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2016

ENERGY POLICY AND
DEVELOPMENT PROGRAM (EPDP)

UPecon Foundation

Working Paper 2017-01R

December 2017

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 This study is made possible by the generous support of the American People through the United States Agency for International Development (USAID) under the Energy Policy and Development Program (EPDP). EPDP is a four-year program implemented by the UPecon Foundation, Inc.

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ABSTRACT

The Philippines provides a leading example of Rodrik's Rule that developing countries experience deindustrialization at lower levels of per-capita income than did developed countries. Previous studies point to the role of protectionist policies, financial crises, and exchange rate overvaluation as explanations for the shrinking share of industry sector. We complement this literature by looking at how power prices influence the growth and composition of manufacturing in the Philippines, in comparison to OECD countries and Indonesia, Thailand, Malaysia, and Singapore. We find that higher power prices are associated with industry's share turning downward at substantially lower levels of per capita income and that the decline is somewhat steeper. We find similar evidence for the movement of industry's share in different regions of the Philippines. The composition of Philippine manufacturing, which stagnated in labor-intensive subsectors, provides supporting evidence that high power rates is likely to be a causal factor behind the structural transformation of the economy.

Keywords: power prices; structural transformation; industrialization

JEL Classification: O14, Q40

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1. INTRODUCTION

One of the arguments for making power more affordable is that expensive power may lead to premature deindustrialization. Premature deindustrialization occurs when the share of industry to total employment or total value added peaks at much lower levels of per capita income than had been historically observed in developed countries (Dasgupta and Singh 2006; Rodrik 2016). Premature deindustrialization is generally viewed as a bane for developing countries. A number of developing countries that went through premature deindustrialization have experienced adverse consequences (Rodrik 2016). For example, Latin American countries have suffered from lower economy-wide productivity and growing informal sectors as manufacturing has declined. In Africa, increased rural-to-urban migration has led to the growth of low skill-intensive and non-tradeable service sectors.

On the one hand, the high cost of power may act as a deterrent for power-intensive industries to invest in the Philippines. On the other hand, for those manufacturing industries that did invest in the Philippines, the high-power prices may be compensated by other cheaper inputs such as labor. However, once established, the manufacturing industries will have to contend with another factor: the reliability of power. Some manufacturing industries, e.g. electronics assembly lines, can be power-sensitive. A few seconds of fluctuating electric current may waste a whole batch, substantially increasing costs.

While it is not difficult to think of why power prices could be part of a cluster of factors disadvantageous to manufacturing, e.g. energy price can deter foreign direct investment (FDI) inflows to the sector (Bilgili et al. 2012), empirical analysis of the relationship between power prices and manufacturing is wanting, however, as is understanding of the mechanisms by which power prices influence structural development in the Philippines.

The Philippine experience has long puzzled development scholars. In the early 19th century, the Philippines was the third Asian country (and first in Southeast Asia) to enter the so-called "5% industrial growth club"—those countries that had experienced at least 5% industrial growth (De Dios and Williamson 2015; Appendix Table A.1). This continued until the early 1960s when the Philippines had the most developed manufacturing sector in Southeast Asia, albeit via import protection (Bautista and Power 1979; Power and Sicat 1971). However, industrialization stagnated from the late 1960s through the 1990s, thereby missing the East Asian Miracle that occurred in the 1970s through the 1990s (e.g., Vos and Yap 1996) that helped lead the dramatic ascent of newly-industrialized economies across Asia. With the relative decline of manufacturing came the rise of services. Workers from rural and agricultural areas, in search of better living standards, often found themselves in low-skill, service-oriented jobs (where productivity and wages are low) or as contract workers overseas.

Daway and Fabella (2015), and de Dios and Williamson (2015) attribute the country's premature deindustrialization to decades of protectionism, political instability, insufficient export promotion, financial crises, and real exchange rate overvaluation. Recent anecdotal accounts, however, stress how higher power prices may have also stunted industrial and manufacturing growth. For instance, Rimando and Mercado (2013) and Deloitte (2014) assert that high power costs hampered the Philippines' ability to compete in the manufacturing sector.[1] For those

[1] Philippine small and medium enterprises (SMEs), in particular, are said to be hit hardest by high power costs (Remo 2014).

manufacturing industries that have been operating in the Philippines, the high cost of power is often cited as among the constraints to expansion.[2]

We seek to illuminate the effects of energy policy, specifically by showing how high energy prices can augment premature deindustrialization. Specifically, we illustrate the role that power prices play in the growth and composition of manufacturing in the Philippines, as well as in other select Southeast Asian countries. We adapted Rodrik's (2016) analysis to capture the dynamics between the share of industry by total output and power prices. We are able to simulate how industry's share changes with power prices.

We find that higher power prices are associated with a downward shift in the share of industry gross value added (GVA) and lower per capita incomes at which industry shares peak. Using Philippine data at the regional level, we also find a similar result for the share of industry in total employment, with higher power prices being associated with the share of industry labor peaking at substantially lower levels of per capita income and declining at a much faster rate.

2. STRUCTURAL TRANSFORMATION AND POWER PRICES

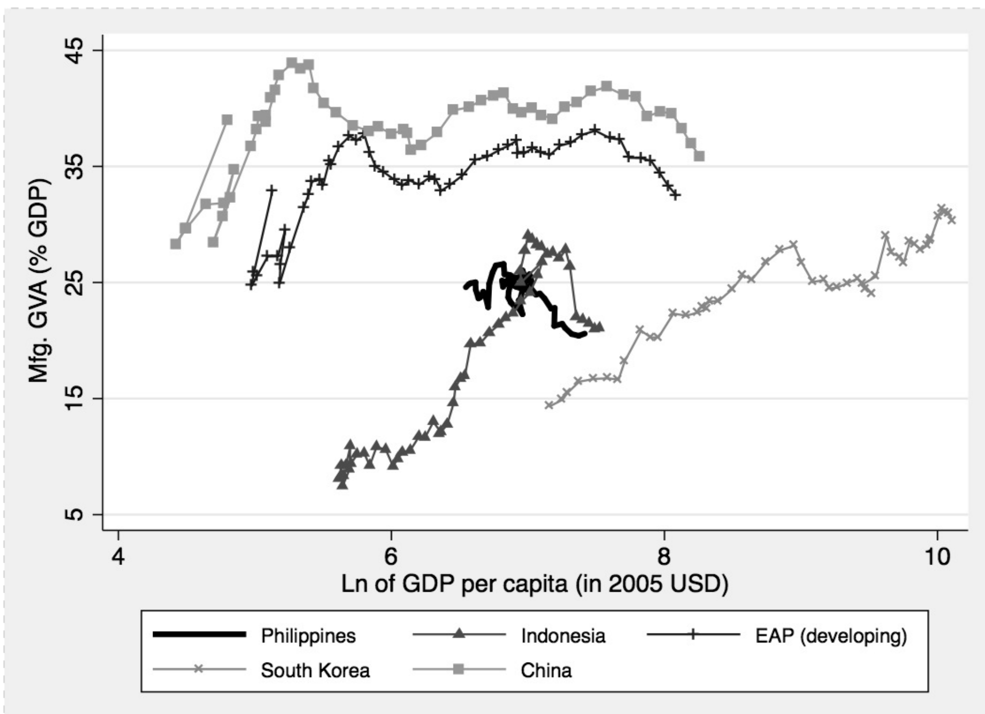
Using data from Groningen Growth and Development Center (Timmer et al. 2014) covering 42 countries, Rodrik (2016) observed that the vast majority of developing countries today are experiencing deindustrialization at lower levels of per-capita income. His analysis indicates that manufacturing employment shares in late peaking countries (after 1990) were about one-third that of earlier peaking countries.

[2] For example, B/E Aerospace has stated that the high cost of power (including both rates and reliability) ranks third in their constraints to expanding business in the Philippines (personal communication with Brian Breuhas of U.S. Embassy in the Philippines).

In order to further investigate premature deindustrialization and to compare the Philippines with its neighbors, we used data from the World Development Indicators (WDI) for developing East Asia and the Pacific, China, Indonesia, South Korea, as well as the Philippines.

Figure 1 shows the relationship between the shares of manufacturing GVA and gross domestic product (GDP) per capita. Manufacturing share in the Philippines reached its peak at a low level relative to the average of East Asian and Pacific (EAP) countries and also relative to its neighbors, China, Indonesia, and South Korea[3] which participated in the East Asian manufacturing renaissance in the latter half of 1980s and early 1990s.

Figure 1. Manufacturing GVA vs. GDP per capita



Manufacturing share in the Philippines fell fast and from a relatively low level.
Authors' calculations. *Sources of basic data:* World Development Indicators, 1960-2015.

[3] The manufacturing share in South Korea appears to be still increasing, although its employment share peaked in 1989 (Cowen 2016), due to a dramatic decrease in labor intensity.

The WDI data shows that the highest share of industry to total output (Gross Domestic Product or GDP) occurred in 2000 for Indonesia at 45.4%, for Malaysia at 48.3%, and for Thailand in 2010 at 44.7%; in the Philippines, it occurred in the early 1980s at only 38.8% (see Appendix Table A.1). The Philippine growth path vis-à-vis its Southeast and East Asian neighbors is characterized by an early substitution away from manufacturing toward services at significantly lower levels of per-capita income. With the Plaza Accord in 1985, Japanese firms sought to restore their competitive advantage by developing a deeply integrated supply chain of component and assembly plants. This impetus (and the competitive response of European and American firms) led countries in East and Southeast Asia to develop particular niches within their own manufacturing sectors according to their own comparative advantages. Thailand was the recipient of major Japanese investments and became a prime location for automotive manufacturing. South Korea and Taiwan became hubs of electronic and semiconductor production. Malaysia was able to boost its IT industry, while Viet Nam gained foreign attention as a promising new economy for low-cost, labor-intensive manufacturing. The Philippines, in contrast, seems to have failed to partake in this industrial renaissance, not only losing ground in manufacturing for much of the latter part of the 20th century but doing so at a comparatively rapid rate.[4]

Have power prices played a significant role in hampering Philippine manufacturing? Since the 1990s, power rates in the Philippines have been consistently high relative to neighboring countries such as Indonesia and Thailand, and this trend persisted to 2000s (Figure 2)

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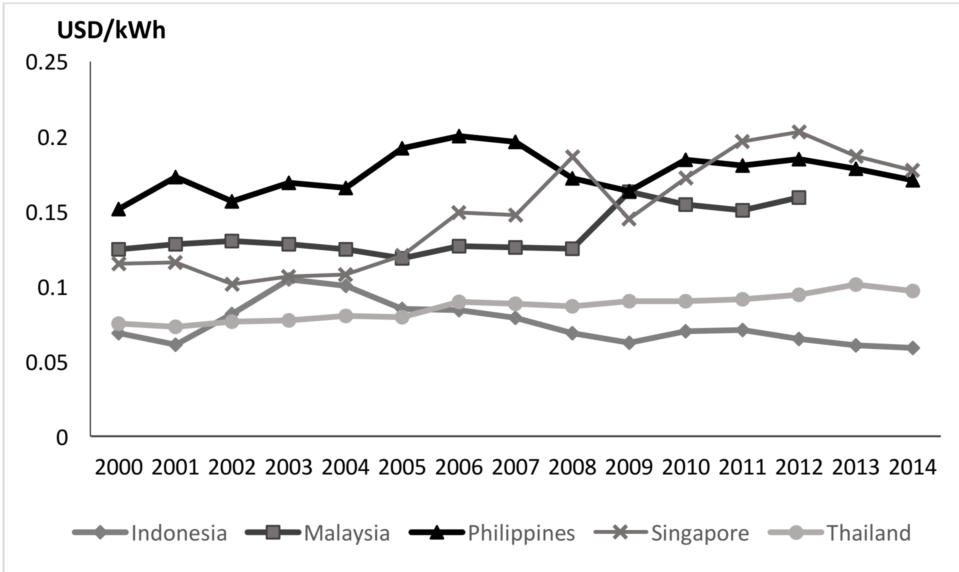
[4] Recently, however, the manufacturing sector has shown signs of resurgence (Deloitte 2014). From 2009-2013, the sector grew at 7.9% in value added terms, owing to greater competitiveness and an improved business climate in the country.

Figure 2. Industrial power prices in select Southeast Asian countries (constant 2010 USD/kWh)



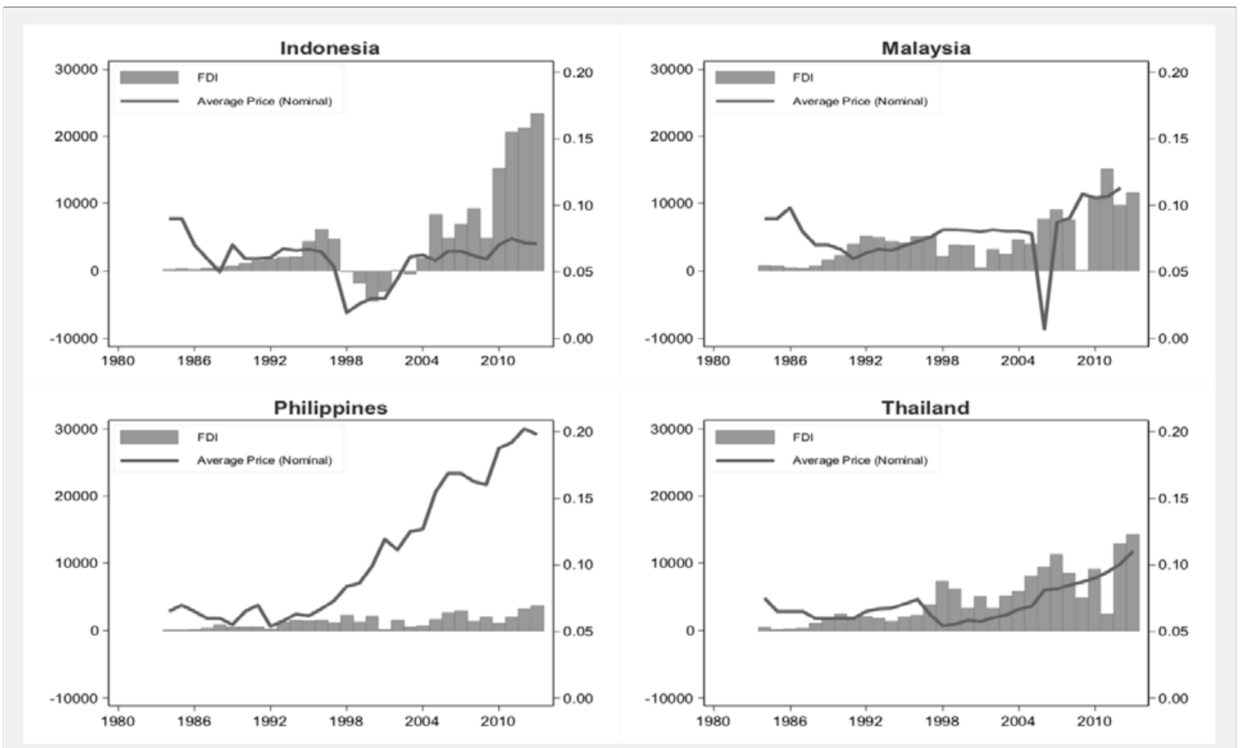
Power rates in the Philippines have been consistently high relative to neighboring countries including Indonesia, Malaysia, and Thailand.
Sources of basic data: Aldaba (2003), Enerdata (various years), Meralco (various years), MEIH Statistics (various years), Singapore National Library Board (various years), Singapore Statistics (various years).
Note: Data come from different sources and may not be entirely comparable.

The high-power rates regime occurred during the period when FDI inflows to East Asia were at record high levels during the 1980s and early 1990s. Indonesia, on the other hand, remained competitive with its lower power rates, followed by Thailand. From 1991-2000, the power industry in the four Southeast Asian countries were all vertically integrated and highly subsidized. With the Philippines' passage of the Electric Power Industry Reform Act (EPIRA) of 2001, the power industry went through a major restructuring. Generation was privatized and more competitive retailing was mandated.[5] Transmission and distribution were left as regulated monopolies. Despite these changes, industrial power prices remain high, however.

[5] As of 2016, implementation of EPIRA has experienced delays and the competitive retail sector has not fully materialized.

Figure 3 compares the trend in power prices vis-à-vis FDI net inflows in the Philippines, Indonesia, Malaysia, and Thailand. All four countries suggest a negative relationship between power rates and FDI inflows.[6] In Indonesia, where average national power prices remained fairly flat at low levels from the late 1980s up to 1997, and from 2004 up to 2010, FDI net inflows have been increasing. In contrast, power prices in the Philippines have risen continuously and the amount of net FDI inflows has remained low.

Figure 3. Power prices and FDI net inflows, select Southeast Asian Countries, 1980-2013



All four countries presented above suggest a negative relationship between power rates and FDI inflows. When FDIs for Indonesia, Malaysia, and Thailand are high, power rates are low. The Philippines shows the opposite trend.
Sources of basic data: Aldaba (2003), Enerdata (various years), Meralco (various years), MEIH Statistics (various years), Singapore National Library Board (various years), Singapore Statistics (various years), WDI-WB (various years)
Notes: FDI net inflows, in current BOP USD Million is shown as bar chart scaled in left axis. Average electricity retail price (across generation, transmission, and distribution) in USD/kWh is shown as trend line scaled in right axis.

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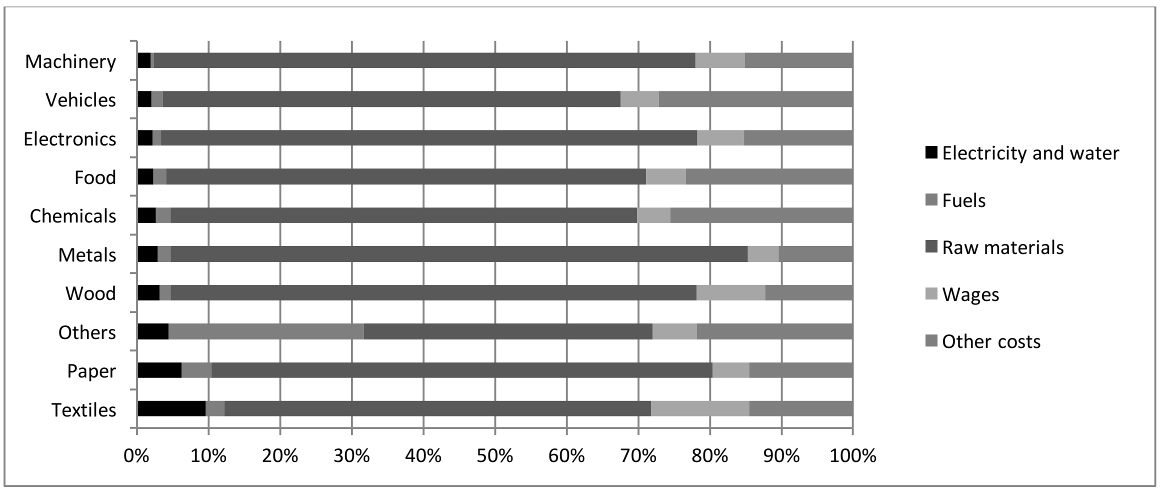
[6] Figure A.1 provides a statistically significant elasticity of FDI with respect to power rates.

We further explore the importance of power prices in the development of the Philippines by examining the cost structure of the manufacturing sector within the country.

Figure 4 shows data from the Annual Survey of Philippine Business and Industry (ASPBI) in 2010 of the Philippine Statistics Authority (PSA). Power and water account for 2-10% of total costs across manufacturing firms. Textiles and paper industries are the most power- (and water-) intensive while machinery, vehicles, and electronics are the least intensive.

Figure 4. Cost structure of manufacturing sector, 2010 (share to total costs)



Electricity and water account for 2-10% of total costs across manufacturing firms.
Source of basic data: PSA (Annual Survey of Philippine Business and Industry (ASPBI))
Notes: Sorted according to share of power and water costs. Includes only firms with 20 or more employees for comparability. Figures computed as shares to total costs (labor and non-labor). Note that for data in 2005 and onward, the ASPBI lumps electricity and water costs.

How does the cost structure of these sub-sectors relate to manufacturing output? The idea is to examine the subsectors that drive the growth of the manufacturing sector and their relative power intensity. In order to do this, we calculate the average power intensity (i.e., energy cost/total output and electricity cost/total output) of each subsector in 1998-1999, and rank them accordingly (Table 1).[7]

Table 1. Energy and power intensity by industry (Philippines and Indonesia), 1998-1999.

ISIC Code	Industry	Philippines		Indonesia	
		Energy cost/ output	Electricity cost/output	Energy cost/ output	Electricity cost/output
31	Manufacture of Food, Beverages, and Tobacco	0.067	0.048	0.063	0.023
32	Textile, Wearing Apparel, and Leather Industries	0.049	0.035	0.030	0.019
33	Wood and Wood Products, Including Furniture	0.039	0.022	0.031	0.013
34	Paper and Paper Products, Printing and Publishing	0.046	0.034	0.044	0.026
35	Chemicals and Chemical, Petroleum, Coal, Rubber and Plastic Products	0.055	0.043	0.076	0.043
36	Non-Metallic Mineral Products, except Products of Petroleum and Coal	0.061	0.032	0.203	0.012
37	Basic Metal Industries	0.052	0.038	0.069	0.041
38	Fabricated Metal Products, Machinery and Equipment	0.045	0.032	0.059	0.032
39	Other Manufacturing Industries	0.035	0.028	0.030	0.015

The energy and electricity intensity of manufacturing industries in the Philippines are consistently higher than in Indonesia.
Sources of basic data: Philippine Statistics Authority (PSA) (Annual Survey of Philippine Business and Industry (ASPBI)) and Badan Pusat Statistik – Statistics Indonesia (Industri Manufaktur - Census of Manufacturing)
Notes: ISIC is International Standard Industrial Classification. The figures reflect the industry average for the periods 1998-1999. Power cost and output is expressed in local currency.

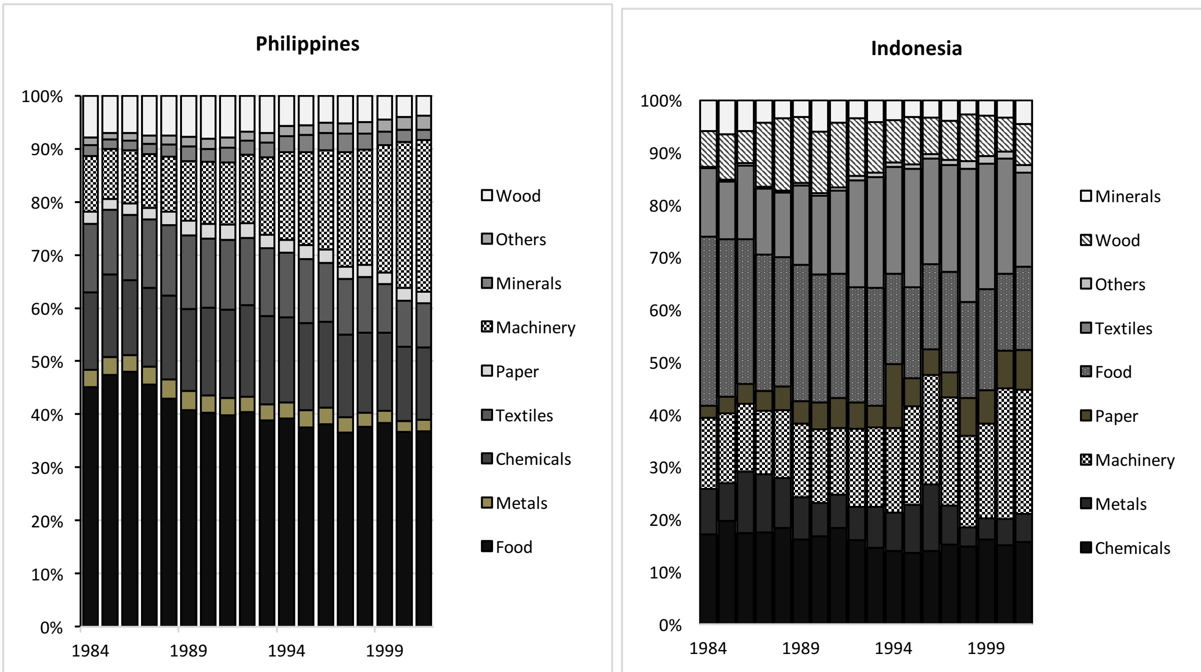
[7] Years of coverage are dictated by the availability of micro-level data containing input costs and output for the firms in the Philippines and Indonesia.

Electricity costs (for Indonesia) consisted of purchases from utilities, both from Perusahaan Listrik Negara (PLN), the State Electricity Company, and non-PLN, while energy costs are purchases of fuels and lubricants (for end use and generation of own electricity) and electricity. Note that for a comparable duration (from 1980s to early 2000s), the energy and electricity intensity of manufacturing industries in the Philippines are consistently higher than in Indonesia.

In order to provide empirical evidence on the possible role of power prices in influencing industrial growth, we compare the growth rates and composition according to power intensity of manufacturing in the Philippines with that in Indonesia. We find that manufacturing GVA grew at an average rate of 2.76%, compared with 14.56% for Indonesia during the same period from 1984 - 2001.

Figure 5 shows the share of various manufacturing subsectors in the Philippines and Indonesia. The composition of Philippine manufacturing changed in favor of machinery and other labor-intensive subsectors while shares of food, chemicals and other power-intensive sectors declined. The fastest growing subsector in the Philippines was machinery, whose growth in turn came from (labor-intensive) assembly operations in the production of semiconductors and electronics. In contrast, textiles, metals, and chemicals, which are more power-intensive, grew at 0.40%, 0.69%, and 2.37%, respectively. Moreover, manufacturing growth in the Philippines was largely composed of the growth of less power-intensive subsectors.

Figure 5. Share of manufacturing sub-sector to total, 1984-2001



The composition of Philippine manufacturing changed in favor of labor-intensive subsectors between 1984 and 2001. In contrast, shares of Indonesia's more power intensive sectors were continuously growing. *Sources of basic data:* Philippine Statistics Authority (PSA) (Annual Survey of Philippine Business and Industry (ASPBI)) and Badan Pusat Statistik – Statistics Indonesia (Industri Manufaktur - Census of Manufacturing)

Notes: Authors' calculations. Food – Manufacture of Food, Beverage, and Tobacco; Textile - Textile, Wearing Apparel, and Leather Industries; Wood - Manufacture of Wood and Wood Products, Including Furniture; Paper - Manufacture of Paper and Paper Products, Printing and Publishing; Chemicals - Manufacture of Chemicals and Chemical, Petroleum, Coal, Rubber, and Plastic Products; Minerals - Manufacture of Non-Metallic Mineral Products, except Products of Petroleum and Coal; Metals - Basic Metal Industries; Machinery - Manufacture of Fabricated Metal Products, Machinery and Equipment; Others – Other Manufacturing Industries.

Subsectors are ranked such that the topmost subsector has the highest share of power costs to output (source of data: 2010 ASPBI and 1983-2001 Industri Manufaktur).

In contrast, growth in Indonesian manufacturing has been driven by power-intensive manufacturing subsectors during the study period, including metals and machinery, which grew at 15.32% and 19.43%, respectively. Compared to its ASEAN neighbors, Indonesia's power prices were both lower and flatter during the period. Moreover, the shares of Indonesia's more power intensive sectors were continuously growing during the same period.

There are a number of mechanisms through which power prices can influence growth in the manufacturing sector and hence, the structural development of an economy. One mechanism operates through firms' investment, since higher power prices increase the marginal costs of production according to the cost share of electric power. The quantity demands of energy intensive goods will also decline. Using US-BEA's National Income and Product Account, Edelstein and Kilian (2007) analyzed how energy price shocks influence non-residential fixed investment and concluded that while the estimated negative response of business fixed investment to energy price shocks tends to be small, it satisfies conventional statistical significance.

Abeberese (2012) looked at the impact of power prices on manufacturing productivity and found that firms switch to less power-intensive production in response to higher power prices. If less power-intensive industries are correlated with technologically-backward products, then this could indicate the impact of power prices on product sophistication and consequently, on productivity among firms. Power rates can also influence national output. Alvarez and Valencia (2015) showed that a 13% reduction in power prices can increase Mexico's manufacturing output by 1.4% to 3.6%. The reduction in power prices is due to policy of substitution of fuel oil for natural gas.

Another channel is through the negative effect of high power prices on FDIs. The literature is replete with studies illustrating how FDIs can increase productivity and growth of the manufacturing sector (e.g., Arnold and Javorcik 2009). Nonetheless, very few have looked at the impact of energy prices on FDI inflows. Bilgili et al. (2012), is one of the rare examples, who found that high-energy prices deterred FDI entry into Turkey, particularly at times when FDI inflow was high.

3. METHODOLOGY

We build on Rodrik (2016)'s econometric model and show the potential influence of power prices on the share of manufacturing in the economy across countries and downscale the model to the Philippine regions.

3.1 Empirical model

The empirical strategy in determining how an economy's manufacturing growth path is associated with power rates makes use of the cross-sectional and temporal variations in power prices between select countries in Asia and within the regions of the Philippines. To examine the relationship among power price, the share of manufacturing output, and per capita output, we estimate the following reduced-form model adapted from Rodrik (2016):

$$S_{ct} = \alpha_c + \beta_0 P_{c,t-1} + \beta_1\left(GDP_{c,t-1}\right) + \beta_2\left(GDP_{c,t-1}\right)^2 + \beta_3\left(GDP_{c,t-1}\right)P_{c,t-1} + \beta_4\left(GDP_{c,t-1}\right)^2 P_{c,t-1} + \delta X + \varepsilon_{ct} \qquad (1)$$

where S_{ct} denotes the share of industry in total output of country *c* in year *t*, $P_{c,t-1}$ is a one-period lagged unit price of power (measured in USC/kWh), and $\left(GDP_{c,t-1}\right)$ is the one-period lagged country-specific GDP per capita. $\left(GDP_{c,t-1}\right)$ and its quadratic form are interacted with power price to account for the possibility that the relationship between industry share and GDP per capita is partially determined by power prices.

The variable α_c is a country fixed effect to account for unobserved time-invariant heterogeneity across countries (e.g., initial resource endowments), and ε_{ct} is the usual error term. X' is a $k\times1$ vector of period dummies (i.e. 1980s, 1990s and 2000s) and log population estimates. The population variable is both in levels and quadratic form following Rodrik (2016). All variables, excluding indicator variables, are all expressed in logarithms.

We also implement the above model with services and agriculture on the left-hand side to examine the relationship between power prices and the overall structural nature of development. We downscale the model to regions of the Philippines, as well as use alternative outcome variables to validate the robustness of our results.

A major issue in said estimation is the potential endogeneity of power prices. For example, the estimated effect of power price on manufacturing share will be biased if something unrelated but concurrent to spikes or drops in power prices also affects a country's industrial trajectory. For this reason, we used one-period lagged values for price and GDP per capita, which can be also a realistic assumption considering the sluggish behavior of macroeconomic variables to energy price shocks.

3.2 Data

We used data from the WDI and International Energy Agency (IEA) Energy Price and Statistics for 1980-2014 to include the dramatic industrial growth period in Asia between 1984 and 1996. Our cross-country analysis of the relationship between manufacturing and power prices relies on manufacturing GVA (as a percent of GDP) data from the WDI. Power price data come from two main sources. Data from Organization for Economic Co-operation and Development (OECD) countries (USD/kWh in PPP terms), available from 1980 to 2014, come from the IEA-OECD Library. Data from Southeast Asian countries--Philippines, Malaysia, Thailand, Indonesia, and Singapore--come from power distribution utility companies: Meralco, Malaysia Energy Information Hub (MEIH) Statistics, Singapore Statistics, Singapore Public Utilities Board (PUB). These are supplemented by data from Enerdata and individual country statistics offices. We also rely on Aldaba (2003) for older power prices from 1980 to 1991 in select Southeast Asian countries. Appendix Table A.2 presents summary statistics for the cross-country data.

For the Philippine regional analysis, we use regional manufacturing GVA and GDP data from the regional income accounts publications of Philippine Statistics Authority or PSA (See Appendix Table A.3). We focus on the years 1990 to 2014--the longest period for which there is comparable regional groupings (16 regions in total) -- and a common base year (1985). Average annual power prices (PhP/kWh measured in 2008 prices) for each region are derived from the Department of Energy's (DOE) historical prices on distribution utilities or DUs (derived from revenues divided by sales). For each year, prices of DU outputs are averaged using each DU's relative share of regional sales from 1998 to 2012. For Meralco, the biggest DU which operates in Metro Manila and surrounding provinces, the relative shares of average regional consumption (2002-2013) compared to total consumption are the weights used for each of three regions it covers. As a check on the accuracy of this DOE-generated data, we compute the simple correlation coefficient with official power price indices of PSA. The two series are highly correlated (0.98 for the Philippines; 0.95 for Luzon; 0.92 for the Visayas; 0.95 for Mindanao; and 0.91 for NCR).

4. RESULTS AND DISCUSSION

4.1 Cross-country analysis

Results from estimating equation (1) using data from OECD and selected Southeast Asian countries (i.e. Philippines, Indonesia, Malaysia, Thailand, and Singapore) are presented in Table 2. Columns (1) and (2) show the results for manufacturing's share of total GDP in nominal and real terms, respectively. Columns (3) to (5) are for industry's share, in nominal and real terms, in total GDP and total employment, respectively. In all regression results, we find that manufacturing and industrial shares follow an inverted U-shape path, consistent with Rodrik's findings.

Table 2. Regression results: (dependent variable: Share of sector to total)

Variables	Manufacturing share		Industrial Share		
	(1) % GDP, real	(2) % GDP, nominal	(3) % GDP, real	(4) % GDP, nominal	(5) Employ-ment
$Price_{t-1}$	-4.020	**-3.785****	**-3.360*****	**-2.461****	**-4.213*****
	(2.485)	**(1.642)**	**(0.911)**	**(0.938)**	**(1.104)**
$GDP/capita_{t-1}$	**4.317*****	**4.459*****	**2.878*****	**2.639*****	**5.085*****
	(1.112)	**(0.941)**	**(0.543)**	**(0.585)**	**(0.606)**
$(GDP/capita_{t-1})^2$	**-0.215*****	**-0.243*****	**-0.147*****	**-0.139*****	**-0.272*****
	(0.059)	**(0.050)**	**(0.029)**	**(0.032)**	**(0.036)**
$Price_{t-1}$* $GDP/capita_{t-1}$	**0.897**	**0.851****	**0.765*****	**0.541****	**0.927*****
	(0.564)	**(0.360)**	**(0.207)**	**(0.208)**	**(0.244)**
$Price_{t-1}$* $(GDP/capita_{t-1})^2$	-0.049	**-0.048****	**-0.043*****	**-0.030****	**-0.051*****
	(0.031)	**(0.020)**	**(0.011)**	**(0.011)**	**(0.013)**
$Population_t$	1.002	4.019	0.937	0.836	-0.624
	(2.963)	(3.344)	(1.652)	(1.745)	(1.555)
$(Population_t)^2$	-0.047	-0.128	-0.044	-0.034	0.009
	(0.089)	(0.100)	(0.050)	(0.052)	(0.045)
Constant	-22.192	-48.549	-14.037	-13.535	-12.421
	(26.308)	(30.372)	(14.670)	(15.677)	(14.765)
Country-fixed effects	Yes	Yes	Yes	Yes	Yes
Period Dummies	Yes	Yes	Yes	Yes	Yes
Observations	799	784	799	784	896
R-sq. (within)	0.417	0.563	0.452	0.412	0.693

Note: The table above presents the results from estimating equation 1 using the share of each sector's output to total output (in current USD and constant 2005 USD) and employment using samples from OECD and select Southeast Asian Countries. All variables are expressed in logarithms. Robust standard errors clustered at the country level are in parentheses. **p*<.10; ***p*<.05; ****p*<.01

More interestingly, we find that, holding other things constant, power price (in real terms) is negatively associated with the shares of manufacturing and industry in both output and employment. The relationship is robust and statistically significant, except for manufacturing's share of total real GDP.

We use the estimates from equation (1) to simulate the trend of industry's share with respect to each GDP per capita level, holding power price constant at different percentiles. Table 3 shows the power price at each percentile, from the 20th percentile or the relatively low power price at 0.10 US$/kWh to the 80th percentile or the relatively high power price at 0.19 US$/kWh. Table 3 also shows the corresponding GDP per capita (log transformed) where the share of industry to total GDP and employment peaked. The peak of the share of industry to total GDP is more vividly illustrated in Figure 6.[8] Using the estimates from equation (1), each curve in the figure represents predicted share of industry, for different power-price levels corresponding to the four percentiles. The vertical solid line points to the log GDP per capita level when the share of industrial GVA is at its maximum, holding power price equivalent to 20th percentile (relatively low power prices). The vertical dashed line points to the GDP per capita level when the share of industrial GVA is at its maximum, this time holding power price equivalent to 80th percentile (relatively high power prices).

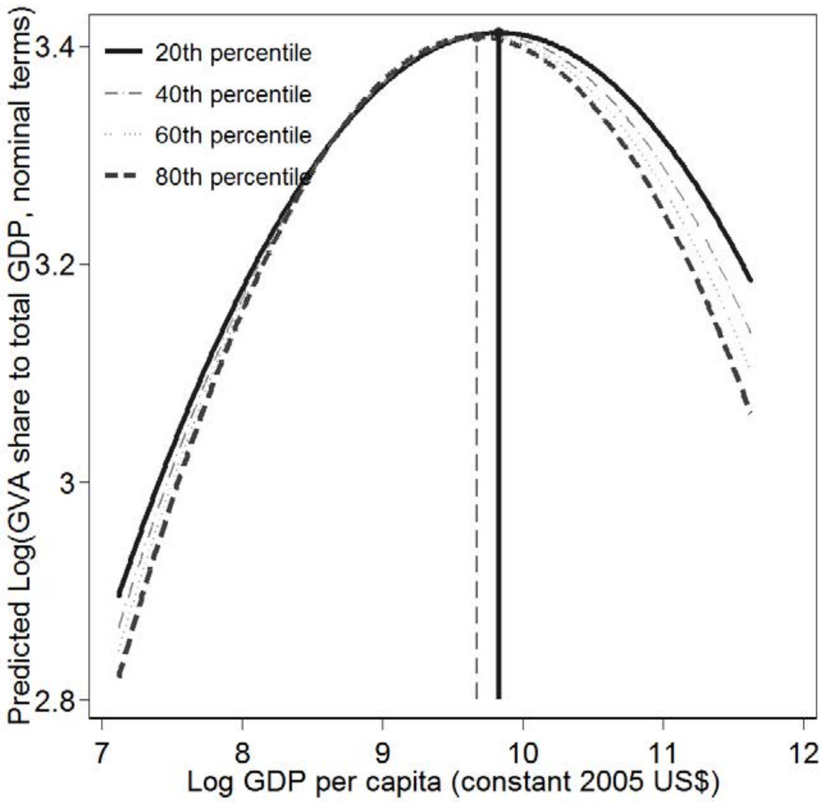
Table 3. Power rates by select percentile, and simulated GDP per capita turning points of industry share, OECD and selected Southeast Asian countries

Power Rates		Log (GDP per capita, US$) turning points		
Percentile	**US$/kWh**	**% employment**	**% GDP (real)**	**% GDP (nominal)**
80	0.19	9.43	10.57	9.67
60	0.15	9.47	10.81	9.72
40	0.13	9.47	11.07	9.75
20	0.10	9.49	11.58	9.83

Note: The table presents the calculated GDP per capita where the share of manufacturing to total GVA peaks using estimates generated from equation (1).

[8] The level of GDP where the share of industry's GVA to total output is indicative and should not be interpreted as the exact level at which the structural transformation might have occurred.

Figure 6. Estimated trends of industrial nominal gross value added or GVA (% of GDP) under different levels of power price, select OECD and selected Southeast Asian Countries, 1980-2014.



Each curve represents the simulated trend of industry's share using equation (1). The predicted values are calibrated to show the average share of industry in OECD and selected Southeast countries in 1980-2014. As shown, higher energy prices decrease the slope of the curve, implying an earlier turning point and a more rapid manufacturing decline. The vertical solid line points to the log GDP per capita level when the share of industry GVA is at its maximum, holding power price equivalent to 20th percentile (relatively low power prices). The vertical dashed line points to the GDP per capita level when the share of industry GVA is at its maximum, this time holding power price equivalent to 80th percentile (relatively high power prices).

It is apparent that for relatively high prices, say at the 80th percentile, the turning point comes at a much lower per-capita GDP, about US$16,000, which is lower compared to a regime where power rates are at the 20th percentile mark, about US$19,000. Moreover, the slope of the industrial share becomes substantially steeper as power prices increase. That is, there is a tendency for countries to deindustrialize sooner and more rapidly as power prices increase. This trend holds for industry shares of both employment and real gross value added (GVA) (see Figures A.2 and A.3, respectively).

4.2 Subnational analysis: Philippine case

Given the above interesting results at the cross-country level, we examine the influence of power prices on manufacturing and industry by exploiting cross-sectional and temporal variations in power prices across Philippine regions. First, we estimated equation (1) using longitudinal data of regions in the Philippines and using the share of manufacturing in national GVA (in real terms). We use the estimates to predict the average trend of each outcome variable, holding power price constant.

Table 4 and Figure 7 illustrate the results of our estimation for the industry share of real GVA. Total industry GVA is generally negatively related to power rates (Table 4, column 2). The relationship is statistically significant and holds true for manufacturing (Table 4, column 1).

Results also show that regions experiencing high power rates, those at the 80th percentile exhibit an inverted U-shape curve relating industry share to GVA of the economy (Figure 7). In contrast, parts of the country with low power rates, particularly those at the 20th percentile, do not exhibit a declining stage of industry.

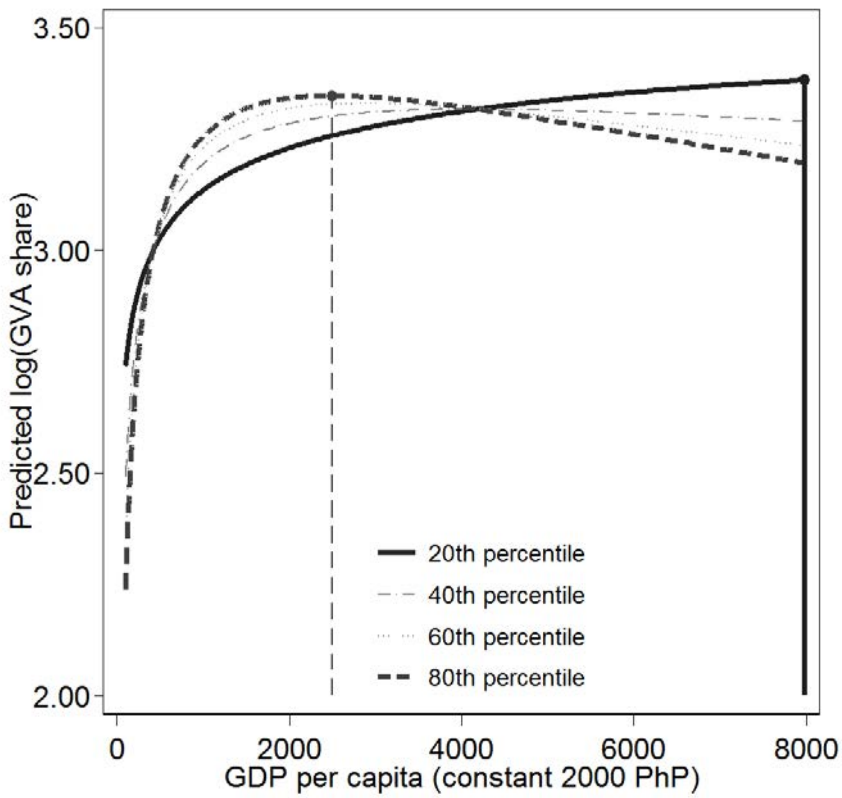
These results are consistent with the cross-country analysis for OECD and selected Southeast Asian countries reported above. We regard this as indicative evidence that structural transformation is not independent of power prices, particularly in the Philippines.

Table 4. Regression results: (dependent variable: Share of sector, % of total GVA)

Variables	**(1) Manufacturing**	**(2) Industry**	**(3) Services**
$Price_{t-1}$	**-14.096***	**-10.076****	**3.394***
	(7.439)	**(4.209)**	**(1.913)**
$GDP/capita_{t-1}$	5.647	3.746	-0.610
	(3.566)	(2.127)	(0.927)
$(GDP/capita_{t-1})^2$	0.412	0.273	-0.036
	(0.275)	(0.159)	(0.067)
$Price_{t-1}$* $GDP/capita_{t-1}$	**-4.329***	**-3.138****	**1.040***
	(2.342)	**(1.268)**	**(0.560)**
$Price_{t-1}$* $(GDP/capita_{t-1})^2$	**-0.325***	**-0.237****	**0.077***
	(0.180)	**(0.094)**	**(0.041)**
$Population_t$	11.180	**12.817***	-1.586
	(7.623)	**(6.409)**	(2.217)
$(Population_t)^2$	-0.254	**-0.348***	0.019
	(0.230)	**(0.178)**	(0.063)
Constant	-89.898	-98.892	20.674
	(61.741)	(58.193)	(19.818)
Region-fixed effects	Yes	Yes	Yes
Observations	370	370	370
R-sq. (within)	0.321	0.326	0.633

Note: The table above presents the results from estimating equation 1 using the share of each sector's GVA to total GVA (in constant 2000 prices) in the Philippines during the period 1990-2014. All variables are expressed in logarithms. Robust standard errors clustered at the country level are in parentheses. *p<.10; **p<.05; ***p<.01

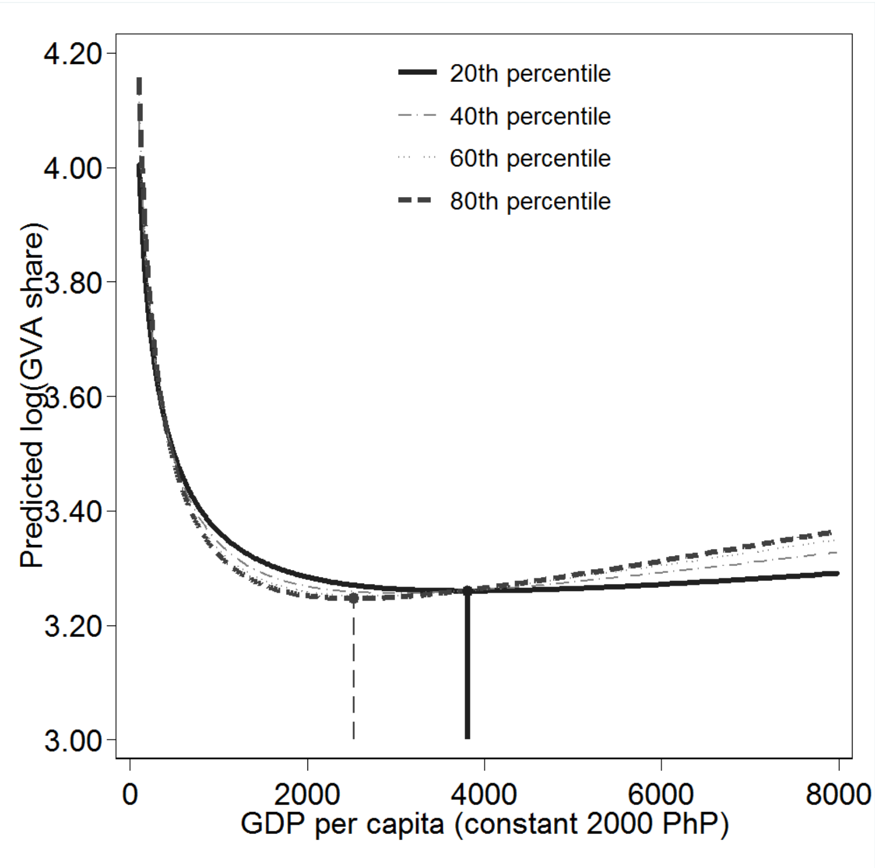
Figure 7. Estimated trend of industry GVA (% of real GDP) under different levels of power price, Philippine Regions, 1990-2014.



Note: Each curve represents predicted trend of industry value-added share to regional GDP, given a certain level power price (i.e., whether price is equivalent to 20th or 80th percentile), using equation (1), with maximum GVA within the period 1990-2014 as weights.

One way to further illustrate the potential influence of power price on the growth path of industrial and manufacturing across different levels of per capita income is to find the opposite trend in the services sector, which is consistent with the findings and predictions of Rodrik (2016). Similar to the cross-country analysis, we estimate equation (1) using the share of services to total GVA in the Philippine regions as outcome variables. Results are summarized in Table 4, column (3) and illustrated in Figure 8.

Figure 8. Estimated trend of services GVA (% of GDP) under different levels of power price, Philippine Regions, 1990-2014.



Note: Each curve represents predicted trend of services value-added share to regional GDP, given a certain level power price (i.e., whether price is equivalent to 20^{th} or 80^{th} percentile), using equation (1), with maximum GVA within the period 1990-2014 as weights.

We find strong evidence to support the hypothesis that the GVA share of services is responsive to power prices. In particular, the share of services is positively related to power prices and the relationship satisfies statistical tests at conventional significant levels. We also find that the share of services seems to follow a U-shaped curve right after the median level regional per capita GDP (about PhP325). More interestingly, high-power-rate regions tend to exhibit the share of services increasing at relatively low levels of per capita GDP. This is consistent the patterns that resources are increasingly allocated towards services and away from industry and manufacturing.

5. CONCLUSIONS AND POLICY IMPLICATIONS

We explore the dynamic effects of energy policy by studying the role of high power prices in the process of structural transformation, within the Philippines and across countries. A simple comparison between the Philippines and Indonesia during the great FDI influx to Asia in the early 1990s reveals that the Philippine power intensive subsectors remained stagnant during the period, while robust Indonesian manufacturing growth was dominated by power-intensive subsectors. Power prices in the Philippines were increasing during the same period while those in Indonesia remained roughly constant, suggesting that higher power prices may inhibit a more uplifting transformation.

Power prices can thereby augment other factors that induce premature deindustrialization. We adapted Rodrik's (2016) specification to allow the growth path of manufacturing move at different stages of development and estimate the relationship between power prices, the share of manufacturing output, and per capita output for OECD and selected Southeast Asian countries. This allows us to illustrate the potential effect of power rate increases on both the level and growth rates of industry. We apply this methodology across countries and across regions in the Philippines.

Our cross-country analysis suggests that high power prices may have an accelerating effect on deindustrialization. For the selected countries studied, we find that higher power prices are associated with a lower share of industry and manufacturing, an earlier downturn in the sectors' shares, and a relatively steeper decline of their respective GVA. We find the same trend at the regional level for the Philippines. We are aware that data limitations constrain definitive conclusions about causality, but it appears that structural transformation is not independent of power prices, particularly in the Philippines.

Moving forward, the analysis can be extended to other components of energy use in manufacturing and industries, including heating processes (especially fuels). Various types of manufacturing (and indeed, production in general) require different mixes of power and heating demands, and should ideally be considered in tandem when analyzing the dynamics of production.[9] We hope to develop an index of power intensity based on the relative share of each subsector (e.g. machinery, chemical, textile, etc.) in the gross value added of the sector and their respective power intensities. We can use this index to compare the composition of each country's manufacturing and industrial power intensity over time, which would enable us to further explore the mechanism behind the influence of power rates on manufacturing performance.

Another fruitful avenue for further research would be to establish the impact of energy prices on the net inflow of FDI, using data from the United Nations Conference on Trade and Development (UNCTAD). The idea is to determine whether the attractiveness of a country to FDIs can be explained, at least in part, by the temporal and cross-sectional variation in power price during the East Asian FDI boom in the 1980s and 1990s. We also intend to expand our analysis by determining the role of electricity prices as a locational determinant of FDI. In particular, we intend to determine the impact of electricity price variation on net FDI inflows in select Southeast Asian countries considered in this study. We are particularly interested in looking at attractiveness of a country to FDIs during the East Asian FDI boom in the 1980s and 1990s. The findings of this study can provide additional insights regarding why the Philippines shifted away from the industrial sector at a much earlier stage of development.

[9] This much has been emphasized by colleagues in the Foundation of Philippine Industries (FPI); current data limitations will be addressed in the future.

One feared downside of efficiency-enhancing energy policies, especially competition policies, is that reduced power prices would bring about greater use of fossil fuels and more pollution. Rather than resisting energy efficiency, however, the remedy is to internalize pollution externalities, e.g. through differential fuel taxes such that the combined reforms will bring out an unambiguous welfare improvement.

The Philippine manufacturing sector still accounts for a 20 percent share of the country's total output. The Philippine government has recently targeted a substantial increase in manufacturing's share. [10] Several promising strategies have been identified—from increasing value added in the electronics sector to improving the competitiveness of paper mills. However, realizing this potential may be difficult without lowering prices and improving the quality of power.

ACKNOWLEDGEMENTS

This research is a product of the Energy Policy and Development Program (EPDP), a four-year project funded by the U.S. Agency for International Development (USAID) and implemented by the UPecon Foundation, Inc [grant reference number AID-492-G-15-00002]. Brucal acknowledges support from the Economic and Social Research Council (ESRC) through the Centre for Climate Change Economics and Policy. We thank Shirra de Guia and J.Kath Magadia for excellent research assistance.

[10] Meeting communication with NEDA Trade and Industry Staff.

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APPENDIX

Table A.1. Manufacturing and industry indicators, 1970-2014

	(a) Share of manufacturing to total employment (%)					
	1970	1980	1990	2000	2010	2014
China			13.5	11.2		
Indonesia		9.0	10.1	13.0	12.3	13.2
South Korea	13.2	21.6	27.2	21.3	16.9	16.9
Malaysia		16.1	19.9	22.8	16.7	16.7
Philippines		10.8	9.7	10.0	8.4	8.3
Singapore	22.0	29.2	28.4	20.7	17.7	15.0
Thailand		7.9	10.2	14.5	14.1	16.9
Viet Nam				9.2		
	(b) Share of manufacturing to GDP (%)					
	1970	1980	1990	2000	2010	2014
China	33.7	40.2	32.5	31.9	31.9	
Indonesia	10.3	13.0	20.7	27.7	22.6	21.6
South Korea	16.7	22.8	25.0	29.0	30.7	30.3
Malaysia	12.4	21.6	24.2	30.9	24.5	24.0
Philippines	24.9	25.7	24.8	24.5	21.4	20.5
Singapore		27.5	25.6	27.7	21.4	
Thailand	15.9	21.5	27.2	33.6	35.6	32.6
Viet Nam			12.3	17.1	18.0	17.5
	(c) Share of industry to GDP (%)					
	1970	1980	1990	2000	2010	2014
China	40.5	47.9	40.9	45.4	46.2	42.6
Indonesia	18.7	41.7	39.1	45.9	43.9	42.9
South Korea	24.5	34.2	38.2	38.1	38.3	38.2
Malaysia	27.4	41.0	42.2	48.3	41.2	40.5
Philippines	31.9	38.8	34.5	34.5	32.6	31.2
Singapore		36.2	32.3	34.8	27.6	
Thailand	25.3	28.7	37.2	42.0	44.7	42.0
Viet Nam			22.7	34.2	38.2	38.5

Sources of basic data: WDI-WB (various years), ILO (various years)

Table A.2 Summary statistics (OECD and Indonesia, Malaysia, Philippines, Thailand, Singapore)

	OECD					Selected Southeast Asian Countries				
	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Power Price (USD/kWh)	718	0.15	0.07	0.05	0.77	169	0.21	0.22	0.05	1.26
Industry GVA (% GDP)	903	28.88	7.29	12.2	48.64	169	38.68	5.85	26.62	48.64
Manufacturing GVA (% GDP)	901	17.02	5.31	4.30	30.96	169	24.25	3.87	12.62	30.96
Services (% GDP)	906	63..57	10.00	34.31	87.99	169	49.79	10.16	34.31	75.02
Agriculture (% GDP)	903	3.86	4.51	0.04	22.70	169	11.03	6.21	0.04	22.70
GDP per Capita (in '000, USD constant 2005$)	1,161	25.61	16.34	0.55	87.77	169	5.93	9.02	.55	38.10
Population (in million)	1075	35.78	45.23	0.36	254.45	169	74.24	71.97	2.41	254.46

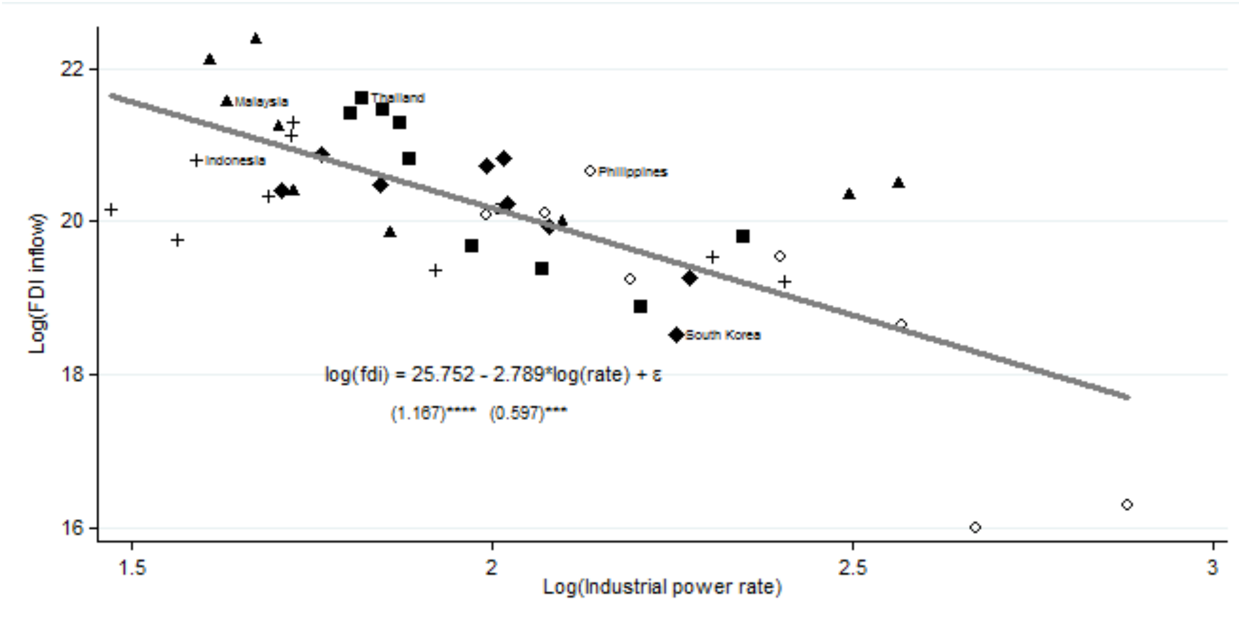
Sources of basic data: Aldaba (2003), Enerdata (various years), Meralco (various years), MEIH Statistics (various years), Singapore National Library Board (various years), Singapore Statistics (various years), WDI-WB (various years), IEA-OECD (various years)

Notes: Unless expressed as percentage shares, all variables are expressed in real terms. For OECD, we drop Turkey, Mexico, and Greece from the analysis due to their extremely unusual CPI trend. For ASEAN, we drop observations with missing real price of electricity.

Table A.3 Summary Statistics (Philippine data), 1990-2008

	Obs	Mean	SD	Min	Max	Source
Agri. GVA	304	12.4	9.0	-	46.3	PSA
Mfg. GVA	304	14.9	24.3	0.2	139	PSA
Serv. GVA	304	27.9	46.2	1.3	306	PSA
Regional GDP (constant 1985 prices)	304	61.2	74.9	6.9	468	PSA
Regional GDP per capita (constant 1985 prices)	304	10,714	6,325	2,909	41,541	PSA
Regional GDP (current prices)	304	213	346	3.0	2,740	PSA
Regional GDP per capita (current prices)	304	35,482	31,564	1,676	243,528	PSA
Population (in Million)	304	4.82	2.78	1.15	14.27	PSA
Average regional electricity price (Php/kWh)	304	4.1	1.6	1.2	8.7	DOE, Meralco

Figure A.1. Correlation between FDI inflow and industrial power rates, select Asian countries, 1984-1992.



Notes: The figure shows the correlation between FDI inflow (BOP, current Million USD) and industrial power rates (in US cents/kWh). All variables are converted in natural logarithms. Robust standard errors are in parentheses.

Figure A.2. Estimated trends of industrial share (% of total employment) under different levels of power price, OECD and select Southeast Asian Countries, 1980-2014.

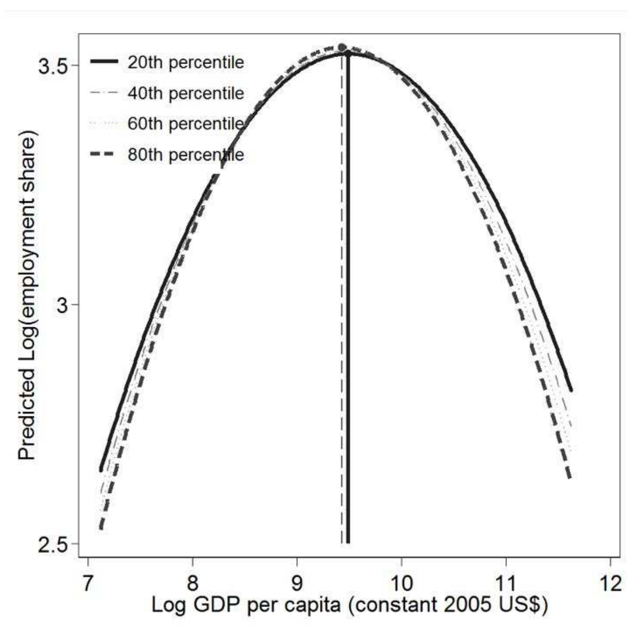
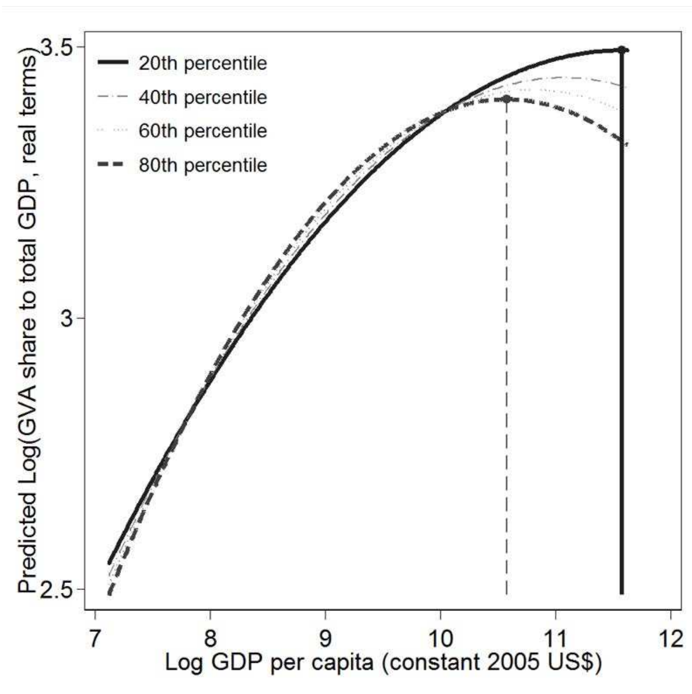
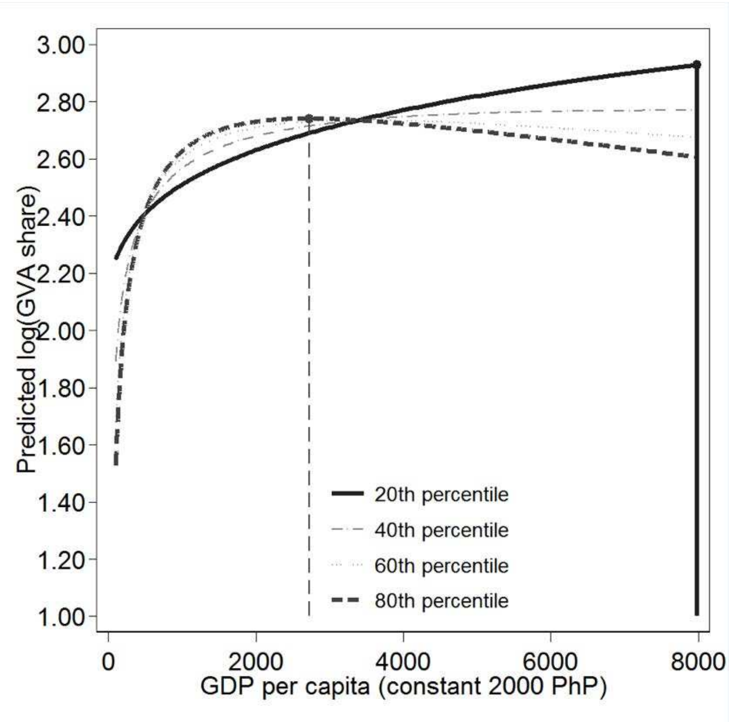


Figure A.3. Estimated trends of industrial GVA (% of real GDP) under different levels of power price, OECD and select Southeast Asian Countries, 1980-2014.



Note: Each curve represents predicted trend of industry value-added share to regional GDP, given a certain level power price (i.e., whether price is equivalent to 20th or 80th percentile), using equation (1), with maximum GVA within the period 1990-2014 as weights.

Figure A.4. Estimated trend of manufacturing gross value added (% of real GDP) under different levels of power price, Philippine Regions, 1990-2014.



Note: Each curve represents predicted trend of manufacturing value-added share to regional GDP, given a certain level power price (i.e., whether price is equivalent to 20^{th} or 80^{th} percentile), using equation (1), with maximum GVA within the period 1990-2014 as weights.