_k^{2,1}, \quad (19)$$

with

$$\tilde{R}_k^{2,1} = \left(\tilde{w}_k^2 - \hat{\alpha}_k^1 + \hat{\gamma}_k^1 z^2 + \hat{\beta}_k^1 \overline{\ln(x_h^2)} \right), \quad k \in \{1, \dots, K\}.$$

The first term at the RHS of equation (19) is the Price effect, Explanation (3), and the second term at the RHS is the new residual, consisting of preference changes, substitution effects and other unknown factors, i.e. Explanation (4). Table 2 summarizes the decomposition as formulated in equation (16) and the decomposition of equation (19).

Table 2: Overview of the decomposition based on equations (16) and (19).

Observed/Predicted Change	$P(w_k^2 - w_k^1)$
Explanation (1), Compositional Effects	
Demographics	$\hat{\gamma}_k^{d,1} (z^{d,2} - z^{d,1})$
Household Employment	$\hat{\gamma}_k^{e,1} (z^{e,2} - z^{e,1})$
Explanation (2), Budget Effect	
Average Budget	$\hat{\beta}_k^1 (\ln(x^2) - \ln(x^1))$
Distributional Aspect	$\hat{\beta}_k^1 (-\Gamma^2 + \Gamma^1)$
Explanation (3), Price effect	$(w_k^2 - \tilde{w}_k^2)$
Explanation (4), New Residual	$\tilde{R}_k^{2,1}$

As mentioned in Section 3 the decomposition can be done the other way around by calculating the compositional differences using parameter estimates of year 2. This also demands another reference period on which the Price effect is based, namely year 2 instead of year 1 (see Appendix B).

4.1 EXPECTED SIGN OF THE PRICE EFFECT

Equation (18) shows that if the reference period is year l then the Price effect in the share of commodity k for household h is given by $(w_{k,h}^2 - \tilde{w}_{k,h}^2)$. Appendix B (equation (B1)) shows that this can be written as:

$$(w_{k,h}^2 - \tilde{w}_{k,h}^2) = w_{k,h}^2 \left(1 - \frac{P_k^1}{P_k^2} \times P_h^{1,2} \right), \quad (20)$$

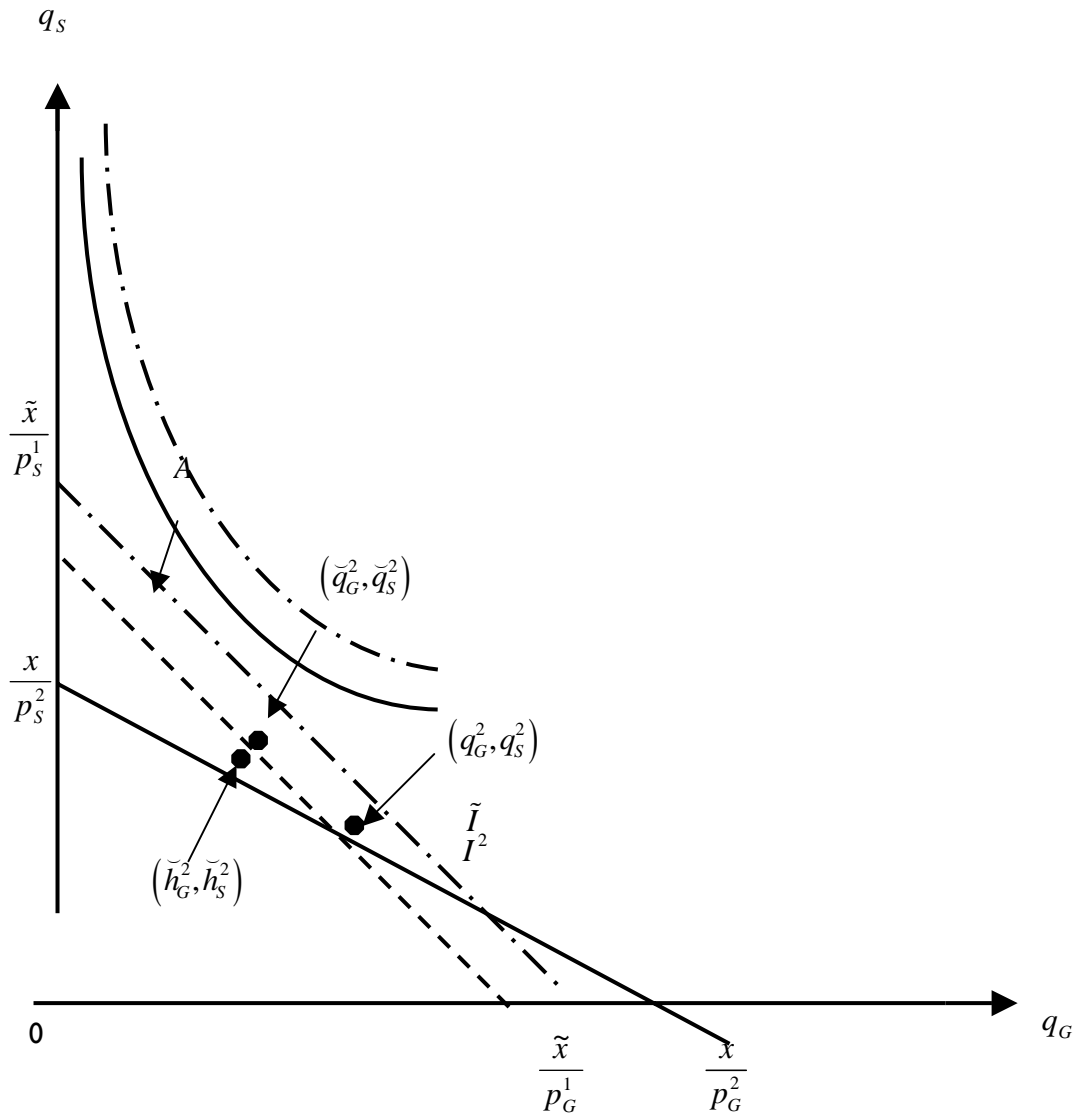
where $P_h^{1,2}$ is a Paasche price index between period l and period 2 for household h . What can be said of the sign of the Price effect at the individual and the aggregate level? Let s denote services as a whole. In all countries in this project, services have become relatively more expensive compared to goods over time. That is to say, for most households: $\frac{P_s^2}{P_s^1} > P_h^{1,2}$, hence $(w_{s,h}^2 - \tilde{w}_{s,h}^2) > 0$. As a consequence $(w_s^2 - \tilde{w}_s^2) > 0$, i.e. a positive Price effect for services (and, obviously, a negative one for goods as a whole).

4.2 SUBSTITUTION EFFECTS

For our decomposition, the idea of the Price effect is to calculate the difference between actual period 2 shares and what would have been bought if consumers faced period l relative price and had an income level that just enabled them to purchase the bundle of goods and services they bought in period 2. Let us denote these choices by \tilde{q}^2 , and the corresponding shares by \tilde{w}^2 . In our empirical application, because we do not calculate price effects, we do not know what this purchase decision would be, and so we approximate \tilde{q}^2 by the actual period 2 choices, and therefore approximate \tilde{w}^2 by w^2 . Thus our Price effect is only the “true” price effect under the assumption of inelastic demand. In general, we will not know the sign of $(\tilde{w}_k^2 - w_k^2)$ for each commodity k . But we can sign the differences for the two-commodity aggregation into goods and services, since we know that services have become relatively more expensive compared to goods from year l to year 2. This is illustrated in figure 2 below. The period 2-budget constraint is shown by the solid line, and the period 2 choices by (q_G^2, q_S^2) , achieving an indifference curve given by I^2 . The dash-dotted line shows the budget constraint when the period l relative prices are passed through the period 2 choices (in period l , services are relatively cheaper), so this

hypothetical budget, \tilde{x} , is given by $\tilde{x} = p_s^1 q_s^2 + p_G^1 q_G^2$. We can see that, with this budget, a rational consumer with the indifference curve I^2 illustrated in the figure will choose a new consumption bundle somewhere between (q_G^2, q_s^2) and point A, and will achieve a higher utility level. In our diagram, the new choices are illustrated by $(\tilde{q}_G^2, \tilde{q}_s^2)$ on indifference curve \tilde{I} . Only with indifference curves that are right angles (i.e. Leontief preferences) will there be no substitution. Thus we know that $\tilde{q}_s^2 \geq q_s^2$ and so $\tilde{w}_s^2 \geq \tilde{w}_s^2$. To calculate the Price effect, we could instead have asked what the consumers would have bought if they were compensated to keep them at their original period 2 utility level (Hicksian compensation), rather than to have been able to purchase their original period 2 consumption bundle (Slutsky compensation). The budget constraint for this counterfactual is illustrated by the dashed line, and the optimal choices by $(\tilde{h}_G^2, \tilde{h}_s^2)$. Let us denote the corresponding shares by $(\tilde{\omega}_G^2, \tilde{\omega}_s^2)$. The difference between $(\tilde{h}_G^2, \tilde{h}_s^2)$ and $(\tilde{q}_G^2, \tilde{q}_s^2)$ is simply an income effect. If (as we estimate them to be) services are a luxury and goods are a necessity, then we expect that $\tilde{\omega}_s^2 > \tilde{w}_s^2 \geq \tilde{w}_s^2$ and $\tilde{\omega}_G^2 < \tilde{w}_G^2 \leq \tilde{w}_G^2$. Hence, whichever counterfactual of the two we think is most appropriate in calculating the price effect (i.e. \tilde{w}^2 or $\tilde{\omega}^2$), our Price effect, which uses \tilde{w}^2 , will tend to be too large for services (i.e. $(w_s^2 - \tilde{w}_s^2) \geq (w_s^2 - \tilde{w}_s^2) > (w_s^2 - \tilde{\omega}_s^2)$) and the residual too small compared to what they would be if we could take the substitution effects out of the residual and put them into the Price effect. Naturally, the opposite is true for goods. A formal analysis of this concept is presented in the Appendix.

Figure 2: Price effects: an increase in the relative price of services over time.



5 US COUNTERFACTUALS

The observed difference in the average budget share in current prices between the U.S. and the country under investigation is:

$$(w_k^{US,t} - w_k^t) = \frac{1}{H_{t,US}} \sum_h w_{h,k}^{US,t} - \frac{1}{H_t} \sum_h w_{h,k}^t, \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (22)$$

The difference is readily available from the descriptive Tables. This Section outlines how to disentangle this difference into a part due to compositional differences and an unexplained part. For this purpose the parameter estimates of the empirical analysis are used (see Section 3).

The (average) predicted budget share is equal to the average observed budget share in the country sample being employed:

$$P(w_k^t) = \hat{\alpha}_k^t + \hat{\gamma}_k^{d,t} z^{d,t} + \hat{\gamma}_k^{e,t} z^{e,t} + \hat{\beta}_k^t \ln(x^t) - \hat{\beta}_k^t \Gamma^t \equiv w_k^t, \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (23)$$

Using the average characteristics of U.S. households, the estimates make it possible to predict the corresponding budget shares:

$$P(w_k^{US,t}) = \hat{\alpha}_k^t + \hat{\gamma}_k^{d,t} z_{US}^{d,t} + \hat{\gamma}_k^{e,t} z_{US}^{e,t} + \hat{\beta}_k^t \ln(x_{US}^t) - \hat{\beta}_k^t \Gamma_{US}^t, \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (24)$$

The predicted differences in year t can be written as:

$$P(w_k^{US,t} - w_k^t) = \hat{\gamma}_k^{d,t} (z_{US}^{d,t} - z^{d,t}) + \hat{\gamma}_k^{e,t} (z_{US}^{e,t} - z^{e,t}) + \hat{\beta}_k^t (\ln(x_{US}^t) - \ln(x^t)) + \hat{\beta}_k^t (-\Gamma_{US}^t + \Gamma^t) \quad t \in \{1,2\}, k \in \{1,\dots,K\}. \quad (24)$$

The first term at the RHS is the predicted difference due to demographic differences. The second term at the RHS is due to differences in the structure of employment. The third term at the RHS is due to differences in average expenditures and the fourth term is due to distributional differences. Table 3 summarizes these effects.

Table 3: Cross-country decomposition based on equation (24).

Observed difference in year t	$(w_k^{US,t} - w_k^t)$
Predicted differences	
Demographic differences	$\hat{\gamma}_k^{d,t} (z_{US}^{d,t} - z^{d,t})$
Employment differences	$\hat{\gamma}_k^{e,t} (z_{US}^{e,t} - z^{e,t})$
Budget difference, level	$\hat{\beta}_k^t (\ln(x_{US}^t) - \ln(x^t))$
Budget difference, distribution	$\hat{\beta}_k^t (-\Gamma_{US}^t + \Gamma^t)$
Unexplained differences	Residual/Remainder $(w_k^{US,t} - P(w_k^{US,t}))$

When doing the cross-country decomposition one needs to correct household total expenditures for purchasing power differences using PPP's. Also note that the unexplained part includes the difference in the Price effect between the two countries.

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APPENDIX A: EMPIRICAL ISSUES.

The commodities investigated in the empirical analysis are reported in Table A1. The budget of a household is defined as the sum over the expenditures on all non-durable goods and services. Table A2 reports on the explanatory variables used in the empirical analysis.

Table A1: Non-durable good and services

Non-Durable Goods	Services
1. Food and non-alcoholic beverages	9. Food and beverages away from home
2. Alcoholic beverages and tobacco	10. Holiday Services
3. Clothing and Footwear	11. Household Services
4. Private Transport Goods	12. Public Transport Services
5. Furnishing and Appliances	13. Private Transport Services
6. Home Energy	14. Communication Services
7. Entertainment Goods	15. Entertainment Services
8. Personal Goods	16. Personal Services
	17. Miscellaneous services

Table A2: Explanatory variables

Demographic variables
1. Ln(Household size)
2. Number of persons under 6 years of age divided by household size
3. Number of person over 5 and under 18 years of age divided by household size
4. Number of person over 17 and under 31 years of age divided by household size
5. Number of person over 30 and under 65 years of age divided by household size
6. Number of person over 64 years of age divided by household size
7. Age and Age squared of the head of household

Employment variables
1. Number of employed persons in the household
2. A dummy variable equal to 1 if all adults are employed, 0 otherwise
3. A dummy variable equal to 1 if all adults are employed and a person under 6 years of age is present in the household, 0 otherwise

APPENDIX B: BUDGET SHARES AT CONSTANT PRICES

The main issue addressed in this Appendix is how to express the budget shares observed in years 1 and 2 in constant prices. To begin with, the reference year is chosen to be year 1. The budget share of commodity k of household h in year 2 in year 1 prices, i.e. $\tilde{w}_{k,h}^2$, is computed follows:

$$\begin{aligned}
 \tilde{w}_{k,h}^2 &= \frac{p_k^1 q_{k,h}^2}{\sum_k p_k^1 q_{k,h}^2}, \\
 &= \frac{p_k^2 q_{k,h}^2}{\sum_k p_k^2 q_{k,h}^2} \times \frac{p_k^1}{p_k^2} \times \frac{\sum_k p_k^2 q_{k,h}^2}{\sum_k p_k^1 q_{k,h}^2}, \\
 &= w_{k,h}^2 \times \frac{p_k^1}{p_k^2} \times P_h^{1,2},
 \end{aligned}$$

(B1)

where $P_h^{1,2}$ is a Paasche price index between period 1 and period 2 for household h , which uses the quantities purchased in period 2 as the base:

$$P_h^{1,2} = \frac{\sum_k p_k^2 q_{k,h}^2}{\sum_k p_k^1 q_{k,h}^2} \equiv \frac{x_h^2}{\tilde{x}_h^2}.$$

(B2)

Note that the sum of all budget shares at constant prices is equal to one for every household:

$$\begin{aligned}
 \sum_k \tilde{w}_{k,h}^2 &= \sum_k w_{k,h}^2 \times \frac{p_k^1}{p_k^2} \times P_h^{1,2} = P_h^{1,2} \left(\sum_k \frac{p_k^2 q_{k,h}^2}{\sum_k p_k^2 q_{k,h}^2} \times \frac{p_k^1}{p_k^2} \right), \\
 &= P_h^{1,2} \left(\sum_k \frac{p_k^1 q_{k,h}^2}{\sum_k p_k^2 q_{k,h}^2} \right) = P_h^{1,2} \left(\frac{\sum_k p_k^1 q_{k,h}^2}{\sum_k p_k^2 q_{k,h}^2} \right) = P_h^{1,2} \left(\frac{1}{P_h^{1,2}} \right) = 1.
 \end{aligned}$$

(B3)

This makes it clear why a household specific price index must be used to deflate period t expenditure. If, instead, some kind of household average price index is chosen in equation (B1),

for example a published retail price index, call it $R^{1,2}$, then instead of the equality of (B3) one would have:

$$\sum_k \tilde{w}_{k,h}^2 = R^{1,2} \left(\frac{1}{P_h^{1,2}} \right). \quad (\text{B4})$$

Notice that, in general, the household specific Paasche price index will be different from the published retail price index for the population as a whole. Therefore, the sum of household h 's budget shares in constant prices over all commodities in equation (B4) will not equal one. Also it is unlikely that the sample average shares would add to one.

Section 4 shows that if the reference year is chosen to be year 1, the Price effect in the share of commodity k for household h is given by $(w_{k,h}^2 - \tilde{w}_{k,h}^2)$. Using equation (B1), this can be written as:

$$(w_{k,h}^2 - \tilde{w}_{k,h}^2) = w_{k,h}^2 \left(1 - \frac{p_k^1}{p_k^2} \times P_h^{1,2} \right). \quad (\text{B5})$$

An Equivalent Decomposition

As pointed out in Section 4, reference prices can be also taken to be prices in year 2. In this case, year 1 budget shares in year 2 prices, say $\tilde{w}_{k,h}^1$, can be now calculated in the following way:

$$\begin{aligned} \tilde{w}_{k,h}^1 &= \frac{p_k^2 q_{k,h}^1}{\sum_k p_k^2 q_{k,h}^1} = \frac{p_k^1 q_{k,h}^1}{\sum_k p_k^1 q_{k,h}^1} \frac{p_k^2}{p_k^1} \frac{\sum_k p_k^1 q_{k,h}^1}{\sum_k p_k^2 q_{k,h}^1}, \\ &, = w_{k,h}^1 \times \frac{p_k^2}{p_k^1} \times \frac{1}{L_h^{1,2}}, \end{aligned} \quad (\text{B6})$$

where $L_h^{1,2}$ is a Laspeyres price index between period 1 and period 2 for household h , which uses the quantities purchased in the first period as the base:

$$L_h^{1,2} = \frac{\sum_k p_k^2 q_{k,h}^1}{\sum_k p_k^1 q_{k,h}^1} = \frac{\tilde{x}_h^1}{x_h^1}.$$

Now the Price effect is equal to:

$$\left(\tilde{w}_{k,h}^1 - w_{k,h}^1 \right) = w_{k,h}^1 \left(\frac{p_k^2}{p_k^1} \times \frac{1}{L_h^{1,2}} - 1 \right)$$

(B7)

Again, similarly to the reasoning as in Section 3, if $p_k^2 > p_k^1$ one expects a positive Price effect. However, there is no reason why (B5) and (B7) should produce the same Price effect. In fact, it is easily shown that the discrepancy between (B5) and (B7) depends on the ratio of quantities in the two periods: the larger the increase in quantities the larger the discrepancy between (B5) and (B7).

APPENDIX C: THE ALMOST IDEAL DEMAND SYSTEM

This Appendix reviews the economic theory underlying the analysis of expenditure patterns of households in the mainstream economic literature, and outlines the Almost Ideal Demand System (Deaton and Muellbauer, 1980b) that is the basis for our empirical investigation.

Household preferences over consumer goods are represented by the household utility function $U(q,z)$, where q is a bundle of quantities of the different commodities and z is a vector of household characteristics. For example, household composition, say the number of children, may affect preferences for certain consumer goods, hence the allocation of household total expenditures (the budget) to consumer goods. The household is assumed to choose a commodity bundle so that household utility is maximised, hereby taking into account the households budget constraint. This can be formalised as follows:

$$\underset{q}{Max} U(q; z) \quad s.t. \quad x = \sum_k p_k q_k ,$$

(C1)

where p_k is the price of good k , q_k is the quantity of good k and x is the budget allocated to consumption (i.e. household total expenditures). The solution to optimisation problem (C1) is described by a complete demand system. Savings behaviour of households can be modelled in a lifecycle framework. It can be shown that an intertemporal additive utility function allows for two-stage budgeting (Blundell and Walker, 1986). In the first stage of the budgeting process, the household derives total (non-durable) consumption at time t by allocating lifetime income to

different periods. In the second stage of the two-stage budgeting process, the household allocates household expenditure within a period to the different consumer goods (e.g. food and clothing). This second stage can be described by optimisation problem (C1).

The demand system can be also derived by solving the dual problem of cost minimisation (Deaton and Muellbauer, 1980):

$$\begin{aligned} \text{Min} \sum_k p_k q_k \equiv x & \quad \text{s.t.} \quad U(q; z) = u. \\ \text{(C2)} \end{aligned}$$

This approach does not require a full specification of the household utility function and the resulting demand equations are consistent with the maximisation problem as formulated in (C1). It does, however, require a full specification of the cost function.

The relationship between total household expenditures and expenditures on a certain good is commonly referred to as the Engel curve. A popular empirical specification of the Engel curve relates the budget share to the logarithm of total household expenditures. A cost function that gives rise to such an Engel curve is given by (Deaton and Muellbauer, 1980):

$$\begin{aligned} \ln(c(u, p; z)) = \ln(a(p; z)) + u \times b(p), \\ \text{(C3)} \end{aligned}$$

where u is the level of utility and $a(p; z)$ and $b(p)$ are function of prices and household characteristics. The resulting budget share equation is then of the following form:

$$\begin{aligned} w_k = \frac{\partial \ln(c(u, p; z))}{\partial \ln p_k} = \frac{\partial \ln(a(p; z))}{\partial \ln p_k} + \frac{\partial \ln(b(p; z))}{\partial \ln p_k} \times \ln\left(\frac{x}{a(p; z)}\right), \\ \text{(C4)} \end{aligned}$$

with

$$w_k = \frac{p_k q_k}{x}.$$

(C5)

As discussed in the main text, insufficient price variation precludes the estimating of a fully specified model. The approach taken for this project is that a reduced form in line with equation (C4) is chosen as the basis for the empirical analysis, i.e. equation (10) of Section 3, in which the budget share depends on household characteristics and the Engel curve is linear in the logarithm of total household expenditures. The reduced form parameters are allowed to vary over time.

Empirical limitations

Equation (C4) is the basis of our empirical analysis. Several comments concerning this model can be made and some of them will be addressed in the empirical papers:

- Within a period all households are assumed to face the same prices. The fact that there are only two or three time periods of available data prevents us from estimating price and cross-price elasticities.
- An empirical complication embedded in this theoretical framework is that it only allows for non-durable consumption. Hence, the empirical analysis is carried out on non-durable goods and services only.
- Leisure time of household members is not observed. Hence, this commodity is not explicitly modelled. The effects of household employment on the allocation of household expenditure are investigated by conditioning the Engel curve system on household employment. This at least allows the distribution of the budget over the consumer goods to be non-separable from household employment (Browning and Meghir, 1991).
- The fact that zero-expenditures are observed for many of the non-durable goods is largely ignored. However, using an IV estimator takes into account the possible endogeneity of household total expenditures in the budget share equation due to, for instance, infrequency of purchases.
- Equation (C4) assumes a linear relationship between the budget share and the logarithm of expenditures. For several goods such as alcohol and tobacco this may not be in line with the observed relationship in the data (e.g. Banks, Blundell and Lewbel, 1997). To allow for a more flexible relationship between household characteristics, total expenditures and budget shares, the Quadratic Almost Ideal Demand System (QUAIDS) has been proposed by Blundell, Pashardes and Weber (1993). This model includes a non-linear relationship between the budget shares and the logarithm of household expenditures, as well as interaction terms between household characteristics and the logarithm of household expenditures.

APPENDIX D: A FORMAL ANALYSIS

A more formal derivation within consumer demand theory of the compensated and uncompensated price effects may improve the understanding of the identified Price effects (Explanation (3), Section 1) as discussed in Section 4.2. The uncompensated effect of a change in

the price of commodity l on the demand for commodity k can be formalised as follows: $\frac{\partial g_k}{\partial p_l}$,

where g_k denotes Marshallian demand (in quantities). As above in Section 4.2, compensated or

Hicksian demand is denoted by h_k . The Slutsky equation is given by $\frac{\partial h_k}{\partial p_l} = \frac{\partial g_k}{\partial x} q_l + \frac{\partial g_k}{\partial p_l}$. Using

the Slutsky equation the change in the budget share of commodity k due to a relative change in the price of commodity l is given by:

$$\frac{\partial \left(\frac{g_k P_k}{x} \right)}{\partial p_l} p_l = \frac{g_k P_l}{x} I(k=l) - \frac{g_k P_k}{x} \frac{g_l P_l}{x} \left(\frac{\partial g_k}{\partial x} \frac{x}{g_k} \right) + \left(\frac{P_k P_l}{x} \frac{\partial h_k}{\partial p_l} \right),$$

(D1)

where:
$$I(k=l) = \begin{cases} 0 & \text{if } k \neq l \\ 1 & \text{if } k = l \end{cases}$$

(D2)

$$k, l \in \{1, \dots, K\}$$

Using, as above, the notation w_k for the (Marshallian) budget share of commodity k and ε_k for the budget elasticity of commodity k , this equation is written as:

$$\frac{\partial w_k}{\partial p_l} \times p_l = w_k I(k=l) - w_k w_l \varepsilon_k + \left(\frac{P_k P_l}{x} \frac{\partial h_k}{\partial p_l} \right), \quad k, l \in \{1, \dots, K\}$$

(D3)

The budget elasticity is identified from estimating the Engel curve (Section 3.3). The left hand side of equation (D3) is the uncompensated price effect of the budget share of commodity k with respect to a price change in commodity l . The first term at the RHS of equation (D3) is essentially the Price effect as formulated in Section 4, i.e. an $x\%$ change in the price of commodity k results in an $x\%$ -point change in the budget share of this commodity, hence keeping quantity demanded constant. This only holds in the case of no income and substitution

effects, i.e. when the second and third terms at the RHS of equation (D3) are equal to zero. The second term on the RHS of equation (D3) is the income effect of a change in price of commodity l on the budget share. Given the shares add up to one and only relative prices are observed, the sum over the income effects of all price changes adds up to zero. The third term are the price substitution effects and are not identified in this study due to a lack of price variation in the data (see Section 3.1).

Denote the change in the relative price of commodity k as Δp_k with $\sum_k w_k \Delta p_k = 0$.

Now the total effect on the budget of commodity k of a change in relative prices is:

$$\begin{aligned}
 \Delta w_k &= \sum_l \frac{\partial w_k}{\partial p_l} \times p_l \times \Delta p_l \\
 , &= \sum_l (w_k I(k=l) \times \Delta p_l) - \sum_l (w_k w_l \varepsilon_k \times \Delta p_l) + \sum_l \left(\left(\frac{p_k p_l}{x} \frac{\partial h_k}{\partial p_l} \right) \times \Delta p_l \right) \\
 , &= w_k \Delta p_k - w_k \varepsilon_k \sum_l (w_l \Delta p_l) + \sum_l \left(\left(\frac{p_k p_l}{x} \frac{\partial h_k}{\partial p_l} \right) \times \Delta p_l \right) \\
 &\quad \text{(D4)}
 \end{aligned}$$

The second term at the RHS is zero, by definition.

$$\begin{aligned}
 , &= w_k \Delta p_k + \sum_l \left(\left(\frac{p_k p_l}{x} \frac{\partial h_k}{\partial p_l} \right) \times \Delta p_l \right) \\
 &\quad \text{(D5)}
 \end{aligned}$$

The first term at the RHS is the Price effect. The Second term at the RHS is a substitution effect.

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DEMPATEM in Perspective. State of the Art in the Analysis of Structural Changes.

Book in preparation:

The US-European gaps in Demand and Employment

Wiemer Salverda and Ronald Schettkat, ed.

Working Papers: (See list below)

LIST OF WORKING PAPERS

Working papers are downloadable at <http://www.uva-aias.net/lower.asp?id=194>

1. **John Schmitt**, Estimating Household Consumption Expenditures in the United States using the Interview and Diary Portions of the 1980, 1990, and 1997 Consumer Expenditure Surveys
2. **Laura Blow**, Household Expenditures Patterns in the UK
3. **Adriaan Kalwij & Wiemer Salverda**, Changing Household Demand Patterns in the Netherlands: Some Explanations
4. **Javier Ruiz-Castillo & María José Luengo-Prado**, Demand Patterns in Spain
5. **Marijke van Deelen & Ronald Schettkat**, Household Demand Patterns in West Germany: 1978-1993*
6. **Francois Gardes & Christophe Starzec**, Household Demand Patterns in France 1980-1995
7. **Francois Gardes & Christophe Starzec**, Income Effects on Services Expenditures
8. **Adriaan Kalwij & Steve Machin**, Changes in Household Demand Patterns: A Cross-Country Comparison
9. **Laura Blow, Adriaan Kalwij & Javier Ruiz-Castillo**, Methodological issues on the analysis of consumer demand patterns over time and across countries
10. **Mary Gregory & Giovanni Russo**, The Employment Impact of Differences in Demand and Production Structures
11. **Ronald Schettkat (Research Assistance: Joep Damen)** Demand Patterns and Employment Structures, An Aggregate Analysis
12. **Andrew Glyn, Wiemer Salverda, Joachim Möller, John Schmitt, Michel Sollogoub** Employment differences in services the role of wages, productivity and demand
13. **Ronald Schettkat & Wiemer Salverda**, Demand Patterns and Employment Growth Consumption and Services in France, Germany, the Netherlands, the United Kingdom and the United States Concluding Summary