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by

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BEYOND ENGEL'S LAW - PURSUING AN ENGELIAN APPROACH TO WELFARE A CROSS COUNTRY ANALYSIS*

Wolfhard Kaus[‡]

Abstract

Engel's law is known to be extraordinarily consistent across time and space. Accordingly, it has been widely used to determine poverty. However, also among the poorest, a certain amount of non food spending is necessary. To substantiate the distinction between necessities and luxuries, already Ernst Engel (1895) approached a behaviorally founded comprehensive assessment of structural changes in consumer expenditures.

To build upon Engel's legacy and to complement the scarce empirical literature, a behavioral approach is applied. It is conjectured that differences in satiation patterns of universally shared needs translate, on the aggregate level, into different shapes of Engel curves and thus also into different income elasticities of demand.

Utilizing a nonparametric regression technique, it is explored whether and which expenditure categories change systematically with rising income. In line with the theoretical expectations, a number of empirical regularities in consumer expenditure patterns can be identified that go well beyond Engel's law.

Keywords: Engel's law, income elasticity of demand, necessities, luxuries, differential satiation

JEL classification: D12

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1 Introduction

Since the work of Ernst Engel it is a well established fact that the expenditure share dedicated to food consumption decreases as income rises. Using a sample of only 199 Belgian family budgets, Ernst Engel (1857, 1895) inferred the observed negative relationship between the expenditure share on food and income to be an economic law. Despite the meager data base available to Engel at this time, this relationship turned out to hold true in most countries and points in time (Houthakker, 1957; Seale and Regmi, 2006; Lewbel, 2008).

The extraordinary consistency across time and space and the predictive character of the relationship led to the use of Engel's law to determine absolute household poverty (see, e.g., Musgrove, 1985) and to define poverty lines (see, e.g., Lanjouw and Lanjouw, 2001, and other references therein). More recently, Engel's law is even used to correct purchasing power parities (Almås, 2012). Although Engel's law is an essential nonmonetary determinant when distinguishing between poverty and wealth, it covers only one decreasing fraction of consumer expenditure as income rises. In contrast, empirical evidence on systematic changes in other consumer expenditure categories is hardly used. A systematic assessment of structural changes in consumer expenditure categories as income rises should, however, allow for a more complete and multidimensional assessment of wealth.

In fact, final per capita poverty lines usually consist of a food poverty line covering an "adequate" energy intake and a certain amount of non food spending that is considered necessary (Lanjouw and Lanjouw, 2001). While the former can be derived by the human body's need for calories, the latter is usually derived by scaling up the former by a certain factor. Determining necessary non food spending reflects the insight that even at very low levels of income some items other than food are essential. The arbitrariness of the choice of the scalar (Deaton, 1997), however, mirrors a still missing comprehension of why and which consumption items are necessities and which are not. As a result, the size of the scalar needs to be chosen ad-hoc. Both theoretical conjectures and empirical evidence on other systematic changes in the composition of consumer expenditures remain scarce. In this paper it is argued that the current state of the art suffers from a missing behavioral foundation for the distinction between necessities and luxuries.

The lack of such an assessment is even more remarkable as Ernst Engel already pursued a much more encompassing approach. In fact, his approach to consumption expenditures was never intended to focus solely on the budget share for food. Engel's original work was indeed an inquiry into the structural changes of consumption patterns with rising income, aiming at determining a measure of household welfare (Chai and Moneta, 2010). Therefore, he started out by categorizing expenditure items according to the underlying "wants" they satisfy. In a second step, he assessed the importance of these wants from the empirically derived expenditure patterns. In this sense, Engel was not only the first to empirically assess the distinction between "necessities" and "luxuries" (instead of subjectively assuming) but also the first to attempt a behavioral explanation for this taxonomy.

Building upon Engel's legacy requires to better found the assumption about the classification of needs by enriching it with current scientific knowledge on the nature of consumer needs and *how* they are satisfied. Therefore, this paper offers a motivational approach to consumer behavior, which allows to formulate expectations about structural changes of expenditure shares as income rises. The theory distinguishes between innate needs on the one hand and both wants and cognitively constructed motives that are acquired in culturally contingent ways on the other hand (Witt, 2001). To the extent to which consumption is driven by innate needs, it can be expected that the common genetic basis induces patterns of behavior that are universally shared by humans. This means that consumer expenditure patterns should change inter-personally and inter-culturally similarly with income.

Engel's law for expenditures on food – for which a fairly rapidly satiable innate need can be identified – is a case in point. For other expenditure categories, the theory identifies other innate needs as driving forces and, corresponding to their differing satiation features, predicts different shapes for the respective Engel curves. The corresponding consumption categories can be qualified accordingly as either necessities or luxuries.

In order to assess the evidence for the suggested human universals, the paper presents an empirical analysis of observable changes in consumption patterns across countries and time. Using the United Nations National Account Statistics, a data set that contains individual consumption expenditure by households in 12 categories for more than 50 countries over up to 50 years is specified. The data at hand allows to

- a) explicitly describe the overall changes in consumption patterns with rising income in real terms (cross-country Engel curves),
- b) assess the consistency of the identified changes in consumption patterns relative to the well known Engel's law.

Our findings broadly confirm the conjecture that the shape of Engel curves (inclusive of, but extending beyond, Engel's law) represent human universals. The study contributes to the literature on income and wealth by a structural assessment of general changes in budget shares across countries that helps to broaden our understanding of the behavioral foundations of the necessity – luxury taxonomy. In doing so, it broadens the scope for a more encompassing and multidimensional consumption based assessment of wealth.

The paper is structured as follows. Section 2 outlines the theoretical framework. In section 3 the creation of a comparable income dimension is described. The empirical results on cross-country Engel curves are shown in section 4. The last section concludes.

2 What determines the shape of Engel curves?

This section applies a behavioral approach to consumption to connect differences in satiation patterns between innate needs with systematic changes in consumption expenditures when income rises. It is conjectured that, at the level of aggregate expenditure data, these differences translate into different income elasticities of demand for groups of goods and services that are likely to be consumed to serve those needs. This way, it should be able to explain a good deal of the differences in the shapes of Engel curves of the underlying goods and services.

2.1 Engel curves and the income elasticity of demand

The general connection between the shape of an Engel curve and the income elasticity of the respective good can easily be illustrated. If an Engel curve for good i is expressed in terms of the expenditures q_i spent on i depending on the households' income y , the slope of the fitted relationship $\partial q_i / \partial y$ can indirectly be used to derive i 's income elasticity of demand. As a good's income elasticity is defined by the relative change in q_i ($\Delta q_i / q_i$) divided by the relative change in y ($\Delta y / y$), it can be estimated by regressing logged q_i on logged y (Lewbel, 2008).

Using expenditure shares ($w_i = q_i / y$), instead of the expenditures spent on i , allows more directly an inference of the income elasticity of demand from the curve's slope. A reformulation of the basic equation, to be derived in section 4.2, shows that downward sloping Engel curves indicate income elasticities smaller than 1 ("necessities"), while upward sloping Engel curves yield income elasticities above 1 ("luxuries"). Although Engel curves usually show considerable nonlinearities (Lewbel, 2008), budget share Engel curves

allow to readily observe the income elasticity of demand for the underlying group of goods and services.

2.2 A motivational approach to consumer behavior

Engel's approach to consumption never solely focused on food expenditures. In fact, Engel's original contribution was meant to determine and measure household welfare (Chai and Moneta, 2010). He started out by categorizing expenditure items according to the underlying "wants" they satisfy. The importance of these wants was subsequently assessed by the empirically derived expenditure patterns. Engel's work thus essentially focused on a behavioral foundation of the necessity – luxury taxonomy. In a revised version of his original contribution, Engel (1895, p.8) made even more explicit that the motivation of human action, and thus also consumption behavior, is rooted in the satisfaction of universally shared needs (Chai and Moneta, 2010).

To build upon Engel's legacy, it is necessary to better found the classification of needs by enriching it with current scientific knowledge on the nature of consumer needs and *how* they are satisfied. However, motivational underpinnings of economic behavior in general and consumer behavior in particular are rarely addressed in economics. Among the existing works, two different explanatory approaches can be identified (Witt, 2010a). While in the utilitarian hedonic approach (Kahneman et al., 1997) the explanation refers to the motives of seeking pleasure and avoiding pain, nonhedonistic variants instead focus on the motivating power that deprived needs and wants have for consumption activities (see, e.g., Menger, 1871; Duesenberry, 1949; Georgescu-Roegen, 1954; Ironmonger, 1972).¹

This paper closely connects to the latter approach. A behavioral – need based – interpretation of the consumption motivation is offered (Witt, 2001, 2010b) to explain the theoretically scarcely substantiated shape of Engel curves. The theory postulates an intimate relationship between human biological and cultural evolution in the sense that cultural development is based upon as well as constrained by innate behavioral dispositions and cognitive learning abilities, which have emerged during human phylogeny. Hence, the theory focuses on the explanation of long-run economic change from a biological and psychological perspective (Witt, 2008).

The theory of the learning consumer (Witt, 2001, 2010b) emphasizes the role of human needs as ultimate motives of consumption behavior. The theory distinguishes between genetically determined – innate – needs and both culture and socialization specific acquired wants that result from processes of conditioning learning (classical, operant, and social-cognitive). The theory holds that the attempt to relieve or reduce of deprivation of the limited number of innate needs, consequently an increase in satiation level of these needs, is one major motivation to consume. Deprivation is thus seen to intrinsically motivate consumers to act which creates a rewarding experience.

Needs are the contingencies under which deprivation occurs. Although needs can be manifold, in this context only the subset of universally shared "basic" needs is relevant. Among these are that for sleep, for something to drink, for something to eat, for maintaining body temperature, for physical activity, for status recognition, or for sensory arousal (Witt, 2011).

An important characteristic of these needs is that their satisfaction by an action effects a primary reinforcement in the sense of instrumental or operant conditioning (Hull, 1943; Herrnstein, 1990; Staddon and Cerutti, 2003). This means that, unless the motivation to act is modified by insetting cognitive reflection, the likelihood that a particular activity

¹In behavioral and human sciences, research on motivational theories continued and extended to focus on biological and evolutionary roots of behavior (Wilson, 1975; Caplan, 1978), which draws attention to inter-personal commonalities that can be conjectured to be relevant also for consumer behavior.

is chosen over another one depends on its relative contribution to reducing deprivation. Under reinforcement learning, the frequency distribution over actions converges to a state satisfying the so called “matching law” (Herrnstein, 1997).

Among the universally shared needs, a further distinction relates to the satiating characteristics they show (Witt, 2010b, 2011). On the one hand, there are basic needs which follow homeostatic features, i.e., deprivation can be reduced relatively easily up to the temporary satiation point once rising income allows to sufficiently increase the corresponding consumption expenditures per period of time. The motivation to consume is, then, temporarily reduced or removed. Satisfaction of these needs depends mainly on the intrinsic value of the corresponding goods and services. Examples are the homeostatic needs underlying eating, drinking, sleeping, and maintenance of body temperature. On the other hand, there are also basic needs where homeostatic features are absent and where it is therefore difficult, if not impossible, to reduce the average deprivation to zero. Typically, these are needs whose satiation level is defined in relative terms, like the need for arousal and for social recognition.

Despite inter-personal sources of variance, which can be expected due to individual cognitive and conditioning learning processes, it can be conjectured that shared innate needs exert some systematic effects on behavior that are visible at the level of the population means, i.e., at the level of aggregate consumer expenditures. As needs differ with respect to the amount of spending that is necessary to reach satiation, this difference can be expected to become relevant with rising real income (Witt, 2010b, 2011). Being able to spend more, consumers should be able to approach the satiation level of some needs faster than the satiation level of other needs. Their consumption motivation is not equally upheld and their spending should thus not expand equally. Differences for the income elasticity of demand for the products that serve the different needs should express this *differential satiation* effect.

Taken together, the behavioral approach to consumption suggests connecting the differences in satiation patterns between innate needs with systematic changes in consumption expenditures when income rises. It is conjectured that, at the level of aggregate expenditure data, these differences translate into different income elasticities of demand for products or groups of goods and services that are likely to be consumed to serve those needs. The behavioral approach to consumption should thus be able to explain a good deal of the differences in the shapes of Engel curves and thus in the income elasticities of the underlying goods and services.

2.3 Applying the theoretical framework

Before hypotheses on the shape of Engel curves can be derived, some attention should be given to the empirical framework. As this paper, on the one hand, aims at inquiring into the generality of Engel curves across countries and, on the other hand, attempts to explain the difference in shapes by universally shared human dispositions, it is necessary to depart from the usual Engel curve framework that plots cross sectional expenditure survey data in one region at a particular point in time on corresponding income or total expenditure data.

In order to derive a more general picture, it is rather desirable to use an empirical framework that allows exploring changes in consumption patterns within and across countries with different levels of income over time. Applying such a framework, however, necessarily entails some flaws. First, it is obvious that an increase in the number of countries and observations across time will challenge the comparability of the expenditure items. Finding comparable expenditure categories is a natural task that will irrevocably lead to a higher level of aggregation. Dealing with various countries over a range of time

moreover involves converting the relevant variables into a common denominator.²

2.3.1 The expenditure categories

The expenditure categories used in this paper are drawn from the United Nations National Accounts Statistics. Since 1956, the United Nations have annually published the *National Accounts Statistics: Main Aggregates and Detailed Tables*.³ The series superseded ten issues of the *Statistics of National Income and Expenditure*. For the purpose of this analysis, Table III.2, i.e., *Individual consumption expenditures*, is used.

Data availability is restricted to member countries of the United Nations and some other countries or areas which report to the United Nations. However, only after joining the *United Nations*, all members are required to report such statistics based on common standards. The sample used in this paper can be found in Table A2 in the appendix. It is restricted to data that complies with the *System of National Accounts 1993* standards (SNA 93).⁴ To the best of the author's knowledge, this is the most valuable source that allows an exploration of structural changes of consumption patterns as income rises in a long term cross-country framework.⁵

As mentioned before, the long term cross-country framework is necessarily accompanied by aggregation of the expenditure categories. In fact, this is the case with the national account statistic data. A big advantage, however, is that the twelve categories (cf. Table A1) are consistently defined for all observations. The data is categorized according to the UN Statistics Division's Classification of Individual Consumption According to Purpose (COICOP).

2.3.2 Connecting innate needs and expenditure categories

When connecting differences in satiation patterns of innate needs with systematic changes in consumption expenditures as income rises, two conceptual problems have to be mentioned first. The one is the problem of determining what expenditures serve what need so that the predicted satiation features of the needs can be translated into predictions about changing consumption expenditure. The second is the aggregation problem. The reactions to increasing satiation explained at the individual consumer level have to be aggregated to the level of aggregate consumption expenditure data, at which structural changes in both consumption and market shares are usually recorded (Witt, 2010a).

The second problem is of a more general nature and lies in micro-founded theories of consumption. The present approach provides a natural solution with the assumption of innate, need-based consumption motives and the corresponding satiation patterns. Since these individual features are shared with the usual genetic variance in human populations, an aggregate level – of the human population – is already implied.

The first problem of associating goods and services with particular needs is more critical as products usually have several characteristics and the different characteristics can appeal to different needs at the same time. Accordingly, the consumption of a particular good can be motivated in multiple ways. If so, it is more difficult, but not impossible, to merge

²For a discussion, please see section 3.

³The data is freely available from the *National Accounts Official Country Data* account of the United Nations.

⁴Data which is only available according to SNA 68 standards is omitted from the analysis to maintain a comparable frame of analysis.

⁵Especially among the currently less affluent countries, there is hardly any, let alone long term, data available. A valuable exception is India, where consumer expenditure surveys have been collected for more than 60 years by now.

the differing satiation patterns into a compound prediction for the satiation dynamics that occur with rising income.

As already mentioned above, a certain set of needs could be identified of which some belong to rather physiological needs that follow homeostatic satiation features and are relatively easy to satiate, while other needs are rather psychological needs that show dynamic nonhomeostatic satiation features which are less easily, if at all, satiable.

Hypotheses on easily satiable needs

In the case of physiological needs, the homeostatic features imply that the motivation for taking actions decreases the closer to the satiation level of the need the consumer gets. The motivation to expand consumption further is then reduced or vanishes such that consumption stagnates, if nothing else happens. As consumption expenditures grow with rising disposable income, satiability of needs results in a saturated demand for corresponding goods.

A very plausible example for an easily satiable need is *food* consumption. Satiation in this case depends on the satiating characteristics of the items consumed such as caloric or caffeine content. Demand is thus naturally constrained by an upper quantity bound that is the absorbing capacity of the human body. On the aggregate level, this effect should allow a decrease of the proportion spent on food with rising income (Witt, 2011).

Another example is the expenditure category of *clothing*. The underlying innate need that is satisfied by the use of clothing and footwear is the maintenance of body temperature. As everybody can only wear a limited number of items at a time, the purely functional demand for *clothing* should be easily saturated once rising disposable income allows this. However, this category is also a prime example for one of the conceptual limitations alluded to above, namely that different characteristics of a particular good can appeal to different needs at the same time. Consumption of clothing and footwear is, of course, not only motivated by the desire to maintain body temperature. The presence of other, more cognitively mediated motivations, such as group affiliation or status recognition, cannot be denied.

In a time series analysis of the U.S., Frenzel Baudisch (2006) shows that the demand for footwear mainly followed basic functional uses up to the beginning of the 1970s. In fact, the expenditure share on footwear was steadily decreasing and thus a “necessity” up to this time. Frenzel Baudisch (2006) is able to show that the subsequent increase in the expenditure share for footwear, albeit relatively small at the aggregate level, was driven by the producer’s reaction to the saturated demand for footwear. Producers increasingly released functionally differentiated product innovations and added new characteristics (cognitively mediated motives) to their products to escape functional satiation. These supply side strategies also gave rise to social comparison and group dynamics that led to a decoupling of the item’s consumption and the initial purely instrumental use (maintenance of body temperature).

Despite the fact that multiple motivations to consume items in the *clothing* category might prevail, the example is suitable to illustrate that, the satisfaction of the universally shared needs for maintaining body temperature and the avoidance of bodily harm can still be expected to explain the main structural pattern in the budget share Engel curve before purely functional satiation occurs, i.e., supply side driven reactions to escape saturated markets set in. It is therefore suggested that, as long as income is low to moderate, the budget share Engel curve for *clothing* should be downward sloping.

Hypotheses on hardly satiable needs

In the case of psychological needs that lack homeostatic features, the motivation to expand consumption, once increasing income allows it, is not easily withheld and, thus, will not lead to a stagnating demand. Therefore, the budget share on expenditure categories that can be related to satisfying such needs are expected to increase once the satisfaction of easily satiable needs and increases of income allow for this.

An illustrative example is the need for sensory and cognitive arousal (Witt, 2011). As already argued by Scitovsky (1981), satisfaction can hardly be achieved, as the arousal drawn from what is currently consumed is subject to a stupefaction effect. Satiability is thus endogenously changing, such that ever stronger stimuli are needed to uphold arousal. Although related expenditures grow, the average deprivation level is hardly decreasing. The insatiability of the need for sensory and cognitive arousal should empirically be reflected at least in the various expenditures related to entertainment (e.g., electronic equipment, ballet, art, theater, sporting events, and the like) and media services. Another vivid expenditure category motivated by the need for arousal is recreational traveling (Chai, 2011). As these items broadly match the expenditure categories *recreation & culture* and *restaurants & hotels*, it is conjectured that upward sloping Engel curves can be expected.

In the case of status recognition, insatiability results from the relative nature of this kind of expenditures. Certain consumption items that are suitable to signal status allow the distinction of oneself from others. However, the strength of this signal diminishes if rising income allows individuals from lower income groups to purchase similar items. To restore the status quo ante, more intense status signals are required. However, additional expenditures are repeatedly neutralized by expenditures of others such that deprivation of status can, if at all, only be avoided by continuously rising expenditures (Witt, 2011). The instability of status races that leads to rising expenditures on status goods has repeatedly been illustrated by Hirsch (1978), Frank (2011), and many others.

In a recent study, Charles et al. (2009) determine which goods are signaling better economic circumstances, "...are readily observable in anonymous social interactions, and [...] portable across those interactions" (ibid p. 426). Accordingly, a basket of goods, including spending on apparel, accessories, such as watches and jewelry, personal care, and vehicles have been identified. When abstracting from the requirement of portability, expenditures on housing additionally qualify (Charles et al., 2009; Frank, 1999). Among the consumption categories in the COICOP system, these items can be found in *transport, housing & utilities, furnishings & household equipment*, and *miscellaneous goods & services* (see Table A1). However, in the case of *transport* and *miscellaneous goods & services*, more than these goods can be found in the respective categories which cannot easily be connected to the need for status recognition. It can, therefore, only tentatively be concluded that upward sloping Engel curves should be expected in these categories.

Budget categories without need based hypotheses

When inspecting the expenditure categories in Table A1, a further limitation needs to be taken into account. The allocation of consumption expenditures is not generally a matter of consumer sovereignty. Institutional settings are likely to interfere for a number of reasons, such as regulated prices in the form of lower or upper price boundaries, taxes, tariffs, or the like. Among the aggregate COICOP categories, *health* and *education* expenditures appear to be the most outstanding examples. Cross-country expenditure patterns in these categories are thus likely to show much less consistency. Accordingly, hypotheses on structural changes in expenditures as income rises are missing.

In the case of *communication*, network externalities are likely to prohibit a consistent pattern in cross-country Engel curves. Individual consumption expenditures on communication very much depends on the provision of information and telecommunication networks, which likely differs between countries.

Lastly, in the case of *alcohol & tobacco*, cognitively constructed motives to consume are likely to dominate. Such “acquired wants” (Witt, 2001) are socially constructed and culturally contingent. Accordingly, cross-country Engel curves are likely to show some heterogeneity. However, the fact that the literal consumption of these goods follows homeostatic satiation features and is limited by physiological bounds might hint to a downward sloping tendency of the cross-country Engel curve.

3 Constructing a comparable income dimension

The empirical setting of the paper requires transforming the variables of interest such that comparisons across countries and time are permitted. In the case of the expenditure categories, this can easily be facilitated by transforming the expenditures, given in current values and local currency, into expenditure shares. Expenditure shares are created by summing the nominal expenditure values and dividing the expenditures of each of the categories by the composite. Without any further adjustments, the shares are already comparable.

To make the income variable comparable across countries and time, several treatments have to be undertaken. First of all, GDP per capita is calculated using population data. Second, using annual exchange rates, the national currency values are transformed into current U.S. \$. Third, current nominal income per capita in U.S. \$ is transformed into real income per capita. Therefore, price changes within countries are accounted for by utilizing implicit price deflator data for each country. Eventually, the resulting income variable, constant U.S. \$ at 2005 prices, is comparable across time and countries.

Although a common currency is created and national inflation is controlled for, the income variable still has a natural limitation. Comparing expenditure shares across a standardized income variable implicitly assumes that one 2005 U.S. \$ allows one to buy approximately the same in country x and y . That would imply that the law of one price holds across space for all kinds of expenditure items. Price levels, however, are consistently found to be higher in more affluent countries. The systematic difference is usually hypothesized to stem from productivity differences in the tradable sector that induce prices in the non-tradable sector, for which similar productivity across countries is assumed, to be biased (Harrod, 1933; Balassa, 1964; Samuelson, 1964). A conversion of income measures at market prices (exchange rate) does therefore not accurately represent the true income differentials.

As the law of one price is unlikely to apply to internationally non-tradable goods, these goods can be purchased at markedly lower prices in less affluent countries. Such systematic differences thus underestimate the purchasing power in less affluent countries. Accounting for the regional prices of non-tradable goods within a standardized consumption basket consequently adjusts for “real” purchasing power. Purchasing power parity conversion rates thus help to alleviate this kind of bias.

The conversion of nominal GDP at current prices in national currency $Y_{NC,t}$ into a common currency at constant prices that is comparable over time and space $Y_{PPP,2005}$, i.e., Geary-Khamis international dollar (I\$), can be conducted as follows:

$$Y_{PPP,2005}(I\$) = \frac{Y_{NC,2005}}{PPP_t\left(\frac{NC}{I\$}\right)} = \frac{\frac{Y_{NC,t}}{IPD_{2005}}}{PPP_t\left(\frac{NC}{I\$}\right)},$$

where $PPP_t \left(\frac{NC}{I\$} \right)$ denotes the implicit purchasing power parity conversion rate that allows the comparison of a similar consumption basket at regional prices and IPD_{2005} denotes the implicit price deflator referring to a fixed base year (2005) to account for national inflation rates.

Recent research on purchasing power adjustment however shows that purchasing power parities are biased as well. Drawing upon micro data from a number of countries, Almås (2012) utilizes Engel curves for food to assess the magnitude of this bias which turns out to be systematic. The results indicate the income of poorer countries to be overestimated. Consequently, PPP adjusted income seems to be over-adjusted.

The degree of purchasing power adjustment can be relevant for the graphical assessment of Engel curves in subsection 4.1. While observations of low income countries tend to move right after purchasing power adjustments are applied, observations of high income countries move to the left. The shape of the Engel curve can thus be expected to change as well. As the results presented by Almås (2012) indicate that PPP adjusted income is over-adjusted, the “true” income adjustment should lie between real income at constant prices (constant U.S. \$ at 2005 prices) and PPP adjusted income at constant prices (Geary-Khamis international dollar, i.e., I\$). Therefore, the charts depicted in the following sections plot expenditure share observations on real GDP (maroon circles) and PPP adjusted real GDP (gray triangles). The resulting nonparametrically derived curves in Figures 1 are color coded as well: real GDP (red dashed line) and PPP adjusted real GDP (black solid line).

To construct a comparable income per capita indicator, annual information on gross domestic product, population, deflator indices, and exchange rates are drawn from the *United Nations National Accounts and Main Aggregates* database. Data on purchasing power adjusted GDP per capita at constant 2005 prices, i.e., Geary-Khamis international dollar (I\$), is drawn from the most recent version of the Penn World Tables (Heston et al., 2011).

4 Beyond Engel’s law

A natural limitation of the approach chosen in this paper is the trade off between breath of the study in terms of the number of countries and years covered and the level of aggregation of the expenditure categories. Therefore, it is not surprising that not all the twelve internationally standardized consumption categories can easily be matched with their underlying universally shared needs (see subsection 2.3). However, the hypotheses put forward already imply that from a behavioral consumption approach perspective there are good reasons to presuppose the existence of more than one robust empirical regularity (“Engel’s law”) in the analysis of demand patterns. To validate the hypotheses and to explore the remaining expenditure patterns, a graphical & nonparametric assessment is used and the consistency of the overall cross-country Engel curves for each expenditure category is evaluated. Moreover, country level functional forms of Engel curves are estimated to assess the consistency of the overall Engel curve shape at the country level.

4.1 Assessing the shape of cross-country Engel curves

This subsection aims at contributing an empirical account of systematic changes in consumption patterns across countries as income rises. While it is a well established stylized fact that the expenditure share dedicated to food consumption decreases as income rises (Engel’s law), evidence on other systematic changes in the composition of expenditure shares remains scarce.

The chosen empirical framework allows looking at changes in expenditure patterns from a different perspective. Deviating from the standard approach of considering a particular population at a certain point in time, it allows for more conclusive insights about whether observable changes in expenditure shares can be generalized across a range of countries.⁶ Utilizing a nonparametric regression technique, it is explored whether expenditure categories, inclusive of, but extending beyond, *food*, change systematically with rising income. Applying this method moreover allows to verify the hypotheses outlined in subsection 2.3.

To properly assess the shape of cross-country Engel curves, a nonparametric approach is used. In contrast to parametric approaches that require an a priori assumption about the functional form, nonparametric approaches allow the data themselves to reveal the actual shape of the estimate (Engel and Kneip, 1996). Various nonparametric regression techniques have been developed in recent years.

An early but still very appealing nonparametric regression approach is local linear regression. The idea of local linear regression is to fit straight lines locally to the data whereby only a limited number of neighboring observations, determined by the bandwidth, are used which are weighted with decreasing weights the further away the observations are (Bowman and Azzalini, 1997). The locally fitted lines are then used to predict a smoothed value y_i^s for each local regression at covariate point x_i . The smoothed curve, thus results from repeated separate local linear regressions for every covariate point.

Local linear regression is used in this paper for its appealing simplicity. Moreover, the technique is, under certain conditions, equivalent to the well known Nadaraya-Watson kernel estimator (Nadaraya, 1964; Watson, 1964) but behaves superior at the edges of the covariate space as it employs a variable bandwidth reflecting the density of the observations through a nearest neighbor distance (Hart, 1997).⁷

Locally weighted scatterplot smoothing (LOWESS, Cleveland, 1979) is a local linear estimator that uses the tricube kernel function to easily evaluate adequately smooth weights for neighboring observations. The smoothing parameter can straightforwardly be interpreted as the share of the sample that enters the local regression with positive weights (Bowman and Azzalini, 1997).

Figures 1 & 2 show Engel curves for all 12 expenditure categories derived via locally weighted scatterplot smoothing. All charts use the sample described in Table A2. Parametric as well as nonparametric regression methods are susceptible to outliers. Both figures therefore draw on a slightly reduced sample.⁸

Regarding the potential income adjustment problem outlined in section 3, it can be found that the shapes of the local linear regression estimates for real GDP and PPP adjusted real GDP are not too different. The curve for PPP adjusted real GDP is usually smoother than in the case of real GDP. Differences result mostly at the upper tail of the income distribution. However, the curves are used to indicate an either positive or negative slope in the overall sample of the data. Therefore, it can be concluded that the qualitative relationship between the expenditure share category and income remains unchanged in all cases.⁹

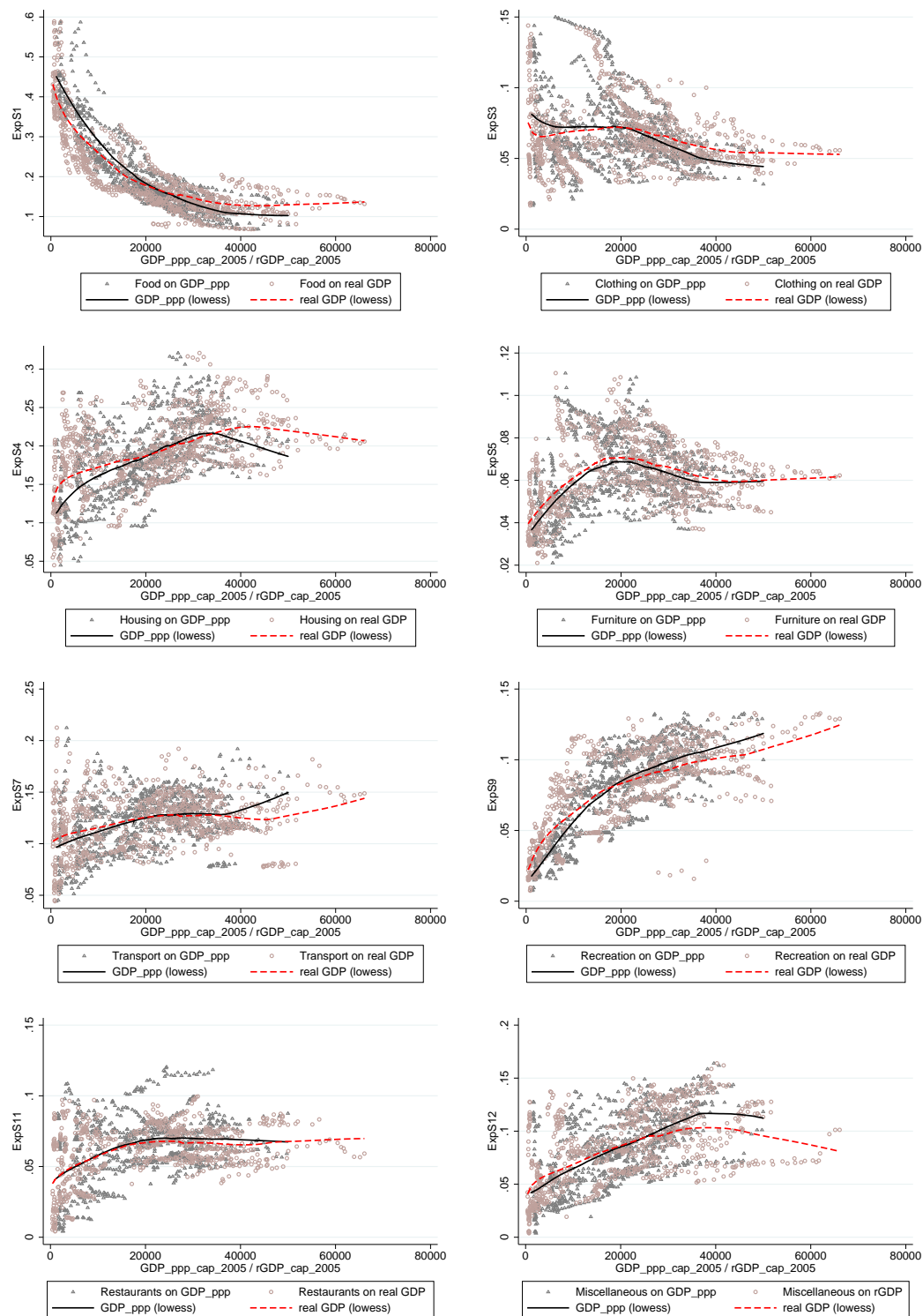
⁶Using national account statistics it is, however, only possible to show changes in the consumption patterns of a mean consumer in each country as income rises.

⁷The Nadaraya-Watson kernel estimator also solves a locally weighted least squares problem but uses local mean values instead of predicted values for imputing the smoothed values. Moreover, the Nadaraya-Watson kernel estimator uses a constant weighting function.

⁸The empirical setting implies the data to be clustered countrywise. Omitting outliers to ensure a less volatile course of the curve is thus more controversial than in a cross sectional setting. For a discussion on the outlier treatment please see appendix A.1.

⁹All estimations in the following subsections use PPP adjusted real GDP.

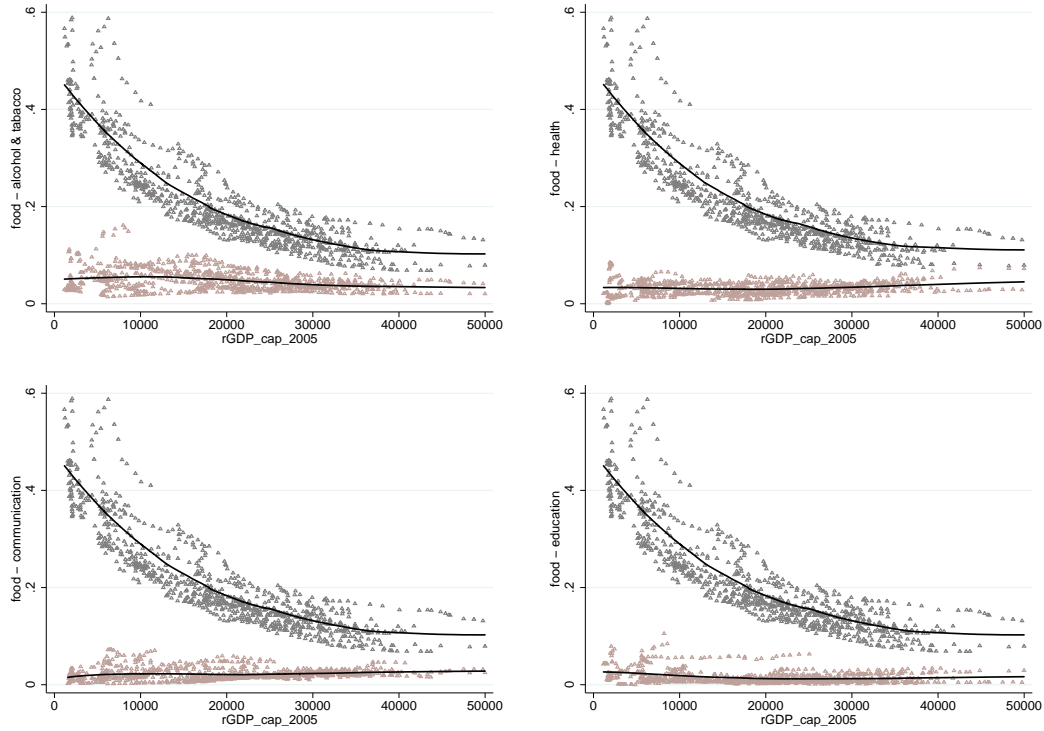
Figure 1: Changes in expenditure shares with rising income – need based



Notes: The charts plot the locally weighted smoothing scatterplots of the respective expenditure share on real GDP (red dashed line) as well as on PPP adjusted real GDP (black solid line). The smoothing parameter is 0.7.

Overall, the charts depicted in Figure 1 suggest that there are much more regularities in cross-country consumption patterns than Engel's law. The tremendous consistency

Figure 2: Changes in expenditure shares with rising income – remaining



Notes: The charts plot the locally weighted smoothing scatterplots of the respective expenditure share relative to expenditures on *food* on PPP adjusted real GDP (black solid line). The smoothing parameter is 0.7.

in the changing expenditure shares as income rises is unlikely to be the result of pure chance. In fact, it calls for a rigorous theoretical foundation. As outlined in section 2, the behavioral interpretation of the consumption motivation offers such an explanation by connecting differences in satiation patterns between innate needs with systematic changes in consumption expenditures as income rises.

The charts depicted in Figure 1 have been conjectured to relate to universally shared human contingencies. The Engel curves of the remaining expenditure categories are shown in Figure 2. Although the slopes are most probably different from zero, compared to the changes in Engel's law their magnitude is negligible. In contrast to the charts depicted in Figure 2, all expenditure categories in Figure 1 show systematic changes as income rises.

Among the changes observable in Figure 1, the steadily and exponentially decreasing shape of the Engel curve for *food* is a unique pattern. Although the expenditure share for *clothing* is decreasing too, the slope is much less steep and rather linear. The downward sloping relationship of the Engel curves indicates the underlying expenditure categories to be necessities. This is in line with the hypotheses in section 2.3 that relate the instrumental use of the expenditure categories *food* and *clothing* to easily satiable basic needs of homeostatic nature.

The most pervasive pattern characterizing half of the categories, i.e., *housing & utilities*, *furnishings & household equipment*, *transport*, *recreation & culture*, *restaurants & hotels*, and *miscellaneous goods & services*, is a positive relationship which increases at a steadily decreasing rate. In some cases, the curve seems to reach an upper ceiling. However, at the high end of the income distribution, the slope of the curves is determined only by a small number of countries. Kinks in the curves in this range should therefore

not distract from the overall pattern. The positive slope of the Engel curves indicates the underlying expenditure categories to be luxuries. This result complies favorably with the hypotheses in section 2.3 which relate these expenditure categories with hardly satiable basic needs of nonhomeostatic nature.

Overall, the visible inspection of Figures 1 & 2 shows that beyond Engel's law a number of consistent relationships between expenditure categories and income exist. In eight out of the twelve COICOP expenditure categories defined by the United Nations statistics division, steady and consistent changes could empirically be identified as income rises. The theoretical explanation offered allows accounting for all of the systematically changing budget categories. Given the above described limitations of the theoretical approach and the widespread reluctance of the economic literature to explain structural changes in expenditure patterns, this is already a lot. To back the descriptive findings in this subsection, the consistency of each of the detected expenditure share – income relationships is assessed in the following subsection.

4.2 Estimating cross-country income elasticities

In section 2, it was conjectured that differences in satiation patterns of universally shared human need translate, on the aggregate level, into different shapes of Engel curves and thus also into different income elasticities of demand. The exact connection, however, is yet to be drawn. As already mentioned in subsection 2.1, if an Engel curve is formulated in levels, the slope of the logged data will yield the income elasticity of demand

$$\varepsilon = \frac{\partial (\log(q_i))}{\partial (\log(y))}. \quad (1)$$

When using budget share Engel curves, the income elasticity of demand can readily be inferred from the curve's slope. While downward sloping Engel curves indicate income elasticities smaller than 1 (“necessities”), upward sloping Engel curves yield income elasticities above 1 (“luxuries”). This can be shown by the following transformation. As a starting point, the log-log specification of the budget share Engel curve is chosen.

$$\log(w) = \log\left(\frac{q_i}{y}\right) = \alpha + \beta * \log(y) \quad (2)$$

The slope of the log-log budget share Engel curve β can be derived by taking the first derivative

$$\beta = \frac{\partial \left(\log\left(\frac{q_i}{y}\right) \right)}{\partial (\log(y))}. \quad (3)$$

Disassembling the first derivative yields

$$\beta = \frac{\partial (\log(q_i) - \log(y))}{\partial (\log(y))} = \frac{\partial (\log(q_i))}{\partial (\log(y))} - \frac{\partial (\log(y))}{\partial (\log(y))} = \frac{\partial (\log(q_i))}{\partial (\log(y))} - 1. \quad (4)$$

Using (1) it can be shown that

$$\beta = \varepsilon - 1. \quad (5)$$

In the log-log specification of budget share Engel curves, a negative slope thus indicates “necessities”, while a positive slope denotes “luxuries.” Although the magnitudes of the estimates differ in size, the same qualitative statement holds for the budget share Engel curves depicted in Figures 1 & 2. While the use of logarithms changes the relative positions

of the observations (which stretches differences between observations in the lower range and wraps in the higher range), it does not change the sequence of the observations. Using the log-log specification will thus not turn a positive into a negative relationship and vice versa.

To assess the consistency of the cross-country budget share Engel curves, income elasticities of demand are estimated using the log-log specification. Figures A4 & A5 plot the transformed data. For each expenditure category, the raw data and a fitted linear line is displayed. In line with the above argument, the direction of the fitted lines complies with the qualitative results of Figure 1. Moreover, it can be observed that the logarithmic transformation sufficiently reduces the nonlinearities of the budget share Engel curves such that a parametric linear fit seems to be appropriate in most cases.

Table 1: Cross-country income elasticities of demand

| Expenditure category | ε | R^2 | R_i^2/R_{food}^2 |
|-----------------------------------|---------------|-------|--------------------|
| Food | 0.49 | 0.80 | 1 |
| Recreation & culture | 1.55 | 0.72 | 0.90 |
| Miscellaneous goods & services | 1.40 | 0.40 | 0.50 |
| Housing & utilities | 1.23 | 0.37 | 0.46 |
| Restaurants & hotels | 1.33 | 0.25 | 0.31 |
| Furnishings & household equipment | 1.18 | 0.23 | 0.29 |
| Transport | 1.14 | 0.22 | 0.28 |
| Education | 0.67 | 0.10 | 0.13 |
| Health | 1.18 | 0.05 | 0.06 |
| Communication | 1.17 | 0.05 | 0.06 |
| Clothing | 0.92 | 0.03 | 0.04 |
| Alcohol & tobacco | 0.94 | 0.01 | 0.01 |

Notes: The income elasticities of demand are estimated using equations (2) and (5). All estimations use the full sample described in Table A2.

A convenient and well known measure of consistency of a parametric linear fit to the data is the coefficient of determination, R^2 . As the ordinary least squares estimator minimizes the sum of squared residuals (unexplained variance) the R^2 that measures the share of variation in the dependent variable explained by the variation in the covariate (1-unexplained/total sample variance) is a straightforward measure to assess the predictive quality and thus the consistency of the model.

Table 1 reports the cross-country income elasticities of demand for all twelve COICOP expenditure categories. Alongside the coefficient of determination, the third column reports the model fit relative to the R^2 for *food*. It is readily apparent from Figure 1 that the clear and clean pattern obtained from the Engel curve for *food* is outstanding compared to the remaining categories. The pin sharp pattern of the Engel curve for *food* thus lends itself to act as a benchmark for judging the relative consistency of the remaining patterns. The lines are ordered by decreasing model fit.

Unsurprisingly, the well known Engel's law relationship turned out to exhibit the highest values in terms of the chosen consistency measure. Likewise expectedly, the categories that do not show systematic changes in expenditure shares as income rises, i.e., *alcohol & tobacco*, *health*, *communication*, and *education*, score low in terms of predictability, i.e., income can hardly be used to predict the expenditure shares in these categories.

Alongside the expenditure share for *food*, the six expenditures categories that show systematically increasing budget shares score relatively high in terms of consistency. Most

remarkably is the case of the expenditure share – income relationship for *recreation & culture* that is almost as strict as the famous relationship discovered by Ernst Engel ($R_i^2/R_{food}^2 = 0.90$). Among the remaining five increasing Engel curve relationships, the relative consistency measure ranges between 0.5 and about 0.3. Bearing in mind that the expenditure shares are related to only one explanatory variable, i.e., PPP adjusted real income, these values are in fact remarkable. Among the expenditure categories that could be related to universal shares human contingencies in subsection 2.3, only *clothing* displays very low R^2 values. An inspection of the data (see Figures 1 & A4) indicates that the data consists of two parallel downward sloping clusters. Accounting for this particularity would yield a more consistent and stronger negative relationship.

Overall, the results presented in this subsection support the findings of the visual inspection of cross-country Engel curves in the former subsection. In all cases the estimation of cross-country income elasticities of demand conform with the identified structural changes in the corresponding Engel curves. While expenditure categories that can be related to hardly satiable needs show increasing slopes and income elasticities above unity, expenditure categories related to easily satiable needs show decreasing Engel curve slopes and income elasticities below unity. Except for *clothing*, the consistency of these relationships is remarkably high.

4.3 How similar are the underlying country level Engel curves?

The previous subsections evaluated the shape and the consistency of the cross-country Engel curves. It could be shown that beyond Engels law a number of theoretically founded empirical regularities exist. Almost axiomatic examples are the budget share – income relationship for *food* and *recreation & culture*. The results point to very uniform shapes of Engel curves across countries and cultures, which imply a highly powerful and predictive connection.

Alongside the more general results presented above, a country level perspective is offered in this subsection, too. While the former analysis draws upon the pooled sample of observations to obtain a general impression of the respective relationships, the country level was neglected. The observed strictness and consistency in the general patterns might, however, consist of a number of countrywise clustered data points that have somewhat different functional forms at the country level. The utmost degree of consistency would require to show that the uniform cross-country Engel curve pattern results from uniform Engel curves at the country level.

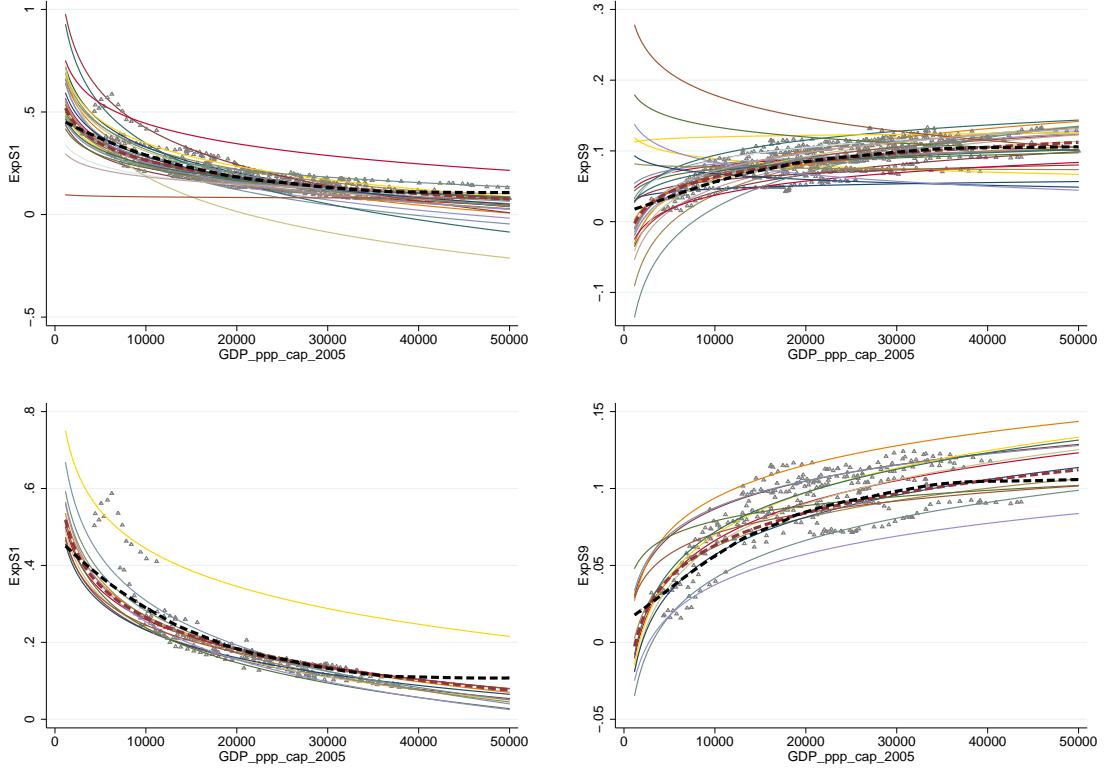
Therefore the functional form of the Engel curves at the country level is compared with the overall shape of the cross-country Engel curves for the two strictest expenditure share - income relationships, i.e., *food* and *recreation & culture*. More precisely, it is tested whether the coefficients of the parametrically described country level Engel curves match the coefficients of the overall functional relationship. As both cross-country Engel curves follow some kind of a logarithmic functional relationship, the following nonlinear least squares regression is estimated:

$$w_i = \alpha + \beta * \log(y) + \varepsilon. \quad (6)$$

The nonlinear least squares regression a priori presumes a logarithmic functional form and estimates the coefficients α and a coefficient β that indicates the curvature of the logarithmic fit.¹⁰

¹⁰Nonlinear least squares is an optimization technique that determines values of the coefficients which minimize the sum of squared residuals through iterative processes.

Figure 3: Changes in expenditure shares with rising income



Notes: The left hand side charts display the Engel curves for *food* while the right hand side charts show *recreation & culture*. The upper charts present the fitted functional forms at the country level for all eligible countries using equation (6). The lower charts present the reduced samples of countries for which no statistically different coefficients can be found. The bold face solid black lines depict the locally weighted smoothing scatterplots of the respective expenditure share on PPP adjusted real GDP. The bold face solid maroon lines depict the functional fit of the overall sample using equation (6).

Equation (6) is first applied to the overall sample to estimate benchmark coefficients. The practicality of the benchmark is assessed by two criteria. Firstly, the fitted values of the nonlinear regression are compared to the locally weighted smoothing scatterplot applied in subsection 4.1. Secondly, the coefficient of determination, R^2 , of the nonlinear estimations should be sufficiently high. Regarding the first criteria, Figure 3 shows that the smoothed and the fitted lines overlap favorably. Moreover, the R^2 of the nonlinear least squares regressions for *food* and *recreation & culture* exceed 0.80 and 0.65 respectively. Both benchmark criteria are thus met reasonably.¹¹

To sensibly estimate a nonlinear fit on the country level, some restrictions on the data are required. The country level data should, on the one hand, consist of ,say, more than at least 10 data points and lie, on the other hand, in the nonlinear part of the cross-country Engel curve. Countries for which only observations in the flat high income range are available, like Luxembourg or Switzerland, are thus not eligible. Likewise, countries for which observations are only available in the vertical lower income space cannot be used as well. Tables A3 and A4 report the eligible sample and the estimated results.

¹¹Of course also other, more complex, functional forms could be presumed. Applying, for example, an exponential fit of the form $w_i = \alpha + \beta_1 * \beta_2^y + \varepsilon$ provides an even better approximation of the locally weighted smoothing scatterplots. The R^2 improves by 0.01. To maintain the simplicity of the illustrative exercise, the simpler model (equation (6)) is chosen where only two instead of three coefficients have to be compared. Results for the more complex model are available upon request from the author.

After omitting a number of countries for the above given reasons, about 30 countries still qualify for the analysis.

Expenditure share data is not available for all countries over the complete income range (see Table A2). A longer observation period is typically available for rather affluent countries, while for less affluent countries periods range between the most recent 5 to 20 years. The functional form of the country level Engel curves is determined given the limited data at hand.

The results are presented in Figure 3 and Tables A3 & A4. Tables A3 & A4 report the coefficient estimates, standard errors, and the coefficient's 95% confidence intervals for each country. The left hand side charts display the Engel curves for *food*, while the right hand side charts show *recreation & culture*. The upper charts in Figure 3 present the estimated functional forms at the country level for all eligible countries. In both expenditure categories a certain heterogeneity is observable. Remarkable is, however, that only in very few cases the estimated functional relationships run counter the overall relationship. The lower charts present the reduced samples of countries for which no statistically different coefficients can be found.¹² Given the heterogeneity of the data availability, the results reflect a surprisingly high degree of similarity also on the country level. This robustness check strengthens and substantiates the overall consistency of the cross-country Engel curves observed in the previous subsections.

5 Conclusions

Since the work of Ernst Engel it is a well established fact that the expenditure share dedicated to food consumption decreases as income rises (Engel's law). The extraordinary consistency across time and space and the predictive character of the relationship led to its use to determine absolute household poverty and the definition of poverty lines. Especially when defining final per capita poverty lines, there is a shared conviction among researchers that also among the poorest a certain amount of non food spending is necessary. In this paper, it is argued that the ad-hoc nature of the non food necessity scalar choice suffers from a still missing comprehension of why and which consumption items are necessities and which are not.

Although Engel's law is an essential nonmonetary determinant when distinguishing between poverty and wealth, it covers only one decreasing fraction of consumer expenditure as income rises. In contrast, empirical evidence on systematic changes in other consumer expenditures categories is hardly used. A systematic assessment of structural changes in consumer expenditure categories as income rises should, however, allow for a more complete and multidimensional assessment of wealth. The lack of such an assessment is even more remarkable as Ernst Engel already pursued a much more encompassing approach. In fact, Engel's original work was an inquiry into the structural changes of consumption patterns with rising income aiming to determine a measure of household welfare. With his pioneering work on a distinction between necessities and luxuries, Engel was not only the first to empirically assess this taxonomy but also the first to attempt a behaviorally founded – need based – explanation.

To build upon Engel's legacy, this paper, on the one hand, improves on part of the theoretical assumptions by enriching Engel's original approach with current scientific knowledge on the nature of consumer needs and *how* they are satisfied. The behavioral approach to consumer behavior offered in section 2 allows for the formulation of expectations about structural changes of expenditure shares as income rises. While expenditure categories

¹²The coefficients cannot be said to differ statistically if the confidence intervals are overlapping.

that can be associated with hardly satiable needs of nonhomeostatic nature are conjectured to show increasing cross-country budget share Engel curves that reflect an income elasticity of demand above unity ("luxury"), expenditure categories that can be associated with easily satiable needs of homeostatic nature are conjectured to show decreasing slopes, reflecting income elasticities of demand below unity ("necessity"). The hypotheses put forward already imply that from a behavioral consumption approach perspective there are good reasons to expect the existence of more than one robust empirical regularity in the analysis of demand patterns.

On the other hand, this paper assesses the systematic changes of consumer expenditure shares with rising income. The paper presents an empirical analysis of observable changes in consumption patterns across countries and time, using a data set that contains individual consumption expenditure in 12 categories for more than 50 countries over up to 50 years. Utilizing a nonparametric regression technique, it is explored whether expenditure categories, inclusive of, but extending beyond, *food*, change systematically with rising income. This way a number of empirical regularities in consumer expenditure patterns can be identified that go well beyond Engel's law. In eight out of twelve expenditure categories steady and consistent changes could empirically be identified as income rises. The theoretical explanation offered allows accounting for all of the systematically changing budget categories. Alongside the Engel curve for *food*, an almost axiomatic example is the Engel curve for *recreation & culture*. The results point to very uniform shapes of Engel curves across countries and cultures, which imply a highly powerful and predictive connection.

Our findings confirm the conjecture that the distinction between luxuries and necessities rests upon behavioral foundations that can be traced back to the differing satiation features of the underlying universally shared needs. The study contributes to the literature on income and wealth by a structural assessment of general changes in budget shares across countries that helps to broaden our understanding of the behavioral foundations on the necessity – luxury taxonomy. In doing so, it broadens the scope for a more encompassing and multidimensional consumption based assessment of wealth.

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A Appendix

A.1 Outlier treatment

In a cross sectional setting, it is usually convenient to cut expenditures on the category of interest as well as the income variable at a specific boundary. As a cutoff point, the mean plus three standard deviations is a commonly used rule of thumb (see, e.g., Banks et al., 1997). This kind of standard procedure however does not fit in with the data structure in this paper.

The empirical setting applied in this paper combines annual country level data for more than 50 countries. Pooling the data of various years implies obtaining a cloud of data points for each country. Depending on the number of years for which data is available, the respective data cloud varies in size. Combining the data of various countries then results in more or less overlapping countrywise clusters. Outliers thus usually don't take the form of displaced single points but separate clusters.

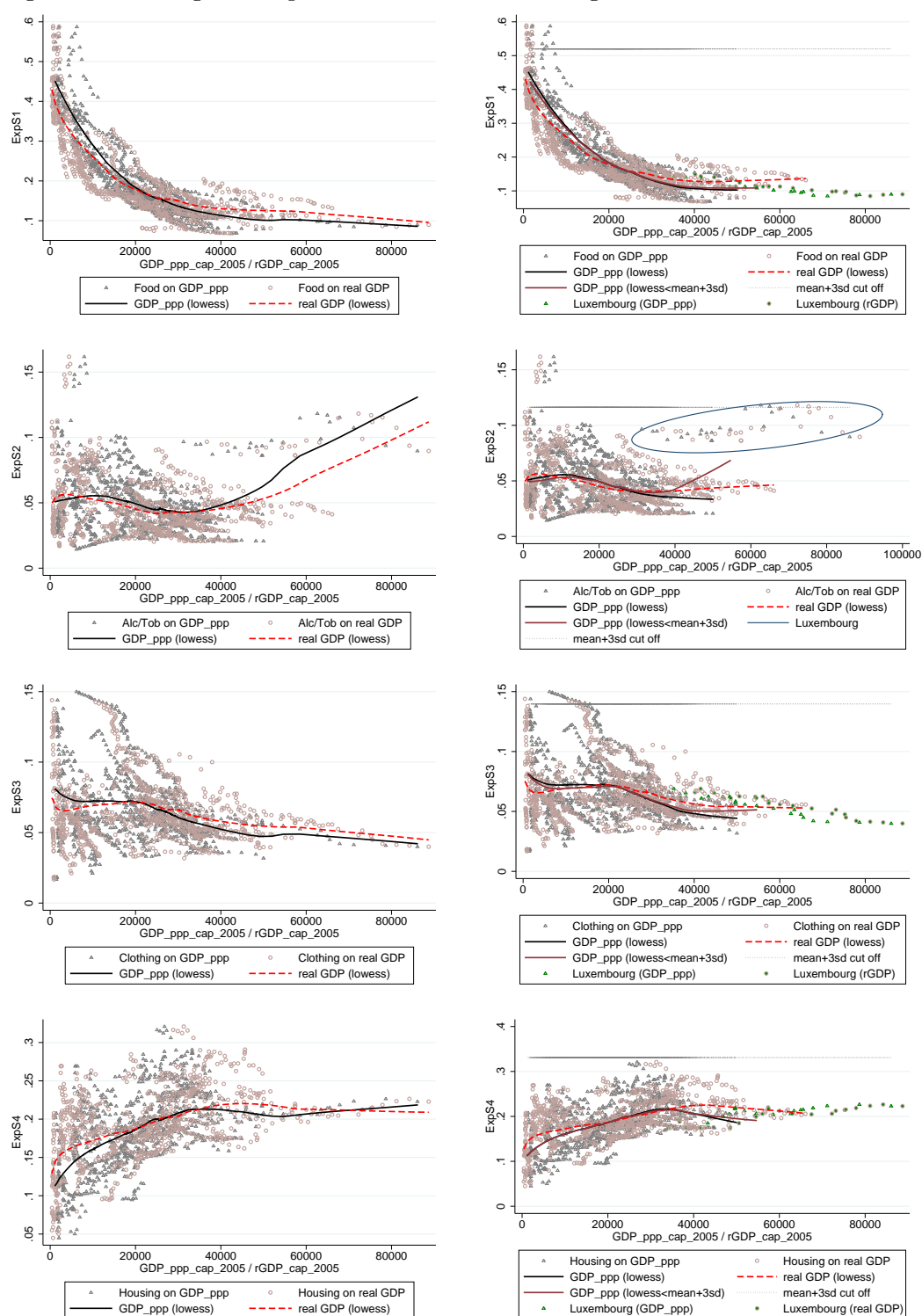
Being interested in assessing and describing structural changes in consumption patterns as income rises, the particularities in a certain country should not determine the overall shape of the estimated Engel curve. An outlying cluster of observations should accordingly be eliminated. Figures A1 to A3 present the applied outlier treatment.

The left hand side charts plot the locally weighted smoothing scatterplots without any outlier treatment. In some cases, the estimated local linear regression curve thus shows unrepresentative shifts. The right hand side charts in Figures A1 to A3 additionally mark outliers with ellipses and/or green color. For comparison, the locally weighted smoothing scatterplots are estimated without the outlying observations. Moreover, another local linear regression curve, which applies the standard procedure of cutting off observations above the mean plus three standard deviations, is added.

Without any outlier treatment, the estimated nonparametric curves would yield unrepresentative shifts particularly in the higher income range. Most remarkable examples are the expenditure categories *alcohol & tobacco*, *health*, and *recreation & culture*. A comparison of both outlier treatments yields remarkable differences too. At least for *alcohol & tobacco* and *furnishings & household equipment* the data cloud for Luxembourg lies above the overall pattern. Applying the standard outlier procedure omits only a part of the data cloud. The estimated local linear regression curve thus remains affected. The comparison of the left with the right hand side charts in Figures A1 to A3 shows the need for an outlier treatment that accounts for the countrywise clustered structure of the data.

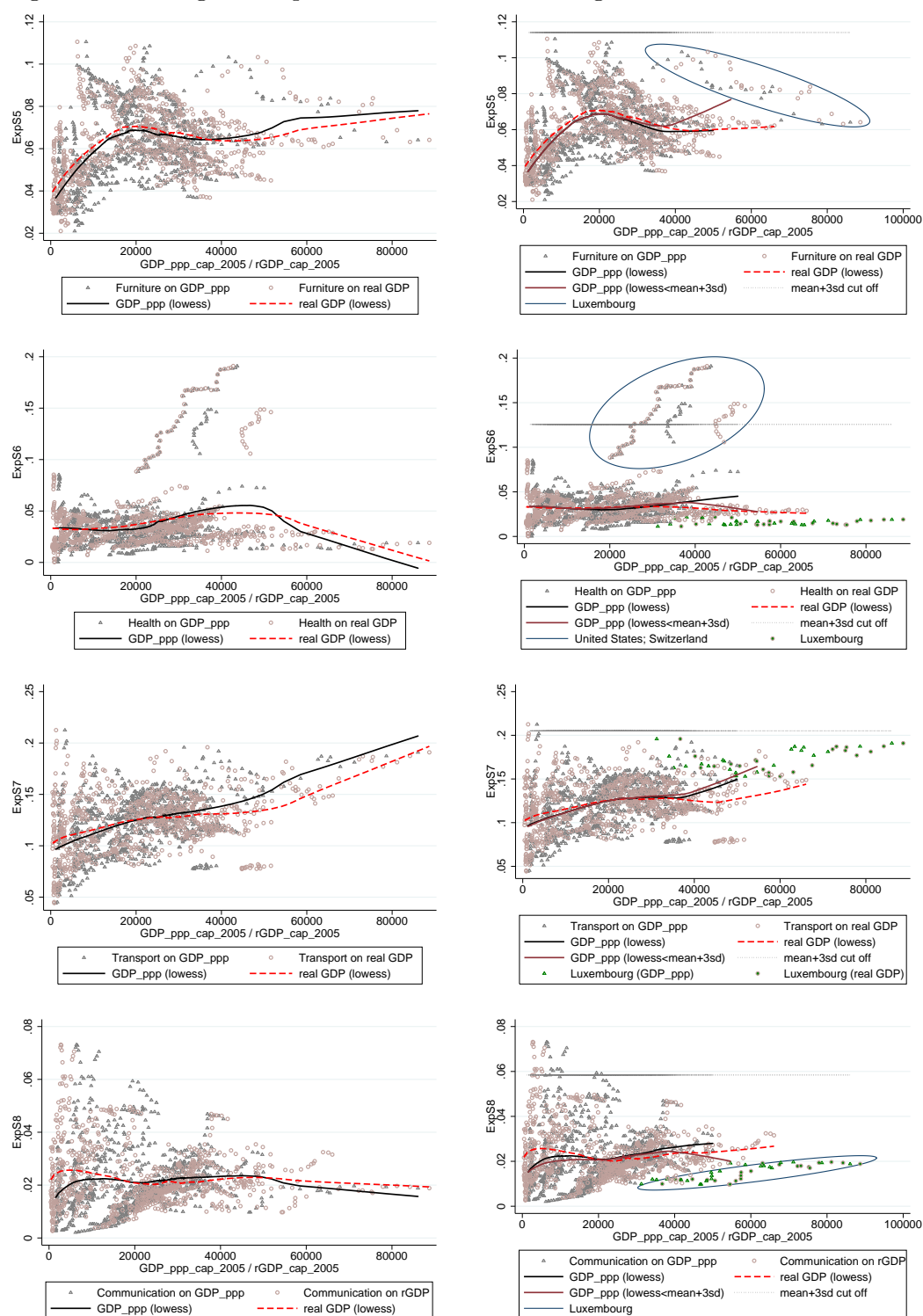
Overall, it can be summarized that especially Luxembourg, the country with the highest income, causes changes in the slope of the locally weighted smoothing scatterplots. Other readily visible outliers are much less disturbing. In fact, only in one case (*health*) the shape of the estimated curves is affected by countries other than Luxembourg. Although the outlier treatment proposed here may appear arbitrary at the first glance, it can be concluded that it reasonably fits the structure of the data.

Figure A1: Changes in expenditure shares with rising income - Outlier correction



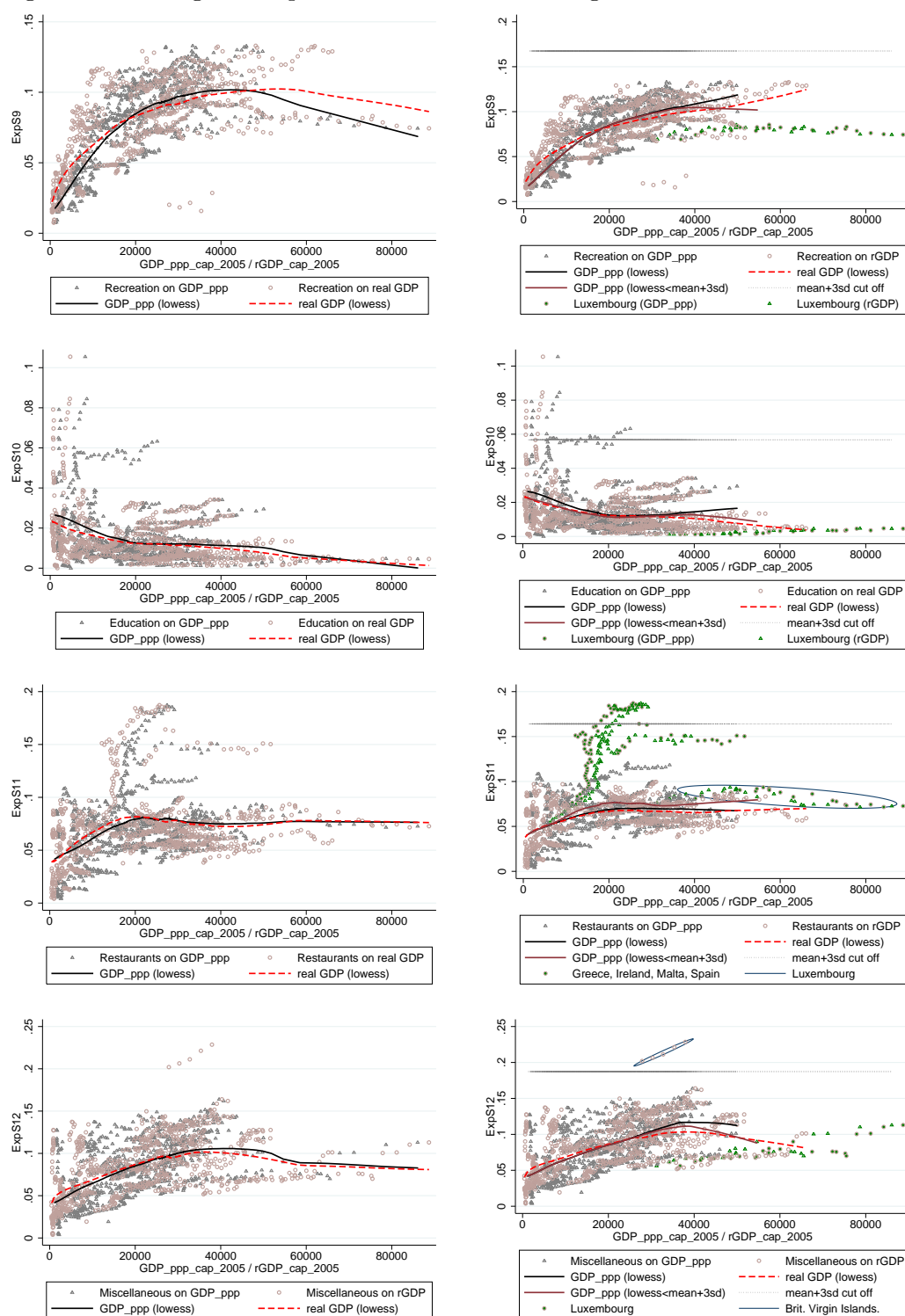
Notes: The left hand side charts plot the locally weighted smoothing scatterplots of the respective expenditure share on real GDP (red dashed line) as well as on PPP adjusted real GDP (black solid line). The right hand side charts additionally mark the identified outliers with ellipses and/or green color. For comparison the locally weighted smoothing scatterplots are run without the outlying observations. Moreover another local linear regression curve for PPP adjusted real GDP is added that applies the standard procedure of cutting off observations above the mean plus three standard deviations (brown solid line). In all cases the smoothing parameter is 0.7.

Figure A2: Changes in expenditure shares with rising income - Outlier correction



Notes: The left hand side charts plot the locally weighted smoothing scatterplots of the respective expenditure share on real GDP (red dashed line) as well as on PPP adjusted real GDP (black solid line). The right hand side charts additionally mark the identified outliers with ellipses and/or green color. For comparison the locally weighted smoothing scatterplots are run without the outlying observations. Moreover another local linear regression curve for PPP adjusted real GDP is added that applies the standard procedure of cutting off observations above the mean plus three standard deviations (brown solid line). In all cases the smoothing parameter is 0.7.

Figure A3: Changes in expenditure shares with rising income - Outlier correction



Notes: The left hand side charts plot the locally weighted smoothing scatterplots of the respective expenditure share on real GDP (red dashed line) as well as on PPP adjusted real GDP (black solid line). The right hand side charts additionally mark the identified outliers with ellipses and/or green color. For comparison the locally weighted smoothing scatterplots are run without the outlying observations. Moreover another local linear regression curve for PPP adjusted real GDP is added that applies the standard procedure of cutting off observations above the mean plus three standard deviations (brown solid line). In all cases the smoothing parameter is 0.7.

A.2 Figures & tables

Table A1: COICOP expenditure categories

| Expenditure category | Description |
|-------------------------------------|--|
| 1 Food | All kinds of food and nonalcoholic beverages consumed at home |
| 2 Alcohol & tobacco | Spirits, wine, beer, tobacco, narcotics |
| 3 Clothing | Clothing & footwear incl. related services (cleaning, repair, hire) |
| 4 Housing & utilities | Rentals, maintenance & repair of dwelling, electricity, water, sewerage, gas, other fuels (incl. heat energy) |
| 5 Furnishings & household equipment | Furniture & furnishings, carpets, household appliances, glass- & tableware, routine maintenance of dwelling, related services |
| 6 Health | Pharmaceutical & therapeutical products/equipment, outpatient services (medical & dental), hospital services |
| 7 Transport | Purchase of vehicles, fuels, maintenance, services by air, rail, road, waterways |
| 8 Communication | Postal services, telephone/fax services & equipment |
| 9 Recreation & culture | Recreation equipment & services, cultural services, package holidays |
| 10 Education | Expenses on primary, secondary, tertiary, and other education |
| 11 Restaurants & hotels | Expenses on catering, restaurants, cafés, canteens, accommodation services |
| 12 Miscellaneous goods & services | Personal care, prostitution, personal effects (incl. jewelry), social protection, insurances (incl. live, dwelling, health, transport), financial services, other services |

Notes: The expenditure categories are defined according to the UN Statistics Division's Classification of Individual Consumption According to Purpose (COICOP).

Table A2: Availability of data by countries

| # | Country | first year | last year | N |
|----|-------------------------------|------------|-----------|----|
| 1 | Australia | 1959 | 2007 | 49 |
| 2 | Belarus | 1994 | 2007 | 14 |
| 3 | Botswana | 1994 | 2001 | 8 |
| 4 | British Virgin Islands | 1995 | 1999 | 5 |
| 5 | Bulgaria | 1995 | 2006 | 12 |
| 6 | Cameroon | 1996 | 2004 | 9 |
| 7 | Canada | 1970 | 2007 | 38 |
| 8 | Hong Kong, China ^J | 1966 | 2004 | 23 |
| 9 | Macao, China ^J | 1993 | 2007 | 15 |
| 10 | Colombia | 1994 | 2005 | 12 |
| 11 | Croatia | 1999 | 2006 | 8 |
| 12 | Czech Republic | 1992 | 2007 | 16 |
| 13 | Denmark | 1966 | 2007 | 42 |
| 14 | Dominican Republic | 1991 | 1996 | 6 |
| 15 | Estonia | 1994 | 2007 | 14 |
| 16 | Finland | 1975 | 2007 | 33 |
| 17 | France | 1959 | 2008 | 50 |
| 18 | Germany | 1991 | 2007 | 17 |
| 19 | Greece | 1960 | 2004 | 45 |
| 20 | Guatemala | 2001 | 2006 | 6 |
| 21 | Honduras | 2000 | 2005 | 6 |
| 22 | Hungary | 1995 | 2008 | 14 |
| 23 | Iceland | 1990 | 2006 | 17 |
| 24 | India | 1999 | 2007 | 9 |
| 25 | Iran ^D | 1992 | 2007 | 16 |
| 26 | Ireland | 1990 | 2007 | 18 |
| 27 | Israel | 1995 | 2007 | 13 |
| 28 | Italy | 1970 | 2007 | 38 |
| 29 | Japan | 1980 | 2007 | 28 |

Table A2 – continued from previous page

| # | Country | first year | last year | N |
|----|-----------------------------------|------------|-----------|----|
| 30 | Kenya ^D | 1996 | 2007 | 12 |
| 31 | Korea, Rep. | 1970 | 2007 | 38 |
| 32 | Kyrgyzstan | 2000 | 2005 | 6 |
| 33 | Latvia | 1995 | 2007 | 13 |
| 34 | Lithuania | 1995 | 2007 | 13 |
| 35 | Luxembourg | 1985 | 2007 | 23 |
| 36 | Malaysia | 2000 | 2007 | 8 |
| 37 | Malta | 1996 | 2007 | 12 |
| 38 | Mexico | 1988 | 2004 | 17 |
| 39 | Mongolia | 1997 | 2007 | 11 |
| 40 | Namibia ^D | 2000 | 2007 | 8 |
| 41 | Netherlands | 1987 | 2007 | 21 |
| 42 | Netherlands Antilles ^F | 1997 | 2006 | 10 |
| 43 | New Zealand ^D | 1987 | 2007 | 21 |
| 44 | Nicaragua | 1994 | 2005 | 12 |
| 45 | Niger ^F | 2003 | 2008 | 6 |
| 46 | Norway | 1980 | 2006 | 27 |
| 47 | Papua New Guinea ^D | 1992 | 2003 | 12 |
| 48 | Poland | 1995 | 2007 | 13 |
| 49 | Serbia | 2002 | 2007 | 6 |
| 50 | Sierra Leone ^F | 2001 | 2007 | 7 |
| 51 | Singapore | 1996 | 2008 | 13 |
| 52 | Slovakia | 1993 | 2007 | 15 |
| 53 | Slovenia | 1995 | 2007 | 13 |
| 54 | Solomon Islands | 2003 | 2007 | 5 |
| 55 | South Africa ^J | 1946 | 2008 | 63 |
| 56 | Spain | 1995 | 2007 | 13 |
| 57 | Sri Lanka | 1998 | 2007 | 10 |
| 58 | Sweden | 1993 | 2007 | 15 |
| 59 | Switzerland | 1990 | 2006 | 17 |
| 60 | Yugoslavia, former (Macedonia) | 1996 | 2007 | 12 |
| 61 | Ukraine | 2001 | 2007 | 7 |
| 62 | United Kingdom | 1970 | 2007 | 36 |
| 63 | United States | 1970 | 2007 | 38 |
| 64 | Yemen ^D | 1996 | 2007 | 12 |

Notes: Countries indicated with ^D are dropped from the analysis due to missings in more than two expenditure share categories. Countries indicated with ^F are dropped from the analysis as they reported no changes in any expenditure share over the sample period. Countries indicated with ^J are dropped from the analysis due to huge – implausible – jumps in expenditure shares at a certain point in time.

Table A3: Country level nonlinear least squares estimates of the Engel curve for *food*

| Country | | Coef. | Std. Err. | 95% Conf. | Interval |
|----------------|----------|-------|-----------|-----------|----------|
| all | α | 1.35 | 0.02 | 1.32 | 1.38 |
| | β | 0.12 | 0.00 | 0.11 | 0.12 |
| Belarus | α | 1.75 | 0.30 | 1.10 | 2.40 |
| | β | 0.14 | 0.03 | 0.07 | 0.22 |
| Canada | α | 1.26 | 0.06 | 1.15 | 1.37 |
| | β | 0.11 | 0.01 | 0.10 | 0.12 |
| Denmark | α | 1.41 | 0.03 | 1.36 | 1.46 |
| | β | 0.12 | 0.00 | 0.12 | 0.13 |
| France | α | 1.29 | 0.01 | 1.26 | 1.32 |
| | β | 0.11 | 0.00 | 0.11 | 0.11 |
| Germany | α | 1.19 | 0.12 | 0.92 | 1.45 |
| | β | 0.10 | 0.01 | 0.08 | 0.13 |
| Hungary | α | 1.44 | 0.12 | 1.18 | 1.70 |
| | β | 0.13 | 0.01 | 0.10 | 0.16 |
| Ireland | α | 1.32 | 0.06 | 1.19 | 1.45 |
| | β | 0.12 | 0.01 | 0.10 | 0.13 |
| Israel | α | 1.61 | 0.64 | 0.20 | 3.02 |
| | β | 0.14 | 0.06 | 0.01 | 0.28 |
| Lithuania | α | 1.85 | 0.23 | 1.35 | 2.34 |
| | β | 0.17 | 0.02 | 0.11 | 0.22 |
| Poland | α | 1.56 | 0.16 | 1.22 | 1.90 |
| | β | 0.14 | 0.02 | 0.11 | 0.18 |
| Slovakia | α | 1.54 | 0.26 | 0.98 | 2.10 |
| | β | 0.14 | 0.03 | 0.08 | 0.20 |
| Spain | α | 1.19 | 0.11 | 0.94 | 1.44 |
| | β | 0.10 | 0.01 | 0.08 | 0.13 |
| United States | α | 1.18 | 0.04 | 1.09 | 1.26 |
| | β | 0.10 | 0.00 | 0.10 | 0.11 |
| Australia | α | 0.82 | 0.03 | 0.76 | 0.89 |
| | β | 0.07 | 0.00 | 0.06 | 0.08 |
| Bulgaria | α | 2.47 | 0.31 | 1.78 | 3.17 |
| | β | 0.25 | 0.04 | 0.17 | 0.33 |
| Czech Republic | α | 2.83 | 0.53 | 1.69 | 3.96 |
| | β | 0.27 | 0.05 | 0.15 | 0.39 |
| Estonia | α | 1.87 | 0.16 | 1.51 | 2.23 |
| | β | 0.17 | 0.02 | 0.14 | 0.21 |
| Finland | α | 1.91 | 0.12 | 1.66 | 2.15 |
| | β | 0.17 | 0.01 | 0.15 | 0.20 |
| Greece | α | 2.00 | 0.12 | 1.75 | 2.25 |
| | β | 0.18 | 0.01 | 0.16 | 0.21 |
| Iceland | α | 1.84 | 0.12 | 1.59 | 2.08 |
| | β | 0.16 | 0.01 | 0.14 | 0.19 |
| Italy | α | 2.79 | 0.04 | 2.70 | 2.87 |
| | β | 0.26 | 0.00 | 0.25 | 0.27 |
| Japan | α | 1.74 | 0.06 | 1.63 | 1.86 |
| | β | 0.15 | 0.01 | 0.14 | 0.17 |
| Korea, Rep. | α | 1.53 | 0.04 | 1.45 | 1.60 |
| | β | 0.14 | 0.00 | 0.13 | 0.15 |
| Latvia | α | 1.93 | 0.18 | 1.53 | 2.33 |
| | β | 0.18 | 0.02 | 0.14 | 0.23 |
| Netherlands | α | 1.04 | 0.03 | 0.97 | 1.10 |
| | β | 0.09 | 0.00 | 0.08 | 0.09 |
| Norway | α | 1.13 | 0.04 | 1.06 | 1.20 |
| | β | 0.09 | 0.00 | 0.08 | 0.10 |
| Singapore | α | 0.13 | 0.05 | 0.02 | 0.24 |
| | β | 0.00 | 0.00 | -0.01 | 0.02 |
| Sweden | α | 0.66 | 0.11 | 0.43 | 0.89 |
| | β | 0.05 | 0.01 | 0.03 | 0.07 |
| United Kingdom | α | 1.88 | 0.07 | 1.74 | 2.02 |
| | β | 0.17 | 0.01 | 0.16 | 0.19 |

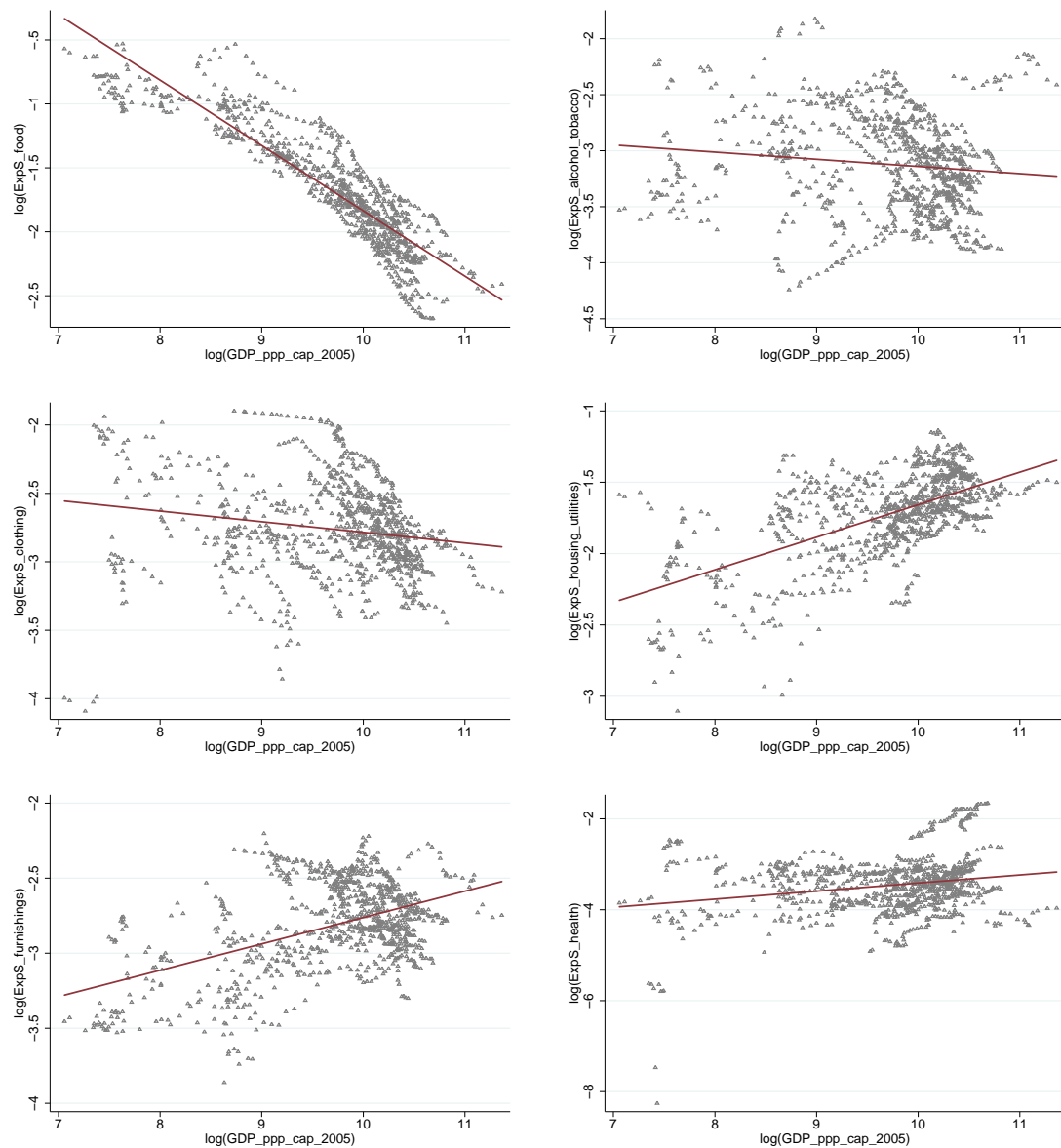
Notes: The table reports the coefficients, standard errors and the coefficient's 95% confidence intervals of countrywise estimations using equation (6).

Table A4: Country level nonlinear least squares estimates of the Engel curve for *recreation* & *culture*

| Country | | Coef. | Std. Err. | 95% Conf. Interval | |
|----------------|----------|-------|-----------|--------------------|-------|
| all | α | -0.22 | 0.01 | -0.23 | -0.20 |
| | β | 0.03 | 0.00 | 0.03 | 0.03 |
| Australia | α | -0.15 | 0.02 | -0.19 | -0.12 |
| | β | 0.03 | 0.00 | 0.02 | 0.03 |
| Belarus | α | -0.23 | 0.03 | -0.30 | -0.15 |
| | β | 0.03 | 0.00 | 0.02 | 0.04 |
| Czech Republic | α | -0.19 | 0.09 | -0.38 | -0.01 |
| | β | 0.03 | 0.01 | 0.01 | 0.05 |
| Denmark | α | -0.26 | 0.02 | -0.31 | -0.22 |
| | β | 0.04 | 0.00 | 0.03 | 0.04 |
| Estonia | α | -0.29 | 0.06 | -0.42 | -0.16 |
| | β | 0.04 | 0.01 | 0.02 | 0.05 |
| Finland | α | -0.14 | 0.02 | -0.19 | -0.10 |
| | β | 0.03 | 0.00 | 0.02 | 0.03 |
| Korea, Rep. | α | -0.19 | 0.02 | -0.23 | -0.15 |
| | β | 0.03 | 0.00 | 0.02 | 0.03 |
| Latvia | α | -0.29 | 0.07 | -0.44 | -0.15 |
| | β | 0.04 | 0.01 | 0.02 | 0.06 |
| Lithuania | α | -0.27 | 0.09 | -0.47 | -0.07 |
| | β | 0.04 | 0.01 | 0.01 | 0.06 |
| Slovakia | α | -0.05 | 0.05 | -0.17 | 0.06 |
| | β | 0.01 | 0.01 | 0.01 | 0.03 |
| Spain | α | -0.11 | 0.06 | -0.24 | 0.02 |
| | β | 0.02 | 0.01 | 0.01 | 0.03 |
| Sweden | α | -0.27 | 0.10 | -0.49 | -0.05 |
| | β | 0.04 | 0.01 | 0.02 | 0.06 |
| United States | α | -0.29 | 0.02 | -0.32 | -0.25 |
| | β | 0.04 | 0.00 | 0.03 | 0.04 |
| Bulgaria | α | -0.37 | 0.06 | -0.50 | -0.24 |
| | β | 0.05 | 0.01 | 0.03 | 0.06 |
| Canada | α | -0.38 | 0.03 | -0.44 | -0.33 |
| | β | 0.05 | 0.00 | 0.04 | 0.05 |
| France | α | -0.06 | 0.01 | -0.08 | -0.04 |
| | β | 0.01 | 0.00 | 0.01 | 0.02 |
| Germany | α | -0.04 | 0.10 | -0.25 | 0.18 |
| | β | 0.01 | 0.01 | -0.01 | 0.03 |
| Greece | α | -0.01 | 0.01 | -0.04 | 0.01 |
| | β | 0.01 | 0.00 | 0.00 | 0.01 |
| Hungary | α | 0.10 | 0.03 | 0.03 | 0.17 |
| | β | -0.00 | 0.00 | -0.01 | 0.00 |
| Iceland | α | 0.09 | 0.14 | -0.20 | 0.38 |
| | β | 0.00 | 0.01 | -0.02 | 0.03 |
| Ireland | α | 0.22 | 0.02 | 0.17 | 0.26 |
| | β | -0.01 | 0.00 | -0.02 | -0.01 |
| Israel | α | 0.18 | 0.16 | -0.17 | 0.52 |
| | β | -0.01 | 0.02 | -0.05 | 0.02 |
| Italy | α | -0.07 | 0.02 | -0.11 | -0.03 |
| | β | 0.01 | 0.00 | 0.01 | 0.02 |
| Japan | α | -0.51 | 0.09 | -0.70 | -0.33 |
| | β | 0.06 | 0.01 | 0.04 | 0.078 |
| Netherlands | α | 0.33 | 0.05 | 0.23 | 0.42 |
| | β | -0.02 | 0.00 | -0.03 | -0.01 |
| Norway | α | -0.64 | 0.03 | -0.70 | -0.58 |
| | β | 0.07 | 0.00 | 0.07 | 0.08 |
| Poland | α | 0.31 | 0.09 | 0.12 | 0.50 |
| | β | -0.02 | 0.01 | -0.04 | -0.01 |
| Singapore | α | 0.60 | 0.12 | 0.35 | 0.86 |
| | β | -0.05 | 0.01 | -0.07 | -0.02 |
| United Kingdom | α | -0.36 | 0.02 | -0.39 | -0.32 |
| | β | 0.05 | 0.00 | 0.04 | 0.05 |

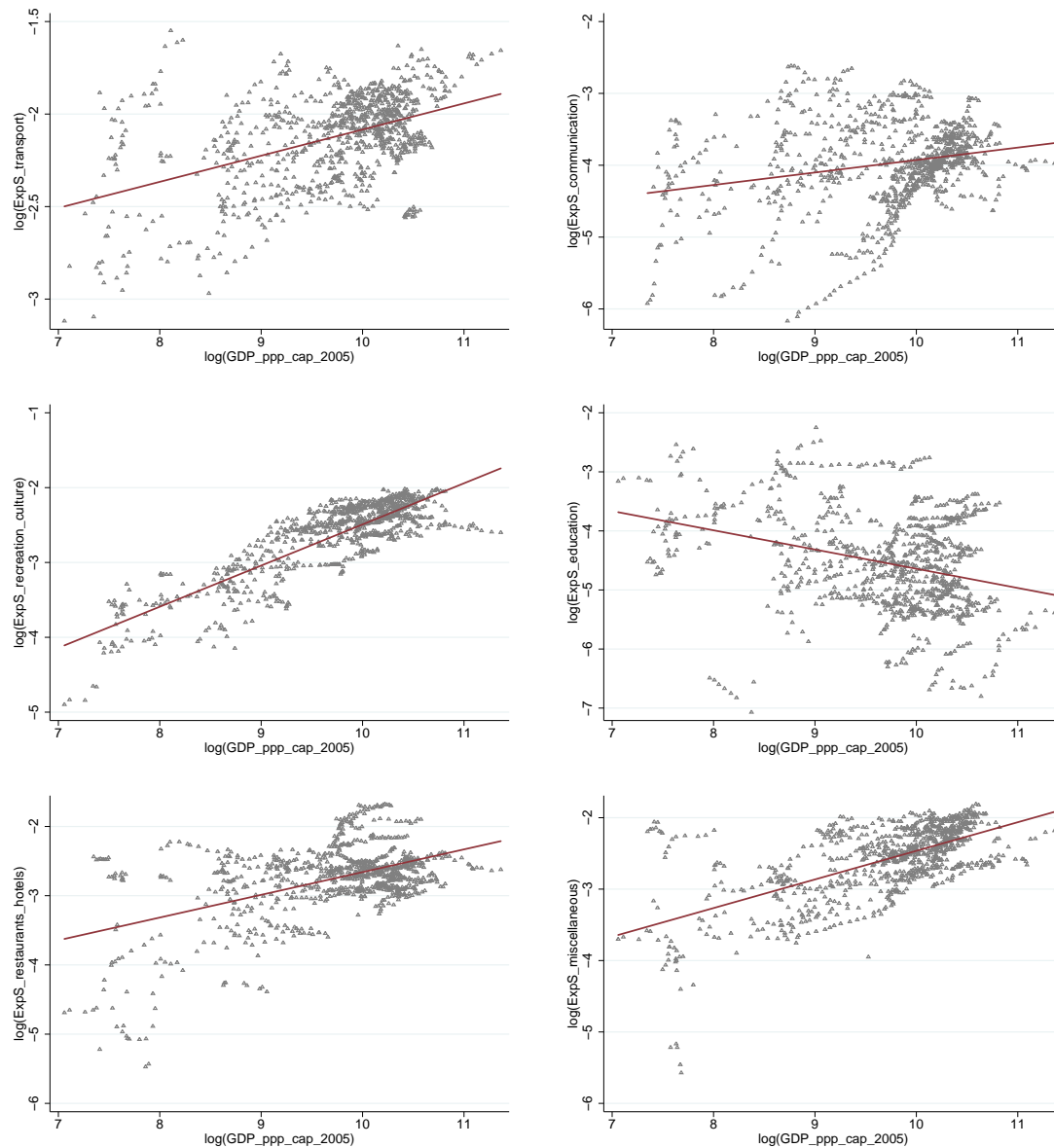
Notes: The table reports the coefficients and 95% confidence intervals of countrywise estimations of equation (6).

Figure A4: Changes in log expenditure shares with rising log income



Notes: The charts display scatterplots for log expenditure shares on log income (PPP adjusted real GDP per capita). A linear fitted regression line is added respectively.

Figure A5: Changes in log expenditure shares with rising log income - continued



Notes: The charts display scatterplots for log expenditure shares on log income (PPP adjusted real GDP per capita). A linear fitted regression line is added respectively.