Peterson Institute for International Economics

Policy Brief

NUMBER PB15-21

NOVEMBER 2015

World on the Move: The Changing Global Income Distribution and Its Implications for Consumption Patterns and Public Policies

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Authors' Note: We are grateful to Jan Zilinsky for excellent research assistance and to William R. Cline, Adam S. Posen, and Steven Weisman for helpful comments. Special thanks to Olivier Dupriez, of the World Bank, for sharing his expertise on household surveys and generously sharing data with us.

Population and output growth projected at a higher rate in emerging economies than in advanced countries in the next two decades will reduce the income gap between the global rich and the global poor. As purchasing power increases, households are expected to spend proportionately less on food and more on transportation. This shift in spending patterns will increase pressures on infrastructure, especially in emerging economies, and aggravate global climate change. Governments will have to respond to these challenges in a fiscally sustainable and environmentally responsible way.

Global consumption patterns reflect the sum of the choices made by individuals worldwide on what to buy, subject to the constraints imposed by their incomes. To forecast global consumption patterns over the next 20 years—and to draw implications for policies by governments and international bodies—it is helpful to project global income distribution at the individual level and to estimate how rising incomes will affect consumption choices.

This *Policy Brief* estimates the empirical association between individual consumption and the share of spending on each of the seven categories of goods and services (food and beverages, transportation, clothing and apparel, housing and equipment, education, health, and other) based on household surveys for a wide range of low-income, emerging, and advanced economies. It then combines these estimates with projections of individual-level total consumption to project consumption globally for each category. This study is the first to project worldwide consumption and an exhaustive set of its broad components for the next 20 years by grounding such projections in micro-economic estimates of how spending patterns change as total consumption rises.

As purchasing power increases worldwide, people will…reduce the share of food and increase the share of transportation in their overall expenditures.

The estimates reveal that as individuals attain higher consumption levels, the share of transportation in their consumption baskets increases—initially at an accelerating pace, later at a slower pace, as satiation sets in—and the share of food declines. The share of spending on other categories does not display a clear relationship with total consumption. At the global level, spending on transportation goods and services will increase by 124 percent between 2015 and 2035, compared with 107 percent for total consumption—a modest difference because much of today's transportation spending occurs in advanced economies, where spending is projected to grow relatively slowly in the next two decades. The gap will be far larger in emerging economies. Growth of transportation spending will be especially strong in emerging Asia—including China

and India—and Sub-Saharan Africa, where large segments of the population are on the cusp of being able to afford cars and air travel for the first time. In China, India, and Sub-Saharan Africa, transportation consumption is projected to grow by 250 percent or more over the next two decades, well in excess of total consumption.

Transportation requires more infrastructure and energy than other consumption categories. The projected rapid growth of this sector suggests the need for a major infrastructure push in the emerging economies most affected. Strategic choices need to be made now about what kind of infrastructure should be built—subways versus roads for in-city commuting, trains versus cars for longer-distance travel, green energy versus coal (at least in the absence of "capture and storage") in power generation. Such choices will lock in the degree of carbon intensity of the emerging economies for many years to come and will determine whether the global community is able to keep further climate change in check. Now is also the time to consider the means by which infrastructure can be sustainably financed (cuts in other spending, additional tax revenues, etc.) in countries with the greatest needs in this area over the next two decades.

Growth of transportation spending will be especially strong in emerging Asia—including China and India—and Sub-Saharan Africa....

ADVANTAGES AND DISADVANTAGES OF THE METHODOLOGY USED

The approach in this *Policy Brief* complements ongoing efforts to project private consumption and the resulting public investment needs. Earlier projections of transportation (OECD and ITF 2015), energy consumption (IEA 2015a), or infrastructure requirements (OECD 2012) have generally been obtained using a combination of bottom-up and top-down approaches or multi-equation models. In several cases these models project various transportation modes (road, rail, ship, air, freight, passenger), allowing each to have its own elasticity with respect to income, and take into account the impact of fuel prices, sometimes in a general equilibrium context. For the most part, however, these estimates do not use information on the distribution of household incomes within individual countries, and their elasticities are based on cross-country relationships estimated using per capita averages. Moreover, studies usually focus on just one or a few expenditure items rather than on all consumption and its subcomponents.

This *Policy Brief* focuses on the consumer demand side. It considers consumption and an exhaustive set of its subcomponents using a consistent framework, based on data from household surveys. Using household-level information on consumption patterns and their composition yields more precise estimates, for three reasons. First, the relationship between total consumption and the share of consumption allocated to a given spending category is estimated more precisely, because the number of observations available from household surveys far exceeds the number from cross-country comparisons. Second, by construction, country averages contain no information on consumption patterns in the tails of the distribution (very low and very high incomes). Third, nonlinearities in the share of consumption allocated to particular types of goods as consumption rises mean that consumption growth of such items depends not only on growth in a country's average per capita consumption but also on the within-country distribution across individuals.

This brief does not delve into important aspects of this issue, which are better captured by other work. For transportation, for example, it captures only direct spending by consumers; it does not take into account the indirect implications of spending on, say, health care or food products for freight transportation. It also abstracts from the general equilibrium implications of consumer demand on commodity and other prices.

The transportation consumption projections reported here are toward the high end of the spectrum of projections that can be inferred from analyses of related issues. Although other studies do not project total transportation expenditure by consumers, they project broadly comparable proxies, such as rail and road passenger travel and the number of cars. For example, the OECD and ITF (2015) estimate that through 2050, road and rail passenger travel will grow at an annual rate of 2.3 to 3.5 percent for the world as a whole and by 3.6 to 5.0 percent in non-OECD economies. This brief projects an annual average growth rate of transportation consumption of 3.7 percent globally and 5.1 percent for non-OECD economies.

HOW RISING INDIVIDUAL INCOMES SHAPE CONSUMPTION CHOICES

We estimate the impact of rising individual incomes on consumption choices by applying well-established methods to underexplored household consumption surveys (box 1). The share of spending on each category is regressed on the natural logarithm of total consumption (in 2011 dollars at purchasing power parity), using data from household surveys from several countries.

The data for this exercise are drawn from household surveys for Albania (2008), Bangladesh (2010), Brazil (2008), Colombia (2010), Indonesia (2010), India (2011), Mexico (2010), Malawi

Box 1 Refresher on the theory of the consumer: Engel curves

Empirical analysis of the relationship between income and the share of spending on specific consumption categories builds on a long tradition in economics. Indeed, textbook theory of the consumer defines goods based on how the quantities consumed evolve as an individual's income increases. Goods with income elasticities below 0 are known as "inferior goods," goods with income elasticities between 0 and 1 are known as necessities, and goods with income elasticities above 1 are known as luxuries. ("Normal goods" encompass both necessities and luxuries.) Income elasticities for some goods may differ depending on the income range over which the relationship is estimated: Some goods may behave as necessities within a certain income range and as luxuries within a different range (a refrigerator, for example, may be a luxury in poor societies and a necessity in advanced economies).

Using data from Belgian surveys of working class families, Ernst Engel (1857, 1895) showed that household expenditures on food rise with income and family size but that food budget shares decrease with income. This relationship, known as Engel's Law, is one of the most robust relationships in economics, having been confirmed in most countries and time periods. The share of spending on food is often found to decline linearly with the logarithm of income, although there is evidence of nonlinearity at very high and very low incomes. Engel curves for other goods have often been found to be nonlinear (see Lewbel 2006 for references).

(2010), Pakistan (2010), South Africa (2010), Uganda (2009), and Vietnam (2008), all made available through the World Bank's Global Consumption Database; Australia (2010), France (2010), Hungary (2012), Mexico (2010), Poland (2010), Russia (2013), Slovenia (2010), South Africa (2010), and Taiwan (2010), all from the Luxembourg Income Study database; and the United States (2013), from the Consumption Expenditure Survey conducted by the Bureau of Labor Statistics. Each survey covers several thousand individuals.[1] Both the Global Consumption Database and the Luxembourg Income Study seek to ensure the cross-country comparability of the surveys, including the definition of spending categories.

For each survey, all households earning incomes per capita within a narrowly defined range (say, $10,000 to $10,100 in 2011 international dollars) are grouped together and their average consumption in each category is calculated. Each of these averages constitutes a data point for estimating the relationship between per capita household consumption and spending on each category of goods and services.

To estimate the relationship between individual incomes and the share of spending on each category, the first step is to plot the data for each country. Consistent with previous studies, figure 1 confirms a negative, broadly linear relationship between the logarithm of total individual consumption and the share of spending on food for most of the total consumption distribution (though imposing a linear relationship would imply a negative share of spending on food at high incomes).[2] Figure 2 reveals a positive, more clearly nonlinear empirical association between individual incomes and the share of spending on transportation: The relationship is convex at lower income levels (the share of spending rises more steeply as income grows), becoming concave at higher income levels (the share of spending rises less steeply as satiation sets in). Both of these findings hold in most countries analyzed, although for transportation convexity prevails in low-income countries and concavity prevails in some of the richest economies. Figures for the other categories are not included, because they do not display any consistent pattern.

The relationship between total household per capita consumption and the share spent on a particular good or service category is estimated using functional forms (Gompertz or logistic) that allow for the possibility of an *S*-shape and have the potential—if warranted by the data—to have two asymptotes, one corresponding to low incomes and the other to high income levels.[3] For transportation a Gompertz function is estimated, as in several studies of the market for cars.[4] For food the

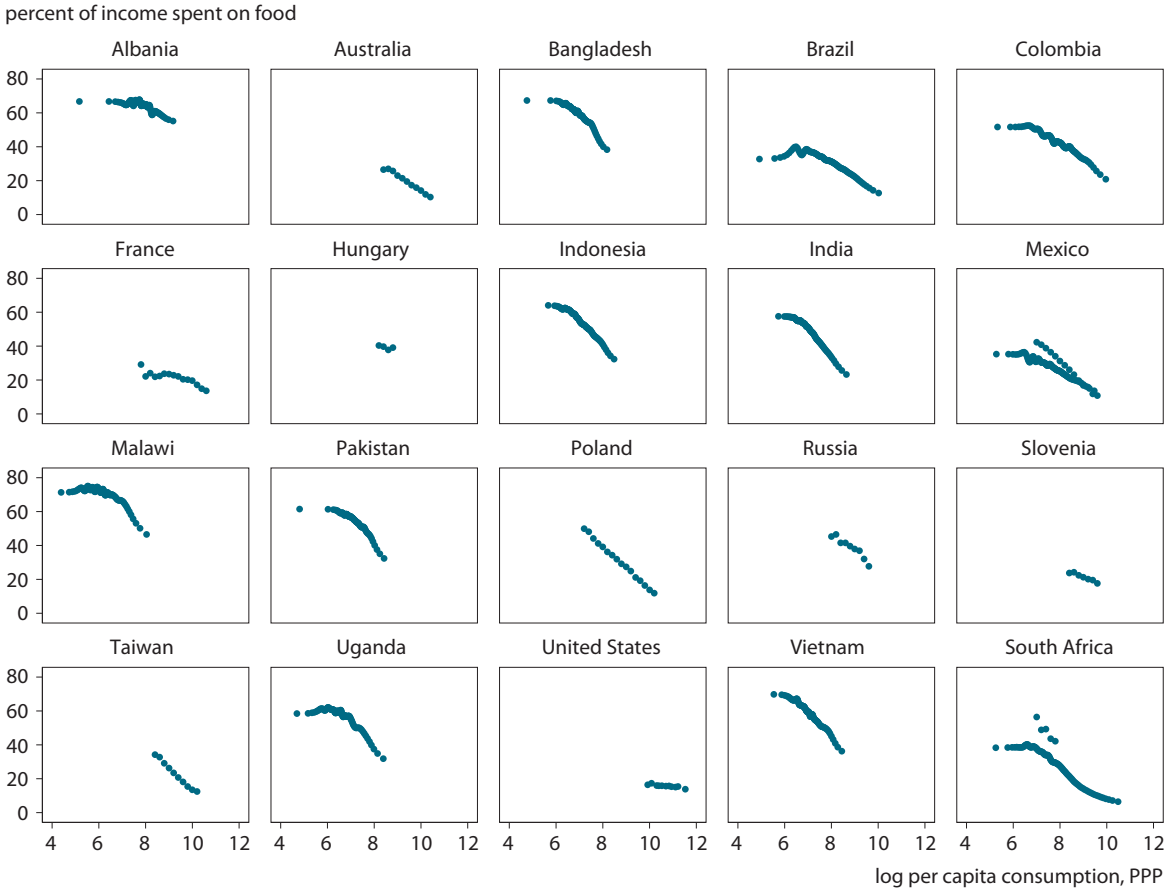
1. For Mexico and South Africa, the two surveys yield slightly different shares spent on food and transportation at each individual income level, but the patterns are similar.

2. "Food" is used as shorthand for "food and beverages." More detailed estimates (not reported) show that the share of beverages (especially alcohol and sugary drinks) in total consumption declines more slowly than the share of food. The share of meat and fish in total consumption also declines more slowly than for food generally.

3. The choice between logistic and Gompertz functional forms was based on goodness of fit and consistency with previous analyses on related topics. Both functional forms are sigmoid. The logistic form is symmetric, the Gompertz can be asymmetric.

4. For example, Dargay, Gately, and Sommer (2007) estimate a Gompertz function relating average per capita real incomes and the average number of cars in the population for a cross-section of countries.

Figure 1 Share of income spent on food versus logarithm of per capita total consumption in selected countries



PPP = purchasing power parity

Note: Data are from most recent household survey in each country in the sample considered. "Food" includes both food and beverages.

Sources: Household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

logistic function is preferred to the Gompertz function, because it provides slightly better fit and because the estimated coefficients imply that although very-high-income individuals reduce their share of food in overall consumption, they continue to increase the absolute amount of expenditure on food as incomes rise. For all other spending categories, linear relationships are assumed for simplicity, given the lack of clear evidence in favor of specific functional forms.[5]

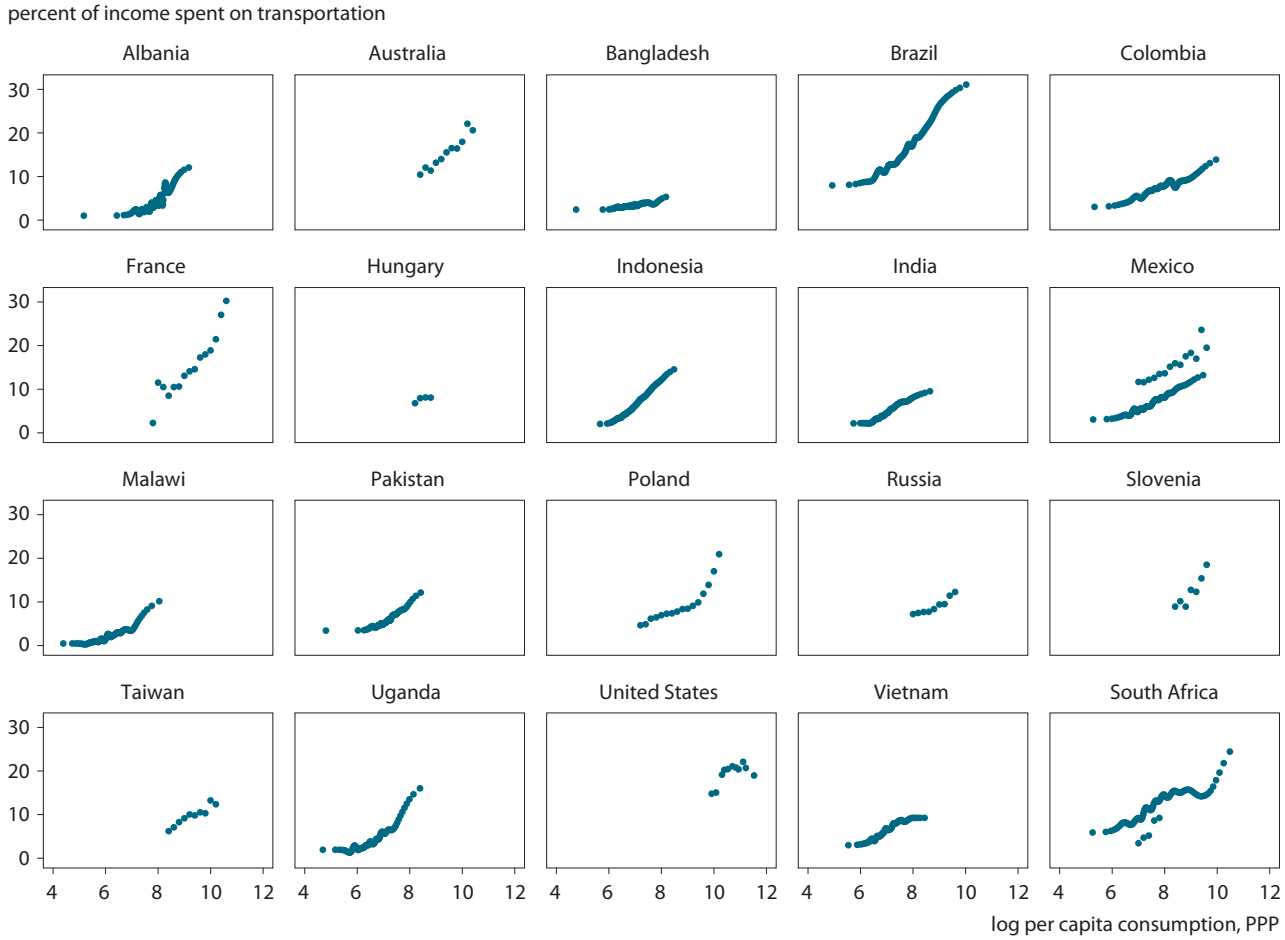
For each spending category, all data points for all countries in the sample are pooled.[6] (Recall that a data point is the combination of the average share of transportation in total consumption and the logarithm of the level of total consumption for all individuals surveyed in a given country within a predetermined total consumption range.) The resulting estimated relationships are shown in figure 3 for food and figure 4 for transportation.

The estimated Engel curves for both food and transporta-

5. Interestingly, the share of health care in total spending bears no clear relationship to individual incomes, in contrast to the strong positive association between the share of health care spending and average GDP per capita documented in studies based on time-series information from macroeconomic data (see, for example, Jones 2015). The absence of an empirical association in the microeconomic data casts doubt on the notion that health care is a "luxury" good, pointing instead to the possibility that an increase in the relative cost of health care over time may have been the key factor at play.

6. The results are similar if each country is allowed to have its own intercept, to allow for country-specific factors influencing average consumption of specific categories of goods or services (including any remaining differences in the way the surveys define the categories, despite efforts to make the surveys internationally comparable). In those estimates, all coefficients except the intercept (and thus the slope and curvature) are constrained to be the same for all countries.

Figure 2 Share of income spent on transportation versus logarithm of per capita total consumption in selected countries



PPP = purchasing power parity

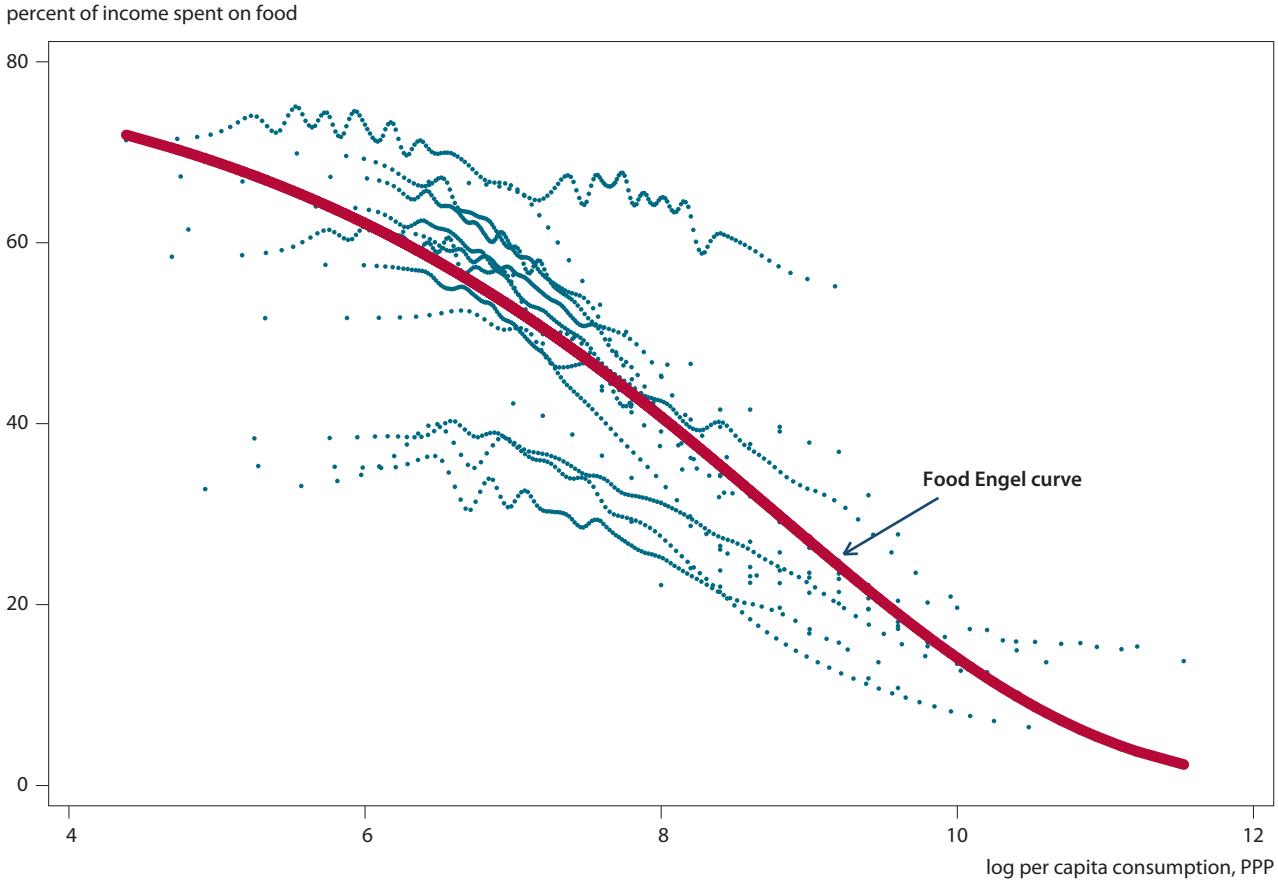
Note: Data are from most recent household survey in each country in the sample considered.

Sources: Household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

tion display high goodness of fit (the adjusted R^2 equals 0.95 for food and 0.86 for transportation). The estimated coefficients are reported in appendix A. Consistent with many previous studies, the estimated slope for food is negative and linear for most income levels. At very high income levels, the relationship asymptotes, so that the share of spending on food remains positive (and the absolute amount of spending on food continues to rise as total consumption rises). Interestingly, even at extremely low levels of total consumption the share of food does not approach 100 percent. This finding is consistent with work by Abhijit Banerjee and Esther Duflo (2007), who report that the share of food in total consumption is 56 to 78 percent among extremely poor households (people living on less than $1 a day) in a sample of 13 low-income countries. They document a significant share of spending on items such as festivals (an important part of life for people with extremely low incomes) and tobacco.

For transportation, nonlinearity manifests itself in the form of a relatively flat relationship between the share of transportation spending and individual total consumption at low levels of total consumption, an increasingly steep slope as consumption rises to levels typically associated with advanced economies, and a somewhat flatter curve once satiation seems to set in. The *S*-shape for total transportation spending is less pronounced (less nonlinear) than in studies on cars alone (Chamon, Mauro, and Okawa 2008; Dargay, Gately, and Sommer 2007), perhaps as a result of two factors. First, cars are lumpy items, implying that households are not able to afford them when their incomes are below a minimum threshold (estimated by Chamon, Mauro, and Okawa at about $5,000 a year). Second, satiation at high income levels is observed for cars in several advanced

Figure 3 Share of income spent on food versus logarithm of per capita total consumption



PPP = purchasing power parity

Note: Figure shows the relationship estimated using a logistic function based on panel data. Each dot is an observation consisting of a combination of the average log per capita consumption and the average share spent on food for all individuals within a predetermined per capita consumption range in a survey. The dots tend to form lines for a given country. "Food" includes both food and beverages.

Sources: Household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

economies,[7] whereas satiation is less likely to affect spending on transportation more generally, including air travel.

To illustrate the advantages of using household-level data rather than countrywide per capita averages, appendix B reports the results obtained from the macroeconomic approach. Goodness of fit is weaker, and the results fail to display the nonlinearities revealed by the estimates based on household-level data (because per capita averages in cross-country relationships mask the information provided at the tails of the countrywide income distribution). The macro-based estimates do confirm that the slope of the Engel curve is positive for transportation and negative for food.

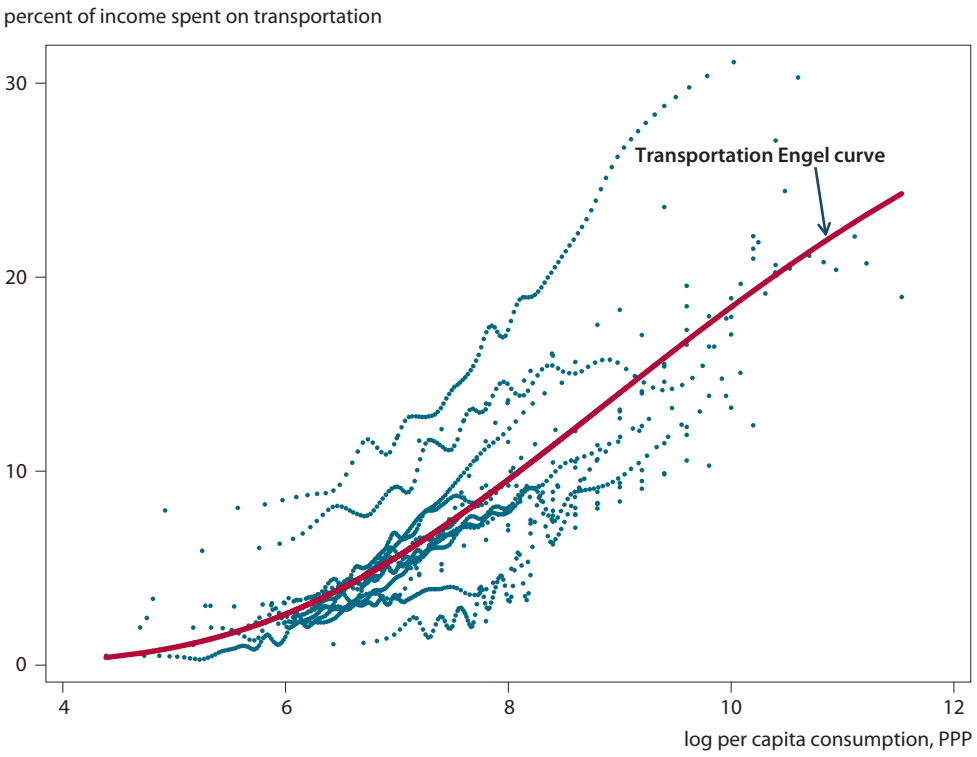
Changes in the shares of food and transportation in total spending as individual incomes rise are significant, both economically and statistically. An individual whose total consumption is $200 a year (in 2011 international dollars) is expected to spend 66.3 percent of total consumption on food and 1.2 percent on transportation. The shares for an individual whose total consumption is $200,000 are 3.4 percent for food and 26.4 percent for transportation (table 1).

For the sake of completeness, the estimated spending share is also reported for the remaining categories (clothing and apparel, housing and equipment, education, health, and other), based on the corresponding Engel curves (assumed to be linear).[8] Although these results are statistically significant (as is often the case with samples consisting of a large number of observations), they are not robust to changes in sample and estimation technique and therefore not discussed in the rest of this *Policy Brief*.

7. Passenger vehicle travel has declined for a few years in several advanced economies, notably Japan and the United Kingdom (OECD and ITF 2015).

8. The linear Engel curve for health is estimated with country fixed effects, to avoid undue influence from the United States, a clear outlier with much higher health care spending at all total consumption levels.

Figure 4 Share of income spent on transportation versus logarithm of per capita total consumption



PPP = purchasing power parity

Note: Figure shows the relationship estimated using a Gompertz function based on panel data. Each dot is an observation consisting of a combination of the average log per capita consumption and the average share spent on food for all individuals within a predetermined per capita consumption range in a survey. The dots tend to form lines for a given country.

Sources: Household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

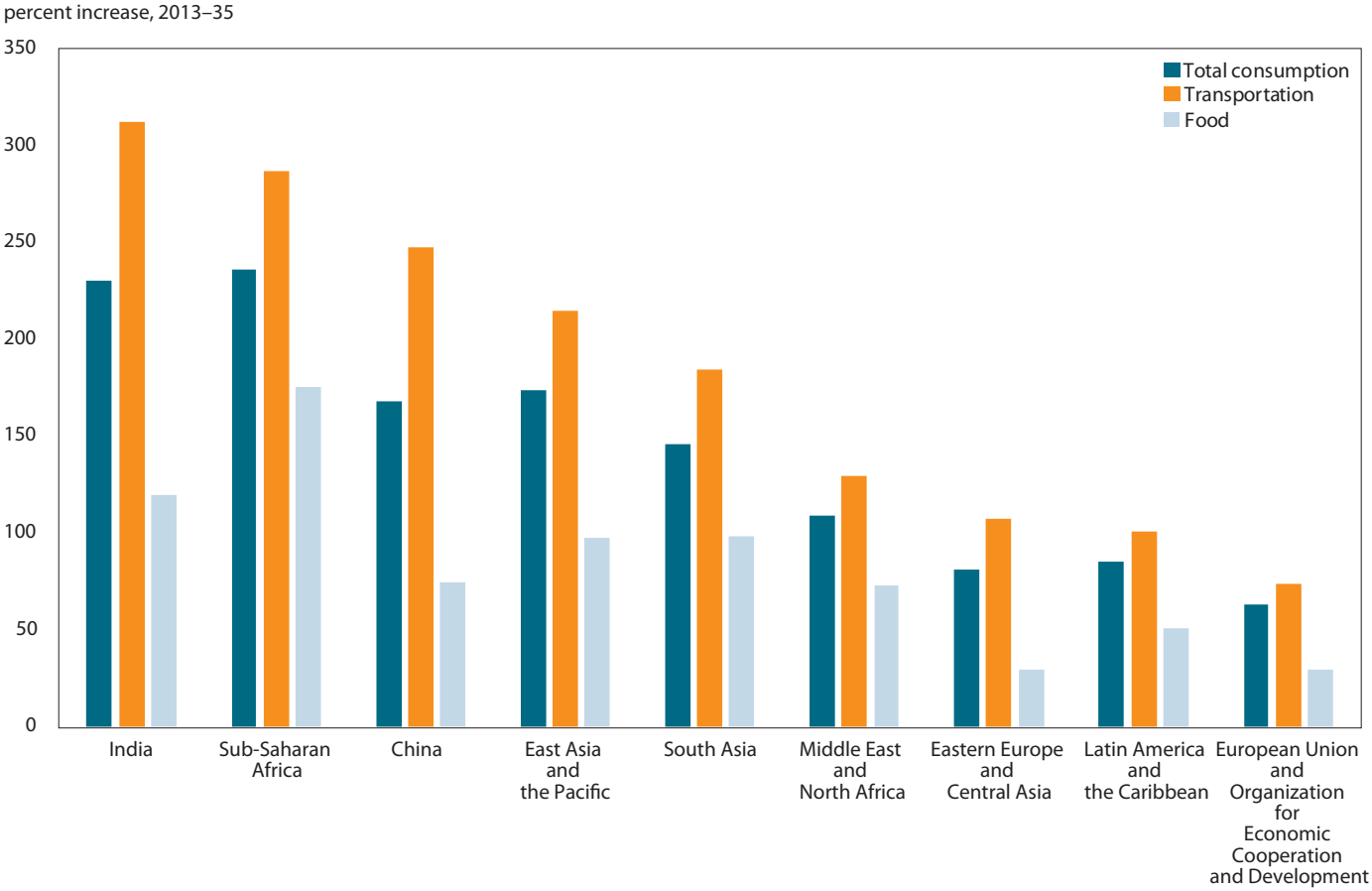
Table 1 Spending on goods and services by individuals at various levels of total consumption (percent of total spending)

	Annual consumption level			
Spending category	**$200**	**$2,000**	**$20,000**	**$200,000**
Food	66.32	45.85	16.36	3.43
Transportation	1.23	7.87	18.03	26.40
Clothing and apparel	5.04	5.09	5.15	5.20
Housing and equipment	13.41	18.81	24.11	29.40
Education	1.61	2.78	3.93	5.09
Health (fixed effects)	2.86	3.58	4.28	4.98
Other (residual)	9.54	16.02	28.14	25.50
Other (regression-based)	6.47	16.09	25.53	34.97

Note: The table shows shares of total individual consumption for individuals whose total consumption is at indicated levels (in 2011 international dollars). The Engel curve for health is estimated allowing for country-specific intercepts ("fixed effects"). "Other (residual)" is the difference between 100 percent and the estimated shares of food and transportation from the corresponding Engel curves. "Other (regression based)" is the predicted share of all other categories from a separately estimated linear Engel curve (so that the shares are not constrained to sum to 100 percent).

Sources: Engel curves estimated by the authors, based on data from household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

Figure 5 Projected growth rates of total, transportation, and food consumption, 2013–35



Note: Data are in constant prices.

Sources: Authors' projections based on data from household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

PROJECTED CONSUMPTION OF FOOD AND TRANSPORTATION

Building on the relationships estimated above, we project worldwide consumption of food and transportation goods and services using two types of inputs. The first are projections of total consumption at the individual level worldwide, obtained by combining the individual distribution of incomes (and consumption) within each country in 2013 with projections for each country's GDP growth between 2013 and 2035 (sources and data are reported in Hellebrandt and Mauro 2015[9]). The second are the Engel curves relating the share of each category in total consumption, obtained in the previous section. Each individual worldwide is assigned the amount of each consumption category that can be read off the Engel curves at his or her income level. Summing the consumption of each category over all individuals yields category totals for each country and for the world as a whole.

Figure 5 reports the growth rates (in constant prices) during 2013–35 for the spending categories that display the most action—namely, food (with the slowest growth) and transportation (with the fastest growth)—by country or region. Consistent with the positive slope of the Engel curve for transportation spending, growth is always higher for transportation than for total consumption. Spending on transportation is projected to increase by a factor of four in India, followed closely by Sub-Saharan Africa; three or more in China and East Asia and the Pacific; and at least two in all remaining emerging-economy regions. The growth of spending on transportation will be slowest in the European Union (EU)/Organization for Economic Cooperation and Development (OECD) group.[10]

9. The methodology used to estimate the global distribution of income has been refined since the publication of Hellebrandt and Mauro (2015). Incomes reported in household surveys have been scaled up to household final consumption expenditure in the national accounts, taking into account known survey measurement issues associated with sample truncation (undersampling in the upper part of the income distribution) and underreporting of self-employment income. More details on the improved methodology will be made available in later publications.

10. Using the full within-country distribution of individual incomes is

Table 2 Projected increase in consumption of food and transportation (as a share of initial total consumption) and shares of food and transportation in total consumption, 2013 and 2035 (percent)

Region	ΔFood/ total initial consumption	ΔTransportation/ total initial consumption	Share of food, 2013	Share of food, 2035	Share of transportation, 2013	Share of transportation, 2035
European Union and Organization for Economic Cooperation and Development	3.7	15.3	12.8	10.1	20.7	22.1
China	22.5	33.2	29.9	19.5	13.4	17.3
India	33.0	46.3	27.6	18.3	14.8	18.5
Latin America and the Caribbean	9.6	18.5	18.8	15.3	18.4	19.8
East Asia and the Pacific	21.4	36.6	22.0	15.8	17.0	19.5
South Asia	30.8	25.1	31.2	25.2	13.6	15.8
Middle East and North Africa	17.2	21.5	23.6	19.5	16.6	18.2
Sub-Saharan Africa	54.6	39.7	31.2	25.5	13.8	15.9
Eastern Europe and Central Asia	5.8	18.7	19.9	14.2	17.4	19.9
World	12.4	22.8	18.6	15.0	18.3	19.9

Note: Data are in constant prices (2011 international dollars). The first two columns report the increase in consumption of food and transportation, respectively, from 2013 to 2035, divided by initial total consumption in 2013; the remaining columns report food and transportation spending as a share of total consumption in 2013 and 2035.

Sources: Authors' projections based on data from household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

For food consumption, the highest growth rate is projected for Sub-Saharan Africa (175 percent), stemming in part from the rapid growth of total consumption there (the gap between the growth rates of food consumption and total consumption is relatively small because of the sizable initial share of food in total consumption in Sub-Saharan Africa).[11] India, Southeast Asia, and East Asia and the Pacific will also see food consumption at least double. The lowest growth rates for food spending (about 30 percent) are projected in the EU/OECD, Eastern Europe, and Central Asia.

Although the growth rate of consumption is lower for food than for total consumption, it may still put considerable pressure on natural resources. As individual incomes rise from very low levels, consumers usually increase the share of meat and fish in their diets. These items require more energy and water to produce and yield more CO_2 emissions than vegetarian sources of calories and protein.

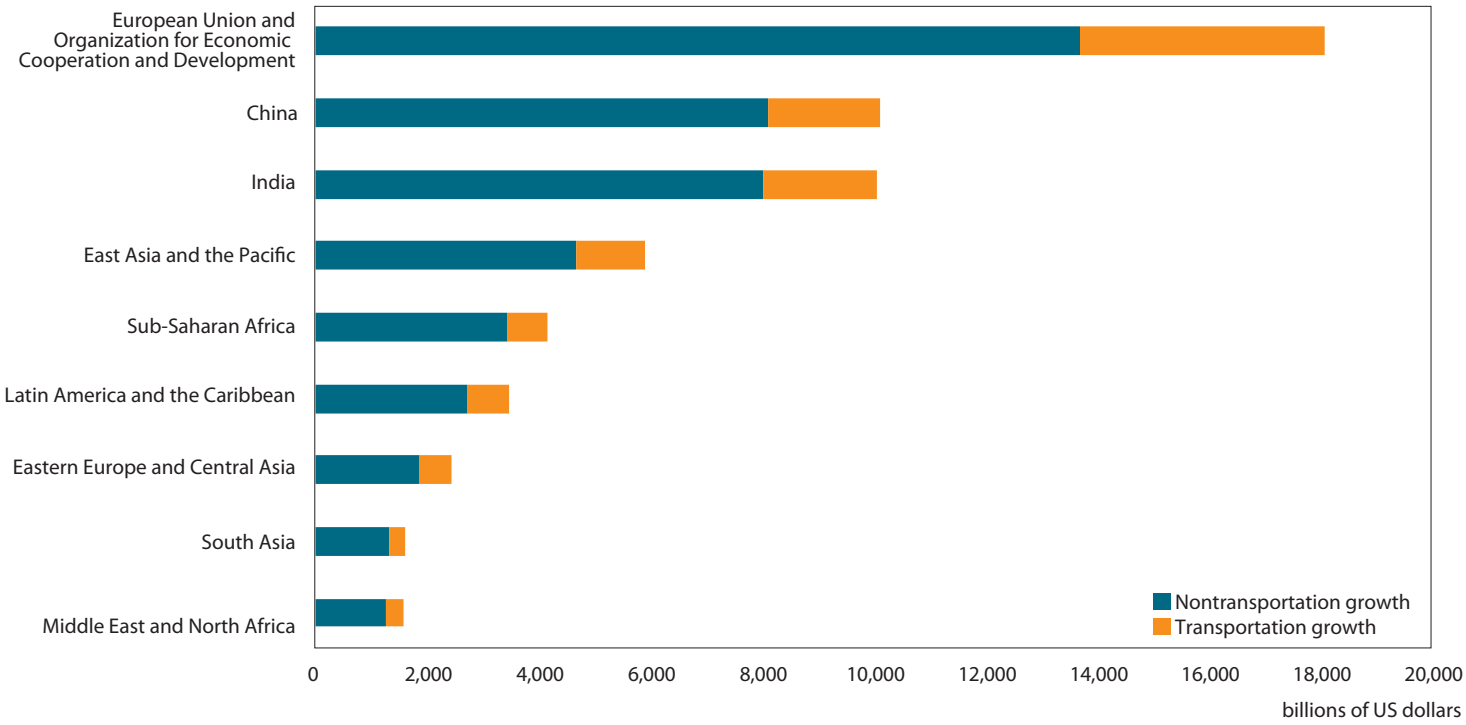
valuable. Had country averages of total per capita consumption been used in conjunction with the micro-based Engel curves reported in figures 3 and 4, the projected growth rates of transportation consumption would have been considerably higher for all countries and regions—by as much as 60 to 70 percentage points in India and Sub-Saharan Africa—primarily because the mean individual income in a country's or region's total consumption distribution is usually in the steepest section of the transportation Engel curve. Using the full distribution of incomes implies that many individuals are in sections of the Engel curve that are not as steep.

11. The gap between the growth rates of spending on food (F) and overall consumption (C) is determined by $\frac{dF/F}{dC/C} = \left[1 + \frac{C}{F}\frac{d(F/C)}{d(lnC)}\right]$. It thus depends not only on the slope of the Engel curve (positively) but also on the initial ratio of spending category F to total consumption (negatively).

Considering the growth rate of a given spending category or the gap between that growth rate and the growth rate of total consumption produces a partial picture of the macroeconomic relevance of increased spending in a category. Rapid growth of a relatively small spending category would have limited macroeconomic relevance. Moreover, as shown in footnote 11, the gap depends on both the slope of the Engel curve (positively) and the initial ratio of the spending category in question to total consumption (negatively). The gap between the projected transportation consumption growth and total consumption growth in advanced economies is smaller than in emerging markets because the slope of the Engel curve is flatter at high incomes and the initial share of transportation in total consumption is higher in advanced economies.

To complement the information from growth rates, we also report the projected behavior of food and transportation spending. Consistent with the negative slope of the Engel curves for food derived in the previous section, the global share of food is projected to decline to 15 percent of total consumption in 2035, down from 18.6 percent in 2013. The average transportation share in total consumption is projected to rise to 19.9 percent, up from 18.3 percent in 2013. The moderate rise in the share of transportation in total consumption stems from the fact that transportation expenditure is currently dominated by advanced economies, which will experience relatively slow economic growth in the next two decades. Shifts in consumption patterns vary considerably across countries or regions, with larger increases in the transportation share in emerging economies (table 2).

Figure 6 Change in consumption in selected countries and regions, 2013–35



Note: Data are in constant prices (2011 international dollars).

Sources: Authors' projections based on data from household surveys from the World Bank Global Consumption Database, the Luxembourg Income Study, and the Consumer Expenditure Survey (conducted by the US Bureau of Labor Statistics).

Table 2 also reports the cumulative increase in food and transportation between 2013 and 2035, expressed as a share of 2013 consumption, to gauge the macroeconomic relevance of the increase. The larger the increase in transportation spending as a share of the initial size of the economy, the greater the fiscal/macroeconomic challenge from the perspective of financing the supporting infrastructure investment. The largest rises are projected for India (46.3 percent), Sub-Saharan Africa (39.7 percent), and China (33.2 percent).

To understand the implications of rising consumption and its shift toward transportation for greenhouse gas emissions, it is helpful to consider the relative sizes of the projected increase in total consumption and the portion accounted for by the transportation sector (the orange bars in figure 6). The greenhouse gas intensity of a dollar of consumption is presumably higher for transportation spending than for total consumption. The orange bars would therefore be larger if the measure were a greenhouse gas metric rather than dollars.

Three aspects of figure 6 are worth emphasizing. First, despite relatively slow projected economic growth, the advanced economies continue to account for a sizable share of the global increase in both total consumption spending and transportation spending, thanks to the large initial size of both consumption and share of transportation. Second, the combined increase in both total consumption and transportation spending by emerging economies is projected to be larger than for advanced economies during the next 20 years, suggesting that controlling emissions by emerging-economy consumers will be a priority (who should pay for doing so is beyond the scope of this *Policy Brief*). Third, for many emerging economies, the transportation sector will account for more than a quarter of the increase in total consumption in the next 20 years—approximately the same as in advanced economies. This pattern marks a significant change from the past: In several emerging economies, including China and India, the share of CO_2 emissions attributable to the transportation sector was about 10 percent or less in 2012 (IEA 2015b).

IMPLICATIONS FOR POLICY

Policymakers need to prepare for the large projected increase in worldwide consumption and its concentration in transportation, a spending category that is intensive in infrastructure and energy. Efforts need to focus on emerging economies, where hundreds of

millions of people are projected to reach income levels at which they will be able to afford cars and air travel. Public discourse has focused on the need to keep in check the rise in CO_2 emissions that will stem from the strong growth in the production of industrial goods in emerging economies. This *Policy Brief* calls for enhanced emphasis on the growth of consumption in those economies and its shift toward the transportation sector.

At the national level, higher demand for transportation strengthens the case for massive investment in infrastructure in the countries and regions where the increase will be greatest, such as China, India, and Sub-Saharan Africa. Financing such an increase will require additional tax revenues or cuts in other forms of spending. Higher taxation of, and lower subsidies on, fossil fuels and the replacement of subsidies with more targeted interventions would also curb energy demand. Participation by the private sector would be a useful complement, as long as the associated fiscal risks for the public sector are monitored, disclosed, and managed. Strategic choices will also have to be made in favor of the types of infrastructure that are less harmful from the perspective of the environment and climate change.

At the international level, coordinated action would be beneficial in areas such as incentives for climate-friendly infrastructure, to be provided by international lenders (such as the regional and multilateral development banks) and export credit agencies; additional research and development funds for green technologies; and taxation of jet fuel or international air travel, a sector that is likely to expand as vast numbers of emerging-economy consumers become more affluent.

APPENDIX A ESTIMATED COEFFICIENTS OF ENGEL CURVES FOR FOOD AND TRANSPORTATION

This appendix presents the estimated coefficients of the relationship between individual total consumption and the share of food or transportation in total consumption, based on 1,293 observations (each of which is an average of many household-level observations within a narrowly defined range of individual consumption, from surveys for various countries listed in the main text). The logistic function is used for food and the Gompertz for transportation.

FOOD (LOGISTIC)

$$\frac{F}{C} = \frac{b_1}{1 + e^{[-b_2(lnC - b_3)]}}$$

Coefficient	Estimate	Standard error
b_1	72.70	2.53
b_2	–0.77	0.05
b_3	8.29	0.10

TRANSPORTATION (GOMPERTZ)

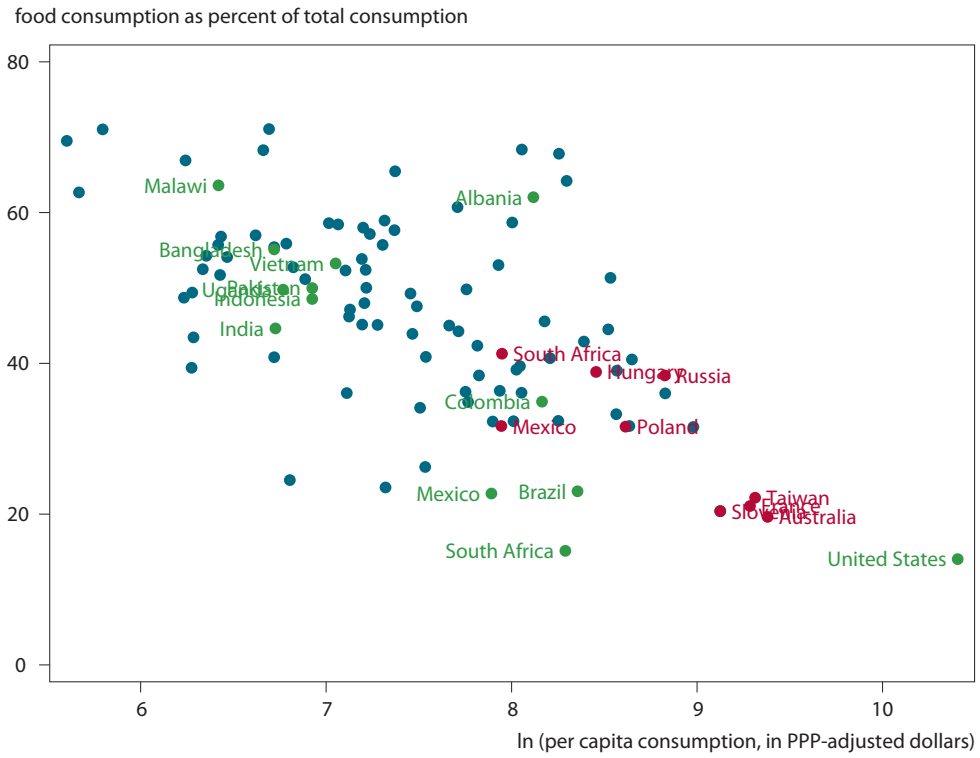
$$\frac{T}{C} = b_1 e^{\{-e^{[-b_2(lnC - b_3)]}\}}$$

Coefficient	Estimate	Standard error
b_1	36.55	4.90
b_2	0.34	0.04
b_3	8.86	0.41

APPENDIX B ENGEL CURVES USING MACROECONOMIC DATA

Figures B.1 and B.2 show the share of food and transportation, respectively, in total consumption (vertical axis) and the logarithm of per capita average consumption in PPP-adjusted dollars (horizontal axis) in a cross-section of about 100 countries. Simple regressions confirm the presence of a statistically significant slope (positive for transportation, negative for food) but yield less precise estimates than do the household survey–based data used in the main text.

Figure B.1 Engel curves for food based on macroeconomic data

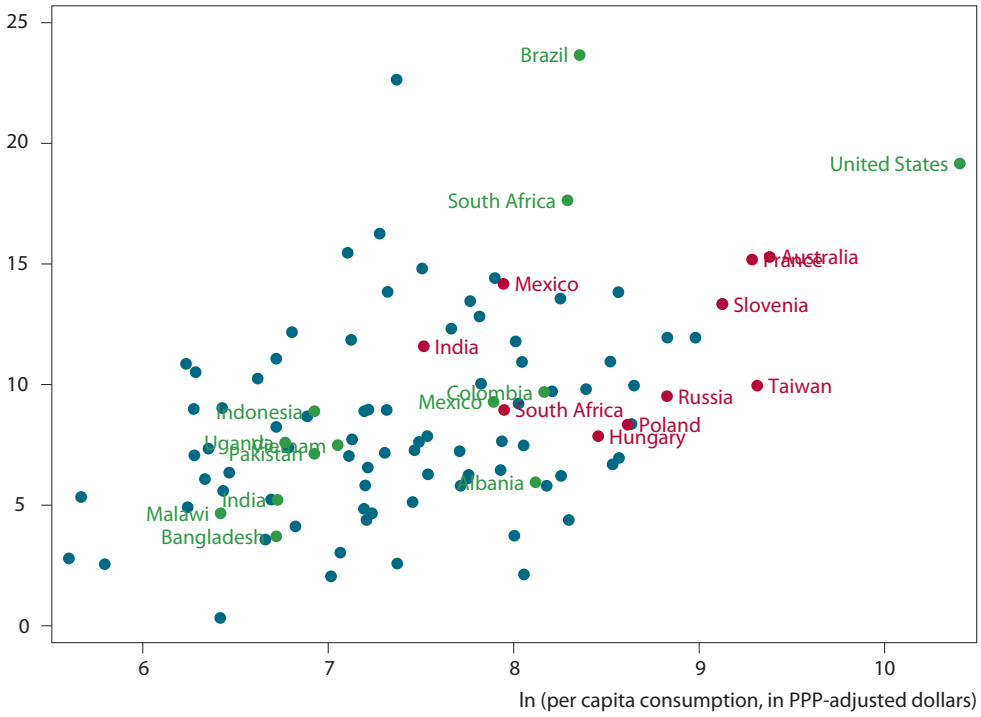


PPP = purchasing power parity

Note: The color of the dots indicates the source of the data. Red = Luxembourg Income Study. Blue = World Bank Global Consumption Database. Green = World Bank Global Consumption Database with detail used in the household-level estimates in the *Policy Brief*. "Food" includes both food and beverages.

Figure B.2 Engel curves for transportation based on macroeconomic data

transportation consumption as percent of total consumption



PPP = purchasing power parity

Note: The color of the dots indicates the source of the data. Red = Luxembourg Income Study. Blue = World Bank Global Consumption Database. Green = World Bank Global Consumption Database with detail used in the household-level estimates in the *Policy Brief*.

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