Demand Complementarities and Cross-Country Price Differences*

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Abstract: Empirical studies document that markups vary across destinations. This paper proposes a novel mechanism to explain variation in markups: Consumers' utility from final goods and services depends on their consumption of complementary goods and services. In countries with more complementary goods and services consumer demand is less elastic, enabling monopolistically competitive firms to charge higher prices. The paper provides empirical evidence documenting a dependence of prices on demand complementarities.

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1. Introduction

Traditional theories of price determination focus on costs. For example, standard explanations of cross-country price differences are based on cost differences under the assumption that the law of one price holds (e.g., Balassa 1964; Samuelson 1964; Crucini, Telmer, and Zacharides 2005), and the standard New Keynesian model predicts that prices depend on costs and the ability of producers to adjust to cost changes. Recent evidence points to the importance of markups, rather than only costs, in determining prices. Simonovska (2015), for example, documents that an online apparel retailer charges higher markups to consumers in rich countries than to consumers in poor countries, which suggests that cross-country variation in demand elasticities contributes to cross-country price differences. Simonovska's evidence is consistent with other recent empirical work documenting a strong role for markups of tradable goods that differ by characteristics specific to the destination countries (e.g., Engel 1999; Gopinath, Gourinchas, Hsieh, and Li 2011; Fitzgerald and Haller 2012; Cavallo, Neiman, and Rogobon 2014).

An open question is what determines these markups and demand elasticities. I propose a new explanation for high markups based on high (and inelastic) demand arising from high consumption of goods and services that complement demand for consumer goods.

That demand for one good depends on the availability of another is quite natural. Home entertainment systems can provide substantial utility in a country with reliable access to electricity, but would provide much less utility in a land without reliable electricity. They also provide more utility when consumers have sufficient space in their homes and a reasonable expectation that their electronics are secure from theft. Consumers without electricity (or homes in safe neighborhoods) get less utility from entertainment systems and thus have lower, more elastic demand for such products.

Many types of goods and services may complement demand for differentiated consumer goods (and differentiated consumer goods could complement demand for each other). To distinguish the complementary goods from the consumer goods in the analysis below, I refer to these complementary goods and services as *catalyst* goods. Often catalyst goods will be durables, such as housing or public infrastructure, but they may also be services or intangibles, such as public safety, other consumer goods, or advertising. The concept of a catalyst captures the notion that some goods and services facilitate consumers' derivation of utility from other final goods and services. The notion of catalysts is similar to the notion of consumer demand proposed by Lancaster (1966), who suggests that goods and services are not direct objects of utility themselves, but rather contain properties and characteristics that consumers combine to generate utility.

Of course, complementarity (in the sense that marginal utility from one good depends on consumption of another good) is not sufficient to guarantee variation in markups. With standard constant elasticity of substitution (CES) preferences, for example, markups are independent of complementarity goods. Below I derive the necessary and sufficient conditions on the utility function such that catalysts affect prices of relevant consumer goods. Catalyst-driven markups are consistent with a wide class of nonhomothetic utility functions, including quadratic utility and Stone-Geary preferences.

To empirically test the demand-complementarities hypothesis, I examine how prices of tradable goods depend on catalysts across destination countries. The test requires data on catalysts that are imperfectly correlated with income per capita across countries. If the catalysts were perfectly correlated with income across countries, then it would be impossible to isolate the demand-complementarities channel from other potential mechanisms associated with income-driven demand elasticities. The analysis also requires isolating catalysts that are strong demand complements for subsets of tradable goods. Differential demand complementarity permits a test of a differential dependence of prices on catalysts between strongly complemented goods and other goods.

A plausible catalyst that is relevant for a large subset of tradable goods is electricity access, which is an important determinant of demand for electric appliances. I use data on electricity production, which is a proxy for access that is measured across a range of countries over time, to show that electric goods are sold at higher prices to countries with higher electricity production, conditional on destination-country income per capita and conditional on the average dependence of consumer goods prices on country-level determinants.

Although electric goods account for a substantial share of traded consumer goods and accurate data on electricity production is available for a wide range of countries, the empirical test faces a number of limitations. First, electricity is highly correlated with income per capita, which poses the challenge of distinguishing demand complementarities from other pricing-to-market mechanisms associated with high income. Second, electricity may complement demand for retail goods generally (if, for example, reliable electricity supply allows retail stores to keep the lights on and stay open). Despite these challenges that bias the results against detection of the demand-complementarities mechanism, the results nonetheless demonstrate a strong dependence of prices on electricity. Placebo tests demonstrate that other subsets of consumer goods, such as battery-powered electronics and luxury items, exhibit a below-average dependence on electricity and an above-average dependence on income per capita.

Two additional catalysts for which I can obtain data across a range of countries is snowfall, which complements demand for skis, and road quality, which complements demand for automobiles. To corroborate the evidence on electricity as a catalyst, I show that prices of cars demonstrate an above-average dependence on road quality; and prices of skis demonstrate an above-average dependence on snowfall. An advantage of the ski-based test is that snowfall is less correlated with income per capita, permitting a stronger test of whether prices depend on independent variation of catalysts.

To isolate the demand-complementarities mechanism, it is important to control for the quality of traded goods. The empirical analysis takes a number of steps to isolate variation in markups from variation in quality. However, there remains the possibility that some of the results may reflect unobserved variation in quality. Therefore I supplement the tests based on traded goods with a test of prices of services for which I can observe direct measures of quality. In particular, I examine whether prices of hotel rooms near the beach depend on exogenous variation in weather. The hotel price data include star ratings as a measure of quality, which helps to isolate markups from star-based quality ratings.

In the context of beach hotel rooms, the demand-complementarities hypothesis implies that hotel rooms are more expensive when the weather is nicer. I find that hotel prices indeed rise during nice-weather periods, conditional on quality. This price variation is unlikely to be driven by seasonal fluctuations in costs. Data on seasonal variation in regional wages for hotel workers demonstrates that hotel wages are far less seasonal than are hotel prices. I also find that the effect of weather on markups is stronger for higher-quality hotels, suggesting that quality and catalysts are complementary.

The remainder of the paper proceeds as follows. Section 2 presents a model of demand complementarities and pricing to market. Section 3 tests the model's predictions using cross-country variation in unit values of U.S. exports. Section 4 examines the effect of weather on hotel prices near the beach. Section 5 concludes.

2. A Model of Catalyst-Dependent Pricing

Here I formalize how markups depend on consumption of complementary goods and services by introducing catalysts into the general variable elasticity of demand (VES) system, which has been explored by Vives (2001) and Dhingra and Morrow (2016), among others. The analysis treats catalysts as predetermined with respect to firms that produce the complemented consumer goods. The catalyst could represent endowments (e.g., snowfall complements demand for skis and ski services) or they could be producible (e.g., electricity access complements demand for electric goods). In either case, producers choose the price, taking as given the relevant destination-market catalysts.

The catalyst enters the utility function as a demand shifter and in that sense is analogous to quality in recent models in which quality and markups are jointly determined (Antoniades 2015). In my framework, as in the Antoniades model, markups are increasing in the demand shifter. The two frameworks differ in that here, catalysts are features of destination markets that exporting firms treat as predetermined.

2.1. Demand Complementarities and Pricing to Market.

A representative household has preferences over a set Ω of differentiated goods:

$$U = \int_{i \in \Omega} u(C, q_i) di, \tag{1}$$

where q_i is consumption of a good of variety i and C is the catalyst. Complementarity between C and q implies that marginal utility from the differentiated good is increasing in the catalyst, $u_{qC} > 0$. Consumer optimization yields inverse demand $p(q_i) = u_q(C, q_i)/\lambda$, where λ is the multiplier on the consumer's budget constraint.

Firms. There is a continuum of potential entrants into the market for consumer goods, each of which pays a fixed entry cost f. Firms take the demand curve for their variety as given and choose price/quantity to maximize profits, $(p_i - c)q_i$, where c is a constant marginal cost faced by all firms. The optimal quantity for firm i satisfies

$$p(q_i) = c - \frac{u_{qq}\big(q_i(C)\big)q_i(C)}{\lambda}.$$

Following the same logic as Dhingra and Morrow (2016), it follows that the markup, $(p - c)/p$, is

$$\mu = -q(C)\frac{u_{qq}(C,q)}{u_q(C,q)}, \qquad (2)$$

where I have dropped subscripts since firms face identical costs and demand. The markup is increasing in the catalyst if and only if $\frac{\partial \epsilon}{\partial C} > 0$, or $-q\left[\frac{u_q u_{qqC} - u_{qq} u_{qC}}{u_q}\right] - u_{qq} q_C > 0$.[1]

It is straightforward to show that the markup (2) is independent of the catalyst for constant elasticity of demand functions, such as $u = C^{\alpha} q^{\epsilon}$ but increasing in the catalyst for linear demand functions such as $u = C^{\alpha} q - \frac{\gamma}{2} q^2$.[2] Below I present empirical evidence consistent with complementarity between catalysts and consumer goods under linear demand.

3. Cross-Country Evidence

Here I provide evidence that prices and markups of subsets of tradables depend on countries' stock of relevant catalysts. I use disaggregated export data from the U.S. Exports Harmonized System data. These data are available on Robert Feenstra's webpage and contain unit values and quantities of bilateral exports leaving U.S. docks for each Harmonized System (HS)-10 product category for years prior to 2006. As discussed by Alessandria and Kaboski (2011), there are two advantages of using these data to study the extent of pricing to market for tradable goods. First, the unit values are free-alongside-ship values, which exclude transportation costs, tariffs, and additional costs incurred in the importing country. Thus the unit values capture the actual price

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[1] To understand the economic intuition behind this condition, it is helpful to derive the conditions on the demand curve under which demand elasticities are falling in the catalyst in partial equilibrium (e.g., holding fixed the budget multiplier). Consider a generic demand curve $q = q(C,p)$. By assumption, $q_C > 0$ and $q_p < 0$. The price elasticity of demand is decreasing in C (and markup increasing in C) if and only if $\frac{\partial \epsilon}{\partial C} < 0$, where $\epsilon \equiv \left|\frac{\partial q}{\partial p}\frac{p}{q}\right|$. We can write $\frac{\partial \epsilon}{\partial C} = -q_{pC}\ \frac{p}{q(D,p)} + q_p \frac{p}{q(D,p)^2} q_C$, in which case the necessary and sufficient condition simplifies to

$$q q_{pC} > q_p q_C,$$

which states that any slope-increasing effects of an increase in C on the demand curve must be more than compensated by a shift out of the demand curve. In the commonly used case of a constant elasticity demand curve, $q = Cp^{-\epsilon}$, these two effects exactly cancel out so that $q q_{21} = q_2 q_1$.

[2] In particular, in equilibrium under quadratic utility (linear demand), $p = \frac{1}{2\lambda}(C^{\alpha} + c)$, $q = \frac{1}{2\gamma}(C^{\alpha} - \mathrm{c})$ and the markup is $= \frac{C^{\alpha} - c}{C^{\alpha} + c}$, which is increasing in C.

of the good, rather than the price of taking the good to retail. Second, the disaggregated nature of the data mitigates potential concerns that different unit values may reflect differences in quality.[3]

3.1 Testing Demand Complementarities and Pricing to Market

There are a number of challenges in testing the model's prediction that prices of tradable goods depend on countries' consumption of relevant catalyst goods. First, it is necessary to isolate the effect of catalyst-based demand from other factors that are associated with pricing to market, including income per capita. In the data, catalyst consumption is imperfectly correlated with income per capita, which permits me to test the dependence of prices on the component of catalyst consumption that is not correlated with income. Different catalysts are likely to have different degrees of correlation with income, and the challenge is to identify a catalyst with (a) reliable cross-country data, and (b) sufficient variation in the component that is orthogonal to income per capita.

A second challenge is to identify a catalyst that is a strong demand complement for a subset of identifiable consumer goods relative to other goods. This differential demand complementarity is necessary to test the dependence of prices of relevant catalyzed goods on catalyst consumption while conditioning on the average dependence of prices on factors related to income and catalyst consumption.

One such catalyst that should exhibit differential demand complementarity is access to electricity, which complements demand for electric goods. McRae (2010), for example, shows that access to reliable electricity in developing countries is associated with a higher likelihood of purchasing electronic appliances.

Data on access to electricity are available from World Development Indicators for only a limited subset of countries, and only starting in 2009, a year past the dates for which I have export price data. As a proxy for electricity access, I use a measure that is both available and consistently measured in multiple years for a broad range of countries: International Energy Agency (IEA) data on electricity consumption, defined as total electricity production less any power used by power plants or lost in transmission and distribution.

[3] Despite the disaggregated nature of the data, there is still room for quality variation within a product category. To help condition on quality, I examine the extent to which catalyst-driven prices are differ between goods with high and low quality ladders.

The IEA proxy is most appropriate for countries with low levels of electricity access and low incomes. There is a mass of countries for which access is nearly 100% of the population and electricity consumption is unrelated to access because everyone has access (Figure 1). But for low values of electricity consumption and low-income areas, access is strongly correlated with electricity consumption. Above incomes per capita of $15,000 (in 2005 USD), incomes and access are nearly independent and access is nearly 100%. Therefore I limit the sample of countries to those with income per capita of less than $15,000. The results presented below are slightly stronger for lower thresholds, consistent with the notion that electricity consumption is a stronger proxy for access among countries with low levels of access.[4]

Despite a number of features of electricity production that are amenable to an empirical test, there are other features that present challenges. First, electricity is highly correlated with income per capita (correlation coefficient of 0.87 among countries in the sample), which poses the challenge of distinguishing demand complementarities from other pricing to market mechanisms associated with high income. Second, electricity may complement demand for retail goods generally (if, for example, a reliable electricity supply allows retail stores to keep the lights on and stay open). Therefore much of the dependence of prices on electricity production may be captured by country-level fixed effects. If so, the estimates presented below are a lower bound on the extent to which prices depend on catalysts.

The test of electricity production as a catalyst is based on a cross-sectional analysis that uses average values (within each country-product observation) of unit values between 2004 and 2006. Table 1 shows summary statistics for the 71 countries in the sample. Data on electricity consumption and income per capita exhibit substantial variation across countries and over time. As mentioned above, electricity consumption is highly correlated with income, so the test of demand complementarities will be based on the limited variation in electricity consumption that is independent of variation in income.

The trade data are limited to consumer goods as identified by their end-use codes. To prevent nonrepresentative products from driving the results, the samples are limited to products

[4] It may seem that an alternative to using data on electricity production is to use data on electricity prices. As discussed below, price data are available for only approximately 50 countries. For many of these countries, access to electricity is unreliable for many consumers, so the listed price of electricity does not accurately capture the true cost to consumers of obtaining reliable electricity. As discussed in McRae (2010) and McRae (2013), consumers' desire to own durables depends on whether reliable electricity is available. Therefore production of accessible electricity is the relevant catalyst and a more accurate proxy for the true cost of obtaining reliable electricity.

that are exported to at least 10 countries and to country–product pairs with more than 100 units sold and more than $1,000 in value.[5] Electric goods are identified in the trade data based on the product description associated with each harmonized system code. I explore two different approaches to classifying electric goods. Under the first approach, I classify any good that is clearly electric and not battery powered as electric, along with associated parts. This approach results in a number of high-unit-value appliances being classified as electric—such as air conditioning units and washing machines—that may be affordable by only limited subsets of the population. It also includes parts of electric goods that may not be sold directly to consumers. Therefore, under an alternative approach, I identify only smaller routine household appliances (but not their parts) as electric. Table 2 lists examples of goods classified as electric, along with the goods that are classified as routine electric appliances.

In addition to testing electricity as a catalyst for electric goods, below I also test two additional consumer goods for which I can identify relevant catalysts in the cross-country data: road quality as a catalyst for automobiles and snowfall as a catalyst for ski equipment.

3.1.1. Electricity and Prices of Electric Goods

To test whether prices of electric goods depend on electricity, I employ the following empirical specification:

$$p_{ch} = \alpha_c + \gamma_h + \beta_1 \ln MwH_c \times Egood_h + \beta_2 \ln y_c \times Egood_h + \epsilon_{ch}, \qquad (3)$$

where p_{cht} is the log of the unit value of good h exported to country c. The coefficient α_c represents country-year fixed effects, γ_h represents fixed effects for each good category in each year, and MwH_c is the per capita electricity consumption in country c. $Egood_h$ indicates whether good h is electric, and ϵ_{ch} denotes the regression error.

The coefficient β_1 captures the extent to which prices of electric goods depend on electricity access, conditional on the average dependence of prices on country-level determinants including electricity consumption (captured by product-time fixed effects) and conditional on the dependence of prices of electric goods on income per capita (captured by β_2). The difference between β_1 and β_2 captures the extent to which the dependence of electric goods prices on

[5] The quantity restriction excludes high-priced products that are clearly unrepresentative (e.g., 17 fans sold to Macau for $66,000, etc.). The results are robust to different quantity and value thresholds.

electricity relative to income per capita exceeds the average dependence of consumer goods prices on electricity relative to income per capita. Since electricity consumption and income are highly correlated, interacting both with a dummy for electric goods isolates the effect of electricity on prices of electric goods from the effect of other mechanisms associated with income.

β_1 can be interpreted as representing a causal relationship if electricity consumption is exogenous to the product price. Electricity consumption is indeed likely to be exogenous with respect to the price of a single imported product. If there is any endogenous response to electric prices, demand complementarity implies that electricity consumption should respond negatively to high import prices. In this case, high electricity consumption is associated with low prices of electric goods, and β_1 will underestimate the causal effect of electricity consumption on electric goods prices. In other words, the estimate of β_1 is biased downward in the presence of endogenous electricity consumption.

Table 3 shows results from estimating (3), along with specifications that replace the country-time fixed effects with country-level covariates. Column (1) reproduces the finding in Alessandria and Kaboski (2011) that unit values of U.S. exports are increasing in destination country income per capita. One potential concern with GDP measures is that they do not accurately capture economic activity for low-income countries. For this reason, Henderson, Storeygard, and Weil (2012) propose energy-related estimates of country-level growth. Consistent with their intuition, column (2) shows that prices are more strongly related to electricity consumption than to GDP. The stronger dependence of prices on electricity could be due either to mismeasurement of GDP or to electricity as a catalyst for consumer goods broadly. To isolate the catalyst effect in the data, columns (4) through (7) interact GDP and electricity with a dummy for electric goods. Country fixed effects absorb the average dependence of prices on country-level characteristics, including GDP. Consistent with the demand-complementarities hypothesis, electric goods exhibit a statistically significant above-average dependence on electricity consumption and a below-average dependence on income per capita. When conditioning on the interaction with GDP, a 100% increase in electricity consumption is associated with a 12.0% increase in the price of electric goods (column 4). This magnitude is slightly larger than markup elasticities with respect to GDP in Alessandrai and Kaboski (2011) and Simonovska (2015). Columns 5 and 6 show that values and quantities of electric goods also exhibit an above-average differential dependence on electricity consumption, consistent with the theory's prediction that high catalyst consumption is associated with outward shifts in the demand curves for tradable consumer goods that increase quantities and reduce the price elasticity of demand. Column (7) includes quantity as a control in the price regressions. Since prices and quantities are jointly driven by unobserved factors such as quality, conditioning on quantity helps to indirectly control for unobserved determinants of prices. The coefficient on the interaction term with electricity remains large and significant. The negative coefficient on quantity is suggestive of declining marginal costs of exporting, perhaps due to bulk discounts.

Alternative Classifications, Additional Quality Controls, and Placebo Tests. Table 4 shows the results from a similar empirical specification using a narrower definition of electric goods. This narrower definition excludes high-unit-cost appliances such as air conditioning units and dishwashers that may be considered luxury items in low-income countries, as well as parts of electric goods. It also limits the classification of electric goods to those that are representative of electronics exported from the United States to the countries in the sample. Of U.S. exports of dishwashers, for example, only 4% are destined for the low-income countries for which there is variation in electricity access, while 44% of U.S. exports of small kitchen appliances are destined for low-income countries. Column 1 shows that a 100% increase in electricity production is associated with a 23.6% increase in the price of routine electric appliances, conditional on the average dependence of consumer goods prices on electricity and conditional on the dependence of prices of routine electric appliances on income per capita.

The strong dependence of prices of electric appliances on electricity may reflect both markups and quality variation. To help isolate the role of markups, I separate appliances into those with high levels of within-product quality variation (long quality ladders) and low levels of within-product quality variation (short quality ladders) based on the quality-ladder estimates in Khandelwal (2010). The estimate of the dependence of electric-appliance prices on electricity is strong for appliances with long and short quality ladders (column 2), suggesting that markups, rather than solely differences in quality, are contributing to price variation.[6]

[6] For a model predicting a relationship between quality of imports and income, see Hallak (2006). To the extent that the evidence here captures some quality variation, it suggests that catalysts, and not only income, contribute to import demand for quality, consistent with the assumption in new theoretical trade models that explain patterns of trade and income across countries. Fajgelbaum, Grossman, and Helpman (2011) develop a model featuring complementarity between a homogenous good and quality of vertically differentiated goods.

One may wonder whether other nonelectric consumer-good categories display a similar dependence on electricity consumption, implying that the estimated dependence is due to some other artifact of the data rather than to demand complementarity. In other words, would placebo goods generate the same result as electric goods? One way to address this question is to estimate the dependence of placebo-goods prices on electricity, and then see whether the dependence of electric goods exceeds the average dependence of placebos on electricity consumption. The estimates based on equation (3) do exactly this by capturing the average dependence of prices of electric goods on electricity in the country-time fixed effects.

While the results based on averages over placebos are informative, it is nonetheless useful to see whether the dependence on electricity differs for subsets of consumer goods that we would most expect to exhibit a different relationship with electricity and income. In particular, battery-powered goods should be in higher demand in countries with less electricity, all else equal. Consistent with this intuition, column (3) shows that prices of battery-powered goods exhibit a strong below-average (and statistically significant) dependence on electricity.

Finally, it is possible that some of the results are driven by the fact that electric goods are luxury items with high income elasticities of demand. As an additional placebo test, I examine whether luxury items demonstrate an above-average dependence of prices on electricity using three alternative classifications of luxury goods. First, I examine prices of equipment for luxury sporting goods (water sports, skiing, golf, tennis, and adventure sports). Second, using import data from UN Comtrade, I classify goods as luxury items if they have high import elasticities with respect to income per capita across countries. The results below are based on elasticities in the upper quartile of the elasticity distribution, but the results are similar using alternative cutoffs. Many of the goods with high import elasticities are jewelry and artwork, so I also examine a third definition of luxury goods based explicitly on goods with end-use classification 413, “coins, gems, jewelry, and collectibles.” Columns 4 through 6 show that none of these classifications of luxury items demonstrates an above-average dependence of prices on electricity. To the contrary, prices of sporting equipment exhibit a below-average dependence on electricity and an above-average dependence on income per capita, consistent with the notion that demand for luxury sporting goods depends more on income (and other associated mechanisms) than on electricity.

Evidence from Electricity Prices. The evidence from Tables 3 and 4 based on electricity production is consistent with the theory's prediction that higher catalyst consumption causes higher prices. A corresponding prediction is that lower catalyst prices (which are associated with higher catalyst quantities) should lead to higher prices of tradable goods. As discussed above, cross-country price data are limited to a small subset of high-income countries for which electricity access is nearly 100%. Therefore, for these countries, variation in electricity prices does not reflect variation in the catalyst (access).

While electricity access does not vary among the countries for which we have electricity price data, it is nonetheless helpful to examine whether prices of electric goods in these countries vary in ways that are consistent with the demand-complementarities hypothesis. In particular, among high-income countries, demand for energy-intensive items is likely to depend on electricity prices when less-energy-intensive substitutes are available.

A number of electronic goods in the sample exhibit varying energy intensity that can be identified based on their product descriptions. These appliances are refrigerators and air conditioning units. Electricity prices determine which level of energy intensity consumers choose to purchase. In particular, energy-intensive appliances should be in lower demand (and have lower prices) in countries with high electricity prices, all else equal. Data on electricity prices faced by households in 36 countries is from the Energy Information Association and is available from 2001. To correspond with the trade data, the sample is based on averages from 2004 to 2006.

Table 5 shows that prices of high-energy appliances exhibit a relatively lower dependence on electricity prices than do prices of their low-energy counterparts. The differential dependence on electricity prices between high-intensity and low-intensity units holds across specifications, consistent with the notion that prices of energy-intensive appliances depend on prices of relevant catalysts.[7]

3.1.2. Additional Tests of the Demand-Complementarities Hypothesis

[7] Prices of smaller, routine electric devices do not exhibit a significant differential dependence on electricity among the rich countries in the sample. This is likely due to the fact that electricity matters on the extensive margin (consumers have the necessary electricity access to use electric shavers) but not the intensive margin (electric shavers are not energy intensive).

Here I explore two additional catalysts using the cross-country data: road quality (which complements demand for automobiles) and snowfall over mountainous terrain (which complements demand for ski equipment).

Passenger Vehicles and Road Quality. Data on road quality is the percentage of paved roads in a country, provided by the World Databank. As in the test on electricity, I perform a cross-sectional analysis using average trade value and quantities sold over 2004 to 2006 to obtain unit values of product-level exports to each country. The sample of exports includes consumer goods (those with end use codes 40000-50000) as well as passenger vehicles.[8] The road quality data is also based on averages over these three years. Because rich countries tend to have high-quality roads (and therefore limited variation in the catalyst), the sample is based on the same set of low-income countries as in the electricity test (with one country excluded due to lack of road quality data).

Table 6 shows the results from an empirical test analogous to equation (3). Prices of passenger vehicles exhibit an above-average dependence on road quality (column 1), including when conditioning on the interaction with GDP (column 2) and electricity (column 3). Similar results hold when I classify passenger vehicles as either new cars (column 3) or used cars (column 4), which suggests that the results are driven by both high-and-low-quality passenger vehicles.

Snowfall and Ski Equipment. Here I test whether prices of skis depend on ski resorts and snowfall over mountainous terrain. I include skis as well as bindings and other ski parts in the classification of skis (HS codes 9506115000, 9506116000, 9506120000, and 9506190000). Although skis are a small share of trade, they are very suitable for a test of the demand-complementarities hypothesis because the catalysts (ski resorts and snowfall) exhibit a relatively low correlation with income per capita, and because the catalysts exhibit strong differential demand complementarity (demand for skis depends on snowfall far more than does demand for other consumer goods).

Country-level data on ski resorts are provided by Snow-forecast.com (http://www.snow-forecast.com/countries). These data were collected in 2013. 85 countries have nonmissing data

[8] Passenger vehicles consist of hs codes 8703105060 through 87039000000. I classify these automobiles as used or new cars based on the product description. For example, "PASS VEH,SPARK IGN, NESOI, NEW, > 3000 CC,&<=4 CYL" identifies a new car.

on the number of ski resorts. The correlation of ski resorts with income per capita is 0.70. As in the tests on electricity and road quality, I use average trade value and quantities sold over 2004 to 2006 to obtain unit values of product-level exports to each country.

I construct data on snowfall over mountainous terrain based on information on rainfall, temperature, and elevation across countries. The Climate Change Knowledge Portal at the World Bank provides country-level data on monthly precipitation and temperature, averaged over the years 1961 through 1999. I compute country-level measures of snowfall by summing a country's precipitation over months when average temperatures are less than 5 degrees Celsius. I consider this snowfall to be conducive to skiing if a country's highest point of elevation is greater than 5,000 feet; otherwise I set the country's measure of skiable snowfall to slightly above zero.[9]

The test for demand complementarity and pricing to market for skis is based on the following specification,

$$p_{ch} = \gamma_h + \beta_1 \ln Snow_c \times Ski_h + \beta_2 \ln y_c \times Ski_h + \epsilon_{ch}, \tag{4}$$

where $Snow$ is the measure of snowfall in country c and other variable definitions are analogous to those in equation (3). The tests include variations of (4) that use snowfall as an instrument for the number of ski resorts in a country. Since the catalysts (snowfall and ski resorts) are positively correlated with income, and since skis may have an above-average dependence on income per capita, $\beta_2 \ln y_c \times Ski_h$ is included to isolate the dependence of prices of skis on catalysts from their dependence on income per capita.

Table 7 shows the results based on the 33 countries with data on ski resorts. This sample of countries is much richer than the sample based on the electricity and road tests, with a median GDP per capita in 2005 of $22,858. Columns (1) and (2) show that ski prices exhibit an economically and statistically significant above-average dependence on snowfall. Column (3) examines ski resorts as the relevant catalyst, using snowfall as an instrument for ski resorts. The magnitude of the elasticity of ski prices with respect to ski resorts is 0.24, nearly double the elasticity with respect to snowfall. The estimates are similar when using quantity to help control for other unobserved determinants of prices (column 4). Column (5) is a placebo specification

[9] Data on country-level elevation is from the CIA World Factbook. The results are robust to using different temperature and elevation thresholds when computing skiable snowfall. The elevation threshold limits the measure of skiable snowfall in countries, such as Ireland, which are wet and often cold, but which do not have mountains conducive to skiing.

that replaces the indicator for ski in the baseline specification (column 1) with an indicator for luxury sporting equipment. Luxury sporting equipment is defined as above but excludes skis. Consistent with the notion that snowfall complements demand for skis but not other sporting equipment, there is no significant above-average dependence of prices of other sporting equipment on snowfall.

According to the estimates, catalysts are a strong determinant of prices, conditional on the dependence of prices on other mechanisms associated with income per capita. The estimated price elasticities with respect to catalysts are much larger than the typical estimates of pricing to market (e.g., Simonovska 2015). The high estimates may reflect quality variation since the data do not distinguish between skis of different quality levels. Despite this caveat, the results document a strong dependence of unit values on catalysts, and a below-average dependence of unit values on income per capita. The below-average dependence of prices of skis on income per capita is especially striking considering that skis are luxury goods for which expenditure shares rise sharply with income. The large negative coefficients on income per capita suggest that demand complementarities, rather than other nonhomotheticities, are responsible for variation in prices of skis.

4. Empirical Evidence from Seasonal Catalyst Variation

As discussed in Section 3, empirically isolating demand complementarities from other mechanisms in cross-country data is challenging due to the high correlation between catalysts and income per capita and due to the lack of information on quality of exported goods. In this section, I isolate independent catalyst variation by focusing on changes in a catalyst within a location across seasons. Casual observation suggests that prices of hotels and other services respond strongly to changes in seasonal demand: services near ski resorts are more expensive in the winter, for example, and local services near the beach are more expensive in the summer. Here I document that these seasonal fluctuations in prices reflect demand-driven markup variation rather than changes in costs or local income. Information on hotel star ratings helps control for quality and isolate variation in markups.

4.1 Data

The sample consists of hotels within two blocks of the Atlantic Ocean in Virginia Beach with price listings on Google Hotel Finder as of March 2015. Hotels with different amenities are co-located in a 2.5-mile-long strip of the beach. I infer amenities based on the star ratings associated with the hotel and its proximity to the oceanfront. I collected the lowest price of a hotel room in each hotel for the nights of Wednesday, March 18 and Wednesday, July 15. Focusing the analysis on mid-week prices helps mitigate any concerns that variation in prices reflects capacity constraints since vacation hotel bookings tend to be higher on weekends. If Google Hotel Finder did not indicate a price, I went through the hotel's website to find prices. Of the approximately 65 hotels along the strip, 48 had price data available online for the dates in March and July. The data were collected in early March 2015.

The variation in prices is assumed to reflect variation in markups under the assumption that wage costs do not fluctuate enough to explain the price variation. Data from the Quarterly Census of Employment and Wages confirms that wages for VA Beach are insufficiently seasonal to explain the seasonal variation in prices, as discussed below.

Why Virginia Beach? Virginia Beach contains a cluster of hotels of varying amenity levels and with oceanfront locations. The clustering helps control for natural amenities around the hotels; along other shorelines, such as in New Jersey, hotels are dispersed across long spans of shoreline. The variation in hotel quality/amenity levels is a feature of Virginia Beach that does not exist in other East Coast locations such as Ocean City, Maryland. Finally, seasonal weather variation in Virginia Beach is strong compared to other beach resort locations. Average high temperatures in March are just below 60 degrees Fahrenheit; in July, the average high is 87 degrees. Average water temperatures vary from the 40s in March to the 70s in July.

4.2 Empirical Results

Figure 1 shows kernel density estimates of the price distributions for March and July. The July distribution is to the right of the March distribution, consistent with the hypothesis that prices are higher during nice-weather seasons. Of course, it is possible that higher summer prices reflect higher preferences for quality and amenities during the summer rather than higher markups. Therefore I examine the dependence of prices on the season, conditional on measures of quality and amenities. I also allow for interactions between quality/amenities and the season.

Table 8 shows the 25th and 75th percentiles of the price change between winter and summer for hotels classified by their star rating and their proximity to the beach. Among low-star-rating hotels, the 25th percentile of the distribution of the price change for hotels on the ocean is above the 75th percentile of the distribution for hotels not on the ocean. The same pattern holds for hotels with three- and four-star ratings.

The dependence of prices on seasons can be captured through the following empirical specification:

$$p_{jt} = \beta_0 + \beta_1 Summer_t + \beta_2 HighAmenity_j + \beta_3 Oceanfront_j + \beta_4 Summer_t \times HighAmenity_j + \beta_5 Summer_t \times Oceanfront_j + \epsilon_{jt},$$

where $Summer_t$ is an indicator variable for whether the price is for the July date, $Oceanfront_j$ indicates whether the hotel is located adjacent to the ocean, and $HighAmenity_j$ indicates whether the hotel is rated three stars or above. Table 9 shows that the estimated coefficients are consistent with demand complementarities: All coefficient estimates are significantly above zero and economically large. [10] July prices are on average \$127 higher (column 1). This estimate is invariant to conditioning on measures of quality (column 2), and the summer premium for a high-amenity (oceanfront) hotel is \$31 (\$51) (column 3). In other words, oceanfront hotels and high-quality hotels increase their prices by more in the summer, suggesting that quality/amenities are q-complements to summer.

Do Price Differences Reflect Cost Differences? One potential concern when interpreting the coefficients is that they may reflect cost differences. These costs include hotel amenities (furniture, artwork, etc.), the cost of the land, and wages. Hotel amenities and the cost of land may affect the price, and therefore be responsible for the positive estimates of β_2 and β_3. Assuming that the cost of fixed amenities and land do not vary by season, these costs cannot account for the remaining estimates. The remaining cost category, wages, are unlikely to explain the estimates. To explain the estimates of β_4 and β_5 though costs, one would have to assume that wages of high-amenity and oceanfront hotels increase by much more than wages of other hotels in the summer. The possibility remains that wages are higher in July than March, which could account for the estimate of β_1. However, according to data from the Quarterly Census of

[10] A specification with log prices yields significant positive estimates of estimates β_0 through β_3 only. Positive values for the interaction term in levels but not logs is consistent with the predictions of a modified version of the utility function (1) to $U = C^{\alpha} Q^{\psi} q - \frac{\gamma}{2} q^2$, where Q is quality and $\alpha, \psi < 1$.

Employment and Wages between 2002 and 2012, third-quarter wages for the hotel industry in Atlantic City are an average of only 6% higher than first-quarter wages. Based on changes in hotel employment between the winter and summer, the total wage bill (employment times wages) increases by an average of 54%. Even if the number of hotel rooms sold remained constant across seasons, the wage-bill increase is insufficient to account for the revenue increase by hotels: The 10th percentile of price changes is 80%, and the maximum price change is 300%. Assuming that the number of rooms sold increases in the summer, then the difference between revenues and costs is even higher, implying strong markup variation.

5. Conclusion

Recent evidence documents that markups vary across destination markets. An open question is what drives the variation in markups. This paper proposes that prices of consumer goods and services depend on consumption of complementary catalysts. A range of empirical tests demonstrates an important role of demand complementarities for price determination.

The analysis in this paper is based in a partial-equilibrium framework. An interesting avenue for future work is to explore implications of demand complementarities in general equilibrium, and in particular for real exchange rates. Rich countries tend to have higher real exchange rates and also potentially produce more catalyst goods. The dependence of demand for consumer goods on country-level catalysts may have additional implications for trade flows, patterns of competitive advantage, and cross-country differences in income. For example, Krugman (1980) illustrates how preferences determine the location of production, and Krugman and Venables (1995) demonstrate how local demand generates production externalities and income.

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Table 1-Summary Statistics.

	N	Mean	StDev	p25	p50	p75
GDP per capita (USD, 2004-2006 average)	71	3359.8	3397.1	822.4	2056.2	4798.0
Electricity Consumption per capita (MwH, 2004-2006 average)	71	1427.1	1453.4	379.8	920.6	2027.1
Electricity Access (percent of population)	64	71.6	29.7	42.8	85.9	98.3
Percent of Paved Roads	70	38.4	27.5	14.8	32.4	57.2

Note: Data on is available through the World Development Indicators. The sample is limited to countries with GDP per capita (in 2005 USD) less than $15,000.

Table 2: Examples of Electric Goods

harmonizd system code	description	Small Appliance
8414510010	FANS FOR PERMANENT INSTALLATION,ELEC MOTOR LE 125W	
8414510090	FANS, NOT PERM INST,SLF-CONT ELEC MTR N/E 125 W	
8414599080	FANS, NESOI	
8414901040	PTS OF FANS INC BLOWERS (OF SUBHEADING 8414.51.00)	
8415100040	AIR-CONDITIONERS,WIND/WALL,SELF-CONTAIN <2.93KW/HR	
8415100060	AIR-COND,WIND/WALL,SELF-CONTAIN,2.93KW/HR><4.98KW	
8415100080	AIR-COND,WIND/WALL,SELF-CONTAIN GE 4.98 KW/HR	
8415103040	AIR-CONDTNRS,WIND/WALL, SELF-CONTAIN LT 2.93 KW/HR	
8415103060	AIR-COND,WIND/WALL,SELF-CONTAIN (2.93-4.98 KW/HR)	
8418210010	REFRIGERATORS, HOUSEHOLD, COMP TYP, VOL <184 LITER	
8418210020	REFRIG,HOUSEHOLD,COMP TYP,VOL 184 < 269 LITERS	
8418210030	REFRIG,HOUSEHOLD,COMP TYP,VOL 269 < 382 LITERS	
8418210090	REFRIG,HOUSEHOLD, COMP TYP, VOL 382 LITERS & OVER	
8418220000	REFRIGERATORS, HOUSEHOLD, ABSORPTION, ELECTRICAL	
8418290000	REFRIGERATORS, HOUSEHOLD TYPE, NESOI	
8422110000	DISHWASHING MACHINES, HOUSEHOLD TYPE	
8422900540	PARTS OF HOUSEHOLD TYPE DISHWASHING MACHINES	
8450110090	WASH MACH,EXC COIN OPERATE, AUTO,CAP NOT EXC 10 KG	
8450120000	WASH MAC WITH BLT-IN CENT DRY,CAP NOT EXC 10 KG	
8450190000	WASH MACH, CAPACITY NOT EXC 10 KG, HOUSEHOLD,NESOI	
8450200090	WASH MACH,CAP EXC 10KG, HOUSEHOLD,LANDRY-TYP,NESOI	
8450900000	PTS OF HOUSEHOLD OR LNDRY-TYP WASH MAC INC WSH/DRY	
8509100020	ELECTRIC DOMESTIC VACUUM CLEANERS, PORTABLE, HAND	X
8509100040	ELECTRIC VACUUM CLEANERS, NESOI	X
8509200000	ELECTRIC DOMESTIC FLOOR POLISHERS	X
8509300000	ELECTRIC DOMESTIC KITCHEN WASTE DISPOSALS	X
8509400020	ELECTRIC DOMESTIC FOOD MIXERS	X
8509400030	ELECTRIC DOMESTIC JUICE EXTRACTORS	X
8509400040	ELECTRIC DOMESTIC FOOD GRINDERS AND PROCESSORS	X
8509800040	ELECTRIC DOMESTIC CAN OPENERS INCL COMBINATION UNI	X
8509800060	ELECTROMECHANICAL DOMESTIC APPLIANCES,HUMIDFIERS	X
8509800091	ELECTROMECHANICAL DOMESTIC APPLIANCES, NESOI	X
8509902000	ELECTRIC DOMESTIC VACUUM CLEANER PARTS	
8509903000	ELECTRIC DOMESTIC FLOOR POLISHER PARTS	
8509904050	ELECTRIC DOMESTIC APPLIANCE PARTS, NESOI	
8510100000	ELECTRIC SHAVERS	X
8510200000	ELECTRIC HAIR CLIPPERS	X
8510300000	HAIR REMOVING APPLIANCES	X
8516210000	ELECTRIC STORAGE HEATING RADIATORS	
8516290000	ELECTRIC SPACE HEATING APPARATUS,NESOI	
8516310000	ELECTRIC HAIR DRYERS	X
8516400000	ELECTRIC FLATIRONS	X
8516500000	MICROWAVE OVENS	X
8516604000	ELECTRIC COOKING STOVES, RANGES AND OVENS	X
8516606000	COOKING PLATES, BOILING RINGS, GRILLERS,& ROASTERS	X
8516710000	ELECTRIC COFFEE OR TEA MAKERS	X
8516720000	ELECTRIC TOASTERS	X
8539224000	CHRISTMAS-TREE LAMPS > 100 V BUT NOT > 200 W	

Note: X indicates goods that are classified as a small electric appliance.

Table 3-Prices of Electric Goods and Per Capita Electricity Consumption

Regressors / Dependent Variable:	Log(price) (1)	Log(price) (2)	Log(price) (3)	Log(price) (4)	Log(value) (5)	Log(quantity) (6)	Log(price) (7)
log(GDP per capita)	0.031						
	(0.032)						
log(MwH per capita)		0.051**					
		(0.023)					
log(MWh per capita) X Electric good			0.003	0.120***	0.168	0.076	0.139***
			(0.031)	(0.018)	(0.136)	(0.142)	(0.041)
log(GDP per capita) X Electric good				-0.159***	-0.059	0.070	-0.142**
				(0.036)	(0.081)	(0.051)	(0.057)
log(quantity)							-0.256***
							(0.017)
Country FEs	NO	NO	YES	YES	YES	YES	YES
Product FEs	YES	YES	YES	YES	YES	YES	YES
R-squared	0.77	0.77	0.78	0.78	0.50	0.54	0.82
# observations	27171	27171	27171	27171	27171	27171	27171
# products	1,327	1,327	1,327	1,327	1,327	1,327	1,327

Notes: Data source: World Bank Development Indicators and U.S. Exports by HS-10 classification. Robust standard errors clustered at the country and end-use levels in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 4-The Dependence of Prices of Subsets of Consumer Goods on Electricity and Income Per Capita

Dependent Variable: Log(price)						
	Isolating low-quality-variation goods:	Isolating low-quality-variation goods:	Placebo Test:	Placebo Test:	Placebo Test:	Placebo Test:
	Prices of low-unit-cost, routine appliances exhibit a strong dependence on catalysts	Prices of short-quality-ladder electronic goods exhibit a strong dependence on catalysts	Prices of battery-powered electronics exhibit below-average dependence on electricity	Prices of luxury sport equipment exhibit below-average dependence on electricity	Prices of luxury goods exhibit average dependence on electricity	Price of jewelry exhibits below-average dependence on electricity
Regressors	(1)	(2)	(3)	(4)	(5)	(6)
log(MWh per capita) X Routine electric appliance	0.236***					
	(0.026)					
log(GDP per capita) X Routine electric appliance	-0.220***					
	(0.037)					
log(MWh per capita) X Short ladder routine electric appliance		0.445***				
		(0.127)				
log(MWh per capita) X Long ladder routine electric appliance		0.180***				
		(0.022)				
log(GDP per capita) X Short ladder routine electric appliance		-0.460***				
		(0.102)				
log(GDP per capita) X Long ladder routine electric appliance		-0.211***				
		(0.035)				
log(MWh per capita) X battery-powered appliance			-0.146***			
			(0.024)			
log(GDP per capita) X battery-powered appliance			0.000			
			(0.041)			
log(MWh per capita) X luxuy sporting equipment				-0.174**		
				(0.072)		
log(GDP per capita) X luxury sporting equipment				0.135***		
				(0.023)		
log(MWh per capita) X luxury good					0.017	
					(0.028)	
log(GDP per capita) X luxury good					0.001	
					(0.021)	
log(MWh per capita) X jewelry						-0.082*
						(0.047)
log(GDP per capita) X jewelry						0.124**
						(0.045)
Country FEs	YES	YES	YES	YES	YES	YES
Product FEs	YES	YES	YES	YES	YES	YES
R-squared	0.78	0.78	0.78	0.78	0.78	0.78
# observations	1327	1327	1327	1327	1327	1327

Notes: Data source: World Bank Development Indicators and U.S. Exports by HS-10 classification. Luxury goods consist of products with import elasticities with respect to income in the highest quartile. Jewelry consists of all good with end use code 413 (coins, gems, jewelry, and collectibles). Robust standard errors clustered at the country and end-use levels in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 5-Dependence of Prices of Appliances with Varying Energy Intensity on Electricity Prices

Dependent Variable: Log(price)		
Regressors	(1)	(2)
log(Electricity Price) X SMALL Refrigerator	-0.107**	-0.225***
	(0.043)	(0.063)
log(Electricity price) X LARGE Refrigerator	-0.385***	-0.422***
	(0.018)	(0.025)
log(Electricity Price) X SMALL Window AC Unit	-0.015	-0.132***
	(0.033)	(0.043)
log(Electricity Price) X LARGE Window AC Unit	-0.322***	-0.411***
	(0.058)	(0.035)
Country FEs	YES	YES
Product FEs	YES	YES
Controls for interactions with log(GDP per capita)	NO	YES
R-squared	0.82	0.82
# observations	22,261	22,261

Notes: Small refrigerators are less than 184 Liters in size. Large Refrigerators are greater than 382 Liters. Small AC units use less than 2.93 KW/hour of energy. Large units use greater than 4.98 KW/hour. Electricity price data is from the Energy Information Administration. The sample is limited to countries with data on electricity prices faced by households. Robust standard errors clustered at the country and end-use levels are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 6-Prices of Automobiles and Road Quality

Dependent Variable:	Log(price)	Log(price)	Log(price)	Log(price)	Log(price)
Regressors	(1)	(2)	(3)	(4)	(5)
Paved Roads X Automobile	0.005***	0.005***	0.005**		
	(0.000)	(0.000)	(0.002)		
log(GDP per capita) X Automobile		-0.036***			
		(0.003)			
log(MwH per capita) X Automobile			0.017		
			(0.036)		
Paved Roads X New car				0.004***	
				(0.001)	
log(GDP per capita) X New car				-0.048***	
				(0.000)	
Paved Roads X used car					0.006***
					(0.000)
log(GDP per capita) X used car					-0.028*
					(0.017)
Country FEs	YES	YES	YES	YES	YES
Product FEs	YES	YES	YES	YES	YES
R-squared	0.78	0.78	0.78	0.78	0.78
# observations	26,799	26,799	26,799	26,799	26,799
# products	1,327	1,327	1,327	1,327	1,327

Notes: Data source: World Bank Development Indicators and U.S. Exports by HS-10 classification. Robust standard errors clustered at the country and end-use levels in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 7-Dependence of Prices of Skis on Snowfall and Ski Resorts

Dependent Variable: Log(price)					
			IV specification		
Regressors	(1)	(2)	(3)	(4)	(5)
log(snowfall) X ski	0.099***	0.100***		0.098***	
	(0.004)	(0.002)		(0.007)	
log(GDP per capita) X ski		-0.283***	-0.729***	-0.125***	
		(0.000)	(0.021)	(0.013)	
log(ski resorts per capita) X ski			0.243***		
			(0.008)		
log(snowfall) X luxury sporting equipment					-0.014***
					(0.004)
log(quantity)				-0.234***	
				(0.016)	
Country Fes	YES	YES	YES	YES	YES
Product FEs	YES	YES	YES	YES	YES
R-squared	0.81	0.81	0.81	0.84	0.81
# observations	21362	21362	21362	21362	21362

Notes: In column 3, log(snowfall) X ski is an instrument for log(ski resorts per capita) X ski. Estimates are based on countries with data on ski resorts. All OLS specifications report robust standard errors clustered at the country and end use code in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 8: Hotel Room Winter to Summer Price Change, by Hotel Type

Hotel Type	Price Change 25th Percentile	Price Change 75th Percentile	Number of Hotels
Low Amenity Not Oceanfront	60	70	11
Low Amenity Oceanfront	120	151	10
High Amenity Not Oceanfront	90	140	5
High Amenity Oceanfront	143	160	21
All Hotels	90	151	47

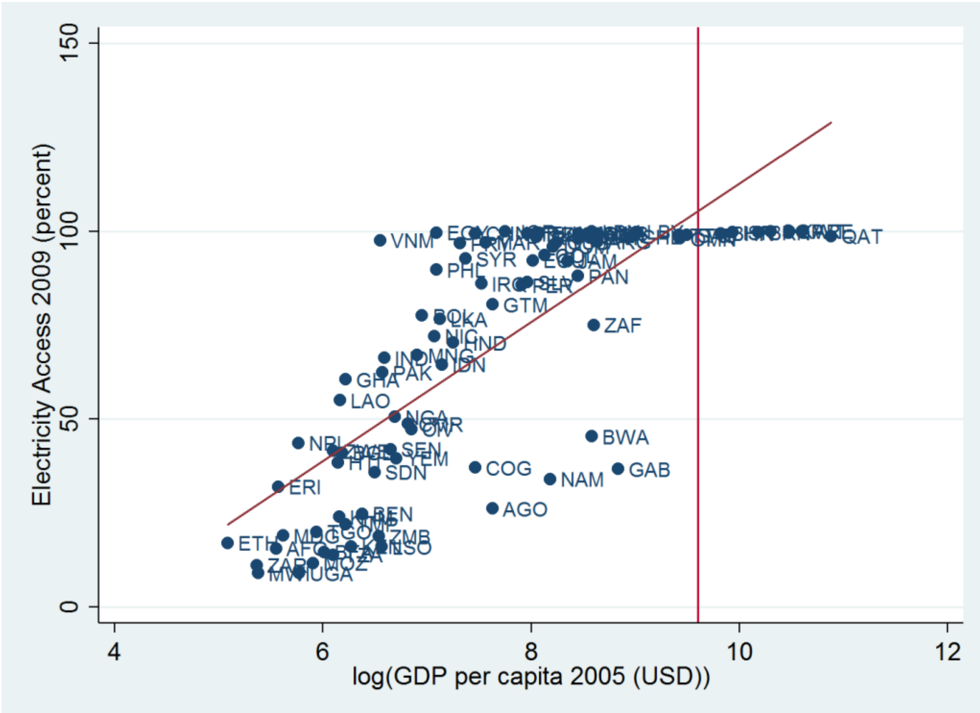
Note: High amenity hotels are rated three stars and above.

Table 9- Dependence of Hotel Prices on Season and Hotel Quality

Dependent Variable: Price			
Regressors	(1)	(2)	(3)
Summer	127.4***	127.4***	77.1***
	(6.7)	(6.8)	(7.5)
High Amenity		48.0***	32.5***
		(9.2)	(6.5)
Oceanfront		51.2***	26.1***
		(9.9)	(7.2)
Summer X High Amenity			31.0***
			(10.8)
Summer X Oceanfront			50.2***
			(12.0)
Constant	83.4***	23.1***	48.2***
	(4.7)	(7.4)	(7.1)
R-squared	0.59	0.81	0.85
# observations	94	94	94

Notes: Robust standard errors clustered at the hotel level in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Figure 1: Electricity Access and GDP Per Capita across Countries.



Note: The vertical line is drawn at GDP per capita equal to $15,000.

Figure 2: Electricity Consumption and GDP Per Capita, Low-Income Countries.

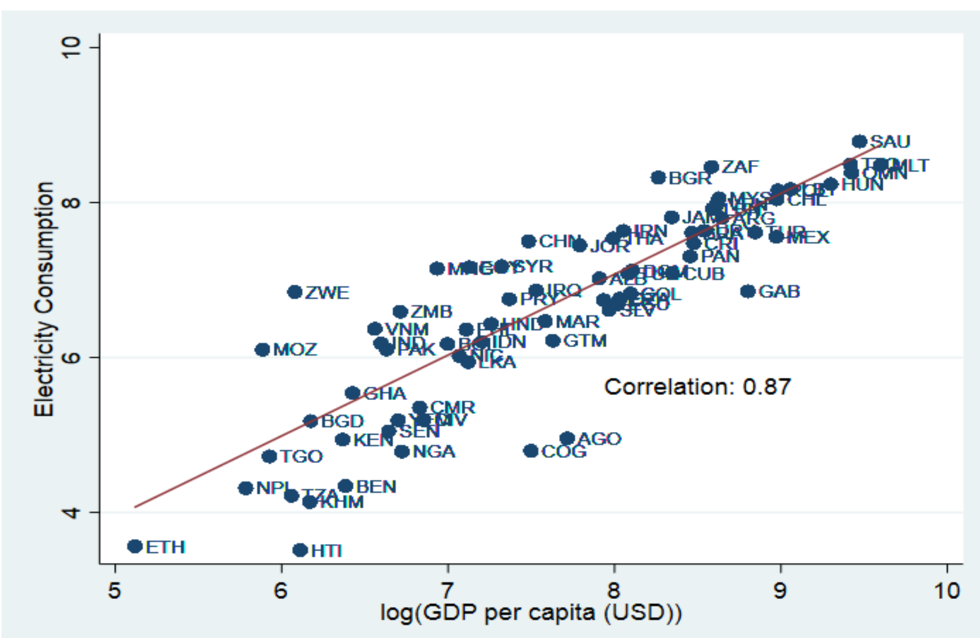


Figure 3: Kernel Density Estimates of Price Distribution in Winter and Summer.