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Carbon Consumption Patterns of Emerging Middle Classes

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Abstract

As households move out of poverty, spending patterns change. This is good news from a development perspective, but changing consumer behaviour may imply substantially more carbon emissions. The lifestyle choices of the emerging middle classes are key, now and in the future. This paper explores the consumption patterns of the emerging middle classes and their carbon intensity, using unique micro data from household surveys conducted in Ghana, Peru and the Philippines. We find that carbon-intensive consumption increases with wealth in all three countries, and most sharply from the fourth to the fifth middle-class quintile due to changes in travel behaviour, asset ownership and use. In Peru, this shift in the upper-middle-class quintiles translates to annual incomes of roughly USD 11,000-17,000 purchasing power parity. Environmental knowledge and concern are fairly evenly spread at mid- to high levels and do lead to more easy-entry sustainable behaviours, but they do not decrease the level of carbon emissions. To some extent, a knowledge/concern–action gap exists. In our study, social status matters less than the literature claims. Our results have two implications. First, the differentiations between developing/developed countries in the global climate debate may be outdated: It is about being part of the global middle classes or not. Second, a positive spillover from existing easy-entry sustainable behaviours to a change in carbon-intensive consumption patterns needs policy support.

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Bonn, March 2020 Babette Never

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Abbreviations

BIC	Bayesian information criterion
CO_2	carbon dioxide
Dfres	residual degrees of freedom
ENAHO	Encuesta Nacional de Hogares
g	grams
HH	household
km	kilometres
kwh	kilowatt hours
Obs.	observations
OLS	ordinary least squares
PCA	principal component analysis
PPP	purchasing power parity
R-sqr	R-squared
Std. dev.	standard deviation
USD	US dollar

1 Introduction

As households move out of poverty, spending patterns change. This is good news from a development perspective, as more purchasing power implies diversified investments and improved livelihood conditions. But it can be bad news from an environmental perspective, as more consumption and changing consumer behaviour may imply more carbon emissions.

The emerging middle classes have choices about what and how they consume. Their lifestyle preferences will determine whether developing countries mirror the unsustainable development paths of industrialised nations. Being part of the global middle classes or not may be more important from a global perspective than being from a developing or industrialised country. In September 2018, the number of global middle-class and rich individuals equalled the number of poor and vulnerable people for the first time in history: 3.8 billion[1] each, according to Kharas and Hamel (2018). Prospectively, the emerging middle classes will add at least another billion consumers by 2030 (Kharas & Hamel, 2018). It is empirically not sufficiently clear what carbon-related consumption patterns and lifestyles of these middle classes look like and which factors drive them.

This discussion paper aims to help close this research gap by shedding light on the lifestyle choices of the emerging middle classes in three middle-income countries. We establish and explain carbon consumption patterns[2] with micro data from middle-class household surveys in Ghana, Peru and the Philippines. First, we identify the consumption segments and consumer behaviours that have the most impact on carbon emissions. Our household surveys include questions on both final consumption expenditures and user behaviours, such as switching off appliances, as we understand consumption patterns to include both dimensions. Second, we explore what drives these carbon consumption patterns, focussing on wealth, status, environmental concern and environmental knowledge. Third, we zoom into the broad wealth brackets that capture the heterogeneous middle classes to identify potential turning points in consumption and emission trends.

Exploring the acquisitive and the behavioural dimensions of carbon consumption patterns has advantages compared to existing research. Previous studies on household carbon emissions in developing countries have primarily used macro data with input–output tables (Irfany & Klasen, 2017; Renner, 2016; Sanches-Pereira, Tudeschini, & Coelho, 2016; Serino & Klasen, 2015; Wiedenhofer, Guan, Liu, Meng, Zhang, & Wei, 2016; Zhang, Yu, Cai, & Wie, 2017). Empirical analyses have hardly differentiated between specific behaviours (e.g. switching off appliances when not in use) and overall carbon consumption.

Yet, psychological research has shown that this distinction is crucial in order to change carbon consumption patterns (Kollmuss & Agyeman, 2002). Incrementally introducing easy-entry, low-cost behaviours, such as switching off the lights, can be a gateway for long-term behavioural change and for more difficult, costlier behaviours, such as abstaining from driving a private car (Freedman & Fraser, 1966; Lanzini & Thøgersen, 2014; Souchet &

1 Kharas and Hamel define middle classes as having income of USD 11-110 purchasing power parity (PPP) per capita per day.

2 By carbon consumption, we mean the emissions embodied in the consumption of goods and services. “Carbon consumption” has become an accepted abbreviated term in the literature. We use both “carbon-intensity of consumption” and “carbon consumption” throughout the paper, depending on the ease of reading of the respective sentence.

Girandola, 2013). Empirical analyses on the existence of such differences between minor and major low-carbon consumption patterns are lacking. We explore whether these differences exist in Ghana, Peru and the Philippines by measuring our dependent variable carbon consumption patterns via acquisitions and expenditures as well as easy-entry, low-cost behaviours.

Ghana, Peru and the Philippines are interesting to analyse and compare precisely because they are not the largest carbon-emitting countries in their respective world regions, but they are catching up quickly. They have experienced steady economic growth, a decline in poverty and rapid urban development (Burchi, Malerba, Rippin, & Montenegro, 2019; Datt, 2017). Furthermore, the urban centres in all three countries currently face similar challenges: increasing traffic and air pollution, a high and rising demand for electricity and ubiquitous plastic waste. The growing middle classes in these cities affect these dynamics through their consumption patterns and lifestyles, which we expect to differ to some extent between the three countries.

We use an empirical definition of middle classes that combines an asset-based approach with information on household expenditures. The extensive debate in economics (e.g. Birdsall, Lustig, & Meyer, 2014; Kharas, 2017; Lopez-Calva & Ortiz-Juarez, 2014; Ravallion, 2009; Schotte, Zizzamia, & Leibbrandt, 2018; Shimeles & Ncube, 2015), sociology (Neubert & Stoll, 2015; Southall, 2016) and other social sciences (Spronk, 2012) on what it means to be middle class has not led to a clear gold standard definition yet. Our definition has the advantage of being multi-dimensional, pragmatic and based on previous consumer segmentation surveys from marketing research agencies in Ghana, Peru and the Philippines.

The remainder of this discussion paper is structured as follows. Section 2 presents an overview of carbon consumption trends in Ghana, Peru and the Philippines, setting the stage. Section 3 summarises theoretical explanations for household carbon consumption and derives hypotheses for the empirical exploration of our data. Section 4 presents the methods employed in this paper, including a description of household sampling and variables construction. In the following sections, we present and discuss regression results for Ghana (Section 5.1), Peru (5.2) and the Philippines (5.3), completed by a comparison of key results across the three countries (Section 6). In the concluding section, we put our results into perspective with existing research and derive implications for policy.

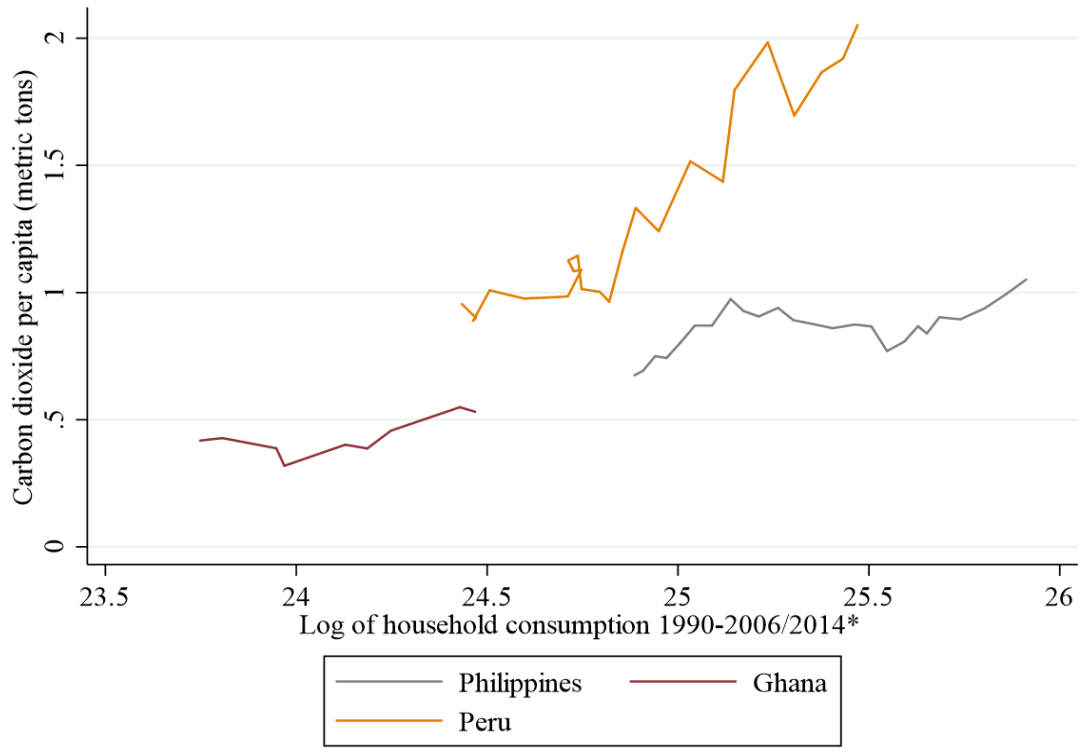
2 Carbon emissions and consumption trends

Direct and indirect household carbon emissions together account for 72 per cent of global greenhouse gas emissions (Edgar, Hertwich, & Peters, 2009). The relation between household consumption and carbon emissions tends to be similar to the relation between gross domestic product and country-wide carbon emissions (Jakob et al., 2014). Although overall per capita carbon emissions in developing countries are usually significantly lower than in industrialised countries, they may still vary substantially within developing countries. An analysis of different wealth groups within these countries can therefore provide illuminating insights. In China, for example, the consumption of urban middle-class and rich households was responsible for 75 per cent of the rise in total household carbon emissions (19 per cent) in the period 2007 to 2012 (Wiedenhofer et al., 2016). An Indonesian household with a similar living standard to a European household also has the

same carbon footprint (Jakob et al., 2014). It is possible that the global middle classes now affect climate change, challenging the developed/developing country distinction usually made in climate change debates. In our paper, an overview of overall carbon consumption trends, the identification of the most carbon-intensive consumption segments and current expenditures in these segments present first steps for the analysis of middle-class carbon consumption patterns in Ghana, Peru and the Philippines.

In all three countries, both carbon emissions (total and per capita) and household consumption have been increasing, especially since around 2005 (Figures 1 and 2). Carbon dioxide (CO_2) emission levels are still low compared to industrialised countries, but an upward trend is particularly visible for Peru and the Philippines. The differences between the countries most likely come about due to different economic development pathways (growth of gross domestic product) and different population sizes. The Philippines have a population of ca. 105 million people, Peru has 32 million inhabitants and Ghana has 29 million inhabitants.

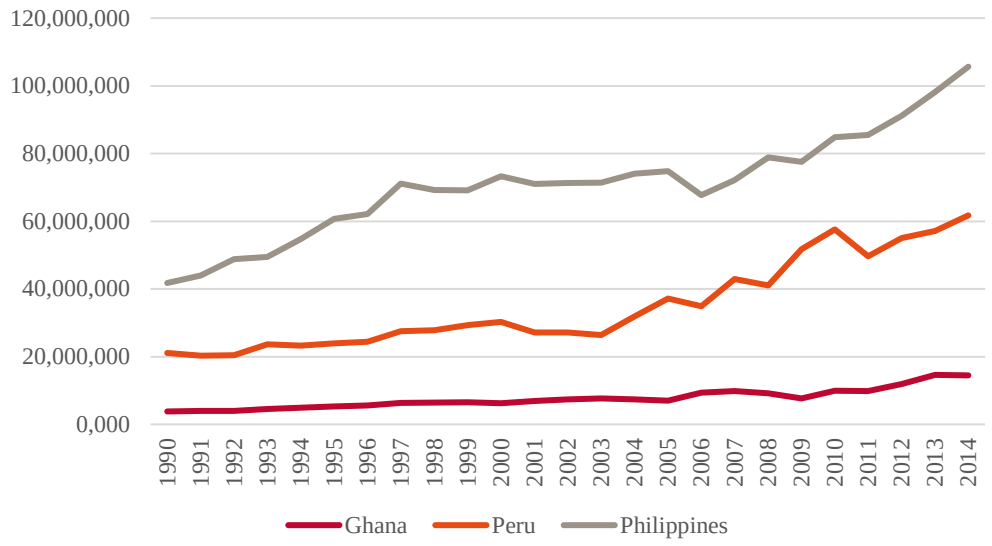
Figure 1: CO_2 per capita and household consumption per capita in Ghana, Peru and the Philippines (1990-2014)



Note: X-axis log of final household consumption including expenditures of non-profit organisations on households; y-axis CO_2 per capita in metric tons. Ghana: 2006-2014 only, no data for 1990 to 2006.

Source: World Bank and CDIAC (2014); all rights reserved, used with permission

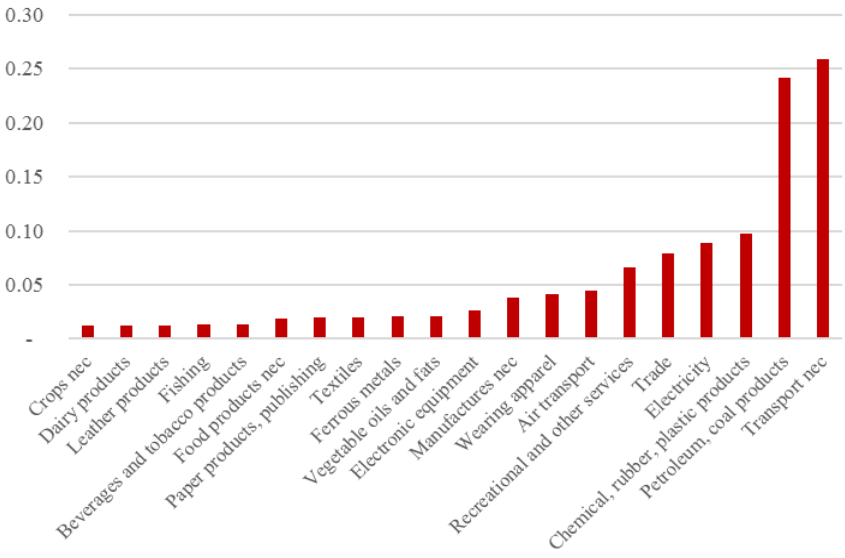
Figure 2: Total CO_2 emissions in Ghana, Peru and the Philippines (1990-2014), metric kilotons of CO_2



Source: World Bank and CDIAC (2014); all rights reserved, used with permission

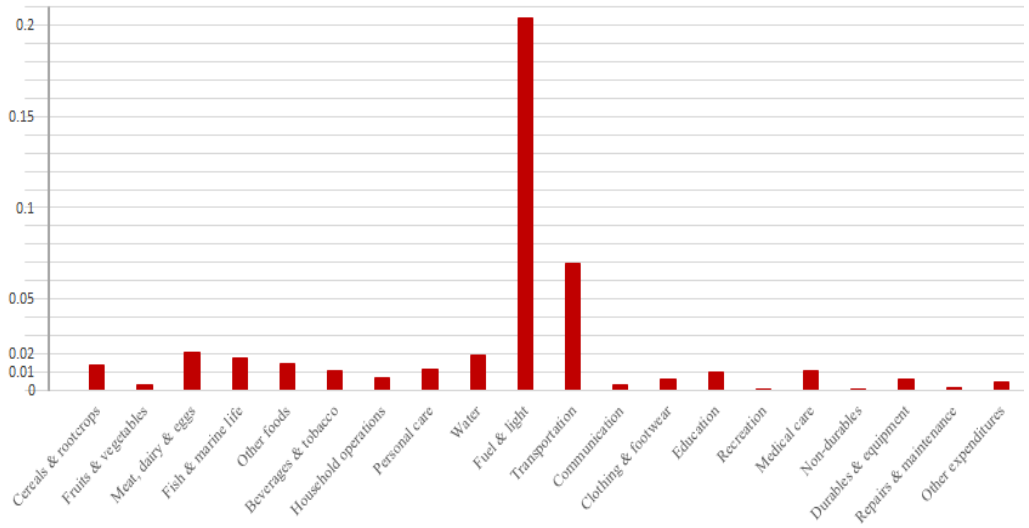
We now turn to the most carbon-intensive consumption segments and carbon footprint data, where available. Unfortunately, no household carbon footprint exists for either of the three countries. Electricity, fuel/gas and transport present the most carbon-intensive consumption segments in Peru and the Philippines (Figures 3 and 4). The data for Peru here is based on production, not household consumption, but the pattern is very likely to be similar. For Ghana, no carbon footprint data exists. The subsequent question then is how much households currently spend on these main carbon-intensive segments.

Figure 3: CO_2 footprint of Peru by sector, metric tons of CO_2 per capita, Peruvian emissions (2015)



Source: Calculations by Daniele Malerba, based on GTAP data base (Global Trade Analysis Project, s.a.); all rights reserved, used with permission

Figure 4: Mean per capita CO_2 emissions of expenditure groups in the Philippines (2006), in metric tons



Source: Serino and Klasen (2015, p. 53); all rights reserved, used with permission

For the year 2010, the World Bank Global Consumption Database (World Bank, s.a.) estimates that households in the middle consumption segments have spent the following shares of their total consumption on transport: 19 per cent (Ghana), 12 per cent (Peru) and 12 per cent (Philippines). Middle consumption segment here means households that have an income of USD 8.44 and USD 23.03 per capita a day. The share of energy in total consumption of the middle consumption segment is lower, but it is relevant due to its carbon intensity: 4 per cent (Ghana), 3 per cent (Peru) and 7 per cent (Philippines). A review of the most recent household surveys available (Encuesta Nacional de Hogares (ENAHO) 2017; Ghana Living Standards Survey 7; Family Income and Expenditure Survey 2015) across all income groups confirms these general patterns. As households become richer, they proportionally spend less on food and more on recreational activities, transport, and information and communications technology (in line with Engel's law). Drawing together the information on sectors' carbon intensities and household expenditures, it is useful to focus our analysis on middle-class carbon consumption of energy and transport.

Future consumption patterns are likely to be shaped by demand for more and more diversified products in the markets that support lifestyles beyond the bare necessities. A continuous increase in demand for private cars and other motorised vehicles is expected in all three countries. For the Philippines, for example, the Asian Development Bank projects an increase in road vehicles from 6.6 million in 2010 to 24.8 million in 2030, primarily due to rising incomes (Asian Development Bank, 2017). In the Peruvian capital region Lima-Callao, total energy use will increase by 78 per cent, emissions from transport by 64 per cent and total city carbon emissions by 84 per cent, when calculating a business-as-usual scenario from 2014 to 2030 levels (Gouldson et al., 2014). In Ghana and the Philippines, demand for air conditioners is expected to soar as rising incomes make them affordable and a warmer climate will make them indispensable, as the International Energy Agency (IEA, 2018) projects for many tropical countries. The consumption behaviour of the middle classes will be key here, as cooling and mobility present important parts of more comfortable lifestyles.

3 Drivers of consumer behaviour: Literature review and hypotheses

The drivers of household carbon consumption and the relation to the lifestyle choices of consumers have been studied extensively in developed countries, and recently in large middle-income countries, particularly China. Wealth, social status, environmental concern and environmental knowledge have been identified as the most important explanatory factors (e.g. Mi, Yu, Yang, & Lu, 2018; Steg & Vlek, 2009; Wiedenhofer et al., 2016). Whereas the former two factors increase carbon emissions, the latter two may motivate and moderate pro-environmental consumer behaviour. Pro-environmental behaviour often, but not automatically, correlates with lower carbon emissions. Regarding the growing middle classes in middle-income countries, empirical research that investigates to what extent these drivers matter is still lacking.

Wealth levels or income strongly predict household carbon footprints.[3] The carbon footprint literature has found a consistent effect of income in many developed countries (e.g. Buechs & Schnepf, 2013), but also in some developing countries. The relationship, however, is not always linear, which leads to the question of turning points, acceleration rates and potential ceiling effects. The Environmental Kuznets curve hypothesis postulates an inverted U-shaped relationship between pollutants and per capita income (Grossman & Krueger, 1995). Ceiling effects could theoretically occur once all major appliances and a private vehicle have been purchased, for example.

In India, for instance, the relationship between household income and carbon consumption is almost linear (Renner, 2016). In contrast, income elasticities of the Chinese middle classes and rich are slightly less than one, indicating a potential ceiling or even decrease, albeit on a very high level of carbon consumption (Wiedenhofer et al., 2016). Country-specific pathways remain when calculating Environmental Engel curves as well. Environmental Engel curves describe how changes in household income affect environmental pollution over time. In the United States, they increase, look concave and then decrease over time for both air pollution (Levinson & O'Brien, 2019) and carbon consumption (Sager, 2019). In Mexico, overall Environmental Engel curves on energy consumption take the form of an elongated S-shape; rural households only show a steady upward slope (Rodriguez-Oreggia & Yepez-Garcia, 2014). Again, these results underline that the general relationship between wealth and household carbon consumption holds, but that it takes different shapes and slopes. We will explore the shape of the relationship in Ghana, Peru and the Philippines in detail, assuming that urban middle-class households follow the Indian example without statistically discernible ceiling effects, that is, no Environmental Kuznets curves. Thus, we predict a linear relationship.

H1 (wealth): The wealthier a middle-class household, the more carbon consumption.

Status consumption is one of the most well-known concepts in marketing research. Individuals tend to define themselves and others by way of their possessions (O'Cass & McEwen, 2014). For the growing middle classes, social status consumption is about generally displaying their new wealth to others (Mi et al., 2018; Nabi, O'Cass, & Siahtiri, 2017) and about owning specific brands or status goods, such as an air conditioner in the

3 If no reliable income data is available, development economists usually construct wealth scores based on assets, house materials and maintenance.

Philippines (Sahakian, 2014). Additionally, status consumption serves individual identity goals such as belonging to or differentiating oneself from a group, as has been shown for the Bangladeshi middle classes (Nabi et al., 2017). Status consumption – especially conspicuous luxury consumption – may increase household carbon consumption, as Mi and co-authors show in China (Mi et al., 2018). Particularly lower-income groups and less-educated female Chinese are more driven by status than by material hedonism (Mi et al., 2018). Less wealthy or not established South African middle-class households also signal status more strongly via visible consumption than other social groups (Burger, Low, de Oliveira Pegado, & van den Berg, 2014).

In background interviews and focus group discussions that we conducted in 2018 before running our household study, middle classes were characterised by their drive to climb up the social ladder, distance themselves from the poor and attempt to keep up with presumably richer friends. Consumer researchers often summarise these behaviours as the "Keeping up with the Joneses" effect (Ordabayeva & Chandon, 2011). Drawing on these various insights, we hypothesise:

H2 (status): Social status considerations impact household carbon consumption.

A lot of social psychology research focusses on the environmental behaviour of affluent consumers in industrialised countries and how to overcome the gap between *environmental concern* and actions (value–action gap; Blake, 1999) or *environmental knowledge* and actions (knowledge–action gap; Kollmuss & Agyeman, 2002). Environmental values capture whether a person cares about the environment at all, whereas knowledge means having factual information about what causes greenhouse gas emissions or how to save energy in the household, for example. Implementation intentions and commitment (Aijzen, 1991; Steg & Vlek, 2009), attitudes, habits and personal norms also impact environmental behaviour (Aarts & Dijksterhuis, 2000; Schwartz, 1977; Verplanken & Faess, 1999), painting a complex picture.

According to the theory of reasoned action, environmental knowledge influences attitudes, which in turn leads to pro-environmental behaviour. Empirical evidence is mixed (Frederiks, Stenner, & Hobman, 2015; Geng, Liu, & Zhu, 2017), especially regarding energy consumption (Paco & Lavrador, 2017). The role of environmental beliefs and concern has been studied from various theoretical and empirical angles, often focussing only on hypothetical behavioural intentions rather than actual behaviour. Higher levels of environmental concern are generally associated with pro-environmental action, even though the relationship is not always strong (Steg & Vlek, 2009). In the United States, a clear link between environmental concern and lower energy consumption exists (Sapci & Considine, 2014). Young consumers in Vietnam are motivated by a mix of psychological factors, including concern, knowledge, attitudes and personal norms, which influence energy-efficient appliance purchases (Nguyen, Lobo, & Nguyen, 2018).

It is likely that there is a difference between easy-entry sustainable behaviours and hard-to-change behaviours or total consumption (including rebound effects). On the one hand, it appears that positive values, beliefs and concern induce actual sustainable behaviours such as energy saving and the adoption of energy efficiency, but they do not lead to an actual reduction in energy use per se as rebound effects occur (Frederiks et al., 2015). On the other hand, several psychological studies have shown that easy-entry behavioural changes can

open the door to more substantial behavioural changes at a later stage (Freedman & Fraser, 1966; Lanzini & Thøgersen, 2014; Souchet & Girandola, 2013). This is known as the "foot in the door effect" (Freedman & Fraser, 1966).

With the value–action gap and knowledge–action gap in mind, we focus on potential positive relations between knowledge, concern and consumption. Furthermore, we differentiate between easy-entry environmental behaviours, which are often low-cost and daily routines, and overall carbon consumption, which includes high-cost, carbon-intensive energy and transport behaviours.

H3 (knowledge):

a. More environmental knowledge leads to easy-entry environmental behaviour.

b. More environmental knowledge leads to less carbon consumption.

H4 (concern):

a. Higher levels of environmental concern lead to easy-entry environmental behaviour.

b. Higher levels of environmental concern lead to less carbon consumption.

These hypotheses can be summarised in the following analytical equation:

$$\gamma_i = ß_0 + ß_1 x_1 + ß_2 x_2 + ß_2 x_2 + ß_3 x_3 + ß_4 x_4 + ß_5 x_5,$$

where γ_i is either carbon consumption or easy-entry environmental behaviour of household i, x1 is wealth, x2 is status, x3 is knowledge and x4 is concern. The term x_5 represents the control variables (age, gender, education of the respondent, number of household members) and $ß_0$ is the intercept.

4 Methods

4.1 Definition of middle class and sampling

All types of middle-class definitions in the literature are to some extent arbitrary; no consensus exists. We have opted for a new combination of criteria that allows for a non-income-based cross-country comparison, in line with our interdisciplinary approach to the topic. Since income data is hardly reliable in developing countries, we developed seven screening questions and a point system on assets, expenditures and education level of the household head. The aim was to cover a broad range of potential middle-class households (oversampling), which could be further defined ex post by excluding outliers. We primarily excluded some outliers in the Philippines (final N = 802) and Ghana (final N = 837) from the analysis. We assume that different groups of middle classes exist within the bracket chosen, so there is no "one" middle class.

The eight screening questions included: house size, house materials, house quality, house ownership or rent, type of water connection in the dwelling, annual expenditures on

education, expenditure on eating out in a proper restaurant (e.g. with air conditioning), level of education of the household head. Three answer categories with 0-2 points were given for each question; a range of 0-14 points was possible (see Appendix A). We purposively set a broad threshold for being middle class at 4-12 point. Initial questions on health expenditures and savings were discarded due to the sensitivity of the information, and thus a danger of losing respondents.

Previous research has shown that the new middle classes live largely in urban centres (Albert, Santos, & Vizmanos, 2018). The surveys were therefore conducted in the capital cities only, as these attract a larger share of the middle classes. We prioritised approximating a representative sample size of middle classes in these cities over capturing more variation within countries by adding more cities.

The sampling of households followed two steps: one geographical and one household-based step. In the first step, slum areas and very rich districts were excluded. In the second step, a probability sampling proportional to the estimated population size for neighbourhoods was applied. Then, every fifth house from a random starting point was approached. In Accra, Ghana, the procedure was slightly adapted to purposively access middle-class gated communities in 26 different neighbourhoods, which required pre-registration of interviews. At least one neighbourhood in the same district of each of the gated communities was randomly selected to account for the variation within the district. The resulting samples approximate a representation of the middle classes in each city; they are not meant to be representative of the national population.

4.2 Measurement of independent variables

This discussion paper focusses on four independent variables to explain carbon consumption patterns: wealth, status, environmental concern and environmental knowledge. The household survey also included questions on socio-demographic background as control variables.

The *wealth index* has been constructed by way of a principal component analysis (PCA) for each of the three countries separately, in line with standard procedures in development economics (Filmer & Pritchett, 2001; Filmer & Scott, 2008; Kolenikov & Angeles, 2009). We base our wealth index on assets and house characteristics, drawing on previous studies on Peru (Jaramillo & Parodi, 2004) and Ghana (Mahama, Anaman, & Osei-Akoto, 2014).

To construct the wealth indices, we include information on 15 assets owned by the household (as dichotomous variables). We exclude energy-intensive assets that almost every household owns (fridge, freezer, air conditioner) to avoid tautological conclusions regarding energy spending. As categorical variables that differentiate into three categories each, we added the house size (number of rooms), house material, quality of the house (maintenance), type of water connection to the dwelling and the education level of the household head to the index. Finally, we also included the number of household members per room. This combination of data allows for the least clumping and truncation when running a PCA. The PCA explains acceptable levels of variation in the data in all three countries (>20 per cent).

Social *status* orientation in consumer behaviour is a complex phenomenon and may vary a lot depending on the type of product or service, or even the lifestyle component. We therefore modified a status consumption scale (Eastman, Goldsmith, & Flynn, 1999) and a status orientation scale (Pantinga, Breugelmans & Zeelenberg, 2020) from marketing research to our purposes (see Appendix B).

Scale reliability was excellent for Peru (Cronbach's alpha 0.80), but rather poor for Ghana (Cronbach's alpha 0.46) and the Philippines (Cronbach's alpha 0.48). This indicates a potential problem with our measurement of status. Even if we omit the 4th item on transport (see Appendix B), scale reliability does not increase (0.48 in Ghana; 0.48 Philippines). We will run two tests for our hypothesis on the influence of social status: a first one to find out whether a strong status orientation exists at all among the middle classes, especially among the less wealthy households, as the literature suggests; a second test will then more directly test the relation between status and carbon consumption.

Environmental concern was measured with six items from Thøgersen, Pedersen and Aschemann-Witzel (2019; we slightly modified item six), using a 7-point Likert scale (see Appendix B). The items form a construct with excellent reliability in all countries (Cronbach's alpha > .70).

For *environmental knowledge*, we draw on Thøgersen, Haugaard and Olesen (2010), but adapt their items to more closely capture knowledge about energy and transport. Items were constructed as dichotomous questions with yes and no responses; the knowledge variable is the sum of yes responses. Scale reliability was satisfactory in all three countries (Cronbach's alpha between 0.50 and 0.70).

4.3 Measurement of dependent variables

Consumption patterns incorporate the acquisition as well as the use of products. To analyse household carbon consumption patterns, we use electricity expenditure of the household and our own transport CO_2 score as proxies. Additionally, we construct a sustainable behaviour index to capture potential differences between minor actions that may be motivated by environmental considerations and major actions that lead to households' final carbon consumption total.

In all three of our countries of interest, electricity is generated with a considerable share of fossil fuels, making electricity an appropriate proxy for carbon consumption. In Ghana, 60 per cent of electricity in 2017 was generated with oil and gas; 40 per cent from renewable energy sources. In Peru, hydropower is still the main source of electricity generated (ca. 60 per cent), but the current 40 per cent of fossil fuel-based electricity generation is likely to increase, as more thermal power plants are being planned to meet increasing demand. Furthermore, the majority of electricity consumers in Lima are customers of the company Enel, which generates the electricity for Lima from two fossil fuel thermal power plants. In the Philippines, almost two-thirds of all electricity generated is derived from coal, oil and natural gas (IEA, 2019). Access of households to the electricity grid in Accra, Lima and Manila is almost universal; all households in our sample were connected to it. In this paper, electricity expenditures are used as dependent variables instead of kilowatt hours (kwh) because not all households were able to share their last electricity bill, which shows the kwh

used. We think that respondents' guesses about their latest electricity bills provide a more accurate estimate of actual energy consumption than respondents' guesses about the amount of kwh they consumed. We ran a robustness check with kwh for the sub-sample of households that provided that data, which confirmed our findings.

The construction of a CO_2 score for transport was only possible for Peru and the Philippines due to a lack of data on the carbon intensity of local transport modes in Ghana. The score is a proxy, not an accurate measurement of the carbon intensity of all travel trajectories by actual kilometres (km) and time travelled. The space in the household survey was too limited to ask for all this data in detail. As a starting point, we instead used our survey question "On a normal day, how often do you…use your own car". We asked this question for 12 available transport modes in Metro Manila and for 11 available transport modes in Lima, using a 5-point Likert scale. Answers for a normal day were extrapolated to annual frequencies in order to match them with annual average CO_2 emissions by vehicle types.

For Lima, detailed data on average CO_2 emissions per capita per person travelled for each type of local vehicle was available (TRANSperú, 2015). For Metro Manila, we replicated the method of the Peru study. We multiplied average vehicle emissions factors per km travelled in Metro Manila for each of the 12 transport modes (Fabian & Gota, 2009; National Economic Development Authority & Japan International Cooperation Agency, 2014) by the inverse average occupancy rates for each vehicle type, using the most recent data available (Japan International Cooperation Agency, 2012). The average occupancy rate captures the vehicle km per person km travelled; the inverse (person km per vehicle km) is necessary to arrive at per capita CO_2 emissions.

CO_2 emissions estimate per capita = daily frequency of travel mode[4] * inverse occupancy rate * emission factor (g of CO_2/km travelled) * 365

Walking, biking and transport via pedicab are human-powered and therefore have no emissions. Data on the occupancy rate and the emission factors of the Manila light rail systems (mass rapid transit, light rail transit) is missing. Yet, light rail systems such as metro lines typically have very high occupancy rates in Manila, and therefore low per capita emissions. Thus, the travel mode "metro (mass rapid transit, light rail transit)" is assigned the value "0" as well (see Table A1 in Appendix B). Annual flight emissions are computed as follows: (i) we utilise information on individuals' flight destinations and approximate the average distance (in km) travelled per air journey; (ii) we multiply the average travel distance by a proxy for average CO_2 per air km and the number of times the person travelled by plane last year.[5]

For each land travel mode, we multiply the daily travel mode frequencies by CO_2 emissions per transport mode times 365 to arrive at a proxy for individuals' annual transport CO_2 score (see equation/calculation above). Given the limited data availability, this approximation is the most accurate measure we could calculate.

4 Weights: Nearly never = 0 km; A few times = 5 km; Sometimes = 10 km; Often = 20 km; Very often = 25 km.

5 Our proxy is 115 grams of CO_2 per air km travelled (Carbon Independent, s.a.). We acknowledge the fact that a typical air journey involves a round trip and, thus, is considered the average distance covered per journey twice.

Finally, the sustainable behaviour index is based on mean scores of easy-entry pro-environmental behaviours from three different domains: electricity use in the household, recycling behaviour and political consumption. For each domain, we asked two questions, using a 5-point Likert frequency scale:

- Do you usually switch off the lights when you leave the room?
- Do you actively try to save energy in your household?
- Do you usually reuse materials such as plastic bags?
- Do you usually avoid taking plastic bags in shops (e.g. supermarkets)?
- In the past 12 months, how often, if ever, have you deliberately bought a product or brand because it is environmentally friendly?
- In the past 12 months, how often, if ever, have you decided not to buy a product or brand because it harms the environment?

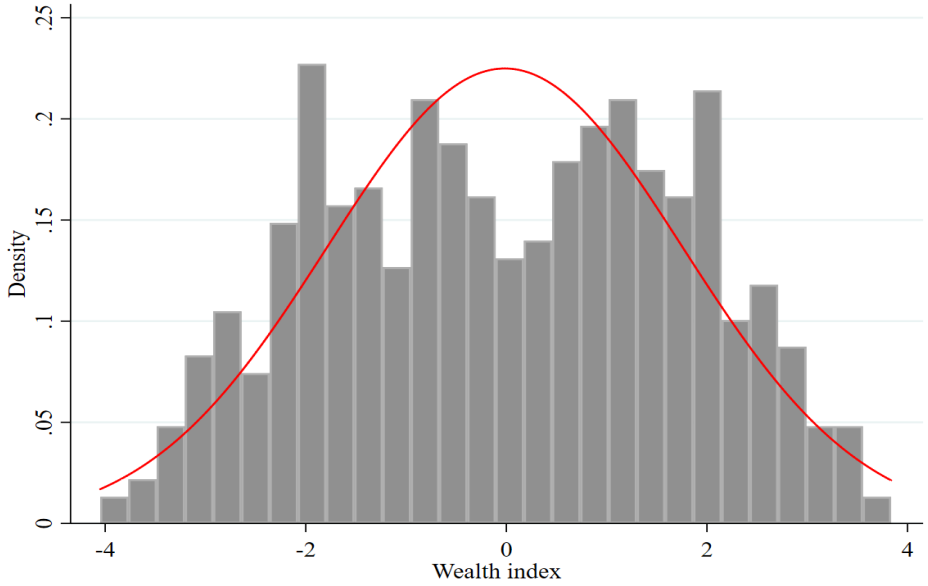
Since the three domains measure different behaviours, it is not surprising that the overall scale reliability is rather low but acceptable (Cronbach's alpha 0.4-0.5).

5 Results: How carbon-intensive are middle-class consumption patterns?

5.1 Ghana

Consumption patterns of the Ghanaian middle classes and their carbon emissions become manifest via households' general living conditions, the type of appliances and other durables they own and how they travel. In Accra, the middle classes live in both gated communities and mixed neighbourhoods. In our sample, two-thirds of households own their dwellings (74 per cent) and almost all households (>95 per cent) own basic assets such as a fan, a TV, a fridge and a smartphone. Ownership levels of other assets vary (see Section 6). Wealth is almost normally distributed in our sample according to the PCA results (Figure 5). On average, middle-class households in Accra have a fairly high level of environmental concern and environmental knowledge and do not overtly care for status (see mean scores in Table 1).

Figure 5: Distribution of middle-class sample in Accra based on wealth index



Source: Authors' calculations

Table 1: Summary statistics middle-class sample in Accra

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Energy spending	813	1.654.171	1.200.051	1	920
Log of energy spending	813	4.880.965	.6926562	0	6.824.374
Sustainable behaviour	813	3.275.933	.6320975	1.667	5
Wealth index	813	-.015054	1.773.804	-4.049	3.835.643
Log of wealth	813	1.531.237	.4100545	-.050253	2.178.794
Concern	813	404.797	.5714737	1	5
Knowledge	813	5.638.376	1.549.544	0	8
Status	813	2.516.298	.6948939	1	5
Education	813	1.881.919	.8672079	0	4
Age	834	4.539.089	1.452.714	18	87
Gender	834	.4088729	.4919207	0	1
HH members	834	4.410.072	2.089.175	1	16

Source: Authors' calculations

Wealth levels clearly drive energy spending among Ghanaian middle-class households, whereas environmental concern, environmental knowledge and status do not make a difference (Table 2). In the ordinary least squares regressions, we add the highest completed education level of the respondent, his/her age and gender as control variables. Furthermore, we control for the number of household members. It is not possible to reliably control for the electricity price, as we only have reliable data on actual kwh and other charges (photo of last electricity bill) for 23 per cent of the households in our sample.

As wealthier households spend more on energy, and thus also emit more carbon derived from energy than less wealthy households, we can confirm *Hypothesis 1 (wealth).* This

result is not surprising in itself, but the effect is big: A 1 per cent increase in wealth correlates with a 0.57 per cent increase in energy spending. Furthermore, the confirmation of a linear slope[6] indicates the trend in consumption dynamics in the Ghanaian middle classes. Patterns rather mirror those of India – and many industrialised countries – than those of Mexico.

Table 2: Regression results (log of) energy spending and wealth in Accra

Log of energy spending	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Log of wealth	0.633***	0.631***	0.609***	0.610***	0.578***
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Status		0.021	0.024	0.024	0.049
		(0.03)	(0.03)	(0.03)	(0.03)
Knowledge			0.021	0.021	0.022
			(0.02)	(0.02)	(0.02)
Concern				-0.008	-0.004
				(0.04)	(0.04)
Education					0.028
					(0.03)
Age					0.001
					(0.00)
Gender					0.103*
					(0.05)
HH members					0.076***
					(0.01)
Constant	3.912***	3.861***	3.772***	3.798***	3.303***
	(0.09)	(0.12)	(0.13)	(0.19)	(0.21)
R-sqr	0.140	0.141	0.143	0.143	0.200
Dfres	811	810	809	808	804
BIC	1599.4	1605.7	1610.5	1617.2	1588.0
* p<0.05, **p<0.01,	***p<0.001				

Note: Standard errors in parentheses.
Source: Authors' calculations

The results of our two tests on status indicate that status orientation by itself exists among the Ghanaian middle classes, but it does not impact carbon consumption (*Hypothesis 2).* In Ghanaian society, educational, traditional-cultural and financial status present elements of a middle-class lifestyle (Hamidu, 2015). In our middle-class sample, the relationship between wealth and status turns out to be weak (low correlation 0.06 and p-value 0.70), but male, slightly younger respondents tend to be more status-oriented. Our second test shows that status is not a significant predictor of energy consumption, meaning that we cannot confirm Hypothesis 2 on status in Ghana.

Several explanations as to why we do not find an effect are possible. Status goods such as appliances that are used outside the house to signal status (e.g. smartphone) are not necessarily energy-intensive. In Ghana, we also had a relatively high share of gated

6 We ran a check for an S-shape and inverted U-shape by adding the logarithm of wealth squared to the regression, but the results look linear.

communities in our sample, which implies that status goods such as air conditioners cannot be seen easily by neighbours (as in the Philippines, for example). Finally, it is possible that status products in the home such as fancy kitchen appliances may actually not be in use much. Overall, the explanatory power of these results is not high, implying that status does play a general role in middle-class Ghanaians' lives, but it is difficult to capture and does not impact energy consumption.

While knowledge (*Hypothesis 3*) and concern (*Hypothesis 4*) do not have an impact on total carbon consumption of the household, as discussed above, the regressions on sustainable behaviours tell a different story. The analysis of these easy-entry behaviours gives more insights on whether households try to save energy, behave in an environmentally friendly manner and reduce their carbon footprint at all. Table 3 shows the regression results for sustainable behaviour. Clearly, more environmentally concerned, more-educated households show more easy-entry, low-cost sustainable behaviours. Interestingly, environmental knowledge has a slightly negative, albeit negligible effect.

In Accra, the absence of proper recycling systems and accompanying regulation turns easy-entry sustainable behaviours into more of a challenge than in contexts in which choices are made easier by supporting infrastructure or policy. The same applies to consumers who wish to avoid or buy specific products for environmental reasons, as reliable consumer information on products and testing results from independent agencies on hazardous substances contained in products are hardly available. On the one hand, the exercising of easy-entry sustainable behaviours by the middle classes should be seen in a more positive way. On the other hand, our survey relies on reported, not revealed, behaviours, meaning that the problem concerning the social desirability of answers may arise.

For our hypotheses on knowledge (H3) and concern (H4), these results imply that easy-entry environmental behaviours may decrease levels of overall household carbon consumption to a small extent, but they are possibly overridden by other carbon-intensive behaviours or rebound effects. However, we do not have data with broad-based evidence for all types of consumer behaviours or the actual carbon footprints of households to follow up on this. It appears that existing average levels of environmental concern and environmental knowledge do not systematically alter hard-to-change, carbon-intensive behaviours. In terms of a knowledge/value–action gap, our results are inconclusive. High education levels coincide with easy-entry sustainable behaviours but not with less energy consumption, which would point towards a knowledge–action gap, but reported environmental knowledge does not fit this argument.

Table 3: Regression results sustainable behaviour index in Accra					
Sustainable behaviour	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Knowledge	0.018	-0.014	-0.019	-0.019	-0.030*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Concern		0.332***	0.327***	0.327***	0.310***
		(0.04)	(0.04)	(0.04)	(0.04)
Wealth			0.018	0.016	-0.011
			(0.01)	(0.01)	(0.01)
Status				0.036	0.036
				(0.03)	(0.03)
Education					0.121***
					(0.03)
Age					0.001
					(0.00)
Gender					0.006
					(0.04)
HH members					-0.025*
					(0.01)
Constant	3.176***	2.014***	2.062***	1.968***	1.953***
	(0.08)	(0.16)	(0.16)	(0.18)	(0.21)
R-sqr	0.002	0.086	0.088	0.089	0.116
dfres	811	810	809	808	804
BIC	1572.2	1507.6	1512.3	1517.6	1520.2
* p<0.05, **p<0.01, ***	p<0.001				

Note: Standard errors in parentheses.
Source: Authors' calculations

Furthermore, middle-class households in Accra are generally familiar with the national energy-efficiency label (83 per cent in our sample), and many also confirm having received energy-saving tips, whereas only 58 per cent reported owning an appliance with an energy-efficiency label. This supports the notion that a knowledge–action gap regarding energy savings pertains to middle-class consumption patterns (Senadza, Asante, & Kuhn, 2020).

In sum, our results for Ghana's middle classes make it clear that wealthier households consume more carbon, regardless of their levels of environmental concern and knowledge. High levels of environmental concern, together with higher education levels, lead to sustainable behaviours that do not substantially impact households' carbon footprints, whereas environmental knowledge does not make a difference. The extent of a knowledge/value–action gap in Ghana is rather inconclusive.

5.2 Peru

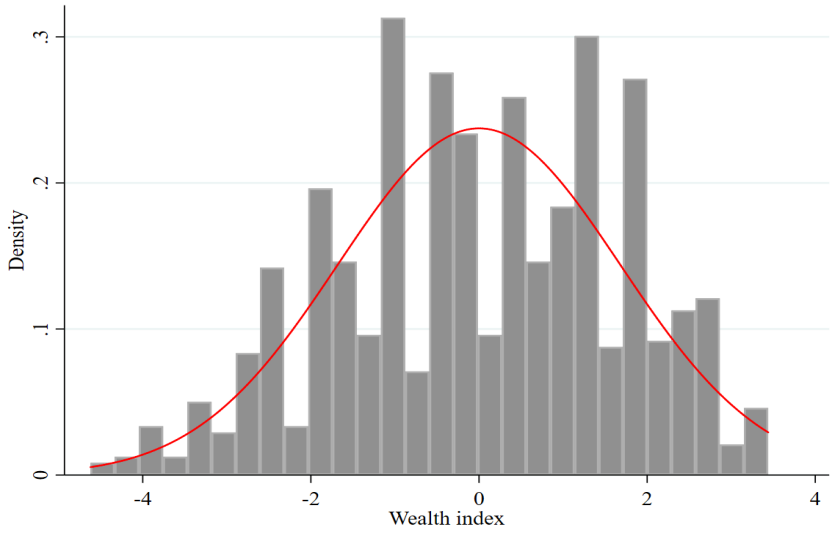
Middle-class households in Lima live dispersed throughout various neighbourhoods. Whereas some neighbourhoods, such as Magdalena del Mar and Jésus Maria, are colloquially known to be "middle-class districts", the actual distribution of the middle classes is scattered across the city. In our survey, we sampled 14 districts. Middle-class

households usually own their house (74 per cent in our sample) and at least some basic amenities, such as a fridge, a stove, and a TV (>95 per cent). The vast majority also have at least one smartphone (92 per cent) in their home. In our sample, a lot fewer households than we expected own a car (12.5 per cent) or motorbike (2 per cent). The ownership levels of other energy-intensive and non-energy-intensive assets vary (see Section 6).

The wealth distribution in our sample is almost normal, with a slight overrepresentation of households in the middle of the distribution (Figure 6). On average, middle-class households in Lima are rather concerned about the environment and also have a good amount of environmental knowledge (see Table 4). Status orientation is in the middle ranges.

To cross-check the validity of our wealth index, we compared our dataset with the ENAHO 2017 data for Lima. Results of a proxy means regression show that predicted consumption in our sample has a higher mean than in ENAHO data, which is to be expected, given that we captured only the middle classes (see Table A2 in Appendix B). The correlation between predicted consumption and our wealth index is good (0.60). Predicted income of our dataset and in ENAHO data for Lima is higher than consumption-based welfare, but it has a similar distribution. Thus, the external reliability of our data is satisfactory.

Figure 6: Distribution of middle-class sample in Lima based on wealth index

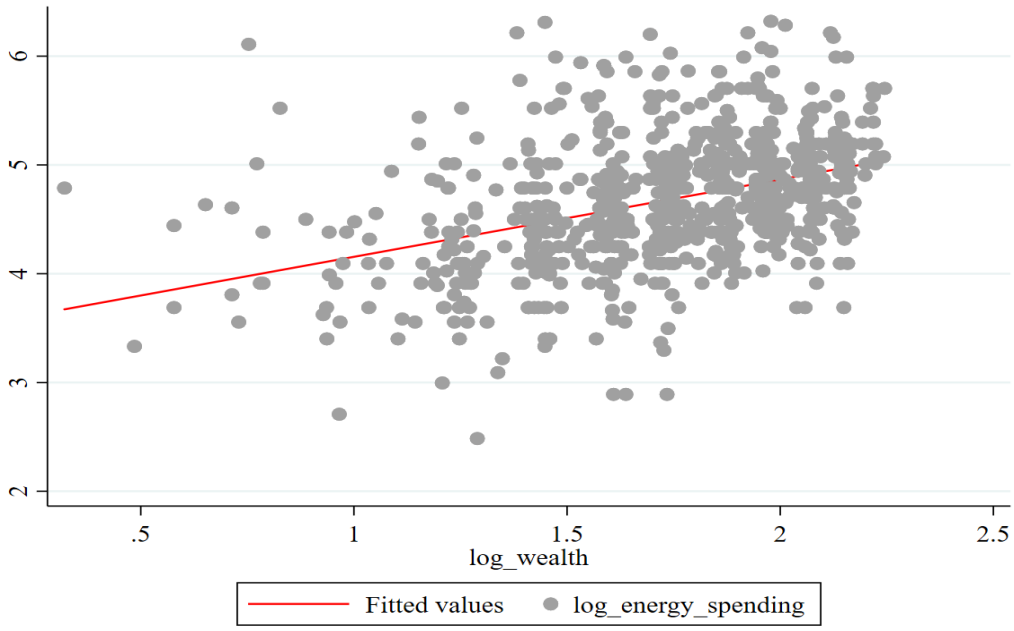


Source: Authors' calculations

Table 4: Summary statistics middle-class households, Lima					
Variable	**Obs.**	**Mean**	**Std. dev.**	**Min.**	**Max.**
Energy spending	832	1.277.623	807.418	12	556
Log of energy spending	832	4.685.841	.5741446	2.484.907	6.320.768
Transport score	832	-7.04e-09	1	-.4226277	1.456.426
Sustainable behaviour	832	3.126.002	.5272197	1.166.667	4.833.333
Wealth	832	6.72e-11	1.680.781	-462.118	343.986
Log of wealth	832	1.745.692	.3197212	.321228	2.244.941
Status	832	2.609.075	.9607452	1	5
Knowledge	832	531.851	1.847.558	0	8
Concern	832	3.764.022	.5720022	1	5
Education	832	1.176.683	.4769382	0	4
Age	832	4.754.207	1.494.895	18	75
Gender	832	5528846	.4974944	0	1
HH members	832	3.927.885	1.561.292	1	12
Source: Authors' calculations					

Table 5: Regression results drivers of (the log of) energy spending, Lima					
Log of energy spending	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Log of wealth	0.711***	0.713***	0.708***	0.715***	0.629***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Status		0.007	0.008	0.001	0.023
		(0.02)	(0.02)	(0.02)	(0.02)
Knowledge			0.003	0.001	0.005
			(0.01)	(0.01)	(0.01)
Concern				0.052	0.068*
				(0.03)	(0.03)
Education					0.057
					(0.04)
Age					0.006***
					(0.00)
Gender					-0.007
					(0.04)
HH members					0.063***
					(0.01)
Constant	3.444***	3.424***	3.413***	3.237***	2.638***
	(0.10)	(0.12)	(0.12)	(0.17)	(0.20)
R-sqr	0.157	0.157	0.157	0.160	0.206
Dfres	830	829	828	827	823
BIC	1308.2	1314.8	1321.5	1325.7	1305.9
* p<0.05, ** p<0.01,	p***<0.001				
Note: Standard errors in parentheses. Source: Authors' calculations					

Figure 7: Middle-class wealth and energy spending in Lima



Source: Authors' calculations

Wealthier middle-class households in our sample spend more on energy, that is, consume more carbon: A 1 per cent increase in wealth correlates with a 0.62 per cent increase in energy spending. Age also matters, albeit much less than wealth (Table 5). The relation between wealth and energy spending looks linear, also after having cross-checked for an inverted U-shape by way of a quadratic regression term (Figure 7). The result that households with more members spend more on energy is intuitive, as demand increases per capita, for instance because more appliances are in use simultaneously.

Carbon consumption from transport increases with rising wealth levels as well, implying that a general shift in carbon consumption patterns happens as households move from the lower to the upper-middle classes. Wealthier middle-class members with higher education contribute more to transport CO_2 emissions by way of their travel mode choices (Table 6). Since car ownership levels are surprisingly low in our sample, a larger sample with more car owners may well show a larger effect of wealth's impact on transport emissions. Drawing the results on energy and transport together, the hypothesis that wealthier households consume more carbon (*H1 wealth*) can be confirmed for Peru.

Regarding the impact of *status* (*H2*), the results for Peru are similar to Ghana. Less wealthy, younger and male-headed middle-class households in Lima are generally more status-oriented (see Table 7). The explanatory power of the model, however, is rather low (R2 = 0.065). Furthermore, status does not impact energy- or transport-related carbon consumption (Tables 5 and 6). Hence, we cannot confirm our hypothesis H2 on the relation between status and carbon consumption. As for Ghana, the discrepancy between the two results suggests that status orientation exists and that it matters for the emerging middle classes – but it is not related to energy and transport.

Knowledge (*Hypothesis 3*) and *concern* (*Hypothesis 4*) have mixed impacts on carbon consumption and consumer behaviour. Knowledge does not influence energy spending or our transport score in any direction, whereas slightly higher levels of concern lead to more energy spending. Given the fairly high mean scores, especially for environmental concern, it is possible that a value–action gap[7] exists here. In contrast, higher levels of environmental concern, more environmental knowledge and being female lead to more easy-entry sustainable behaviours (Table 8). Interestingly, status also has a small impact. A possible explanation is that signalling easy-entry sustainable behaviours may have actually become a way to show belonging in a certain group. Given the rather small coefficient (0.06), another possibility is that this is a rather random effect that can be neglected. Here, some follow-up qualitative work would be necessary to find out more.

In sum, our results for Peru make it clear that carbon consumption from energy and transport increases as middle-class households move up the wealth ladder. Existing high levels of concern for the environment and fairly good environmental knowledge do not matter for carbon-intensive, hard-to-change behaviours, but they drive easy-entry sustainable behaviours.

Table 6: Regression results transport CO_2 score, Lima

Transport score	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Wealth	0.164***	0.163***	0.157***	0.153***	0.147***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Status		-0.027	-0.017	-0.001	-0.010
		(0.03)	(0.04)	(0.04)	(0.04)
Knowledge			0.018	0.023	0.008
			(0.02)	(0.02)	(0.02)
Concern				-0.123*	-0.108
				(0.06)	(0.06)
Education					0.200**
					(0.07)
Age					0.003
					(0.00)
Gender					-0.089
					(0.07)
HH members					-0.040
					(0.02)
Constant	-0.000	0.070	-0.050	0.342	0.236
	(0.03)	(0.10)	(0.17)	(0.25)	(0.35)
R-sqr	0.076	0.077	0.078	0.082	0.100
dfres	830	829	828	827	823
BIC	2307.6	2313.8	2319.7	2322.2	2333.2
* p<0.05, ** p<0.01,	***p<0.001				

Note: Standard errors in parentheses.
Source: Authors' calculations

7 We assume values and environmental concern to capture the same phenomenon. In the literature, measurement scales for both are often used interchangeably.

Table 7: Wealth and status orientation among Lima's middle classes		
Status orientation	**Model 1**	**Model 2**
Wealth	-0.051**	-0.048*
	(0.02)	(0.02)
Education		-0.088
		(0.07)
Age		-0.013***
		(0.00)
Gender		-0.266***
		(0.07)
Constant	2.609***	3.477***
	(0.03)	(0.15)
R-sqr	0.008	0.065
dfres	830	827
BIC	2300.2	2271.2
* p<0.05, ** p<0.01,	***p<0.001	
Note: Standard errors in parentheses. Source: Authors' calculations		

Table 8: Regression results for sustainable behaviour, Lima					
Sustainable behaviour	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Knowledge	0.040***	0.036***	0.029**	0.035***	0.045***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Concern		0.254***	0.259***	0.247***	0.252***
		(0.03)	(0.03)	(0.03)	(0.03)
Wealth			0.024*	0.024*	0.019
			(0.01)	(0.01)	(0.01)
Status				0.035	0.058**
				(0.02)	(0.02)
Education					0.068
					(0.04)
Age					0.002
					(0.00)
Gender					0.178***
					(0.04)
HH members					0.012
					(0.01)

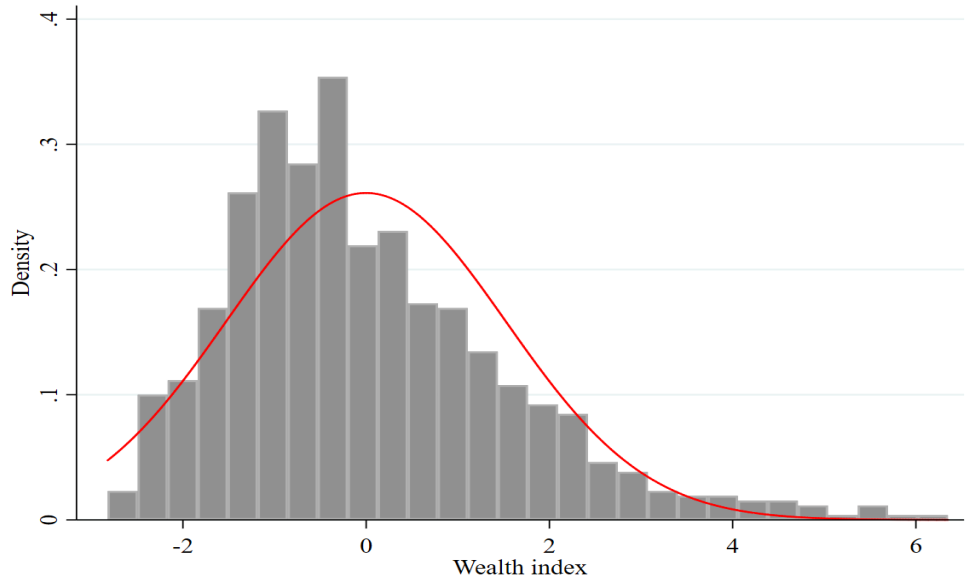
Table 8 (cont): Regression results for sustainable behaviour, Lima					
Constant	2.912***	1.977***	1.998***	1.921***	1.469***
	(0.06)	(0.12)	(0.12)	(0.13)	(0.18)
R-sqr	0.020	0.096	0.101	0.104	0.134
dfres	830	829	828	827	823
BIC	1291.7	1231.5	1233.4	1236.9	1235.8
* p<0.05, ** p<0.01,	***	p<0.001			

Note: Standard errors in parentheses.
Source: Authors' calculations

5.3 Philippines

The Filipino middle classes are mostly urban, growing in size and contribute to human capital with steady jobs and high education levels (Never & Albert, 2020). Although data from national household surveys shows that living conditions of middle-class households have been improving in the past 20 years, a larger proportion of the middle classes still belong to the lower parts of the middle-income bracket (Never & Albert, 2020). The sample in our survey reflects this as well, being skewed towards the less wealthy (Figure 8). The vast majority of Manila's middle classes own their houses (>85 per cent in our sample), a fan, a smartphone, a TV (>90 per cent) and a fridge (81 per cent). Both car ownership (7 per cent) and air conditioner ownership (28 per cent) levels are low in our sample, which is somewhat surprising given the high number of cars on Manila's streets, the congestion and the prestige that some Filipinos ascribe to air conditioner ownership (Sahakian, 2014). On average, middle-class households in Metro Manila score high on environmental knowledge. Environmental and status concerns are in the mid-ranges (Table 9).

Figure 8: Distribution of wealth across middle-class sample in Manila



Source: Authors' calculations

Table 9: Summary statistics middle-class sample, Manila					
Variable	**Obs.**	**Mean**	**Std. dev.**	**Min.**	**Max.**
Energy spending	794	2.233.366	1.756.316	151.1	12000
Log of energy spending	794	7.454.454	7312736	5.017.942	9.392.662
Transport score	800	1.86e-10	1	-.2028731	1.518.816
Sustainable behaviour	794	3.271.201	5033742	1.666.667	4.833.333
Wealth	794	-.0017692	1.527.742	-2.820.594	634.915
Log of wealth	794	1.315.771	3769325	1650107	2.336.904
Status	794	2.661.209	6028937	1	4.5
Knowledge	794	6.066.751	1.600.545	0	8
Concern	794	3.832.494	4474634	1.833.333	5
Education	797	1.182	0.505	0	4
Age	797	3.822.334	1.250.579	18	65
Gender	797	8030113	3979735	0	1
HH members	797	5.356.336	2.465.032	1	20
Source: Authors' calculations					

The regression results on energy and transport confirm our hypothesis H1 that wealthier households emit more carbon (Tables 10 and 11). The effect is even bigger than in Ghana and Peru: A 1 per cent increase in wealth correlates with 0.67 per cent more energy spending. Furthermore, we find that possibly households with female heads or purchasing decision-makers spend more on electricity. However, we have a female respondent bias in our sample (80 per cent), so we would not want to jump to definite conclusions here.

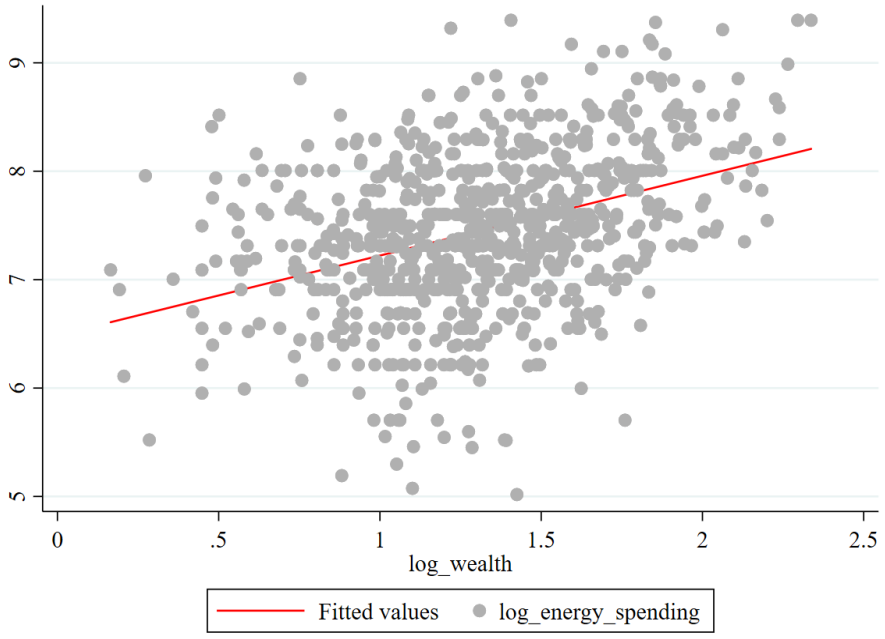
The relationship between wealth and energy spending is linear and has a fairly steep slope (Figure 8). Even though it is graphically not easy to discard a quadratic, additional tests confirmed the linear relationship. Wealth and household size may not be the only reasons for the slope, but also the electricity tariff structure of the electricity provider, Meralco (which we could not control for; see Section 3). Apart from the usual cross-subsidies of poorer consumers' lifeline tariffs by higher tariff groups, the distribution charge increases from 1 peso per kwh to 1.31 pesos per kwh for users of more than 200 kwh per month. The average electricity retail price of Meralco in 2018 was the same as in the Netherlands (International Energy Consultants, 2018), making electricity more expensive than in many other developing countries.

Table 10: Regression results, drivers of the (log of) energy spending in Manila					
Log of energy spending	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Log of wealth	0.736***	0.733***	0.718***	0.716***	0.673***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Status		0.033	0.029	0.024	0.030
		(0.04)	(0.04)	(0.04)	(0.04)
Knowledge			0.023	0.020	0.010
			(0.02)	(0.02)	(0.01)
Concern				0.036	0.042

Table 10 (cont): Regression results, drivers of the (log of) energy spending in Manila					
				(0.06)	(0.05)
Education					0.056
					(0.04)
Age					0.006***
					(0.00)
Gender					0.117*
					(0.06)
HH members					0.100***
					(0.01)
Constant	6.486***	6.402***	6.295***	6.189***	5.351***
	(0.09)	(0.13)	(0.15)	(0.23)	(0.24)
R-sqr	0.144	0.145	0.147	0.147	0.272
dfres	792	791	790	789	785
BIC	1645.3	1651.3	1655.7	1662.0	1563.3
* p<0.05, ** p<0.01,	***	p<0.001			

Note: Standard errors in parentheses.
Source: Authors' calculations

Figure 9: Energy spending and wealth in Manila



Source: Authors' calculations

Table 11: Transport score regressions, Manila					
Transport score	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Wealth	0.087***	0.088***	0.087***	0.087***	0.072**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Status		-0.028	-0.030	-0.031	-0.016
		(0.06)	(0.06)	(0.06)	(0.06)
Knowledge			0.007	0.006	0.001
			(0.02)	(0.02)	(0.02)
Concern				0.014	0.020
				(0.08)	(0.08)
Education					0.166**
					(0.06)
Age					0.001
					(0.00)
Gender					0.036
					(0.09)
HH members					0.004
					(0.01)
Constant	0.002	0.077	0.039	-0.005	-0.289
	(0.04)	(0.16)	(0.20)	(0.33)	(0.38)
R-sqr	0.018	0.018	0.018	0.018	0.027
dfres	792	791	790	789	785
BIC	2257.2	2263.7	2270.2	2276.9	2296.3
* p<0.05, ** p<0.01,	***p<0.001				
Note: Standard errors in parentheses. Source: Authors' calculations					

Regarding transport, not only wealthier middle-class members, but also more highly educated ones emit more carbon. We also find a small positive correlation between status and transport CO_2, which only appears when education is controlled for. Given the very small number of car owners in our sample, we cannot infer that cars are a status symbol for wealthier, educated, middle-class households, even though our focus group discussions and background interviews suggested this. There is no correlation between wealth and our measure of status in our Filipino sample. It is possible that wealthier, more educated Filipinos are happy to pay a higher price to use a UV Express, Uber, taxi or other shared car service because they can afford the extra comfort. Using buses, the metro or Jeepneys is cheaper but involves standing in queues for a long time, especially during rush hour – an air conditioned car in a traffic jam may be the more comfortable option for some. Moreover, in Metro Manila, all available transport modes are used to the maximum capacity during rush hours. In sum, we do not find support for our hypothesis on status (H2) in the Philippines.

The results this far point towards the existence of value/knowledge–action gaps: The existing concern and knowledge does not lead to less carbon consumption from energy spending or transport behaviour. However, the regression results on sustainable behaviour make it clear that wealthier, more environmentally concerned and more knowledgeable middle-class Filipinos engage in more easy-entry sustainable behaviours (Table 12). A

stronger status orientation and a higher education level also play minor roles. Thus, we can only partly confirm hypotheses 3 (knowledge) and 4 (concern).

Table 12: Regression results, sustainable behaviour					
Sustainable behaviour	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Knowledge	0.070***	0.044***	0.038***	0.038***	0.037***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Concern		0.303***	0.289***	0.274***	0.274***
		(0.04)	(0.04)	(0.04)	(0.04)
Wealth			0.049***	0.049***	0.047***
			(0.01)	(0.01)	(0.01)
Status				0.063*	0.064*
				(0.03)	(0.03)
Education					0.021
					(0.03)
Age					-0.001
					(0.00)
Gender					-0.021
					(0.04)
HH members					0.001
					(0.01)
Constant	2.849***	1.841***	1.931***	1.823***	1.852***
	(0.07)	(0.15)	(0.15)	(0.15)	(0.18)
R-sqr	0.049	0.115	0.137	0.142	0.144
dfres	792	791	790	789	785
BIC	1135.7	1085.1	1072.0	1073.6	1098.7
* p<0.05, ** p<0.01,	***p<0.001				
Note: Standard errors in parentheses. Source: Authors' calculations					

In sum, the carbon consumption patterns of the Filipino middle classes are more driven by wealth than by any other factor. Environmental concern and knowledge lead to easy-entry sustainable behaviours, which may provide entry points for changing current or avoiding future carbon-intensive consumption patterns. For changing transport CO_2 emissions, changes in the Manila infrastructure and the operations of the transport system itself are necessary to make sustainable alternatives more attractive.

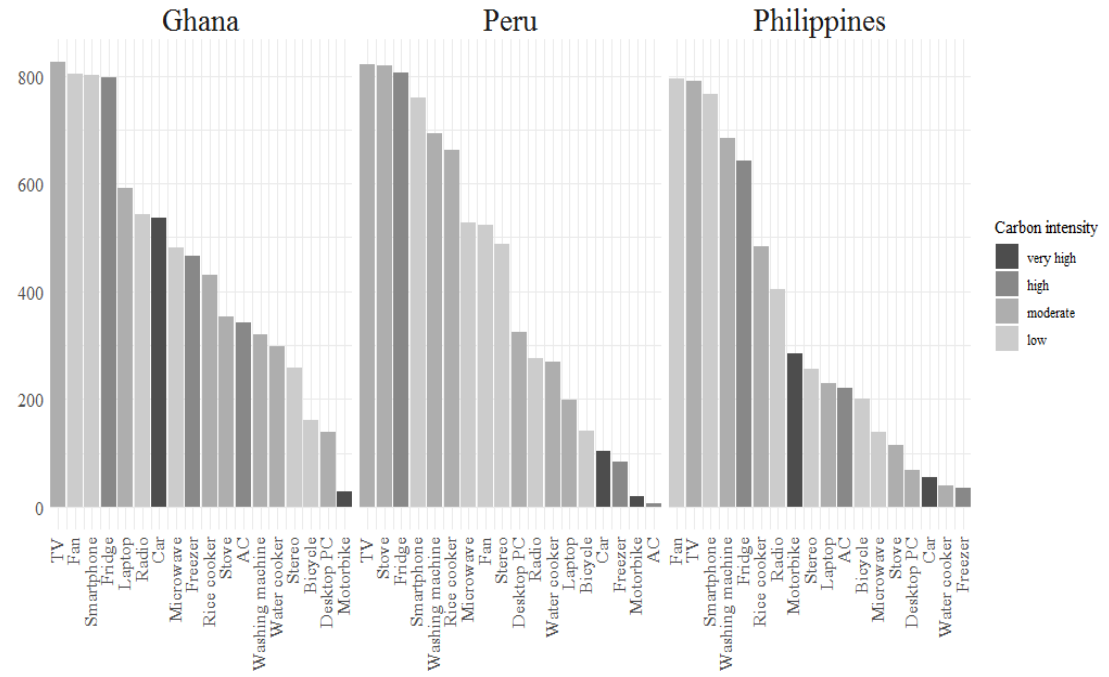
6 Comparative discussion

The drivers of middle-class carbon consumption are similar in Ghana, Peru and the Philippines. Increasing levels of wealth correlate with more carbon consumption from energy and transport, whereas high levels of environmental concern – and to some extent also environmental knowledge – correlate with more easy-entry, low-cost sustainable behaviours. A comparison of the carbon consumption patterns provides additional interesting insights on the number and type of assets middle-class households own, the

travel patterns and the changes in consumer behaviour. This section shows that carbon-intensive consumer behaviour is starting to become a clear policy challenge in the fourth and fifth middle-class wealth quintiles in all three countries.

Middle-class households in all three countries all own a basic range of appliances. Upper-middle classes enjoy a fairly easy, stable lifestyle with a broader range of appliances at their disposal, both carbon-intensive ones, such as an air conditioner or a freezer, and low-carbon ones, such as a radio (Figure 10). Motorbike and car ownership levels are lower than expected in all three countries. On a general scale, the middle classes in Ghana, Peru and the Philippines are similar. The number and type of appliances, cars or motorbikes that households owned present further points of differentiation, both within and across countries.

Figure 10: Appliance ownership in Ghana, Peru and the Philippines in comparison



Note: Y-axis means number of households in the sample that own one or more of the respective assets. Carbon intensity based on authors' own estimations.

Source: Authors' calculations

The share of carbon-intensive appliances, such as air conditioners, freezers or cars, owned by households increases most clearly among the fourth and fifth middle-class wealth quintiles in all three countries (see Figures 13-16). The percentile shares show the concentration of variables in the sample. Freezer ownership in Peru is somewhat of an exception, but total freezer ownership levels among our sample are low, that is, Figure 12 should be rather understood as indicating a distribution trend.

In both Peru and the Philippines, car ownership in our sample is clearly a luxury that only the wealthier middle-class households can afford. The share of car ownership in Ghana underlines that having one or more cars is a sign of wealth – alongside other potential reasons such as comfort, necessity for out-of-town travel or transport of own produce. Interestingly, in both Peru and the Philippines, car ownership levels spike in the top 5 per cent of households, implying that car purchases really only become an option for many

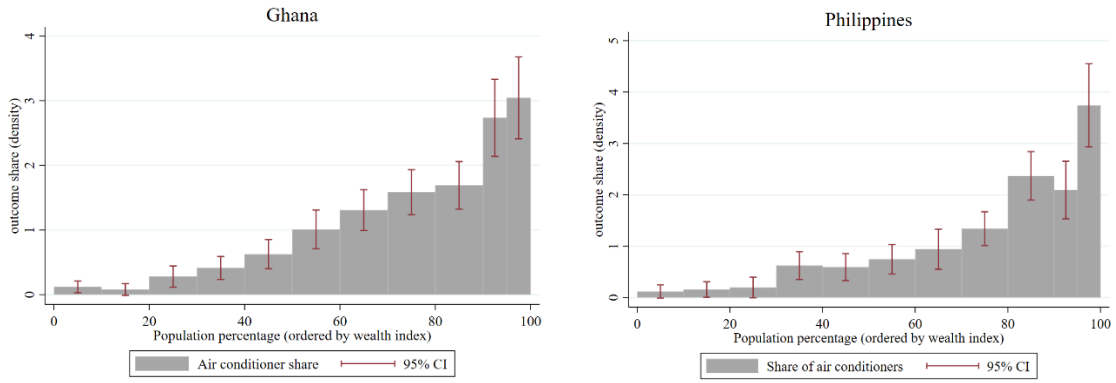
middle-class households when their wealth has reached a high, stable level. This finding is somewhat contradicts our qualitative focus group discussions and background interviews leading up to our survey, in which low interest rates and options to pay by instalment were frequently mentioned as reasons why cars are now affordable, even for less wealthy people.

Travel patterns and possibilities to invest in carbon-intensive leisure activities such as air travel also change quite clearly from the lower-middle to the middle classes in all three countries. Although a few households in the first and second middle-class wealth quintiles of our distributions have been able to travel by airplane in the past 12 months, flying becomes a more important feature of consumer behaviour among the upper-middle classes. Here, an exponential – instead of a linear – relationship may exist that we unfortunately cannot test in detail due to the small sub-sample of airplane travellers. Domestic airfares in all three cases have become much more affordable, as low-cost airlines exist in all three countries. In Ghana, family matters such as funerals or visiting relatives are still more often the reason for travelling than pure tourism, whereas Filipino middle classes have started to explore their country also for tourism reasons.

Carbon consumption patterns start changing as middle-class households move from the fourth to the fifth middle-class wealth quintile, as our findings suggest. In Peru, this translates to a shift that is happening once households have reached an annual income of roughly 20,000 soles (ca. USD 11,550 PPP), with a sharp increase in carbon consumption among the wealthiest 5-10 per cent of the middle classes (income ca. 25,000-30,000 soles or more in our sample = USD 14,550-17,300 PPP).[8] The energy poverty and carbon footprint literature argues that moving out of poverty can be energy-intensive, and to some extent carbon-intensive, as households are able to expand consumption beyond the bare necessities (Wiedenhofer et al., 2016). We add that not only the entry into the lower or vulnerable middle classes is relatively carbon-intensive, but especially moving into the stable lifestyles of the affluent middle classes on the cusp of being upper class.

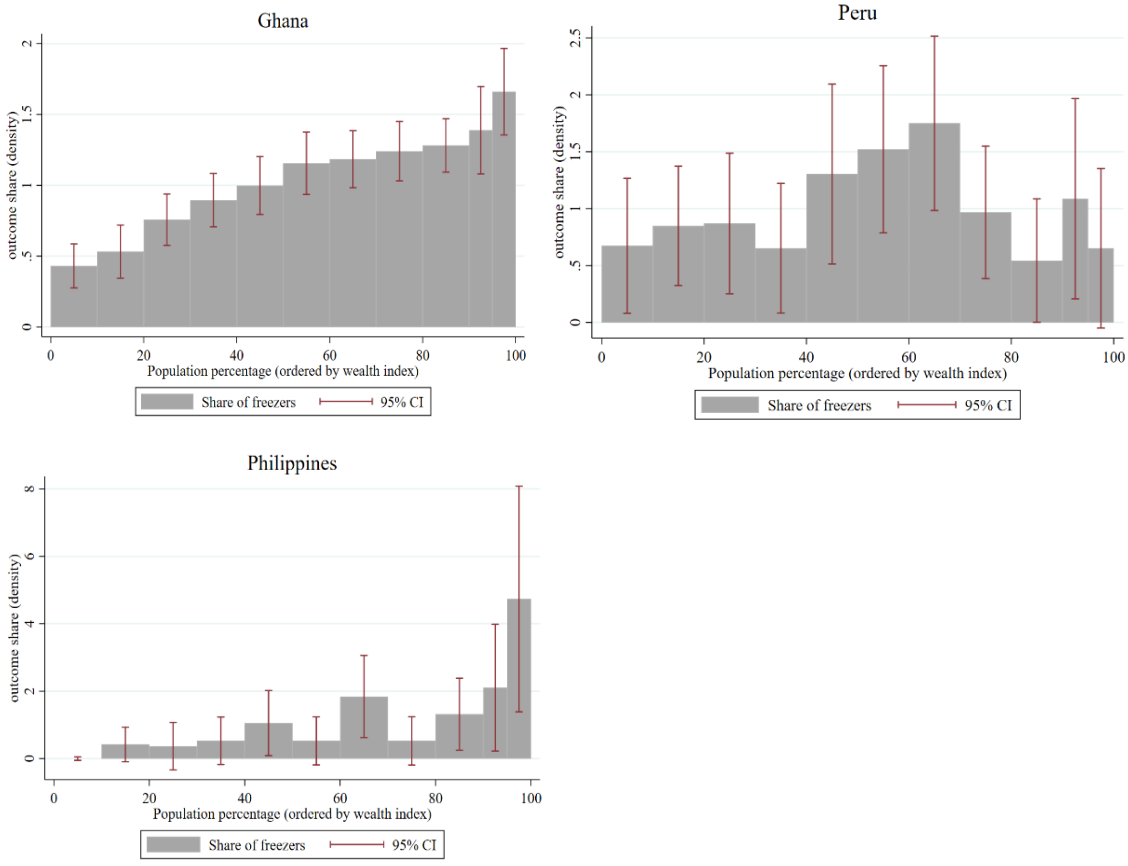
8 Calculation of predicted income values using a proxy means regression with our data and ENAHO (2017) data for Lima (see Section 4.2).

Figure 11: Share of air conditioners owned in the sampled households, ordered by wealth



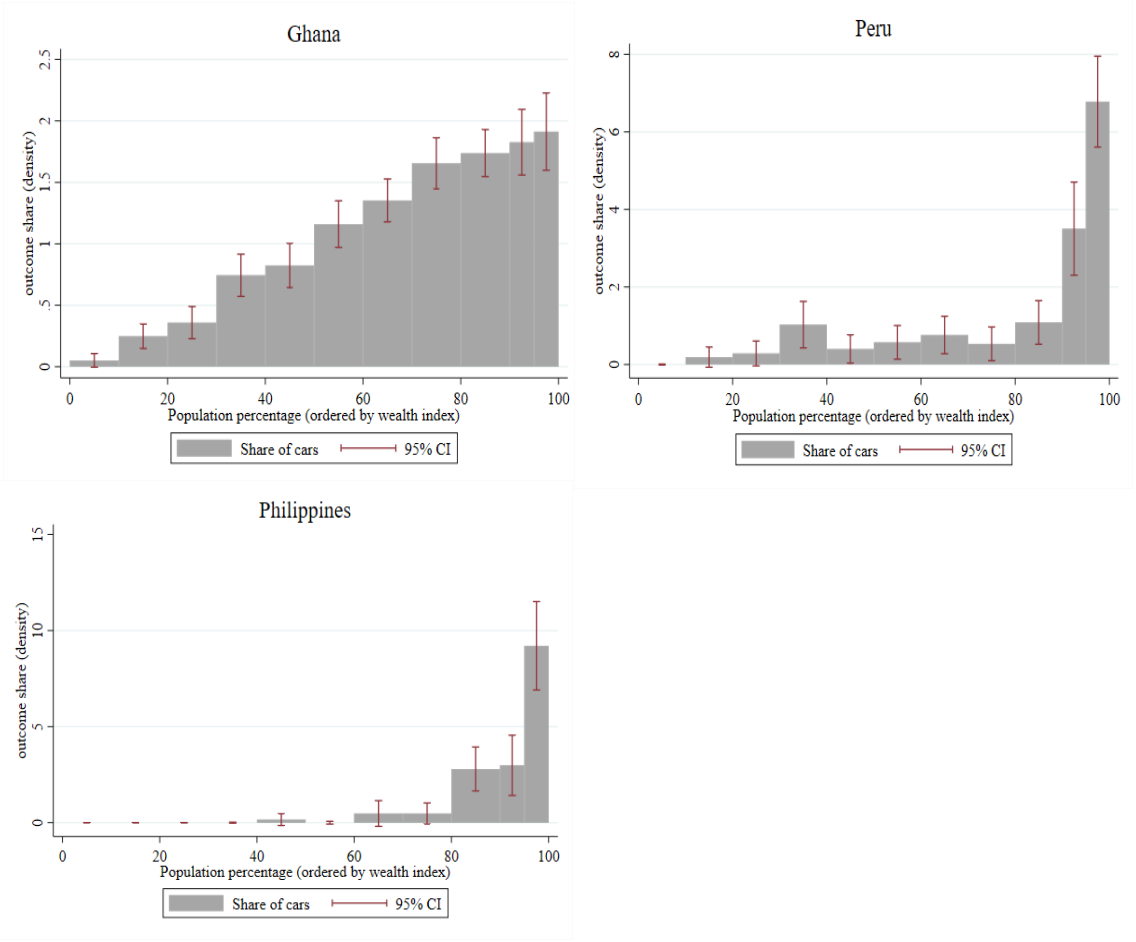
Source: Authors' calculations

Figure 12: Share of freezers owned in the sampled households, ordered by wealth



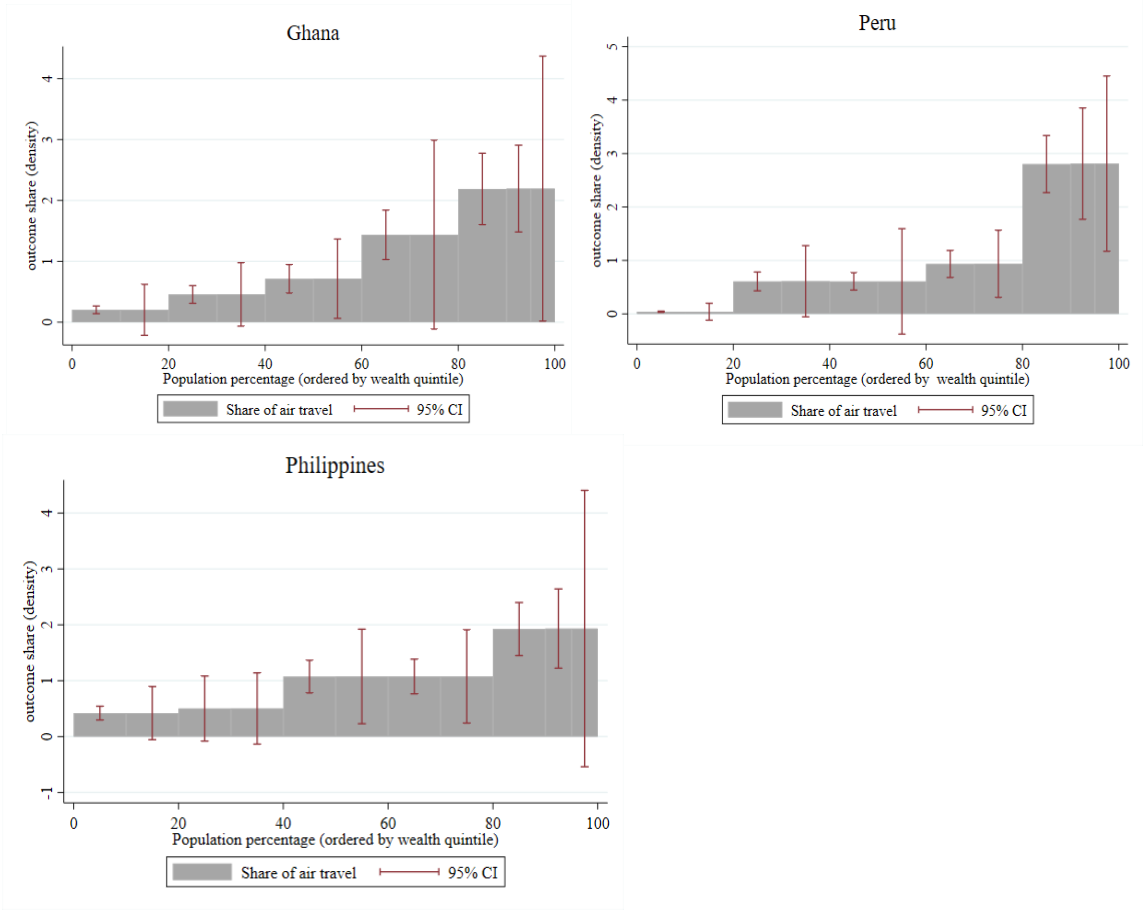
Source: Authors' calculations

Figure 13: Share of cars owned by sampled households, ordered by wealth



Source: Authors' calculations

Figure 14: Share of air travel in the past 12 months by wealth quintile



Source: Authors' calculations

In comparison, our findings point towards an intention–action gap that is either based on high levels of knowledge, high levels of environmental concern, or both. If there were no such gap, we would expect to find an influence of knowledge or concern on carbon consumption (energy/transport). Generally, the emerging middle classes thus behave the same way as consumers in industrialised countries. The actual deeper understanding of specific concepts such as recycling or levels of trust in available consumer information varies among the middle classes in all three countries of our analysis. In comparison, more respondents from the Ghanaian middle classes recognised the national energy-efficiency label (83 per cent) than the Filipino (68 per cent know the old label, 18 per cent the new label introduced in 2018) and Peruvian respondents (23 per cent; label only introduced in April 2018). Roughly half of Ghanaians and Filipinos stated that they understand the information on these labels at least to some degree (57 per cent Ghana; 52 per cent Philippines) and trust or strongly trust the label (47 per cent Ghana, 56 per cent Philippines). In Peru, of those respondents who know the label, around 23 per cent said they understand its information, and half say they trust or strongly trust the label (53 per cent).

With respect to the energy-efficiency labels, the difference between superficial awareness and deeper understanding and trust may explain why labels have not driven purchases of appliances as strongly as in European countries (e.g. Switzerland; see Sammer & Wüstenhagen, 2006). In our survey, we also asked how important a range of criteria is to

the respondent when purchasing an appliance (price, brand, energy efficiency label, recommendations of friends or family). Since the question was quite general, and of course hypothetical, we did not expect to find results that were as reliable as those that discrete choice experiments on air conditioners in Ghana and the Philippines have produced (Kuhn, Kutzner, & Thøgersen, 2020). But if one factor such as the energy efficiency or the price of the appliance proved to be the most important for decision-making, we would have expected to see this in our results. This was not the case. From a policy perspective, information campaigns need to be optimised to foster a deeper understanding of the concept at stake and to overcome trust issues, but in themselves, they will hardly change carbon-intensive behaviours.

The intention–behaviour gap can be overcome for easy-entry sustainable behaviours in Ghana, Peru and the Philippines. Environmental knowledge (except for Ghana) and concern correlate clearly with easy-entry sustainable behaviours that can be performed quite easily at home or while shopping. For carbon consumption related to transport, infrastructure availability and security concerns may override environmental intentions, which explains the concern–action gap. The difference between easy-entry sustainable behaviours and overall carbon consumption patterns may also be due to what psychologists call moral licensing (Thøgersen & Ölander, 2003; Tiefenbeck, Staake, Roth, & Saschs, 2013), and what energy economists know as rebound effects (Berkhout, Muskens, & Velthuijsen, 2000). Moral licensing describes individuals' feelings of entitlement to a non-environmental behaviour after a pro-environmental behaviour has been performed, often leading to a high overall environmental impact over time (Merritt, Effron, & Monin, 2010). Moral licensing helps to explain the rebound effect in neoclassical economics from a psychological perspective. According to the rebound effect literature, net negative outcomes of investments in energy-efficient technology come about through freed capital and price effects. Irrespective of disciplinary backgrounds, the question of how to overcome the difference between sustainable easy-entry and unsustainable high-entry, high-cost behaviours in order to lower overall carbon consumption presents one of the key questions for both research and policy globally.

On the one hand, moral licensing, rebound effects and carbon consumption driven by wealth and simple material interest among the growing middle classes are discouraging from an environmental perspective. On the other hand, the existence of easy-entry sustainable behaviours can be used to create positive spillovers by way of a "foot in the door" effect (Freedman & Fraser, 1966). Besides, individuals who start to reduce their carbon consumption levels accept low-cost behaviours more readily (Dubois et al., 2019). This phase-in may be particularly important in developing countries, where sustainable consumption policies hardly exist yet.

Moreover, in spite of the pattern of increasing carbon consumption, not all wealthy middle-class households in our samples spent a lot on electricity and have a high transport CO_2 score. In each of our three countries of analysis, there were some households that were wealthier but that had fairly low energy and/or transport consumption levels. Starting points for policy therefore exist.

7 Conclusion and policy implications

The carbon consumption patterns of the emerging middle classes in Ghana, Peru and the Philippines largely reflect those of households in industrialised countries. The distinction between developed and developing countries in the global climate debate may therefore be outdated. The point of distinction in a global world with a global climate turns out to be whether a household is part of the global middle classes.

Changes in emerging middle-class consumer behaviours increase emission levels with increased energy and transport consumption due to both purchasing decisions and user behaviours. Wealth presents the most important driver of carbon consumption: As the emerging middle classes become more wealthy, their carbon consumption levels from energy and transport emissions increase. From an environmental perspective, this is bad news. The middle classes in all three countries have mid- to high levels of environmental knowledge and environmental concern. More knowledge and higher levels of concern lead to easy-entry environmental behaviours (e.g. switching off lights, reusing plastic bags, avoiding specific products for environmental reasons), but they do not decrease the levels of carbon consumption (from energy and transport emissions). High-cost, carbon-intensive behaviours such as buying cars or travelling by plane are as difficult to change in Ghana, Peru and the Philippines as in industrialised countries. Thus, there is now an empirical confirmation for a knowledge/value–action gap in middle-income countries that has not been documented before. In contrast to previous findings, we do not find an effect from our measure of status on carbon consumption. Only in Peru did our findings confirm our hypothesis that less wealthy middle classes are more prone to signal status via consumption.

Our overall findings are in line with both carbon footprint studies, psychology and other social science literature on the intention–action gap as well as with literature on the discrepancies between easy-entry, often low-cost and difficult to change, usually high-cost sustainable behaviours. We find linear relationships and steeper slopes for transport CO_2 than for electricity expenditures. However, when disaggregating results into actual lifestyle choices, it becomes clear that a sharp increase in carbon consumption starts to come about between the fourth and fifth middle-class wealth quintiles, and most clearly among the wealthiest 5-10 per cent of the middle classes. The wealthy middle classes start acquiring cars, own more assets of the same type and more frequently use airplanes. We see this more clearly for Ghana and Peru, as our sample in the Philippines is slightly skewed towards less wealthy households. The link to the Peruvian ENAHO data revealed that once households acquire annual incomes of approximately USD 11,550 PPP, consumer behaviour becomes much more carbon-intensive. Carbon consumption increases sharply among the wealthiest middle-class households in Lima, who have an annual income between USD 14,550 and 17,300 PPP.

Looking towards the future of middle-class consumer trends, our results are both discouraging and encouraging. From a development perspective, the middle classes in Ghana, Peru and the Philippines are expected to grow and stabilise their wealth, and thus, their consumption capacities. Energy and transport systems, however, will also struggle to meet growing demands in a way that actually keeps development opportunities open. If carbon consumption patterns of the emerging middle classes remain as they currently are, this will present a challenge for the global climate and local environments. The encouraging messages from our findings are that easy-entry sustainable behaviours in energy, recycling and political

consumption are already happening. Furthermore, a few households in each of our three country samples are wealthy and do not score high on energy and transport emission levels.

Our findings have the following implications for policy:

- Sustainable consumption policies aimed at reducing carbon consumption levels are also required in middle-income countries to make low-carbon consumption attractive.
- These policies do not need to deprive individuals of development or the experience of travel, for example, but can promote "cool" (low-carbon) lifestyles and new technologies that are explicitly low-carbon.
- The "foot in the door" effect from existing easy-entry sustainable behaviours should be supported. Systematically encouraging such low-cost, low-carbon behaviours may increase the acceptance and effectiveness of more substantial changes at a later point in time.
- Information and knowledge-enhancing campaigns alone are unlikely to work to transform carbon consumption patterns (but can nevertheless be important elements).
- If information and knowledge campaigns are pursued (e.g. for energy-efficiency labels), they should foster a deeper understanding of the issues in a clear, simplified fashion that also enhances trust.
- Policy packages are necessary that create viable alternatives for consumers (e.g. improved transport infrastructure, most-efficient technologies available in the market) and use behavioural insights to change consumer behaviours.

Future research could investigate the lifestyles and identities of those few middle-class consumers who do not emit a lot of carbon in spite of their relative wealth. Experimental approaches could shed light on how to change high-cost, carbon-intensive consumption behaviours.

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Appendices

Appendix A. Middle-class screening questions (example Philippines)

1. Appearance of the house

	Lower class (do not interview)	Threshold to lower-middle and upper-middle classes	Threshold to high class (do not interview)
Size	Small, several people sharing one room	Several rooms, not more than 2-3 people sharing a room, may have front yard	Roomy house or apartment with garage, front yard and/or lawn
Points	0	1	2
Materials	Wood and light materials only	Concrete or mix of wood and concrete	Concrete, well-constructed with high-quality materials
Points	0	1	2
Quality	Non-permanent, bad quality, Needs paint and repairs	May or may not need a new coat of paint, permanent, well-constructed structure, may need some repairs	Very well-maintained and painted
Points	0	1	2

2. Rent or ownership of the house

	Lower class	Threshold to lower-middle classes	Threshold to upper-middle and high class
	Rent or squat, less than 5,000 pesos rent	Rent of 5,000 pesos or more	Ownership
Points	0	1	2

3. **Water/sanitation:** What is the main source of water supply to this household?

	Lower class	Threshold to lower-middle classes	Threshold to upper-middle and high class
	Borehole, bottled water, sachet water, piped water outside compound…	Piped water inside dwelling or compound	Piped water inside dwelling or compound, used to water garden, fountain etc. as well
Points	0	1	2

4. **Expenditures/savings on health:** How much did you pay for health insurance and medical supplies in the past four weeks? *If nothing, then ask:* How much did you save for future health expenditures in the past four weeks?

	Lower class	Threshold to lower and upper-middle classes	Threshold to high class
Health expenditures	Up to 500	500-2,000 pesos	More than 2,000 pesos
Points	0	1	2
Health savings	none	For emergencies only, small amount up to 500 pesos	Regular savings, more than 500 pesos monthly
Points	0	1	2

5. **Expenditures/savings on education:** How much did you pay for education in the past year (school and/or university fees)? *If nothing, then ask:* How much did you save for future education expenditures in the past year?

	Lower class (do not interview)	Threshold to lower and upper-middle classes	Threshold to high class (do not interview)
Education expenditures	up to 5,000 pesos	5,000-80,000 pesos	More than 80,000 pesos
Points	0	1	2
Education savings	Up to 2,000 pesos	2,000-10,000 pesos	More than 10,000 pesos
Points	0	1	2

6. **Expenditures on restaurants/eating out:** In the past two weeks, how often did you eat out (in a proper restaurant or fast food restaurant, not a street stall)?

	Lower class	Threshold to lower and upper-middle classes	Threshold to high class
Education expenditure	Never	1-4 times	More than 5 times
Points	0	1	2

7. **Level of education of household head:** What is the highest grade of education of the household head?

	Lower class (do not interview)	Threshold to middle classes	Threshold to high class (do not interview)
Level of education	High school	Some college education, different price ranges	Graduate of exclusive schools and colleges (Master or PhD level)
Points	0	1	2

Appendix B. Measurement scales for the independent variables

Social status scale:

Participants were asked to what extent they agree or disagree with the following questions (5-point Likert scale):

1. I buy the type of car or appliance that is likely to show my social standing.
2. When buying a product, it is important to me to know what other people think of it.
3. I prefer to buy well-known brands, even though they are sometimes more expensive.
4. I don't like to use public transport because I believe I deserve something better.

Environmental concern scale:

1. It is important to me that the products I use do not harm the environment.
2. I consider the potential environmental impact of my actions when making many of my decisions.
3. My purchase habits are affected by my concern for our environment.
4. I am concerned about wasting the resources of our planet.
5. I would describe myself as environmentally responsible.
6. I am willing to restrict myself in order to take actions that are more environmentally friendly.

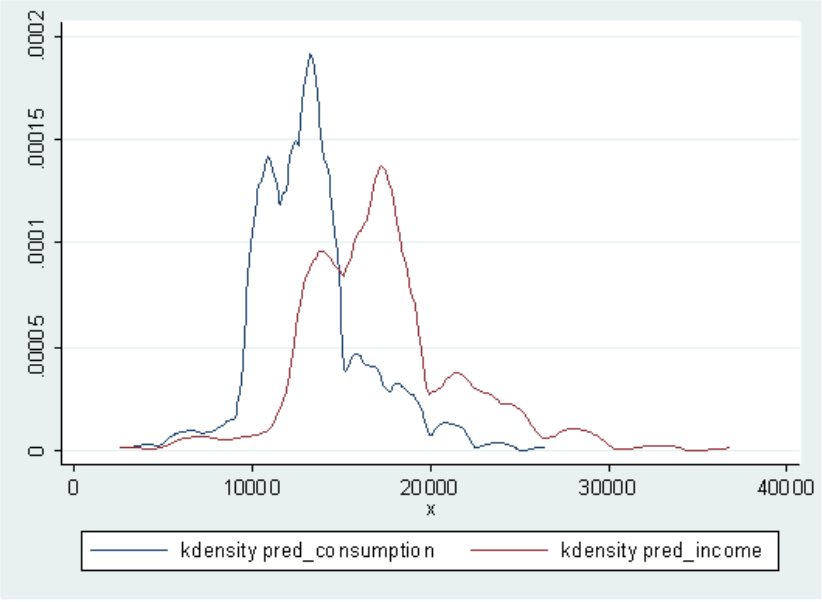
Environmental knowledge scale:

1. I know a lot about the topic of global climate change.
2. I know quite a lot about the different possibilities how to save energy in my household.
3. Compared with others, I have a good understanding of the impact of transport on air pollution.
4. You can save energy when you set your air conditioner two degrees warmer.
5. Using a lot of energy has a negative impact on the environment.
6. You can save energy and money in the long run when you buy a new fridge with energy-efficient technology.
7. Whether I leave the light on the whole day or turn it off when I leave the room does matter for my energy consumption.
8. Using public transport instead of a private car is better for the environment.

Table A1:	**Philippines' emission factors for the calculation of the transport score**			
Transport mode	**Average occupancy** (person km per vehicle km travelled)	**Occupancy (inverse)** (person km per vehicle km travelled)	**Emission factor** (g of CO_2 per vehicle km travelled)	**CO_2 consumption** (g of CO_2 per person km)
Car (private)	1.7	0.59	270	159.3
Jeepney	10.0	0.1	385	38.5
Bus	35.3	0.03	870	26.1
UVX	9.94	0.01	385	38.5
Motorcycle	1.1	0.91	60	54.6
Tricycle	1.75	0.57	110	62.7
Taxi	1.54	0.65	270	175.5
Grab	1.54	0.65	270	175.5
Drive other	1.54	0.65	270	175.5
Source: Authors' calculations				

Table A2:	**Peru – cross-check of our data validity with ENAHO 2017 data**					
	Variable	Obs.	Mean	Std. dev.	Min.	Max.
Own data	pred_consumption	898	13,208.77	3155.314	3,374.35	26,438.62
ENAHO Lima	gashog2d_pc	3,964	12,640.69	9569.738	1,573.807	131,227.4
Source: Authors' calculations						

Figure A1: Cross-check of our data with ENAHO data: Distribution of predicted welfare (consumption) and predicted income



Source: Authors' calculations

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