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David M. Arseneau

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David M. Arseneau†
Federal Reserve Board

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Abstract

This paper uses disaggregated data from a broad cross-section of countries to empirically assess differences in energy consumption profiles across countries. We find empirical support for the energy ladder hypothesis, which contends that as an economy develops it transits away from a heavier reliance on traditional fuel sources towards an increase in the use of modern commercial energy sources. We also find empirical support for the hypothesis that structural transformation—the idea that as an economy matures, it transforms away from agriculture-based activity into industrial activity and, finally, fully matures into a service-oriented economy—is an important driver for the distribution of end-use energy consumption. However, even when these two hypotheses are taken into account, we continue to find evidence suggesting that the patterns of energy consumption in the BRIC economies are importantly different from those of other economies.

JEL Classification: Q41; Q43

Keywords: Energy and development; Energy ladder hypothesis; Structural transformation

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†The views expressed in this paper are those of the author and do not represent those of the Board of Governors of the Federal Reserve System or other members of its staff. E-mail address: david.m.arseneau@frb.gov.

1 Introduction

One of the defining characteristics of global energy markets over the past decade is the rapid growth of energy consumption in the emerging market economies. The 2010 Annual BP *Statistical Review of World Energy* shows that over the past ten years the average annual growth rate of global total final energy consumption was just under 1 percent. Over this period, energy consumption in OECD economies declined slightly. In contrast, the emerging market economies experienced a collective growth rate of roughly 2 percent, making it clear that the developing world has been the primary engine for global energy consumption growth. Moreover, much of this growth was concentrated in just four countries—the so-called BRIC economies of Brazil, Russia, India, and China. These four economies accounted for approximately half of the growth in emerging markets taken as a whole over the past decade.

This growth differential has potentially important implications for global energy markets going forward. Existing research suggests that the dynamics of energy consumption in emerging market economies are importantly different from the developed world.[1] If the growth differentials observed over the past ten years persist, the resulting shift in the distribution of global consumption could give rise to a markedly different energy landscape; one that is much more heavily weighted toward developments in the emerging markets. In light of this, understanding the behavior of energy consumption in the emerging markets–and in the BRICs in particular–is an increasingly pressing priority for energy economists. Existing literature has made some strides in this direction, however it very much remains an open area of research.

This paper moves in this direction by using disaggregated micro-level data to examine energy consumption patterns in a wide cross-section of countries. We construct a dataset detailing energy usage in 35 different countries which, taken together, comprise roughly 80 percent of global total final energy consumption. These data are then used to empirically assess two alternative theoretical explanations for why energy consumption portfolios differ across countries.

In order to do this we examine the data from two separate dimensions. The first is what we refer to as the *fuel intensity profile*, which describes the fraction of energy consumption, either at the aggregate level or disaggregated at the sectorial- or industry-level, derived from a given source fuel. Here, we are interested in identifying characteristics that make a country more (or less) reliant on a specific fuel source for energy generation.

The so-called "energy ladder hypothesis" offers a theoretical guide around which we organize our empirical investigation. This hypothesis contends that as the level of economic development in a country rises, substitution takes place away from traditional biomass, including wood and agricultural and animal waste, as a primary fuel

[1] See, for example, Gately and Huntington (2002) and Dargay, Gately and Huntington (2007), document notable differences in oil and/or energy consumption dynamics across different subsets of countries.

source and into more modern, cheaper, and cleaner (less polluting) energy sources such as natural gas, oil and petroleum products, and electricity.[2] This transition along the energy ladder occurs not only in residential usage, but also in industrial, commercial, and agricultural usage as technologies and physical infrastructure for energy generation using these fuels become more widespread.[3]

To test this hypothesis we exploit the systematic variance between fuel intensity profiles and the level of economic development. In particular, the fuel intensity profile should vary in such a way that higher income countries tend to rely more heavily on higher quality, cleaner fuels. In fact, this is exactly what we find in the data – both in the aggregate data as well as the disaggregated data at both the sector- and industry-level. Thus, the first main result of this paper is that there is strong empirical support for the energy ladder hypothesis as a determinate of a countries' fuel intensity portfolio.

The second dimension we explore is a countries' *end-use consumption profile*, which describes the fraction of total energy consumed in a given sector of the economy or, at a more disaggregated level, in a given industry within a sector. Along this dimension, the goal is to identify characteristics that lead to a country to consume a higher (or lower) fraction of total energy in one particular sector of the economy relative to other countries.

Our empirical investigation here is guided by the so-called "structural transformation hypothesis", which keys off the widely accepted view that an economies' industrial structure changes endogenously as it undergoes the process of economic development.[4] Economic activity in underdeveloped countries tends to be focused mainly in agriculture. However, as a country grows agricultural activity gives way to industry as a country begins to develop. At later stages of development, once industrialization is complete industrial activity tends to decline as the process of development transforms the economy toward more service-oriented activity.

This shift in the composition of the economy implied by the process of structural transformation has implications for patterns of end-use energy consumption.[5] We test these implications at both the sector- and industry-level and we find that, in general, the data are supportive of the structural transformation hypothesis. Thus, the second main result of the paper is that the process of structural transformation is an important determinant of a countries' end-use consumption profile.

[2] Hosier and Dowd (1987), Leach (1992), Barnes and Floor (1996), Heltberg (2004), and Hosier (2004) all examine the energy ladder hypothesis using micro data on residential usage.

[3] Grübler (2004), Bashmakov (2007), Marcotullio, and Schulz (2007) all provide descriptive evidence of how the energy mix changes with economic development. Burke (2010a,b) explicitly tests this hypothesis in two contributions concentrating on the total energy mix and on the electricity mix, respectively.

[4] The link between economic development and structural change owes to Kuznets (1971).

[5] Judson, Schmalensee, and Stoker (1999), Medlock and Soligo (2001), and Schäfer (2005) all examine implicaitons of structural change for energy demand from an empirical standpoint. See Arbex and Perobelli (2010) and Stefanski (2010) for some recent theoretical contributions.

Backed with these two empirically-relevant theoretical explanations for why and how energy consumption profiles might differ across countries, we next ask the question: Are the BRICs different? In short, we find that they are indeed notably different along a number of dimensions. This is an important finding both from the perspective of energy economists trying to understand ongoing market developments as well as from the perspective of policy-makers who ultimately need to deal with the consequences of these developments.

As noted above, the BRICs have been a significant engine of growth for global energy consumption and are likely to remain so in the future. Accordingly, these economies in particular will play an increasingly important role in shaping the energy landscape of the future. The results of this paper highlight the need for future research to shed more light on energy consumption dynamics–both at long-run as well as at cyclical frequencies–in the emerging markets, in general, and the BRICs, in particular. A key aspect of this research will inevitably involve delving further into the data at an even more disaggregated level, suggesting that continuing to improve the depth, scope, quality, and ease of dissemination of energy usage statistics should be a top priority.

Regarding related literature, one paper in particular deserves further discussion. Using a panel dataset, Burke (2010b) also finds evidence in favor of the energy ladder hypothesis. Along this dimension, we reach a broadly similar conclusion here, thus our findings can be viewed as complimentary to Burke (2010b). Nevertheless, there are a number of important differences across the two papers. For example, the two papers reach similar conclusions despite the use of different data. While the country coverage in our data is smaller and there is no time series dimension, we exploit data at a more disaggregated level than does Burke (2010b). Data differences notwithstanding, the key point of differentiation between the two papers is the focus here on behavior of the BRIC economies as outliers.

The remainder of the paper is organized as follows. The next section discusses the data and presents the empirical methodology used to assess the validity of the energy ladder hypothesis to describe cross country differences in the fuel intensity profile and the structural transformation hypotheses to explain cross country differences in the end-use consumption profile. The main results are presented in Section 3. Section 4 investigates whether or not the energy consumption profiles of the BRIC economies are significantly different from that of other countries beyond what can be explained by the core hypotheses outlined in section 2. Finally, section 5 offers some concluding comments as well as some suggested areas for further research.

2 Data and Empirical Methodology

The data used in the analysis consist of the 2007 annual energy consumption portfolios of 35 different countries, listed in Table 1, from various geographic regions and levels of economic development. We use the 2007 data because it is the most recently available. Taken together these 35 countries constitute 80 percent of global total final energy consumption. In what follows, let n be an integer that indexes country, where $n \in [1, 35]$. All data are obtained from the Energy Balances of OECD and Non-OECD Countries published by the International Energy Administration (IEA).

These data are presented along two primary dimensions for each of the n countries in the sample. The first dimension is energy usage by primary fuel source. Let the integer k index primary fuel source, where $f \in [1, 6]$ indicating energy generated from: Combustibles, renewable energy sources, and waste ($f = 1$); coal and peat ($f = 2$); crude oil and petroleum products ($f = 3$); natural gas ($f = 4$); geothermal, hydroelectric, and/or nuclear energy ($f = 5$); and electricity ($f = 6$).

The data are also presented along a second dimension of end-use consumption broken out by sector as well as by industry within a given sector. In terms of notation, let the integer s index sector, where $s \in [1, 4]$ indicating energy consumed in the: Industrial sector ($s = 1$); transportation sector ($s = 2$); residential and commercial sector ($s = 3$); and agricultural sector ($s = 4$). Moving down one level of aggregation, let the integer i index industry within sector s. In the raw data presented by the IEA the upper limit of the index i is conditional on the sector of interest. For example, the data for the industrial sector can be disaggregated into thirteen separate industries. Similarly, there are six industries within the transportation sector and three within the residential and commercial sector excluding agriculture, forestry, and fishing, which we have chosen to break out as a separate category.

When all is said and done, at the most disaggregated level the dataset consists of a (23×6) matrix for every country in the sample, totaling $4,830$ individual data points across the entire sample. These data are sufficiently detailed to describe, for example, energy derived from coal and peat that is consumed in the iron and steel industry expressed as a fraction of aggregate energy consumption for country n.

In the interest of simplicity, as well as for the ease of presentation, we aggregate the industry-level data into just two industries per sector, so that $i \in [1, 2]$ regardless of s. For the industrial sector, we group industries into those that are more energy intensive and those that are less energy intensive based on classifications presented by the U.S. Department of Energy (DOE).[6] The transportation sector is grouped into road transportation and non-road transportation[7]. Finally, both residential and commercial energy usage are broken out as separate industries. The agricultural sector is not disaggregated further. The resulting condensed dataset is an (6×6) matrix of data for each country in the sample, consisting of $1,260$ individual data points.

[6] The following industries are classified as "more energy intensive": Iron and steel, chemical and petrochemical, non-ferrous metals, non-metallic minerals, and paper pulp and printing. The remainder, transportation equipment, machinery, mining and quarrying, food and tobbacco, wood and wood products, construction, and textile and leather, are classified as "less energy intensive".

[7] Road transportation consists of both private and commercial transportation. Non-road transportation consists of domestic aviation, rail, pipeline transport, and domestic navigation.

Our goal in the analysis is to explain cross-country differences in energy consumption portfolios broken out along the two dimensions of fuel source and end-use consumption. Before we provide formal definitions of the metrics that we will use to empirically describe these two dimensions, some additional notation is useful.

At the lowest level of aggregation, let $c_{n,f,s,i}$ denote consumption for country n of fuel f in industry i of sector s. At the other extreme, let $C_{n,\cdot,\cdot,\cdot}$ denote aggregate energy consumption for country n across all fuels and end-use sectors, where $C_{n,\cdot,\cdot,\cdot}$ is defined as:

$$C_{n,\cdot,\cdot,\cdot} = \sum_f \sum_s \sum_i c_{n,f,s,i}$$

Thus, our notation has a consumption aggregate denoted by an uppercase $C_{n,\cdot,\cdot,\cdot}$. The subscript $n, \cdot, \cdot, \cdot$ reveals that the aggregate is for a given country, n, while the (lack of a) dots $(\cdot)$ reveals the level of aggregation. Generally speaking, a dot in place of a given subscript n, f, s, or i means that we have aggregated over that dimension, so more dots in the subscript implies a higher level of aggregation. For example: $C_{n,\cdot,\cdot,\cdot}$ is aggregate consumption summed over all fuels, f, sectors, s, and industries, i; $C_{n,f,\cdot,\cdot}$ is consumption by fuel f aggregated across all sectors, s, and industries, i; $C_{n,\cdot,s,\cdot}$ is consumption by sector s aggregated across all fuels, f, and industries, i; $C_{n,f,s,\cdot}$ is consumption by fuel f in sector s aggregated across all industries, i, and so forth.

With this notation in mind, we turn now to a formal definition of the variables of interest and a description of the empirical models that will be used to explain them.

2.1 Fuel Intensity Portfolio

The empirical metric used to summarize the energy portfolio along the fuel source dimension is *fuel intensity*. We aim to explain the cross-country variation in fuel intensity at three different levels of aggregation.

Aggregate fuel intensity is simply a measure of the share of aggregate energy consumption accounted for by fuel f aggregated across all sectors and industries for country n. A formal definition is as follows:

$$AFI = \frac{C_{n,f,\cdot,\cdot}}{C_{n,\cdot,\cdot,\cdot}} = \frac{\sum_s \sum_i c_{n,f,s,i}}{\sum_f \sum_s \sum_i c_{n,f,s,i}}$$

where: AFI denotes aggregate fuel intensity; $C_{n,f,\cdot,\cdot}$ denotes aggregate energy consumption accounted for by fuel f across all sectors and industries; and $C_{n,\cdot,\cdot,\cdot}$ is aggregate energy consumption across all fuels, sectors, and industries.

Disaggregating one level gives *sector-level fuel intensity,* which measures the share of energy consumption in sector s accounted for by fuel f, formally defined as:

$$SFI = \frac{C_{n,f,s,\cdot}}{C_{n,\cdot,s,\cdot}} = \frac{\sum_i c_{n,f,s,i}}{\sum_f \sum_i c_{n,f,s,i}}$$

where: SFI denotes sector-level fuel intensity; $C_{n,f,s,\cdot}$ denotes energy consumption in sector s accounted for by fuel f across all industries, i; and $C_{n,\cdot,s,\cdot}$ is energy consumption within sector s across all fuels and industries.

Finally, the lowest level of aggregation gives *industry-level fuel intensity*, which measures the share of energy consumption in industry i of sector s accounted for by fuel f. A formal definition follows:

$$IFI = \frac{c_{n,f,s,i}}{C_{n,\cdot,s,i}} = \frac{c_{n,f,s,i}}{\sum_f c_{n,f,s,i}}$$

where: IFI denotes industry-level fuel intensity; $c_{n,f,s,i}$ denotes energy consumption in industry i of sector s accounted for by fuel f; and $C_{n,\cdot,s,i}$ is energy consumption within industry i of sector s across all fuels.

Note that the three indices, AFI, SFI, and IFI, are normalized differently. The aggregate index is created by normalizing with total energy consumption. It can address the intensity of coal usage in aggregate energy consumption, for example. The sectorial–level index is created by normalizing by total energy consumption within the sector. It measures the intensity of oil usage within the industrial energy consumption, for example. Finally, the industry-specific index is created by normalizing by total energy consumption within an industry specific to a given sector. It addresses the use of renewables and was in the non-energy intensive industrial sector, for example

2.1.1 Empirical Model

The goal is to explain the portfolio of fuel intensity at each of three levels of aggregation for a given country. At the aggregate level, our analysis aims at explaining, for example, why India is more reliant on combustibles, renewables, and waste for energy generation than is either Brazil or Germany. At lower levels of aggregation, the point of our analysis is to identify country characteristics that can help to explain the difference between the fuel intensity portfolios in two different countries at the sector level—why Mexico uses more energy generated from oil and petroleum products and less energy generated from coal and peat than does the U.S. Going one step further, we would also like to explain cross-country differences at the industry level within a given sector.

There are two primary hypotheses for structural factors that might be important in determining the fuel intensity profile for a given country, regardless of the level of disaggregation of the data. First, *resource endowment* is likely to be important. All else equal, countries that are rich in coal reserves, such as the U.S., are likely to use coal more intensely to meet domestic energy demand at all levels of aggregation relative to a country where coal is relatively scarce. A similar case can be made for oil; recent experience in Saudi Arabia, where the use of crude oil for electricity generation is increasingly frequent, stands out as a case in point. A less dramatic, but equally relevant, example is the extensive use of natural gas in Russia. In the most simple terms, exploiting domestically abundant energy resources is desirable for both economic as well as political reasons and we would expect a countries' fuel intensity profile to reflect this.

The second hypothesis for the determinates of a given countries' fuel intensity profile relates to the level of economic development. Existing research has drawn links between economic development and the development of energy infrastructure. This is commonly referred to in the literature as the *"energy ladder"* whereby economic development leads to maturation in the technology available for energy provision. As a country develops it cycles from relatively inefficient fuels, such as combustibles, to more efficient fuels such as coal and, eventually, matures to the current technological frontier in energy provision, exploiting refined fuels derived from petroleum as well as natural gas and electricity.

We test these two candidate hypothesis to explain cross-country differences in fuel intensity profiles using the following regression framework

$$FI = \beta_0^f + \beta_1^f ENDOW_{n,f} + \beta_2^f RGDP_n + \boldsymbol{\beta_3^f}\mathbf{REGION_n} + \varepsilon_n \tag{1}$$

where: FI is a fuel intensity measure defined at one of the three levels of aggregation (that is, in our empirical analysis FI is given by one of the three variables AFI, SFI, or IFI defined in the previous section depending on the level of disaggregation desired) for fuel f in country n; $ENDOW_{n,f}$ is the share of global proved reserves for fuel f held by country n, which is intended to capture resource abundance for that particular fuel; $RGDP_n$ is (log) real per capita GDP for country n, which is a direct measure the level of economic development; finally, $\mathbf{REGION_n}$ is a vector of dummy variables, each of which takes on a value of one if country n is classified as a European, Developed Asian, Latin American, Emerging Asian, or Emerging Other economy, respectively, and takes on a value of zero otherwise. (Accordingly, the estimated coefficients on the regional dummies are interpreted as the regional effect relative to North America.) The specific regions are chosen based on existing literature which has shown that these country groupings are relevant for explaining cross-country differences in oil consumption. The dummies are intended to control for all other unobserved factors within a given region that may help to determine the fuel intensity profile. Finally, the error term is assumed to be independent and identically distributed, $\varepsilon_n \sim N(0, \sigma_n^2)$,. The equation is estimated using simple ordinary least squares (OLS).

Within this regression framework we test the following two hypotheses:

$$H_0^{Endowment}: \quad \beta_1^f > 0$$

and

$$H_0^{EnergyLadder}: \quad \begin{array}{c} \beta_2^f < 0 \text{ for } f = \{1,\ 2\} \\ \beta_2^f > 0 \text{ for } f = \{3,\ 4,\ 5,\ 6\} \end{array}$$

The first tests the statistical validity of the endowment hypothesis. If the hypothesis is valid we would expect that the *aggregate fuel intensity of fuel f in country n is increasing in the resource endowment of that fuel*, thus the coefficient estimate for β_2 should be positive and significantly different from zero.

The second tests the validity of the energy ladder hypothesis. Here, we would expect the *aggregate fuel intensity of lower quality fuels* such as combustibles, renewables, and waste ($f = 1$) and coal and peat ($f = 2$) to *decrease as a country becomes more developed* and makes its way "up the energy ladder" as it adapts more efficient, cleaner technologies for energy generation. Hence, for these fuels we would expect the coefficient estimate for β_2 to be negative and significantly different from zero. In contrast, for the *higher quality fuels* such as oil ($f = 3$), natural gas ($f = 4$), geothermal, hydoelectric, and nuclear ($f = 5$), and electricity ($f = 6$) we expect that *aggregate fuel intensity should increase with the level of development.* We would expect the coefficient estimate for β_2 to be positive and significantly different from zero for these fuels.

2.2 End-use Portfolio

The second dimension of the energy portfolio that we would like to explain is the cross-country variation in end-use consumption. We summarize this aspect of the energy portfolio with the empirical metric, *energy usage* defined at two levels of disaggregation.

Sectorial energy usage measures of the share of aggregate energy consumption accounted for by sector s aggregated across all fuels and industries for country n. A formal definition is as follows:

$$SEU = \frac{C_{n,\cdot,s,\cdot}}{C_{n,\cdot,\cdot,\cdot}} = \frac{\sum_f \sum_i c_{n,f,s,i}}{\sum_f \sum_s \sum_i c_{n,f,s,i}}$$

where: SEU denotes sectorial energy usage; $C_{n,\cdot,s,\cdot}$ denotes aggregate energy consumption accounted for by sector s across all fuels, f, and industries, i.

Similarly, moving down one level of aggregation, *industry-level energy usage* measures the share of aggregate energy consumption accounted for by industry i aggregated across all fuels, f, for country n. We formalize this as

$$IEU = \frac{C_{n,\cdot,s,i}}{C_{n,\cdot,\cdot,\cdot}} = \frac{\sum_f c_{n,f,s,i}}{\sum_f \sum_s \sum_i c_{n,f,s,i}}$$

where: $IEU^n_{s,i}$ denotes industrial-level energy usage; $C_{n,\cdot,s,i}$ denotes energy consumption accounted for by industry i within sector s, aggregated across all fuels, f.

2.2.1 Empirical Model

With regard to end-use consumption, our analysis aims to explain, for example, why consumption in the industrial sector comprises a larger fraction of total energy consumed in Argentina (41.1 percent) as opposed to Hong Kong (28.6 percent). At a higher level of disaggregation, road transport (consisting of both passenger and commercial transport activity) comprises 33.1 percent of aggregate energy consumption in Spain, but only 21.7 percent in Canada. What can explain the difference? In short, as with fuel intensity above, the point of the analysis here is to identify characteristics that can help to explain cross-country differences in end-use consumption portfolios at both the sectorial and the industry level.

We examine three hypotheses. The first two relate to *sector size* and the *energy efficiency* of the sector in question, respectively. All else equal, as the economic size of a given sector increases we might expect energy consumption within that sector to grow as a fraction of total energy consumption. On the other hand, as the energy efficiency of a given sector increases we might expect energy consumption within that sector to decline as a fraction of total energy consumption.

Beyond size and efficiency, we also explore the *structural transformation* hypothesis. There is a well-known, established literature dating to Kuznets (1971) which contends that a countries' industrial structure changes endogenously as it undergoes the process of economic development. Initially, for countries at low levels of development, agricultural production constitutes the largest share of economic activity. However, as an economy begins to develop industrialization causes the share of industry in total output to rise as economic activity moves away from agriculture and into heavy industry. Later phases of development tend to be characterized by a decline in manufacturing activity as industrialization eventually gives way to a transformation toward a more service-oriented economy.

Transformation of the industrial structure, of course, has implications for energy usage. For countries at low levels of economic development the structural transformation hypothesis suggests that end-use consumption profiles should be weighted toward greater energy usage in the residential and agricultural sectors and relatively low weights on industry. As a country develops and undergoes the process of industrialization, industries' share of total energy usage should rise at the expense of agriculture and residential usage. Finally, at high levels of development, after industrialization has occurred and the transformation toward a more service oriented economy underway, the share of residential and commercial usage should rise at the expense of industry.

Thus, there are two empirical implications of the structural transformation hypothesis for energy usage that can be tested, both of which exploit the compositional shift of economic activity implied by the process of structural transformation. The first keys off the change in industries' share of total energy usage, which according to the structural transformation hypothesis should be increasing with income for relatively low levels of economic development—reflecting the effect of industrialization on energy usage—and then decreasing for sufficiently high levels of development—reflecting deindustrialization as the economy transforms into service-oriented activity. The second keys off the change in residential and commercial usage. According to the structural transformation hypothesis, residential usage should be declining with income at low levels of development and then increasing, along with commercial usage, at sufficiently high levels of development.

We test the three candidate hypothesis to explain cross-country differences in end-use energy consumption profiles using the following general regression framework

$$\begin{aligned} EU_{s,i}^{n} &= \beta_0^s + \beta_1^s SIZE_{n,s} + \beta_2^s EFFICIENCY_{n,s} \\ &\quad + \beta_3^s RGDP_n + \beta_4^s RGDP_n^2 + \boldsymbol{\beta_5^s}\mathbf{REGION_n} + \varepsilon_n \end{aligned} \tag{2}$$

where: EU_n^k is the end-use consumption measure defined at one of the two levels of aggregation (either SEU_s^n, or $IEU_{s,i}^n$ as defined in the previous section depending on the level of disaggregation desired) for fuel s in country n; $SIZE_{n,s}$ is the value added (expressed in percentage terms) the sector s in total output for country n; as in the the previous subsection; $EFFICIENCY_{n,s}$ is the total energy consumed in sector s, measured in units of thousands of tones of oil equivalent, expressed per U.S. dollar of real GDP; $RGDP_n$ is (log) real per capita GDP for country n which, for reasons discussed below, enters quadratically into the regression framework to capture the non-linear response of the sectorial and industry shares to income at different stages of a structural transformation; finally, as above we include the vector of regional dummies, $\mathbf{REGION_n}$, to control for other unobserved factors. The error term is assumed to be iid and normally distributed, $\varepsilon_n \sim N(0, \sigma_n^2)$. In order to address possible endogeneity between our metric for end-use consumption and the proxy for sectorial energy efficiency, the equation is estimated using two stage least squares (2SLS) using aggregate energy efficiency as an instrument for energy efficiency at the sectorial level.

Within this regression framework, we examine whether or not sector size is an important determinate of the end-use energy consumption profile by testing the following hypothesis.

$$H_0^{\mathrm{Si}ze} : \quad \beta_1^s > 0$$

We expect that the share of total energy consumption in sector s is increasing in the economic size of the sector as measured by value added in GDP, so that the coefficient estimate for β_1^s should be positive and significantly different from zero.

Next, we test the validity of the hypothesis that increased energy efficiency in sector s leads to a decrease in that sectors share of aggregate energy consumption.

$$H_0^{Efficiency}: \quad \beta_2^s < 0$$

If sectorial-level efficiency is an important determinate for the end-use energy consumption profile we would expect the coefficient estimate for β_2^s to be negative and significantly different from zero.

Finally, we test the validity of the structural transformation hypothesis as follows.

$$H_0^{Transform}: \quad \begin{array}{l} \beta_3^s > 0,\ \beta_4^s < 0 \text{ for } s = 1 \\ \beta_3^s < 0,\ \beta_4^s > 0 \text{ for } s = 3 \end{array}$$

As discussed above, the hypothesis predicts that industries' share of total energy usage will have an inverse U-shaped relationship with the level of income, which should be captured by the quadratic income term with $\beta_3^{s=1} > 0$ and $\beta_4^{s=1} < 0$. In contrast, commercial and residential usage should have a U-shaped relationship with the level of income, falling for low levels of development and then growing at a sufficiently high level of development, which should be captured by the quadratic income term with $\beta_3^{s=3} < 0$ and $\beta_4^{s=3} > 0$. For the final two sectors, we expect transportation's share to increase with income, so that $\beta_3^{s=2} > 0$, and agricultural's share to decrease, so that $\beta_3^{s=4} < 0$, but do not necessarily have reason to think that either should enter into the regression in a non-linear way.

3 Main Results

The main results are presented below in the following two subsections. The first examines cross-country differences in fuel intensity profiles while the second examines differences in end-use consumption.

3.1 Fuel Intensity Profile

Table 2 presents summary statistics for the share of total energy usage broken out by source. The table shows that the dominate energy source comes from crude oil and petroleum products, which alone accounts for about half of all energy consumed globally. Electricity accounts for about 20 percent of global energy consumption, followed by natural gas at roughly 15 percent. The remaining share is comprised of combustibles, renewables, and waste as well as coal and peat, which account under 15 percent of global energy consumption. The remaining fraction comes from geothermal, hydroelectric, or nuclear power, which taken together account for a trivial fraction of global usage.

Comparing the developed economies to the emerging markets economies hints at some key differences when energy usage profiles are broken out by primary source. The data show that, relative to emerging market economies, developed economies tend to rely more heavily on petroleum products, natural gas, and electricity as primary sources of energy. In contrast, developing economies tend to rely more heavily on coal and peat as well as combustibles, renewables, and waste. Thus, even a cursory glance at the data suggests that there may be some systematic difference in the energy usage portfolio between the two sets of countries.

A more formal assessment can be found in Table 3, which presents the regression results for Equation (1). The table shows a set of results for each fuel, with one set corresponding to the regression without the regional dummies (first column of numbers) and the second set corresponding to the regression with the dummies (second column).

Concentrating on the first column of numbers for each fuel, we see that there is strong support for the energy ladder hypothesis across nearly all the fuels. For five of the six, the estimated coefficient has the predicted sign and is significantly different from zero at the 95 percent confidence level.[8] As real per capita GDP rises, countries shift their aggregate fuel intensity portfolios away from lower quality, more polluting fuels such as combustibles, renewables, and waste as well as coal and peat and into higher quality, cleaner fuels such as refined petroleum products, natural gas, and electricity. Moreover, in looking at the quantitative magnitude of the coefficients and the precision with which they are estimated, the evidence in favor of the energy ladder hypothesis is clearly strongest at the two extremes of the ladder. There is a large, highly significant negative correlation between income and the lower end of the quality ladder—the usage of combustibles, renewables, and waste—while the opposite is true at the higher end of the ladder as reflected in electricity usage. The coefficients for the intermediate fuels tend to be smaller in magnitude and, although many are statistically significant, taken as a whole they tend to be more imprecisely estimated.

In contrast to the energy ladder hypothesis, there is only mild support for the endowment hypothesis. Although the estimated coefficients have the correct sign for all three fuels for which we have an empirical proxy for endowment available, only in the case of natural gas do we find that proved reserves are significantly correlated with the share of natural gas in total energy usage. Natural gas, more so that coal or oil and petroleum products, may be particularly susceptible to the endowment hypothesis given the relatively large (even for the energy industry) capital expenses associated with international trade in natural gas either via pipeline or in liquefied form.

Moving to the regressions with the regional dummies, we find that support for the

[8] The lone exception is for geothermal, hydoelectric, and nuclear, but that likely reflects the fact that this category only accounts for a miniscule fraction of energy in most countries and is completely absent in many others.

energy ladder hypothesis is largely robust to controlling for unobserved region-specific characteristics For three of the six fuels (combustibles, renewables, and waste, oil and petroleum products, and electricity) the estimated coefficient on the real GDP per capita remains of the correct sign and continues to be statistically significant at high confidence levels. Evidence in favor of the endowment hypothesis is marginally stronger due to the introduction of the regional dummies owing largely to natural gas. With regard to the country dummies themselves, two things stand out. First, the Asian economies—both developed and developing—tend to rely heavily on coal for energy generation relative to other countries in the sample. Importantly, this is true even when controlling for resource endowment. Second, the emerging other category, which includes Israel, Russia, and Saudi Arabia, stands out in its low reliance on renewables, combustibles, and waste relative to other countries. and its high reliance on geothermal, hydroelectric, and nuclear power and strong electricity usage.

Extending the analysis to disaggregated data at the sectorial and industry level reveal that much of the support for the energy ladder hypothesis stems from the industrial as well as the residential and commercial sectors. Fuel intensity in the transportation and agricultural sectors does not, in general, fit well into our hypothesized determinates. For the sake of brevity, I do not present the full set of disaggregated regression results and instead simply highlight some of the interesting insights.[9]

Support for the energy ladder hypothesis comes primarily from the industrial as well as the residential and commercial sector and, much like the aggregate data, tends to be strongest at the two extreme ends of the energy ladder. Specifically, usage of combustibles, renewables, and waste falls significantly with income in both residential as well as commercial usage and also in non-energy intensive industries. At the other extreme of the energy ladder, electricity usage rises significantly in both residential and commercial usage as well as in both energy-intense and non-intense industrial usage. The evidence is somewhat more mixed for the intermediate fuels in these sectors. Coal usage falls with income amongst energy-intensive industries. Natural gas usage rises with income in non-energy intensive industrial usage as well as in both residential and commercial usage, although the results for natural gas are not robust to the inclusion of regional dummies. Industrial usage of oil and petroleum products is interesting because it falls with income for energy-intense industries, but rises with income for energy non-intense industries, suggesting that there is fuel switching within industries usage itself. Finally, there is very little, if any, evidence for the energy ladder hypothesis in the transport sector while oil and petroleum product usage declines with income in the agricultural sector.

With regard to the endowment hypothesis, the disaggregated data reveal that support comes primarily from coal usage in commercial and agricultural activity, oil and petroleum product usage in non-energy intensive industries, as well as from

[9] The full set of results would require a set of tables describing results from 60 different regressions, which is is too cumbersome to include in the paper. However, the results are available upon request.

residential and non-road transport natural gas usage.

3.2 End-use Profile

Table 4 presents summary statistics for the share of total energy usage by sector. For the sample as a whole, industrial usage accounts for the largest share of global energy consumption at 37 percent, while transportation and residential and commercial usage each account for roughly 30 percent. Agricultural energy usage accounts for the remaining 2.5 percent. This carries over to the industry-level with each sector as well. Thus, in contrast to aggregate fuel intensity, a cursory glance at the data reveals very little difference in the sectorial distribution of energy usage between developed and emerging market countries.

Regression results for Equation 2 are presented in Table 5. Again, we present two sets of results for each end-use sector, one with regional dummies (first column for each sector) and one without regional dummies (second column). Generally speaking, the results are robust across both specifications. There is little evidence that either sector size or sector-specific efficiency is an important determinate of energy usage. There is, however, support for the structural transformation hypothesis. For industrial usage the coefficient on (logged) real GDP is positive and significant while the coefficient on the log real GDP squared is negative and significant. This indicates that the share of industrial energy usage starts out at a low level for relatively undeveloped economies. As these economies grow, the industrial share of energy usage increases reflecting the process of industrialization which is a key component of economic development. However, once a country reaches a certain level of development, deindustrialization occurs as the economy transforms into more service-oriented activity; hence, industry share of total energy consumption begins to fall once an economy has reached a certain level of development. In our estimates, this peak occurs at a real per capita level of roughly $10,500, about the level of development of Brazil. This inverse U-shape for the share of industrial energy usage is very much in line with the structural transformation hypothesis.

For residential and commercial energy usage, we see the opposite pattern. The coefficient on (logged) real GDP is negative and significant while the coefficient on the log real GDP squared is positive and significant. This is also in line with the structural transformation hypothesis in the sense that at low levels of economic development residential usage carries a large fraction of total usage, but this declines as an economy grows and industrialization occurs. Eventually, the economy hits a point at which the emergence of the service sector causes the share of commercial usage to increase. In addition, the share of residential usage increases as the demand for energy-intense consumer durables begins to pick up at sufficiently high income levels. The net effect gives rise to a U-shaped pattern for the share of residential and commercial usage taken as a whole. According to the regression results reported in [**Table 5**], the turning point at which residential and commercial usage stops declining and begins to rise is roughly \$14,000, about the level of Mexico or Argentina.

In contrast with industrial usage and residential and commercial usage, neither the transportation nor the agricultural sector fit neatly into the structural transformation hypothesis. For both the estimated coefficients on the level of income is positive while the squared term is negative, but both are insignificant. While the size of the agricultural sector helps to explain cross-country variation in the agriculture share of total energy usage, we did not have much success in explaining cross-country variation in energy usage with the transportation sector.

Table 6 shows regression results for the industry-level data. Support for the structural transformation hypothesis is not robust at the disaggregate level. For the residential and commercial sector we see that the nonlinear relationship at the sectorial level is driven by residential usage. In contrast, commercial usage, like agricultural usage, appears to be driven by sector size. Finally, we have a bit more success in explaining transportation usage at the disaggregated level. In particular, for road transport we see the share is rising in income presumably reflecting increased automobile purchases at higher income levels. Non-road transport is significantly correlated with efficiency, indicating that the share tends to be higher in countries where transport usage is relatively inefficient.

4 Are the BRICs Different?

Much of the impetus for the shift toward emerging market economies and away from developed economies as the primary driver of global energy consumption growth has come from the so-called BRIC economies of Brazil, Russia, India, and China. Not surprisingly, these economies have garnered a lot of attention from energy market participants in particular, as well as financial market participants more generally as well as policy-makers interested in understanding developments in commodity markets. Given that the BRIC economies are playing a larger and larger role in global energy consumption, it seems natural to ask whether there is something inherently different about the consumption patterns in these countries in particular.

Methodologically, we answer this question by simply introducing dummy variables into the regression equations 1 and 2 both for the BRICs as a whole (i.e., a single indicator variable that takes on the value of one if the country is a BRIC member and is zero otherwise) and then for each of the BRICs individually. If energy usage in the BRICs is different in some way not already addressed by the hypotheses laid out in the previous section, then the dummies will capture this difference. The aggregate BRIC dummy is intended to capture systematic differences in the BRIC economies as a whole, while the individual dummies are intended to capture country-specific differences.

We are interested in answering two questions. First, how does the inclusion of the BRIC dummies influence our conclusions regarding our hypothesized determinates of the energy consumption portfolio? Second, given that we control for these hypothesized determinates, do the BRICs themselves, either taken together as a group or individually, have systematically different consumption portfolios from other countries? Results are reported below in two subsections.

4.1 Fuel Intensity

Referring back to Table 1, the fuel intensity profiles of the BRIC economies stand out in two respects. First, they tend to rely more heavily on combustibles, renewables, and waste as well as coal for energy generation relative to other economies. Taken together these two fuel sources constitute nearly 35 percent of total energy consumption, whereas comparable number for the developed economies and non-BRIC emerging market countries are 9 and 15 percent, respectively. Second, they tend to rely less heavily on oil and petroleum products, which constitute 31 percent of the fuel intensity profile in the BRIC economies as opposed to 48 and 52 percent, respectively, in the developed and non-BRIC emerging markets. Thus, a preliminary look at the data suggests that the BRICs may indeed be different with respect to the fuel intensity profile.

Table 7 presents regression results from Equation 1 estimated with the separate BRIC dummies, which are directly comparable to what was reported above in Table 2. The table reveals that the high share of combustibles, renewables, and waste in the BRIC economies is largely driven by Brazil and Russia. The disaggregated data show that for Brazil the high share of combustibles, renewables, and waste comes from non-energy intensive industries as well as both road an non-road transportation. For Russia, the high share stems primarily from commercial usage. The strong coal usage is driven by China, which uses coal more intensely than the other countries in all four sectors. Importantly, this is true even after controlling for China's relatively large endowment of coal. On the other hand, the relatively low share of oil and petroleum products in the fuel intensity profile of the BRIC economies appears to be largely due to India and China. In summary, even after controlling for some hypothesized determinates of the fuel intensity profile, the BRIC economies still seem to be different form other countries in the sense that they have an over-reliance on lower quality fuels and an under-reliance on oil an petroleum products relative to other countries.

With regard to the main conclusions regarding the determinates of the fuel intensity profile the inclusion of the BRIC dummies appear to have little impact. Even after allowing for a country-specific effect for each of the BRIC economies, we continues to see strong support of the energy ladder hypothesis, principally at the two extremes of the energy ladder. For the intermediate fuels, the evidence remains mixed. For oil and petroleum products, support for the energy ladder hypothesis is not robust to the inclusion of the BRIC dummies due to the low usage in India and China. Instead, controlling for each of these two countries separately strengthens empirical support of the endowment hypothesis.

Disaggregating data to the sectorial and industry level offers little in the way of new insights. The results are essentially unchanged relative to those discussed in the previous section.

4.2 End-use Consumption

Table 4 shows that although there do not appear to be any notable differences between developed and developing countries with respect to end-use consumption, there do appear to be big differences in the BRIC economies. In particular, the BRICs stand out as different in nearly every sector and also in industries within a given. They tend to have a larger share of industrial energy usage—nearly 10 percent higher than either developed economies or the non-BRIC emerging market economies—and this extends down to both energy-intensive and non-energy-intensive industries. The BRICs also have a higher percentage of energy use in agricultural activity—nearly double that of either developed or non-BRIC emerging market economies. In contrast, transportation does not play as large a role in the BRICs as it does in other economies. When we look at the disaggregated industry data we can see that this is primarily due to low energy usage in road transport. Finally, residential energy usage carries a larger share in BRIC energy consumption relative to the rest of the world, while commercial energy usage plays a smaller share.

Regression results from Equation 2 estimated with separate BRIC dummies are presented in Table 8 and are directly comparable to results presented in Table 5. At the sectorial level, it turns out that once we control for the hypothesized determinates of the end-use consumption profile, industrial energy consumption in the BRICs is not significantly different from other countries. Thus, contrary to the impression created by the unconditional data in Table 4, it appears that there is nothing different about industrial energy usage in the BRICs *per se*; instead, they simply tend to have higher shares of industrial usage primarily because these economies are undergoing a period of rapid industrialization. This sectorial-level result does not necessary apply when the data are disaggregated down to the industry level. Table 9 shows that China, in particular, is importantly different in that it has a very high share of energy-intense industrial energy usage. The results in Table 8 also show that the BRICs really don't stand out in terms of agricultural usage. But, at the sectorial-level what appears to set energy consumption apart in the BRICs is transportation, where energy usage is considerably lower relative to other countries, as well as residential and commercial usage, where the opposite is true primarily in China and India. A look at the disaggregated data in Table 9 reveals that the low transportation usage is due to road transport in India and China as well as with non-road transportation industries in Russia.

With regard to the main conclusions regarding the determinates of the end-use consumption profile, the inclusion of the BRIC dummies appear to have little impact. We continue to find broad support for the structural transformation hypothesis at both the sectorial as well as the industry-level.

5 Conclusion

This paper used a dataset detailing energy usage in a broad cross-section of countries to explain country-to-country differences in energy consumption portfolios along two separate dimensions: the fuel intensity profile and the end-use consumption profile. Specifically, we tested two hypotheses regarding determinates of the differences in consumption portfolios across countries. The energy ladder hypothesis implies that as the level of economic development increases energy consumption will transit from lower quality, cheaper fuels such as biomass (wood and animal and plant waste) to higher quality fuels such as natural gas and petroleum products. The structural transformation hypothesis implies that as the level of economic development increases the bulk of end-use energy demand will shift away from agricultural usage toward industrial usage as an economy undergoes a structural transformation. Once the transformation has occurred higher levels of economic development will push the bulk of end-use energy demand out of industrial usage and into residential and commercial usage as the economy becomes more service-oriented. We found statistical evidence to support both of these hypotheses.

In addition, the paper also showed that even when these determinants of the energy consumption portfolio are taken into account, the energy consumption portfolios of the BRIC economies are still notably different from those of other countries. The BRICs tend to rely more heavily on lower quality fuel sources—combustibles, renewables, and waste, as well as coal and peat—and, in terms of end-use consumption, tend to underconsume energy in the transportation sector relative to other countries. In addition, we found that China consumes a large fraction of total energy in energy-intense industry—even more than what can be explained by the structural transformation hypothesis.

The policy implications of this paper are relatively straight-forward. From the perspective of energy analysts and policy-makers, the empirical results presented here suggest that understanding global energy market developments probably requires a more intense focus on developments at the country- and industry-specific level. In this sense, this paper is very much in line with the broad conclusions of Stefanski (2009) and Arbex and Perobelli (2010), which emphasize that microeconomic foundations are important for understanding global energy developments. Future empirical work should concentrate on examining how far the systematic differences in energy consumption portfolios can go in explaining differences in the dynamics of energy consumption over the business cycle. Arseneau (2010) is a paper that moves in this direction. Such an explanation seems promising in explaining why country-specific heterogeneity is typically so important to control for when estimating price and income elasticity parameters for energy demand.

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Table 1. Countries in sample, by region

Developed Economies			Emerging Market Economies			
Europe	North America	Developed Asia	Latin America	Emerging Asia	Emerging Other	BRICs
Austria	Canada	Australia	Argentina	Hong Kong	Israel	Brazil
Belgium	Mexico	Japan	Chile	Indonesia	Saudi Arabia	China
Finland	US	South Korea	Colombia	Malaysia		India
France			Venezuela	Philippines		Russia
Germany				Singapore		
Ireland				Thailand		
Italy						
Netherlands						
Portugal						
Sweden						
Spain						
Switzerland						
UK						

Table 2. Fuel intensity profile

	Coal and Peat (*f* = 1)						Crude Oil and Petroleum Products (*f* = 2)					
	Mean	Median	St. Dev.	Min.	Max.	N	Mean	Median	St. Dev.	Min.	Max.	N
World	0.047	0.026	0.062	0	0.330	34	0.479	0.478	0.118	0.232	0.763	34
Developed Economies	0.029	0.022	0.020	0.008	0.090	19	0.488	0.478	0.085	0.317	0.639	19
BRIC Economies	0.131	0.080	0.138	0.035	0.330	4	0.308	0.276	0.097	0.232	0.446	4
Non-BRIC Emerging Markets	0.048	0.029	0.052	0	0.144	11	0.523	0.517	0.127	0.332	0.763	11
	Natural Gas (*f* = 3)						**Nuclear, Geothermal, and Hydro. (*f* = 4)**					
	Mean	Median	St. Dev.	Min.	Max.	N	Mean	Median	St. Dev.	Min.	Max.	N
World	0.144	0.128	0.107	0	0.363	30	0.003	0	0.010	0	0.058	30
Developed Economies	0.177	0.169	0.093	0.016	0.340	19	0.002	0.001	0.002	0	0.009	19
BRIC Economies	0.111	0.052	0.130	0.036	0.305	4	0.001	0.001	0.002	0	0.003	4
Non-BRIC Emerging Markets	0.102	0.084	0.112	0	0.363	11	0.005	0	0.017	0	0.058	11
	Combust., Renew., and Waste (*f* = 5)						**Electricity and Heat (*f* = 6)**					
	Mean	Median	St. Dev.	Min.	Max.	N	Mean	Median	St. Dev.	Min.	Max.	N
World	0.091	0.045	0.105	0	0.409	30	0.228	0.217	0.089	0.072	0.447	30
Developed Economies	0.058	0.045	0.051	0.007	0.169	19	0.246	0.227	0.076	0.147	0.447	19
BRIC Economies	0.213	0.218	0.172	0.006	0.409	4	0.236	0.202	0.127	0.124	0.416	4
Non-BRIC Emerging Markets	0.102	0.037	0.119	0	0.351	11	0.197	0.171	0.094	0.072	0.439	11

Table 3. Cross-country differences in aggregate fuel intensity profiles (AFI)

	Combustables, Renewables and Waste (f = 1)		Coal and Peat (f = 2)		Oil and Petroleum Products (f = 3)		Natural Gas (f = 4)		Geothermal, Hydroelectrical and Nuclear Power (f = 5)		Electricity and Heat Generation (f = 6)	
Constant	**1.05**	**1.22**	**0.42**	**0.27**	0.004	-0.18	-0.26	-0.02	-0.01	-0.02	***-0.3***	**-0.43**
	(7.12)	***(5.78)***	***(3.85)***	***(1.86)***	*(0.02)*	*(-0.48)*	*(-1.23)*	*(-0.07)*	*(-0.44)*	*(-0.52)*	***(-1.81)***	***(-1.70)***
Europe	.	0.04	.	0.04	.	-0.09	.	-0.004	.	0.001	.	0.05
	.	*(0.92)*	.	*(1.29)*	.	*(-1.05)*	.	*(-0.06)*	.	*(0.11)*	.	*(1.06)*
Developed Asia	.	-0.01	.	***0.07***	.	-0.02	.	-0.06	.	0.001	.	0.06
	.	*(-0.24)*	.	***(1.85)***	.	*(-0.21)*	.	*(-0.75)*	.	*(0.06)*	.	*(0.85)*
Latin America	.	-0.02	.	0.02	.	0.01	.	0.01	.	0.001	.	0.03
	.	*(-0.33)*	.	*(0.39)*	.	*(0.11)*	.	*(0.84)*	.	*(0.11)*	.	*(0.47)*
Emerging Asia	.	-0.01	.	***0.09***	.	-0.01	.	-0.1	.	0.002	.	0.08
	.	*(-0.23)*	.	***(2.38)***	.	*(-0.14)*	.	*(-1.34)*	.	*(0.21)*	.	*(1.32)*
Emerging Other	.	***-0.09***	.	-0.004	.	0.01	.	-0.14	.	**0.02**	.	**0.12**
	.	***(-1.66)***	.	*(-0.09)*	.	*(0.11)*	.	*(-1.56)*	.	***(2.55)***	.	***(1.85)***
Economic Development	***-0.22***	***-0.26***	**-0.09**	**-0.06**	**0.11**	**0.16**	**0.09**	0.05	0.003	0.004	***0.12***	***0.14***
	(6.53)	***(-5.64)***	***(-3.48)***	***(2.01)***	***(1.94)***	***(1.92)***	***(1.92)***	(0.68)	*(0.57)*	*(0.56)*	***(3.20)***	***(2.50)***
Resource Endowment	.	.	0.23	**0.32**	0.6	-0.17	**0.83**	**1.25**	.	.	.	.
	.	.	*(1.63)*	***(2.22)***	*(0.62)*	*(0.13)*	***(2.03)***	***(2.49)***	.	.	.	.
R^2	**0.56**	**0.67**	**0.33**	**0.57**	**0.11**	**0.18**	**0.18**	**0.37**	**0.01**	**0.29**	**0.24**	**0.35**
$\hat{\sigma}^2$	**0.005**	**0.004**	**0.003**	**0.002**	**0.013**	**0.014**	**0.010**	**0.009**	**0.000**	**0.000**	**0.006**	**0.006**
Nobs	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Notes: The estimated regression, equation (1.) in the text, is given by

$$AFI = \beta_0^f + \beta_1^f ENDOW_{n,f} + \beta_2^f RGDP_n + \boldsymbol{\beta_3^f} \mathbf{REGION_n} + \varepsilon_n \text{ where } \varepsilon_n \sim N(0, \sigma_n^2).$$

The equation is estimated using OLS on 2007 annual data from 35 different countries.

Table 4. End-use consumption profile

	Industry (S = 1)						Transportation (S = 2)					
	Mean	Median	St. Dev.	Min.	Max.	N	Mean	Median	St. Dev.	Min.	Max.	N
World	0.371	0.390	0.097	0.198	0.545	35	0.290	0.294	0.093	0.104	0.522	35
Developed Economies	0.364	0.355	0.087	0.216	0.513	19	0.294	0.294	0.075	0.173	0.443	19
BRIC Economies	0.454	0.441	0.071	0.390	0.545	16	0.184	0.163	0.096	0.104	0.307	16
Emerging Market Economies	0.356	0.375	0.112	0.198	0.508	4	0.318	0.317	0.099	0.168	0.522	4
	Residential and Commercial (S = 3)						**Agriculture (S = 4)**					
	Mean	Median	St. Dev.	Min.	Max.	N	Mean	Median	St. Dev.	Min.	Max.	N
World	0.314	0.306	0.097	0.143	0.534	35	0.025	0.024	0.021	0.000	0.099	35
Developed Economies	0.317	0.316	0.073	0.194	0.475	19	0.025	0.024	0.020	0.006	0.099	19
BRIC Economies	0.320	0.328	0.122	0.166	0.461	16	0.041	0.042	0.010	0.028	0.052	16
Emerging Market Economies	0.306	0.267	0.128	0.143	0.534	4	0.020	0.007	0.024	0.000	0.059	4

Table 5. Cross-country differences in end-use energy consumption, by sector (SEU)

	Sector							
	Industrial (S = 1)		Transportation (S = 2)		Residential and Commercial (S = 3)		Agriculture (S = 4)	
Constant	**-3.83**	**-6.61**	-2.52	-0.55	**7.70**	**8.61**	-0.65	-0.43
	(-1.71)	***(-2.64)***	*(-1.13)*	*(-0.19)*	***(4.00)***	***(3.92)***	*(-1.48)*	*(-0.79)*
Europe	.	0.04	.	**-0.11**	.	0.06	.	0.004
	.	*(0.79)*	.	***(-1.77)***	.	*(1.34)*	.	*(0.37)*
Developed Asia	.	0.11	.	-0.11	.	0.008	.	-0.01
	.	*(1.65)*	.	*(-1.47)*	.	*(0.14)*	.	*(-0.64)*
Latin America	.	0.004	.	-0.02	.	0.03	.	0.001
	.	*(0.06)*	.	*(-0.27)*	.	*(0.49)*	.	*(0.07)*
Emerging Asia	.	0.05	.	-0.07	.	0.04	.	-0.02
	.	*(0.77)*	.	*(-0.98)*	.	*(0.69)*	.	*(-1.24)*
Emerging Other	.	**-0.14**	.	-0.03	.	**0.19**	.	-0.09
	.	***(-1.96)***	.	*(-0.42)*	.	***(2.98)***	.	*(-0.63)*
Economic Development	**2.11**	**3.45**	1.32	0.36	**-3.62**	**-4.07**	0.29	0.19
	(1.91)	***(2.81)***	*(1.21)*	*(0.25)*	***(-3.87)***	***(-3.79)***	*(1.43)*	*(0.74)*
Economic Development (Squared)	**-0.26**	**-0.43**	-0.15	-0.03	**0.44**	**0.49**	-0.03	-0.02
	(-1.95)	***(-2.86)***	*(-1.15)*	*(-0.18)*	***(3.89)***	***(3.79)***	*(1.34)*	*(-0.67)*
Sector Size	0.06	0.06	-0.48	-0.84	0.17	0.32	**0.31**	**0.37**
	(0.32)	*(0.34)*	*(-0.52)*	*(-0.85)*	*(0.51)*	*(0.98)*	***(2.19)***	***(2.41)***
Efficiency	0.64	1.28	0.14	0.02	-1.08	**-1.68**	0.32	0.37
	(0.61)	*(1.31)*	*(0.13)*	*(0.02)*	*(-1.24)*	***(-2.06)***	*(0.15)*	*(0.15)*
R^2	**0.24**	**0.52**	**0.11**	**0.25**	**0.41**	**0.61**	**0.21**	**0.36**
$\hat{\sigma}^2$	**0.008**	**0.006**	**0.009**	**0.009**	**0.006**	**0.005**	**0.001**	**0.001**
Nobs	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Notes: The estimated regression, equation (2.) in the text, is given by
$SEU = \beta_0^s + \beta_1^s SIZE_{n,s} + \beta_2^s EFFICIENCY_{n,s} + \beta_3^s RGDP_n + \beta_4^s RGDP_n^2 + \boldsymbol{\beta_5^s}\mathbf{REGION_n} + \varepsilon_n$
where $\varepsilon_n \sim N(0, \sigma_n^2)$. The equation is estimated using 2SLS on 2007 annual data from 35 different countries.

Table 6. Cross-country differences in end-use energy consumption, by industry within sector (IEU)

	Industrial Sector				Transportation Sector				Residential and Commercial Sector			
	Energy Intensive Industries (S = 1; I = 1)		Non-energy Intensive Industries (S = 1; I = 2)		Road Industries (S = 2; I = 1)		Non-road Industries (S = 2; I = 2)		Residential (S = 3; I = 1)		Commercial (S = 3; I = 2)	
Constant	-2.31	-1.84	-1.10	-0.64	-4.50	-5.15	-0.64	0.50	7.42	**8.32**	1.39	0.26
	(-0.93)	*(-0.62)*	*(-0.95)*	*(-0.44)*	*(-1.53)*	*(-1.36)*	*(-0.89)*	*(0.55)*	*(3.91)*	***(3.64)***	*(0.87)*	*(0.16)*
Europe	.	0.06	.	0.02	.	-0.11	.	**-0.03**	.	0.06	.	0.00
	.	*(1.04)*	.	*(0.70)*	.	*(-1.46)*	.	***(-1.71)***	.	*(1.29)*	.	*(-0.07)*
Developed Asia	.	0.09	.	0.04	.	-0.13	.	-0.02	.	-0.02	.	0.05
	.	*(1.12)*	.	*(1.12)*	.	*(-1.29)*	.	*(-0.75)*	.	*(-0.27)*	.	*(1.24)*
Latin America	.	0.00	.	0.00	.	-0.01	.	-0.01	.	0.00	.	0.07
	.	*(-0.02)*	.	*(-0.02)*	.	*(-0.11)*	.	*(-0.57)*	.	*(-0.07)*	.	*(1.56)*
Emerging Asia	.	-0.06	.	-0.03	.	0.05	.	**-0.05**	.	-0.02	.	**0.15**
	.	*(-0.85)*	.	*(-0.91)*	.	*(0.53)*	.	***(-2.25)***	.	*(-0.41)*	.	***(3.65)***
Emerging Other	.	-0.09	.	-0.03	.	-0.01	.	-0.01	.	**0.11**	.	**0.08**
	.	*(-1.16)*	.	*(-0.84)*	.	*(-0.14)*	.	*(-0.51)*	.	***(1.74)***	.	***(1.71)***
Economic Development	1.20	1.06	0.62	0.43	**2.34**	2.57	0.30	-0.23	**-3.33**	**-3.71**	-0.78	-0.38
	(0.98)	*(0.73)*	*(1.09)*	*(0.62)*	***(1.64)***	*(1.39)*	*(0.85)*	*(-0.52)*	***(-3.61)***	***(-3.33)***	*(-1.01)*	*(-0.49)*
Economic Development (Squared)	-0.15	-0.14	-0.08	-0.06	-0.28	-0.29	-0.04	0.03	**0.38**	**0.42**	0.11	0.07
	(-0.97)	*(-0.79)*	*(-1.13)*	*(-0.72)*	*(-1.60)*	*(-1.29)*	*(-0.83)*	*(0.50)*	***(3.46)***	***(3.14)***	*(1.16)*	*(0.79)*
Sector Size	-0.03	0.04	-0.08	-0.06	-0.95	-0.02	0.29	0.32	-0.19	-0.02	**0.78**	**0.62**
	(-0.16)	*(0.19)*	*(-0.89)*	*(-0.66)*	*(-0.80)*	*(-1.49)*	*(0.97)*	*(1.06)*	*(-0.59)*	*(-0.06)*	***(2.81)***	***(2.62)***
Efficiency	1.12	1.23	-0.05	-0.01	-0.66	-0.76	**0.81**	**0.75**	0.02	-0.53	-1.17	-0.94
	(0.96)	*(1.06)*	*(-0.09)*	*(-0.02)*	*(-0.47)*	*(-0.53)*	***(2.35)***	***(2.14)***	*(0.03)*	*(-0.63)*	*(-1.63)*	*(-1.58)*
R^2	**0.07**	**0.33**	**0.08**	**0.29**	**0.13**	**0.3**	**0.19**	**0.37**	**0.52**	**0.57**	**0.52**	**0.57**
$\hat{\sigma}^2$	**0.010**	**0.008**	**0.002**	**0.002**	**0.015**	**0.014**	**0.001**	**0.001**	**0.006**	**0.005**	**0.004**	**0.003**
Nobs	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Notes: The estimated regression, equation (2.) in the text, is given by

$$IEU = \beta_0^s + \beta_1^s SIZE_{n,s} + \beta_2^s EFFICIENCY_{n,s} + \beta_3^s RGDP_n + \beta_4^s RGDP_n^2 + \boldsymbol{\beta_5^s}\mathbf{REGION_n} + \varepsilon_n$$

where $\varepsilon_n \sim N(0, \sigma_n^2)$. The equation is estimated using 2SLS on 2007 annual data from 35 different countries.

Table 7. Cross-country differences in fuel intensity profiles and the BRIC economies (AFI)

	Combustables, Renewables and Waste (f = 1)		Coal and Peat (f = 2)		Oil and Petroleum Products (f = 3)		Natural Gas (f = 4)		Geothermal, Hydroelectrical, and Nuclear Power (f = 5)		Electricity and Heat Generation (f = 6)	
Constant	**0.90**	**1.09**	**0.26**	**0.19**	0.32	0.19	-0.17	-0.004	-0.01	-0.01	**-0.43**	**-0.55**
	(5.62)	**(5.10)**	**(2.91)**	**(1.85)**	(1.26)	(0.54)	(-0.64)	(-0.01)	(-0.38)	(-0.38)	**(-2.30)**	**(-2.02)**
Europe	.	0.04	.	0.01	.	-0.06	.	0.04	.	0.001	.	0.05
	.	(0.96)	.	(0.51)	.	(-0.91)	.	(0.63)	.	(0.13)	.	(1.06)
Developed Asia	.	-0.01	.	**0.05**	.	-0.002	.	-0.02	.	0.001	.	0.05
	.	(-0.29)	.	**(2.05)**	.	(-0.03)	.	(-0.29)	.	(0.07)	.	(0.87)
Latin America	.	-0.04	.	-0.003	.	-0.02	.	0.06	.	0	.	0.03
	.	(-0.75)	.	(-0.13)	.	(0.23)	.	(0.81)	.	(0.04)	.	(0.54)
Emerging Asia	.	-0.01	.	**0.05**	.	0.003	.	-0.07	.	0	.	0.08
	.	(-0.10)	.	**(2.02)**	.	(0.04)	.	(-0.89)	.	(0.04)	.	(1.42)
Emerging Other	.	-0.07	.	-0.02	.	0.12	.	-0.13	.	**0.028**	.	0.05
	.	(-1.33)	.	(-0.67)	.	(1.23)	.	(-1.52)	.	**(3.64)**	.	(0.74)
Brazil	**0.13**	**0.16**	-0.02	0.004	-0.05	-0.03	-0.06	-0.13	0	0	0.01	0.03
	(2.05)	**(2.35)**	(-0.60)	(0.13)	(-0.44)	(0.27)	(-0.58)	(-1.26)	(-0.09)	(0.10)	(0.13)	(0.39)
Russia	**0.16**	**0.12**	0.03	0.01	-0.16	-0.15	-0.05	-0.01	0	0	0.04	0.02
	(2.17)	**(1.74)**	(0.83)	(0.38)	(-1.37)	(-1.26)	(-0.39)	(-0.12)	(0.03)	(0.21)	(0.44)	(0.23)
India	**-0.11**	-0.04	-0.01	0.03	**-0.35**	**-0.43**	-0.46	-0.69	0	**-0.03**	**0.22**	**0.22**
	(-1.66)	(-0.52)	(-0.21)	(0.67)	**(-3.10)**	**(-3.41)**	(-1.11)	(-1.59)	(-0.21)	**(-2.70)**	**(2.94)**	**(2.35)**
China	-0.04	-0.06	**0.26**	**0.23**	**-0.24**	**-0.23**	-0.1	-0.06	0	0	0.09	0.07
	(0.58)	(-0.88)	**(6.35)**	**(6.48)**	**(-2.18)**	**(-2.07)**	(-0.86)	(-0.57)	(0.22)	(0.46)	(1.18)	(0.84)
Economic Development	**-0.19**	**-0.23**	**-0.05**	**-0.04**	0.04	0.07	0.07	0.03	0.003	0.003	**0.15**	**0.17**
	(5.17)	**(-4.93)**	**(-2.50)**	**(-1.70)**	(0.64)	(0.93)	(1.18)	(0.42)	(0.49)	(0.41)	**(3.53)**	**(2.76)**
Resource Endowment	.	.	0.02	0.03	**1.66**	**0.71**	2.61	**4.10**	.	.	.	.
	.	.	(0.15)	(0.24)	**(1.80)**	**(0.63)**	(1.54)	**(2.19)**	.	.	.	.
R^2	**0.70**	**0.77**	**0.75**	**0.86**	**0.41**	**0.51**	**0.24**	**0.47**	**0.01**	**0.46**	**0.43**	**0.48**
$\hat{\sigma}^2$	**0.005**	**0.005**	**0.001**	**0.001**	**0.012**	**0.010**	**0.011**	**0.011**	**0.000**	**0.000**	**0.007**	**0.008**
Nobs	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Notes: The estimated regression, is given by

$$AFI = \beta_0^f + \beta_1^f ENDOW_{n,f} + \beta_2^f RGDP_n + \boldsymbol{\beta_3^f}\mathbf{REGION_n} + \boldsymbol{\beta_4^f}\mathbf{BRIC_n} + \varepsilon_n$$

where $\varepsilon_n \sim N(0, \sigma_n^2)$. The equation is estimated using OLS on 2007 annual data from 35 different countries

Table 8. Cross-country differences in end-use energy consumption and the BRIC economies, by sector (SEU)

	Sector							
	Industrial (S = 1)		Transportation (S = 2)		Residential and Commercial (S = 3)		Agriculture (S = 4)	
Constant	**-4.92**	**-7.63**	0.03	1.11	**6.48**	**7.83**	-0.59	-0.32
	(-1.79)	***(-2.75)***	*(0.01)*	*(0.37)*	***(3.03)***	***(3.52)***	*(-1.12)*	*(-0.47)*
Europe	.	0.03	.	-0.10	.	0.06	.	0.01
	.	*(0.65)*	.	*(-1.90)*	.	*(1.63)*	.	*(0.54)*
Developed Asia	.	0.09	.	**-0.14**	.	0.04	.	0.01
	.	*(1.45)*	.	***(-1.94)***	.	*(0.76)*	.	*(0.32)*
Latin America	.	-0.01	.	-0.09	.	**0.09**	.	0.01
	.	*(-0.20)*	.	*(-1.12)*	.	***(1.67)***	.	*(0.36)*
Emerging Asia	.	0.04	.	-0.10	.	0.07	.	-0.01
	.	*(0.63)*	.	*(-1.51)*	.	*(1.43)*	.	*(-0.14)*
Emerging Other	.	**-0.19**	.	-0.02	.	**0.22**	.	-0.01
	.	***(-2.58)***	.	*(-0.24)*	.	***(3.72)***	.	*(0.29)*
Brazil	0.07	0.07	0.04	-0.04	-0.12	-0.05	0.02	0.02
	(0.69)	*(0.74)*	*(0.39)*	*(-0.41)*	*(-1.56)*	*(-0.60)*	*(0.83)*	*(0.76)*
Russia	0.11	0.19	-0.14	**-0.25**	0.01	0.05	0.02	0.01
	(0.94)	*(1.56)*	*(-1.28)*	***(-1.85)***	*(0.09)*	*(0.47)*	*(0.90)*	*(0.39)*
India	-0.02	-0.04	-0.10	**-0.17**	**0.13**	**0.21**	-0.01	-0.003
	(-0.23)	*(-0.43)*	*(-1.07)*	***(-1.65)***	***(1.64)***	***(2.84)***	*(-0.30)*	*(-0.14)*
China	0.15	0.15	**-0.21**	**-0.29**	0.05	**0.14**	0.01	0.01
	(1.50)	*(1.55)*	***(-2.30)***	***(-2.74)***	*(0.66)*	***(1.74)***	*(0.55)*	*(0.29)*
Economic Development	**2.58**	**3.86**	0.03	-0.45	**-2.92**	**-3.60**	0.32	0.19
	(1.93)	***(2.88)***	*(0.03)*	*(-0.31)*	***(-2.81)***	***(-3.35)***	*(1.22)*	*(0.57)*
Economic Development (Squared)	**-0.31**	**-0.47**	0.00	0.06	**0.35**	**0.43**	-0.04	-0.02
	(-1.95)	***(-2.90)***	*(0.01)*	*(0.34)*	***(2.80)***	***(3.35)***	*(-1.26)*	*(-0.62)*
Sector Size	0.09	0.18	**0.33**	**0.36**	**-0.37**	**-0.50**	-0.05	-0.04
	(0.45)	*(1.02)*	***(1.81)***	***(1.85)***	***(-2.39)***	***(-3.52)***	*(-1.32)*	*(-0.97)*
Efficiency	0.48	0.65	0.10	-0.31	-0.76	-0.53	2.16	2.11
	(0.42)	*(0.66)*	*(0.09)*	*(-0.28)*	*(-0.86)*	*(-0.66)*	*(0.83)*	*(0.72)*
R^2	**0.33**	**0.63**	**0.38**	**0.52**	**0.59**	**0.76**	**0.22**	**0.31**
$\hat{\sigma}^2$	**0.008**	**0.006**	**0.008**	**0.008**	**0.006**	**0.005**	**0.001**	**0.001**
Nobs	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Notes: The estimated regression is given by

$$SEU = \beta_0^s + \beta_1^s SIZE_{n,s} + \beta_2^s EFFICIENCY_{n,s} + \beta_3^s RGDP_n + \beta_4^s RGDP_n^2 + \beta_5^s \mathbf{REGION_n} + \beta_6^s \mathbf{BRIC_n} - \varepsilon_n$$

where $\varepsilon_n \sim N(0, \sigma_n^2)$. The equation is estimated using 2SLS on 2007 annual data from 35 different countries.

Table 9. Cross-country differences in end-use energy consumption and the BRIC economies, by industry within sector (IEU)

	Industrial Sector				Transportation Sector				Residential and Commercial Sector			
	Energy Intensive Industries (S = 1; I = 1)		Non-energy Intensive Industries (S = 1; I = 2)		Road Industries (S = 2; I = 1)		Non-road Industries (S = 2; I = 2)		Residential (S = 3; I = 1)		Commercial (S = 3; I = 2)	
Constant	-2.21	-0.48	-0.22	0.56	-3.10	**-5.70**	-0.04	1.16	**5.05**	**6.68**	2.34	-0.68
	(-0.76)	*(-0.17)*	*(-0.15)*	*(0.34)*	*(-1.01)*	***(-1.75)***	*(-0.04)*	*(1.30)*	***(2.22)***	***(2.49)***	*(1.02)*	*(-0.35)*
Europe	.	0.05	.	0.02	.	**-0.10**	.	**-0.04**	.	0.06	.	-0.01
	.	*(1.04)*	.	*(0.65)*	.	***(-1.69)***	.	***(-2.39)***	.	*(1.37)*	.	*(-0.32)*
Developed Asia	.	0.08	.	0.04	.	-0.16	.	-0.02	.	-0.01	.	0.06
	.	*(1.13)*	.	*(1.08)*	.	*(-2.08)*	.	*(-0.98)*	.	*(-0.09)*	.	*(1.31)*
Latin America	.	0.00	.	-0.01	.	-0.11	.	0.00	.	0.03	.	**0.08**
	.	*(-0.001)*	.	*(-0.18)*	.	*(-1.39)*	.	*(-0.12)*	.	*(0.48)*	.	***(1.73)***
Emerging Asia	.	-0.09	.	-0.04	.	0.02	.	**-0.05**	.	-0.01	.	**0.18**
	.	*(-1.45)*	.	*(-1.13)*	.	*(0.27)*	.	***(-2.62)***	.	*(-0.17)*	.	***(4.37)***
Emerging Other	.	**-0.14**	.	-0.04	.	0.05	.	**-0.05**	.	0.12	.	0.07
	.	***(-1.83)***	.	*(-0.90)*	.	*(0.59)*	.	***(-2.00)***	.	*(1.62)*	.	*(1.44)*
Brazil	0.10	0.08	0.06	0.05	-0.02	-0.07	0.00	-0.02	-0.13	-0.10	-0.03	0.05
	(0.97)	*(0.83)*	*(1.13)*	*(0.83)*	*(-0.14)*	*(-0.63)*	*(0.15)*	*(-0.62)*	*(-1.60)*	*(-1.13)*	*(-0.38)*	*(0.71)*
Russia	0.05	-0.06	-0.05	-0.10	-0.09	-0.04	-0.01	**-0.07**	0.12	0.09	-0.05	**0.16**
	(0.40)	*(-0.44)*	*(-0.81)*	*(-1.43)*	*(-0.67)*	*(-0.29)*	*(-0.24)*	***(-1.69)***	*(1.21)*	*(0.73)*	*(-0.53)*	***(1.89)***
India	0.06	0.05	0.00	0.00	**-0.27**	**-0.33**	**0.09**	**0.07**	0.08	0.12	0.05	0.09
	(0.56)	*(0.56)*	*(0.04)*	*(-0.01)*	***(-2.38)***	***(-3.03)***	***(3.04)***	***(2.42)***	*(0.93)*	*(1.37)*	*(0.55)*	*(1.37)*
China	**0.25**	**0.18**	0.03	0.00	**-0.29**	**-0.30**	0.01	-0.02	-0.02	-0.01	0.01	**0.15**
	(2.36)	***(1.72)***	*(0.58)*	*(-0.02)*	***(-2.59)***	***(-2.65)***	*(0.33)*	*(-0.76)*	*(-0.21)*	*(-0.07)*	*(0.12)*	***(2.25)***
Economic Development	1.09	0.34	0.19	-0.14	1.57	**2.79**	0.02	-0.55	**-2.17**	**-2.92**	-1.13	0.17
	(0.77)	*(0.24)*	*(0.27)*	*(-0.17)*	*(1.05)*	***(1.77)***	*(0.04)*	*(-1.27)*	***(-1.96)***	***(-2.25)***	*(-1.01)*	*(0.18)*
Economic Development (Squared)	-0.13	-0.05	-0.03	0.01	-0.19	**-0.32**	0.00	0.07	**0.24**	**0.33**	0.15	0.01
	(-0.74)	*(-0.28)*	*(-0.32)*	*(0.08)*	*(-1.02)*	***(-1.72)***	*(-0.02)*	*(1.28)*	***(1.84)***	***(2.11)***	*(1.10)*	*(0.06)*
Sector Size	0.00	0.12	-0.07	-0.04	**0.47**	**0.00**	0.00	0.00	-0.13	-0.14	-0.20	**-0.36**
	(0.01)	*(0.63)*	*(-0.72)*	*(-0.40)*	***(2.12)***	***(2.28)***	*(-0.05)*	*(0.03)*	*(-0.83)*	*(-0.80)*	*(-1.20)*	***(-2.93)***
Efficiency	0.63	0.40	-0.07	-0.18	-0.40	-0.73	0.49	0.50	0.59	-2.16	-11.25	-0.69
	(0.53)	*(0.39)*	*(-0.12)*	*(-0.31)*	*(-0.31)*	*(-0.61)*	*(1.35)*	*(1.52)*	*(0.05)*	*(-0.19)*	*(-0.99)*	*(-0.08)*
R^2	**0.25**	**0.59**	**0.16**	**0.39**	**0.47**	**0.69**	**0.39**	**0.64**	**0.57**	**0.68**	**0.44**	**0.79**
$\hat{\sigma}^2$	**0.010**	**0.007**	**0.002**	**0.002**	**0.012**	**0.011**	**0.001**	**0.001**	**0.006**	**0.006**	**0.005**	**0.003**
Nobs	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Notes: The estimated regression is given by

$$IEU = \beta_0^e + \beta_1^e SIZE_{n,s} + \beta_2^e EFFICIENCY_{n,s} + \beta_3^e RGDP_n + \beta_4^e RGDP_n^2 + \boldsymbol{\beta_5^e \mathrm{REGION}_n} + \boldsymbol{\beta_6^e \mathrm{BRIC}_n} + \varepsilon_n$$

where $\varepsilon_n \sim N(0, \sigma_n^2)$. The equation is estimated using 2SLS on 2007 annual data from 35 different countries.