



Identification and Estimation of Quadratic Food Engel Curves: Evidence from Cameroon

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Abstract

In this paper we estimate quadratic food Engel curves using data from the 2001, 2007 and 2014 Cameroon household consumption surveys. To address potential mismeasurement of regressors, we employ the heteroscedasticity-based identification strategy. Exploratory non-parametric analyses suggest quadratic forms for the food Engel curves. The regression results in this study confirm these patterns. At lower spending levels, unit increases in total spending increase the food budget share, while at levels above the spending thresholds unit increases in total spending reduce the food budget share. We

also find evidence of major shifts in the quadratic food Engel curves over time. These findings suggest that reducing taxes on food items would be more beneficial to poor households.

Introduction

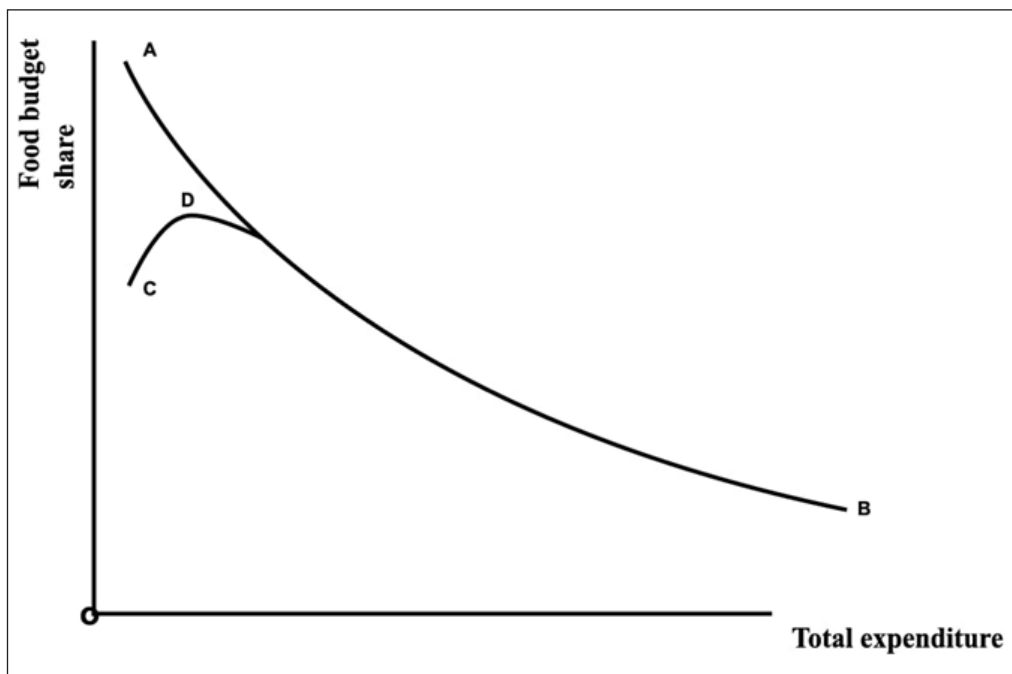
Household expenditure is an essential element of aggregate demand when modelling household consumption behaviour. The major components of household expenditure are food and non-food, with clothing, education, housing and fuel the key components of non-food spending. Household food expenditure is a very important component of household total expenditure. On average, food expenditure accounts for about 50% of the total expenditure of households in low-income countries (USDA, 2011). Deaton (2018) indicates that the essential role of food expenditure in gauging household levels of welfare is evident from its huge share in the household total budget among underprivileged households. Zereyesus et al. (2017) corroborate this claim by indicating that resource poor households in Northern Ghana spend 66%, on average, of their expenditure on food.

Therefore, the share of household food expenditure can be used as an essential measure in gauging household welfare. The link between food expenditure and income was first studied empirically by Engel (1857), a German statistician. He observed that the income elasticity of demand for food was relatively low; an observation that became the basis of the famous Engel law. *Engel's law stipulates that as the income of a household increases, the proportion of the income devoted to basic necessities such as food decreases*, stating that the elasticity for food is always positive but less than one. In this context, if Engel's law is verified, poorer households will be vulnerable to price shocks. That is, poorer households are likely to witness greater welfare losses from food price hikes as food constitutes a greater portion of their budget, and these poor households have fewer substitution options (Wood et al., 2009). Robles and Keefe (2011) use data from Guatemala to corroborate this view by observing that households in rural settings were more vulnerable to food price shocks compared to their urban counterparts.

Household responses to income changes in terms of food budget shares are useful to both economists and policy stakeholders. It is an essential element in designing tax and transfer policies (Deaton, 1992; Jappelli and Pistaferri, 2010). In developing countries, it can inform the design of consumption support policies and other targeted interventions (Luseno et al., 2014; Fenn et al., 2015). A key reason for the importance of such responses is that they provide information about the potential sources of possible poverty traps. If households show a strong response to income changes in terms of food consumption, a nutrition-based poverty trap is plausible (Banerjee and Duflo, 2011; Schofield, 2014). Kedir and Girma (2007) also confirm that the Engel curve is an essential tool in understanding welfare dynamics.

The food insecurity status of a household is likely to be linked to the budget the household devotes to food consumption. High income households are expected to spend a low proportion of their income on food, which is usually greater than the minimum amount needed for a nutritious and healthy diet. Conversely, households with limited resources devote a greater share of their income to food, which would usually be less than the minimum amount required for a nutritious and healthy diet, leading to forms of food insecurity such as reduced food intake and disrupted eating patterns. Therefore, the amount of income spent on food by a household can provide an insight into the household's food security status. This suggests an Engel curve depicting a negative relationship between the household food budget share (proportion of income allocated to food) and household total expenditure (proxy for income), as illustrated by the AB curve in Figure 1.

Figure 1: Two possible Engel curves



Source: Adapted from Edirisinghe (1987)

However, researchers have raised the possibility that ultra-poor households are likely to defy this standard Engel relationship (Edirisinghe, 1987). This defiance is illustrated by the CDB curve in Figure 1. The implication of this behaviour for abjectly poor households is that, following a positive income shock, they are likely to first increase household food spending, leading to an increase in the proportion of income devoted to food up to a saturation point, beyond which the standard Engel relationship starts to manifest. These turning points can be used to define poverty lines.

Grigg (1994) provides a plausible explanation for the defiance of the standard Engel relationship. First, ultra-poor households, unable to meet their nutritional requirements, usually devote almost all of their additional income to food. Second, with a growth in income, households are likely to shift from cheap staples to costly food items like eggs, milk, fish, and meat. Such shifts among households at the lower tail of the income distribution are likely to be minimal. Even if such shifts in preferences occur, they do not explain why the food share begins to relate inversely to income after point D in Figure 1. These possibilities suggest the likelihood of quadratic food Engel curves for developing countries. Identifying the positive segment of the Engel curve is important for food security, as well as other welfare policies. Households with total spending within this segment are likely to be those highly in need of targeted social welfare interventions, such as cash transfers or work-for-cash public works programmes.

Earlier empirical studies used the Working-Leser specification in which food shares are perceived as a linear function of total expenditure (Leser, 1963; Deaton and Muellbauer, 1980). This linear functional form of the Engel curve cannot depict the positive segment of the Engel curve, which can be used in identifying the proportion of food-poor households that should be targeted through interventions such as conditional cash transfers. In the 1990s, a great body of empirical work provided evidence of non-linear Engel curves for non-food items (Lewbel, 1991; Hausman et al., 1995; Banks et al., 1997). Empirical work on non-linear food Engel curves is still minimal. The few studies that have endeavoured to model and estimate quadratic food Engel curves in developing countries include Bhalotra and Attfield (1998) for Pakistan, Kedir and Girma (2007) for Ethiopia, and Moss et al. (2016) and Nsabimana et al. (2020) for Rwanda. To the best of our knowledge, no published work has estimated quadratic food Engel curves using Cameroonian data.

Quadratic food Engel curves may have important implications for the design of tax policies. For example, a higher tax on food items compared to non-food items implies that a higher proportion of the tax burden is borne by low-income households. The formulation of government tax and transfer policies relies on the nature of the Engel curve to a great extent (Deaton and Muellbauer, 1980; Blundell, Duncan and Pendakur, 1998; Banks, Blundell and Lewbel, 1997). Within this, a wrong specification of the Engel food curve is likely to limit its usefulness by generating misleading policy advice. The curvature of the Engel food curve is likely to be important for countries such as Cameroon, where a significant percentage of households still have subsistence income levels. Since the 2008 food crisis, the Government of Cameroon has implemented policies aimed at reducing import taxes on food items such as rice, flour, and fish. Also, little attention has been devoted to the evolution of Engel food curves over time. This is surprising as the shifts in food Engel curves over time, even during periods of stable prices, are likely to provide researchers and political entrepreneurs with essential information on changes in household welfare. Thus, estimating Engel food curves over time is expected to empirically contribute to the research on household consumption behaviour.

This study contributes to the empirical literature by estimating quadratic Engel food curves over time, which can be key inputs into public policy debates on household welfare and food security. Based on this, the research questions that need to be addressed are: (i) What is the nature of Engel food curves using data from the three most recent waves of Cameroon household consumption surveys?; and (ii) What income range defines the turning points of the Engel food curves, if any? The objectives of the study are to: (i) examine the nature of Engel food curves; and (ii) explore the income range defining the turning points of Engel food curves, if any. To address these issues, the study uses the 2001, 2007 and 2014 Cameroon household consumption surveys data, and an augmented heteroscedasticity-based identification strategy.

Background information on the Cameroon economy

In the past 20 years, the economy of Cameroon has witnessed several shocks, including price rises in essential household expenditure items that reduced the purchasing power of households. The increase in the general price level is predominantly driven by the increase in the prices of food items. The soaring prices of food items appear to be higher than the increase in the general price level, as shown in Figure 2. This figure also shows great volatility in food price inflation over the period 2000–2021. In a country where the food budget share is over 50%, rising food prices have detrimental food security implications. The current global price inflation of almost all food items affects several developing countries, including Cameroon, that rely on food imports.

Figure 2: Evolution of prices in Cameroon, 2000–2021



Source: Author, using data from Food and Agriculture Organization of the United Nations. (2022)

In 2002, annual food price inflation stood at about 5.8%. This spike in the prices of food items can be attributed to the depreciation of the exchange rate. The depreciation of the exchange rate is expected to have been the cause of food price inflation based on the idea that in Cameroon most food items, such as wheat, vegetable oil and rice, are mainly imported. Real exchange rate depreciation increases the prices of food items by increasing the cost of importing food items and, equally, the cost of importing fertilizer and other finished products relating to agricultural commodities, leading to rising domestic market prices. This was coupled with the high local prices of grains following a poor harvest. Prices stabilized later in 2003 as a result of the appreciation of the FCFA/USD, and we observe a sharp drop in food price inflation, only for it to regain momentum in 2005.

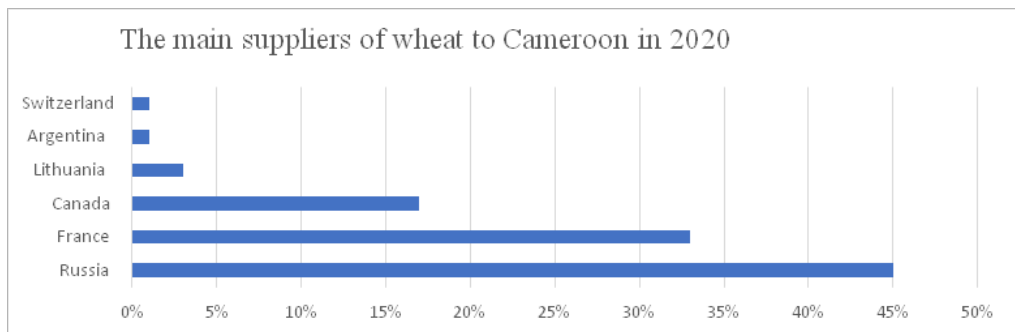
Another significant peak in food price inflation is observed in 2008, which corresponds to the 2008 food crisis. At the time, Cameroon was one of the countries in the world that was greatly affected by soaring food prices in world markets. This crisis was so damaging because it led to social unrest as the food security of households was threatened. Similar to the prevailing inflation in almost all global regions, the 2008 food price hike was mainly due to the “spike” in international commodity prices that led to price increases of almost 80% between early 2006 and mid-2008, before dropping sharply in 2009 (Davidson et al., 2012). Cameroon was seriously affected because the majority of Cameroon’s imports consist of rice, frozen fish, and wheat flour. The famous February 2008 riot in Cameroon indicates the damaging effects of price hikes. As a response to this riot, the Government of Cameroon put in place policies aimed at increasing the purchasing power of households. In particular, the Government of Cameroon slashed customs duties on basic necessities such as rice, wheat flour and fish, and the prices of petroleum products were reduced at the pump.

Following these measures, food price inflation in Cameroon decreased from 2009 to 2011 but did not return to the level observed in 2004. From 2011 to 2021 there was a similar and continuous rise in the general price level and food prices in Cameroon. However, the evolution of food price inflation appears to be very volatile. Food price inflation was perceived to have moved from an average of 1.7% in 2011 to an average of 3.2% in 2013, then decreasing in 2014. Another interesting episode of food price inflation in Cameroon occurred in the period 2017–2021. We observe a continuous rise in food price inflation in Cameroon: food price inflation rose from about 0.04% in 2017 to an average rate of about 3.6% in 2021. Multiple factors can be attributed to this continuous rise in food inflation in Cameroon. According to the Institut National des Statistiques du Cameroun [INS] (2022a), the continuous increase in prices of local food items could be attributed to the contraction in supply resulting from the Anglophone crisis that affected the English-speaking regions of Cameroon, climate change and the disruption in market supply chains due to the COVID-19 pandemic. Regarding the increase in prices of imported products,

the persistent increase can mainly be attributed to the disruption caused by the pandemic, particularly the restriction of imports, the energy crisis, and the increase in maritime transport costs.

The Russia-Ukraine crisis has led to financial sanctions and embargoes on Russia, which is expected to result in an import reduction from Russia and Ukraine, and soaring commodity prices across the globe. According to the INS (2022b), the Cameroon-Russia trade balance recorded a deficit of FCFA96.5 billion in 2020, following FCFA84.3 billion in 2019, an increase of 14%. With regard to global trade, the Russian Federation ranks 14th among Cameroon's trading partners in 2020. It ranks 8th in imports and 74th in exports. Over the period 2018–2021 the main imported goods to Cameroon from Russia were wheat flour and fertilizer. Russia contributes about 45% and 43% to the total import of wheat and fertilizer, respectively, and as such Russia is the main supplier of these products to Cameroon. Figure 3 illustrates the main suppliers of wheat flour to Cameroon, with Russia as the main supplier.

Figure 3: Main suppliers of wheat to Cameroon, 2020



Source: Authors using data from INS (2022b).

According to the INS (2022b), the Cameroon-Ukraine trade balance increased by 60% in 2020, amounting to FCFA64.1 billion against FCFA40.1 billion registered in 2019. As of 2020, Ukraine was ranked the 19th largest trading country with Cameroon. Regarding imports, Ukraine occupies the 15th position while in exports it occupies the 93rd position. Iron and steel are the main products imported from Ukraine, constituting about 95% of imports.

The Russia-Ukraine armed conflict is already disrupting the supply chains of products to Cameroon and is expected to lead to increases in import costs and, therefore, increased inflationary pressures in general on products from these two countries, specifically wheat flour and its by-products (such as bread and pasta), fertilizers and certain building materials.

Data source

This study makes use of a pool of three recent waves of the Cameroon Household Survey on income expenditure and consumption (ECAM 2, 2001; ECAM 3, 2007; ECAM 4, 2014).. The Cameroon household consumption surveys contain nationally representative data. Two types of sampling designs are employed based on the zone of residence. In the main cities of Yaoundé and Douala, two-stage sampling is adopted. For other areas, three-stage random sampling is used.

The 2001 wave of the consumption survey (ECAM 2) comprised 10,992 households and was carried out by the government's statistics office, the National Institute of Statistics, from September to December 2001. The main objective of this survey was to put in place a novel methodology of calculating poverty lines and also to correct the mistakes identified in the first survey (Institute Nationale des Statistiques [National Institute of Statistics], 2002). The data were obtained from 22 strata comprising 12 urban and 10 rural areas. The main cities of Douala and Yaoundé were employed as separate strata, while each region was partitioned into two strata: one urban and one rural.

The third wave of the consumption survey (ECAM 3) constituted 11,391 households and was carried out from May to July 2007. The major aim of this wave of the consumption survey was to evaluate efforts towards the implementation of the poverty reduction strategy paper and the millennium development goals (MDGs), and also to update the poverty profile for Cameroon. The 2007 survey was collected from 32 strata comprising 10 semi-urban strata and 10 rural strata, with a stratum extracted from each region, and 12 urban strata. The data consist of 742 primary sampling units of which 290 are in rural areas and 452 are in urban areas.

10,303 households were contacted for ECAM 4 in 2014. The 2014 survey aimed to update the poverty profile of 2001 (ECAM 2) and 2007 (ECAM 3), to assess the progress made in the fight against poverty and towards the achievement of the MDGs, and to guide the ongoing revision of the poverty reduction strategy paper. In order to render the three surveys comparable, the three data sets were intertemporally harmonized using price indices computed by the National Institute of Statistics. Indeed, the expenditures of 2007 and 2014 were deflated in terms of the 2001 prices. The consumer price indices (CPIs) were 174.8, 196.2 and 224.2, respectively, for 2001, 2007 and 2014, while the food price indices (FPIs) stood at 195.9, 218.1 and 259.3, respectively, for 2001, 2007 and 2014.

Conclusion and policy implications

This study aimed to estimate food Engel curves for Cameroon while correcting for measurement errors using the three most recent Cameroon household surveys. Specifically, the study set out to: (1) examine the nature of the food Engel curves for 2001, 2007 and 2014; and (2) calculate the critical expenditure (turning point) beyond which households experience diminishing returns. Regarding the empirical strategy, the paper used a non-parametric analysis to examine the nature of the food Engel curves for the three surveys, and a Lewbel (2012) heteroscedasticity-based instrument supplemented by external instruments to identify and estimate quadratic food Engel curves.

Findings from the non-parametric analysis indicate that the food Engel curves are parabolic in nature for 2001 and 2014, and linear for the 2007 survey. Results from both the OLS and the 2SLS estimations of the food Engel curves reveal that total expenditure increases with household food budget share up to a critical expenditure point, beyond which this critical expenditure total expenditure starts declining with household food budget share total.

The shift in food Engel curves over the period 2001–2007 and 2001–2014 can be translated as a decrease in food poverty and an improvement in household welfare over these periods. This can be explained by the decrease in the responsiveness of household food budget share to total expenditure. This is supported by Engel (1857), who stipulated that richer households have lower income elasticities. Thus, the decrease in the magnitude of the effects of log of total expenditure and the log of total expenditure squared can be interpreted as welfare improvement.

The study's findings reveal that the food Engel curves for Cameroon are quadratic in nature. This is contrary to the food Engel curve typically found for developed countries, which appears to be Working-Leser (linear in nature). Our analysis thus provides additional evidence to support the hypothesis that quadratic Engel curves are a feature of developing countries. Importantly, in case of a negative income shock, mis-specified models of the Engel curve underestimate expenditure variability. Based on the evidence of a quadratic food Engel curve (presence of an increasing segment in the Engel curve), a reformulation of policies aimed at reducing food insecurity and improving the welfare of ultra-poor households is crucial. Indeed, if taxes on food items are high, low-income households will be most affected. Therefore, it would be better if taxes are levied in such a way that the impact is lower on resource poor households. Policies such as reducing taxes on food items should be encouraged as the tax burden on food items is likely to be borne by low-income households. In particular, the Government of Cameroon can reduce custom duties on basic necessities such as rice, flour and fish that will, in turn, increase the purchasing power of households and

thus increase food security. Another policy that the Government of Cameroon should consider in order to ensure food security of ultra-poor households is targeted transfer schemes. Transfer schemes are expected to compensate for adverse effects such as price hikes in some staple food items, which mainly affect ultra-poor households.

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